

BLUE-GREEN ALGAE (CYANOPHYTA) AT A GLANCE

(microscope views are blue-stained)

Members of this group form




- floating (planktonic) scums on water – some of these may be poisonous, or cause skin sensitivity 
- thin, slippery coatings on rocks and masonry that can be black, green or red and may dry into flakes 
- small gelatinous blobs on hard, moist surfaces that may be dark green (Fig. 3)
- fuzzy coatings on water plants or other algae
- velvety lawns, a few mm tall, on moist soil
- crusts forming on sediments, seen best in the intertidal region at low tide, or on dry soils, especially in the outback of Australia  (Fig. 2)
- intimate associations (symbioses) within the tissues of other organisms, some forming a “partnership” with fungi that produces a compound organism called a lichen (Fig. 4)



Fig. 1: slippery, dark-stained granite rock (arrowed) in a zone that is wet from wave surges, at Victor Harbor, SA



Fig. 2: salt crust on Lake Gairdner, SA, stained a dirty colour by blue-green algae



Fig. 3: dark green gelatinous blobs in the intertidal, on granite at Victor Harbor, SA

Blue-green algae, commonly called “Blue-greens”, are only recognisable to the unaided eye when they form populations of enormous numbers of separate individuals or clumps of individuals called colonies. Unfortunately, practically all identification has to be undertaken using high power microscopes in order to ascertain fine cellular details.



Fig. 4: intricate (fruticose) lichen from Kangaroo Island, SA – a combination of a fungus and a Blue-green alga

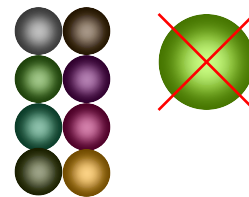


Fig. 5: some colour variations of Blue-greens (above) compared to Green algae (RHS)

The colour of Blue-green algae can be

- dirty green
- dark green, almost black
- reddish or brownish

and depends on the amount of bluish or reddish pigments that are accessory to the green chlorophyll present. The colour contrasts with the grassy-green of Green algae (Chlorophyta) which some of the Blue-greens resemble (Fig. 5).

Under the microscope, individual cells can be bacterial size (1 μm long). Some may approach the size of cells of other algal groups (for example, 10 μm long), which makes separating them from Green algae particularly difficult, **but**, Blue-green algal cells usually have few visible bodies inside their cells, and certainly no coloured plastids.



Fig. 6: dot-shaped or coccoidal *Gloeocapsa* colonies, of cells in 2-3s within sheaths

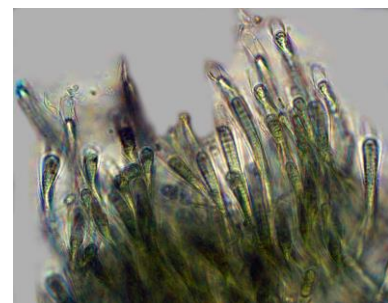
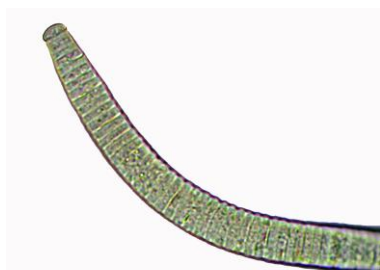


Fig. 7: thread-like or filamentous *Lyngbya*

Fig. 8: disc-shaped cells of *Oscillatoria* strung in a line (a trichome) with a convex tip cell









Most of the cells look similar, but some species have

- larger, thick-walled cells (akinetes) that may spread the organism vegetatively (Fig. 9)
- rounded cells (heterocytes, also called heterocysts) where gaseous nitrogen is fixed into ammonia (Fig. 10)

Cells can be

- single
- strung together in a line (a trichome, Figs 8, 9, 10), and some trichomes can glide backwards and forwards
- clumped together, sometimes in packets (colonies) of 2 or 4 or many. They usually have their own walls, but, also, cells can be wrapped in a sheath or they can be embedded in a gelatinous matrix (Fig. 11).

The Blue-greens illustrated below are found in these habitats:-

- freshwater 
- saline lakes 
- marine, either in calm estuarine situations or, in rough water 
- on moist soil 
- on rock 
- on other plants, including the bark of trees 

Blue-greens can often withstand great fluctuations of salinity, temperature and drying (Fig. 12). They are even found at the edges of hot-water springs. see for example <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC378340/>

REFERENCES:

1. Baker, P. D., & L. D. Fabbro (2002). **A guide to the identification of common blue-green algae (Cyanoprokaryotes) in Australian freshwaters. 2nd edition.** Identification & Ecology Guide No. 25. Albury. Cooperative Research Centre for Freshwater Ecology.
2. Prescott, G. W. (1970). **How to know the freshwater algae. Second edition.** Pictured-key nature series. Wm. C Brown Co, USA

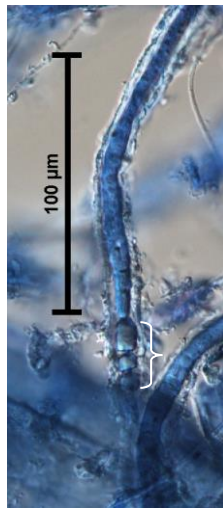


Fig. 9: trichome of *Lyngbya* with a string of akinetes (bracketed)

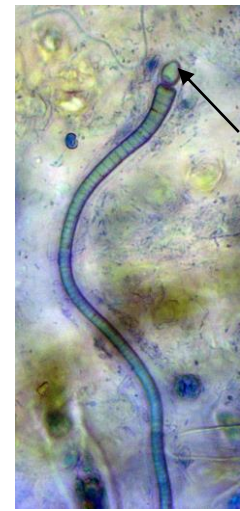


Fig. 10: trichome of *Calothrix* with a terminal heterocyte (arrowed)

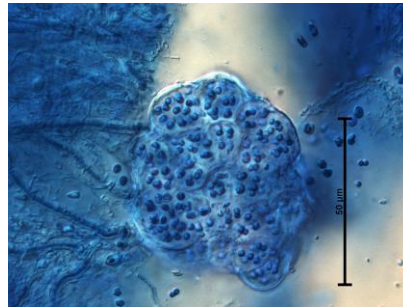


Fig. 11: many colonies of *Chroococcus* adhering into a single mass

Fig. 12: bacterial mat (green Cyanophytes and purple sulfur bacteria) on tidal flats amongst mangrove pneumatophores (arrowed). The organisms in the mat withstand desiccation and fluctuating air temperatures when exposed at low tide, even in summer when this occurs in the hot, middle part of the day. The Cyanophytes “fix” atmospheric nitrogen into organic compounds which then become available for other organisms in the food web, especially small grazing snails. The mat stabilizes the sticky, fine sediments, so limiting erosion by wave action when the tide comes in



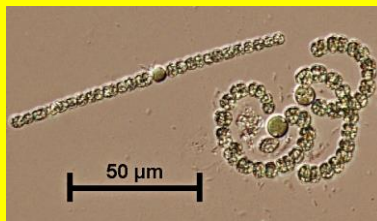
BLUE-GREEN ALGAE AT A GLANCE

I. PLANTS PLANKTONIC (FLOATING)

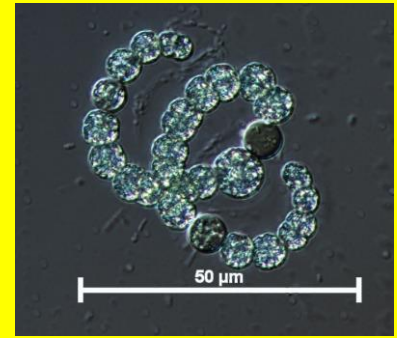
Ia. plants multi-cellular



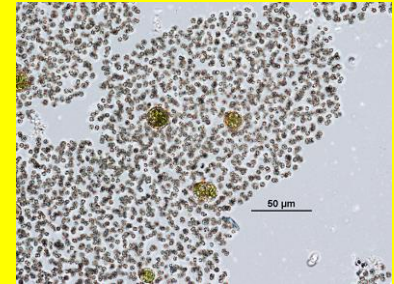
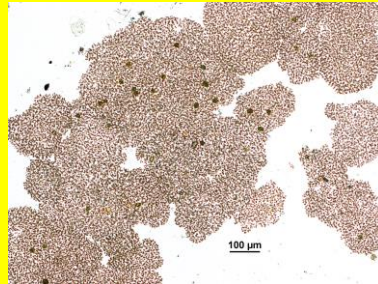
1. *Anabaena circinalis*.
Torrens Lake, SA



2. *Anabaena circinalis*. West Beach pond, SA
beadlike chain of cells, heterocytes lying within the chain



3. *Microcystis aeruginosa*
Torrens Lake, SA
mass of minute cells



4. *Arthrospira* sp
St Kilda mangroves, SA, in detritus, seen with a yellowish diatom for comparison (arrowed)
Plants move in a slow spiral motion. They are many-celled, but the cross partitions are difficult to see, and so the plant can be mistaken for the next genus, *Spirulina*

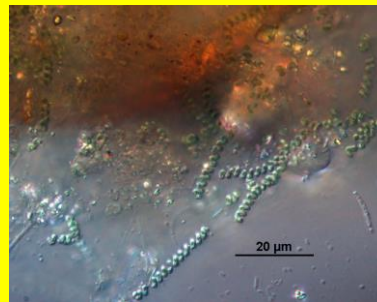


Ib. plants single-celled

5. *Spirulina* sp, outfall at Kangaroo Island, SA



Plants move relatively quickly in a spiral motion

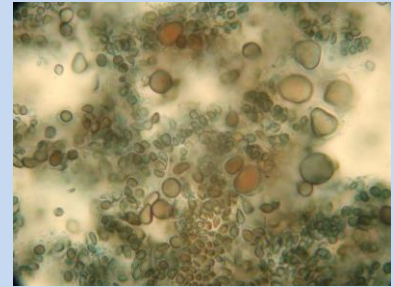
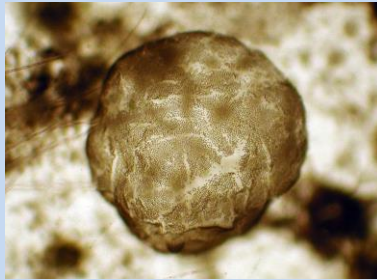
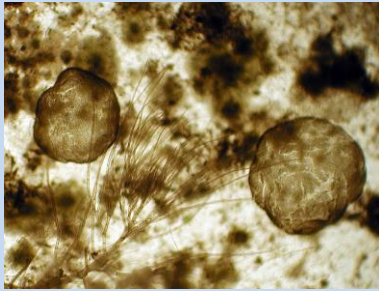



6. *Spirulina*, in detritus of a mangrove swamp, St Kilda, SA




II. PLANTS CONSISTING OF ONE to MANY INDIVIDUAL EGG-OR DOT-SHAPED CELLS

IIA. CELLS SCATTERED



7. *Microcystis* sp on a settlement plate, Whyalla, SA 
hollow, papery colony ≈ 3 mm across

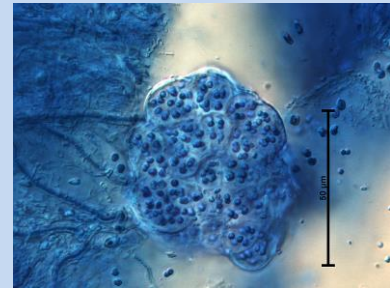
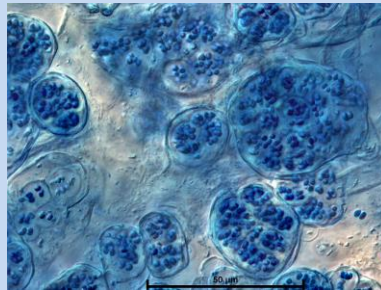
8. *Synechococcus* sp on a settlement plate, Whyalla SA 
scattered pinkish cells 2-8 μm across with rigid cell walls

IIB. CELLS GROUPED INTO COLONIES OR SMALL PACKETS

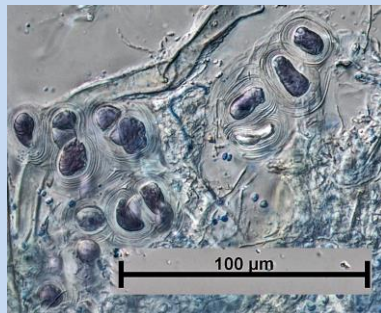
9. *Chroococcus* sp near Mt Gambier, SA



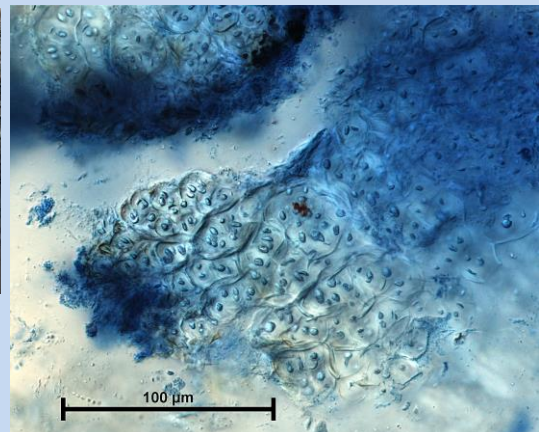
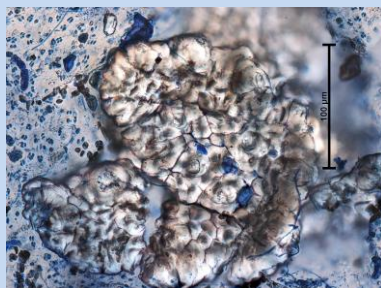
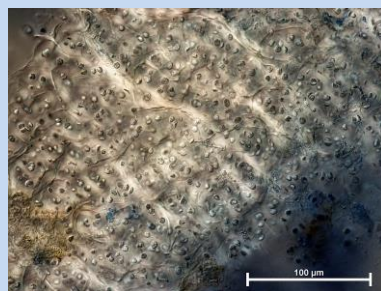
Cells minute, both small clusters and larger aggregates of clusters are surrounded by sheaths



10. *Gloeocapsa* sp on soil mixed with moss rhizoids and lichen
1-3 cells grouped in common lamellate sheaths and covered in jelly



11. *Chondrocystis* sp in a deep, saline lake, Innes Conservation Park, SA, heavily encrusted with lime. A tough, cushion-shaped mass of many colonies, each with their individual sheaths



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12. *Entophysalis* coating rock in the mid-intertidal, Apollo Bay, Victoria



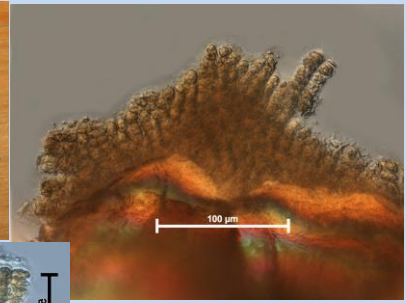
cells in erect rows, fanning out from a base (“pseudo-branching”), forming cushion-shaped masses

§also called *Oncobrysa*

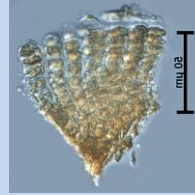


Above: dried colony forming a dark patch on siliceous rock

Right: dissected cells showing pseudo-branching



Above: profile view of a colony appearing above large crystals of the substrate

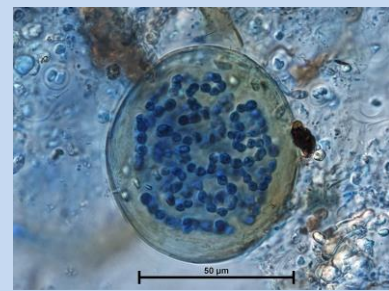


IIC. CELLS IN BEAD-LIKE THREADS

13. *Nostoc* trichomes germinating in a thick walled resting spore (akinetete)

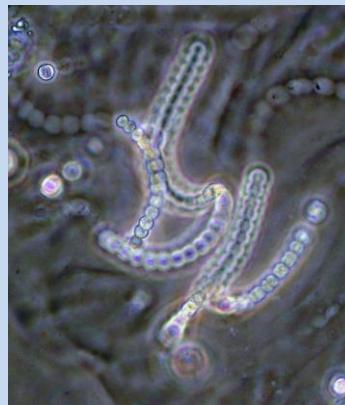


thick walled resting spores (akinetetes) on a background of *Gloeocystis*



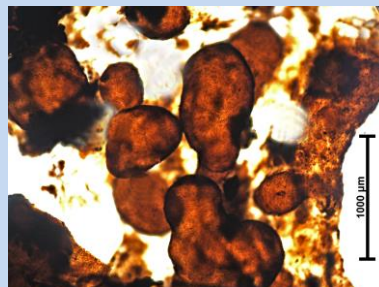
detail of bead-like threads within the thick-walled akinetete

14. *Nostoc* on wet soil, Warrawong Park, Adelaide Hills, SA

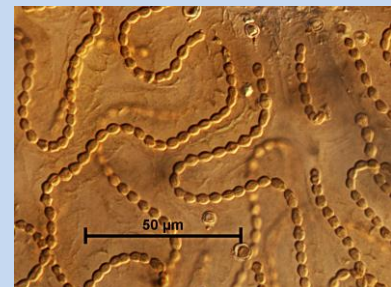


bead-like chains of cells, basal heterocyste

15. *Nostoc pruniforme* Coorong, SA

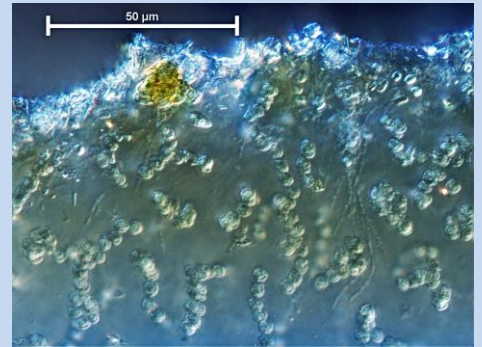


microscopic trichomes are embedded in a rubbery, reddish, gelatinous matrix

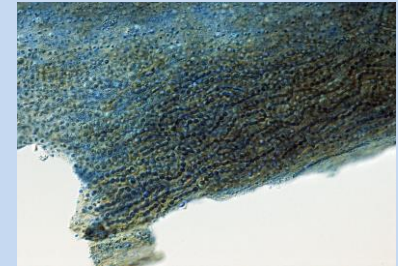


trichomes consist of bead-like strings of > 20 cells all of the same shape

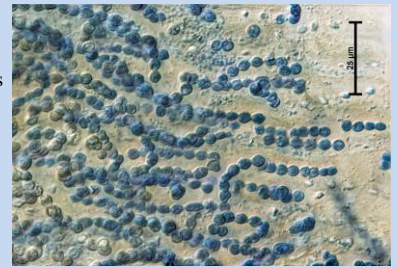
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16. *Nostoc commune* arid NW of SA, in ephemeral watercourses
 Rubbery, strap-like colonies in a drying watercourse (far left), colonies reconstituted in water in the lab. (above, centre), edge of the colony (above, right) with bead-like strings of < 20 cells seen under the microscope



visible, dark, wiry threads with numerous, microscopic, bead-like chains of cells in a tough, gelatinous sheath



17. *Nostoc flagelliforme*, arid NE of SA, on wet soil amongst saltbush

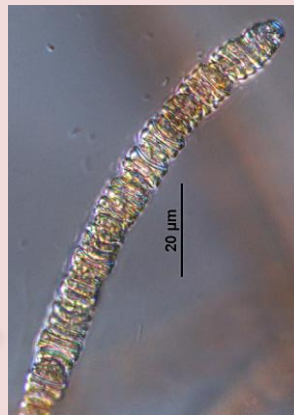
III. CELLS DISC- OR CYLINDER-SHAPED IN UNBRANCHED, THREADS (TRICHOMES)

III.A. TRICHOMES NAKED (NOT LYING IN A SHEATH OR GELATINOUS MATRIX)

Aa. trichomes glide slowly back and forth when alive, *not* tapering apically - *Oscillatoria*

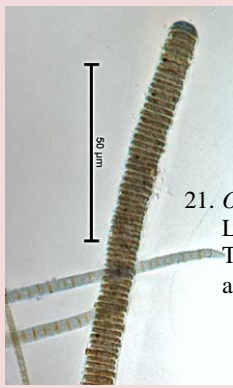


18. *Oscillatoria* sp Kangaroo Island, SA estuary
mass of gliding trichomes (above), detail of numerous disc-shaped cells in the trichome (right)



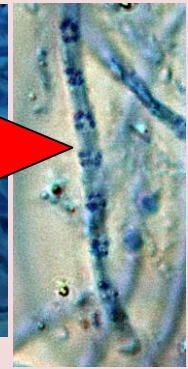
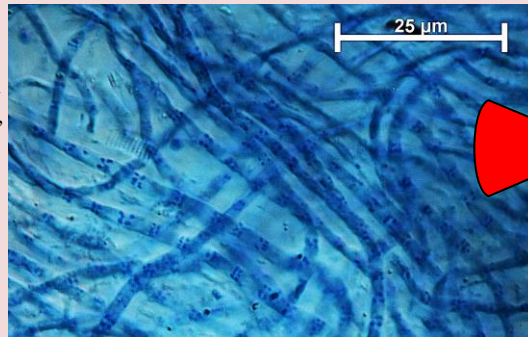
19. Left: *Oscillatoria* sp West Lakes, SA estuarine,

20. Right: *Oscillatoria* sp, pond in the Botanic Gardens Adelaide, with distinctive apical cell



21. *Oscillatoria* Lake Torrens, arid SA

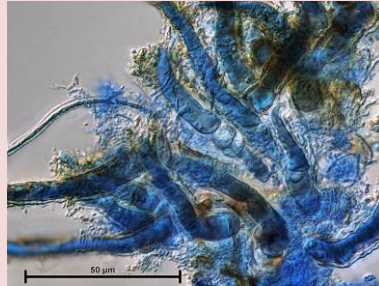
22. *Jaaginema pseudogeminatum* Portland, Victoria, trichomes very thin, 2-3 prominent granules either side of end walls



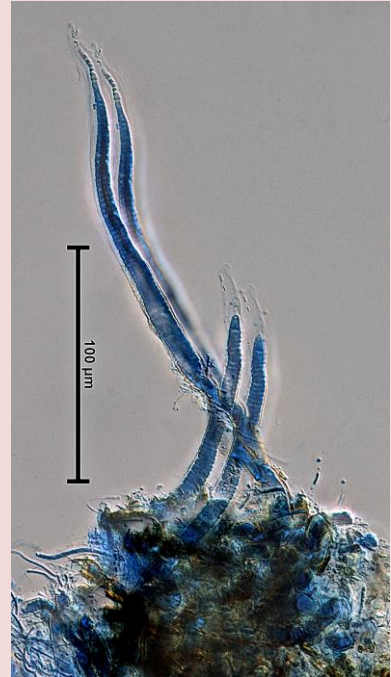
Ab. trichomes usually solitary, *tapering apically*, heterocyte, if present, *basal* - *Calothrix*



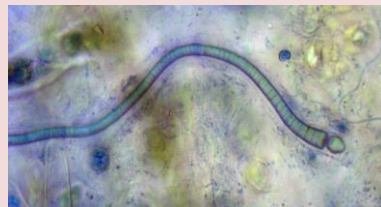
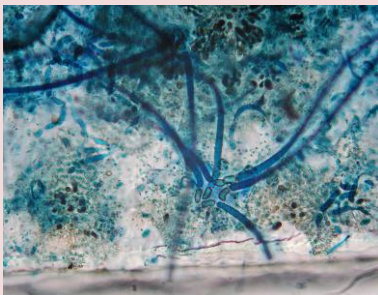
23. *Calothrix fasciculata* West Island, Victor Harbor, SA zone (arrowed) staining a wave-swept granite boulder



Above: trichomes, massed, some with a basal heterocyte



25: *Calothrix fasciculata*: Cape Leeuwin, WA trichomes, tapering apically



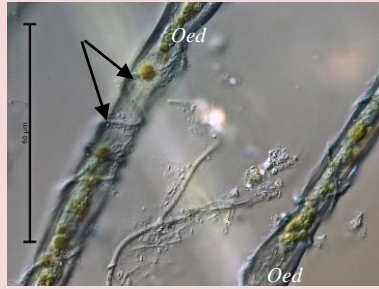
24. *Calothrix* sp (left & right) Stony Point, upper Spencer Gulf, SA

on a plastic settlement sheet

(III. CELLS DISC- OR CYLINDER-SHAPED IN UNBRANCHED, THREADS (TRICHOMES) – continued)

Ac. trichomes extremely thin and *spirally wrapped* around other algae and waterplants

26. *Leibleinia epiphytica*
Botanic Gardens
Adelaide, SA, recycle-
water ponds
(arrowed) wrapped around
the Green alga *Oedogonium*
(*Oed*)





27. *Leibleinia* sp
Pearson Island
SA,
(arrowed) on
trichomes of another
Blue green alga
attached to the Brown
alga *Cystophora*



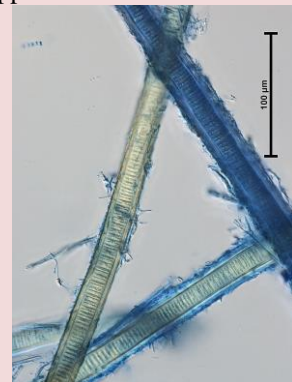
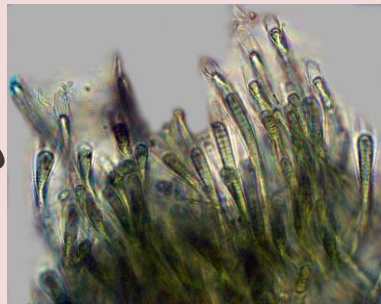
IIIB. TRICHOMES LIE IN A SHEATH

Ba. sheath *firm*, often extending beyond the trichome
trichome may *glide* within the sheath –[§]*Lyngbya* spp

Left: 28. *Lyngbya* sp
Pt Pirie, SA 
trichomes densely clumped

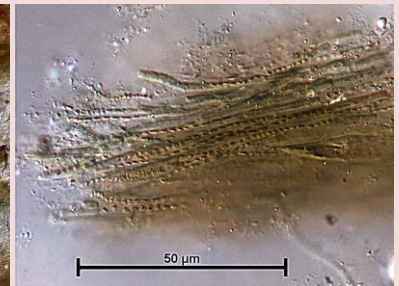
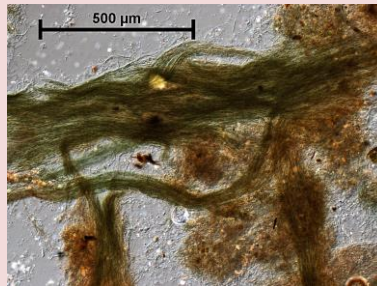
Right: 29. *Lyngbya* sp
Lake Woolp0oloo, SA; 
detail of thick sheaths


Far right: sheath extending beyond
the trichome



Bb. sheath *diffuse, sticky* and about the *same length* as the trichome

30. [§]*Phormidium*
sheath is diffuse but
sticky, filaments cling
together, there are no
erect filaments and cells
are rectangular



31. [§]*Phormidium*
West Lakes Adelaide,
SA 
the sheath is hard to
detect, but sticky, and
the end cell of the
trichome is semicircular
or bulbous

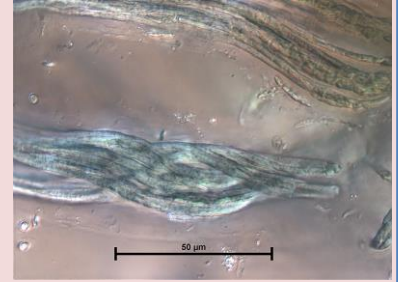
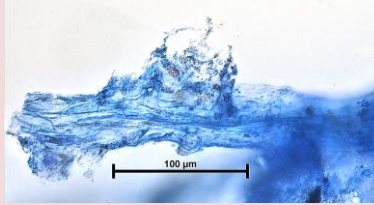


§ some modern works merge *Lyngbya* and *Phormidium* into *Oscillatoria*

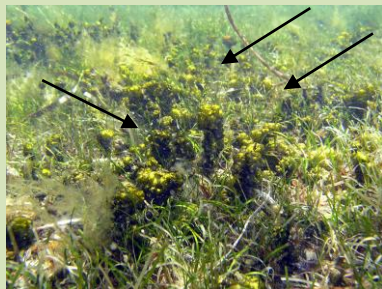
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Bc trichomes numerous, *wrapped together* into strands

32. *Microcoleus* sp
"Deep Lake", Innes CP, SA On limestone
in saline water

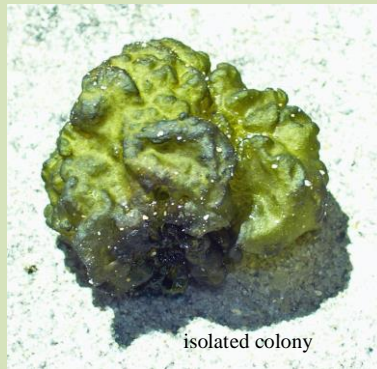


IV. TRICHOMES NUMEROUS, EMBEDDED IN A GELATINOUS MATRIX VISIBLE TO THE UNAIDED EYE

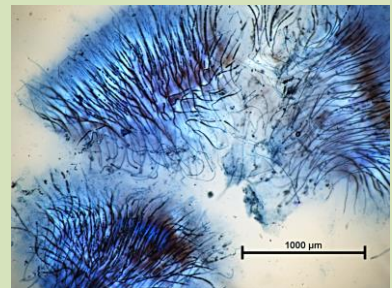


33. *Rivularia polyotis* Encounter Bay,
Victor Harbor, SA, 11.xii.2005

epiphytic on seagrasses (arrowed)



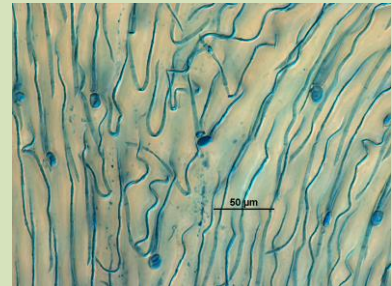
isolated colony



dissected pieces of the matrix with
numerous embedded, hair-like trichomes

34. *Rivularia* §*firma* The Bluff, Victor
Harbor, SA, 26.iii.2006

Right: on granite rock in wave surge
Far right: highly magnified view of hair-like
trichomes embedded *in parallel rows* in the
gelatinous matrix

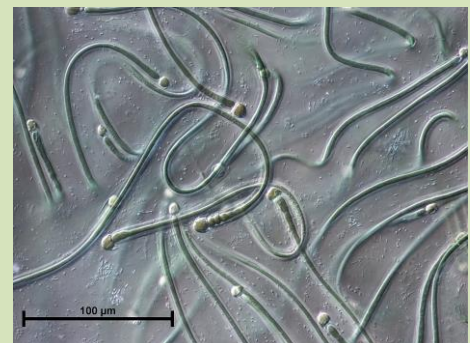


§ a name to be changed to *Rivularia australis*

35. *Gloeotrichia* sp
Middle Point Swamp lower SE,
05 xii.2017

Right: soft colony epiphytic on
Lamprothamnion

Far right: hair-like trichomes embedded
irregularly in a soft gelatinous matrix



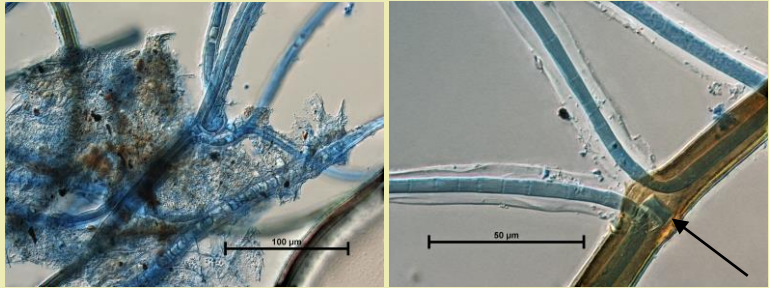
V. PLANTS WITH *BRANCHED* THREADS OR FILAMENTS

VA. THREADS *FALSELY* BRANCHED (threads that “detour” in direction, forming side-branches)

36. *Scytonema* sp Bridgewater Lakes, Portland, Victoria

Right: floating in great numbers

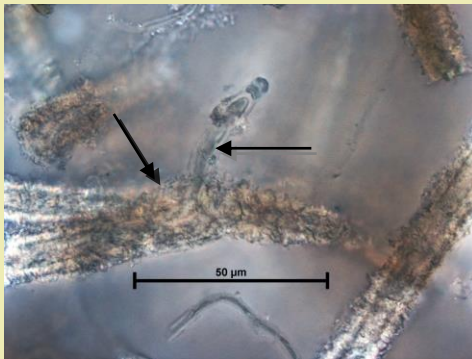
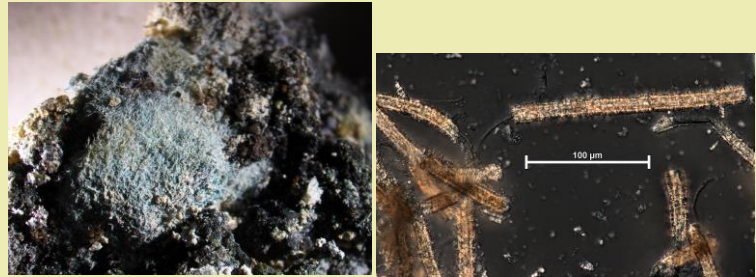
Far right: false branching produced by reflexing of a *pair* of filaments when they meet at the site of a heterocyte (arrowed)



37. *Scytonema* sp Snake Hill, Myora Forest near Mt Gambier, SA, near sinkholes

Right: patch about 2 mm across of branched, bluish, calcified filaments lying on black lichen on soil

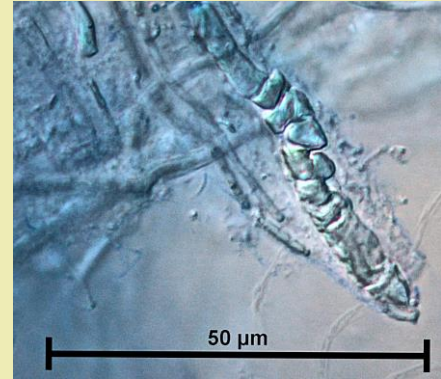
Far right: filament with encrusting aragonite crystals on the surface of the sheath, making the trichomes brittle, and break into pieces when handled



(*Scytonema* Snake Hill, continued):

Left: pseudo-branches emerging from highly calcified trichome sheaths (arrowed)

Right: stack of akinetes at the apex of a trichome exposed by dissolving the calcified coating with acid



38. *Tolypothrix* sp Meningie, SA, on cherry tree bark

Right: Carpet of filaments on bark (graduations on scale = 1 mm)

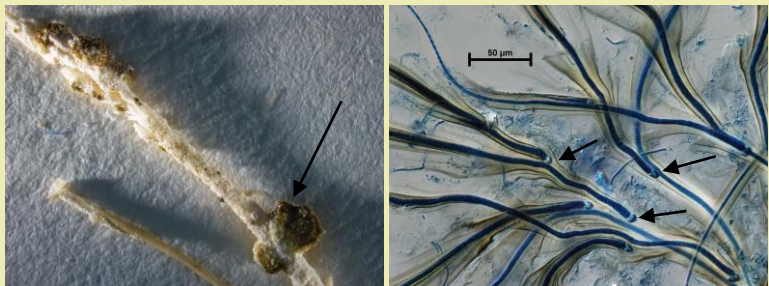
Far right: false branches produced by the reflexing of *one* filament at the site of a heterocyte (arrowed)



39. *Sacconema rupestre* Borzi ex Bornet & Flahault, Bridgewater Lakes, Portland Victoria

Right: tufts (arrowed) on dead sticks

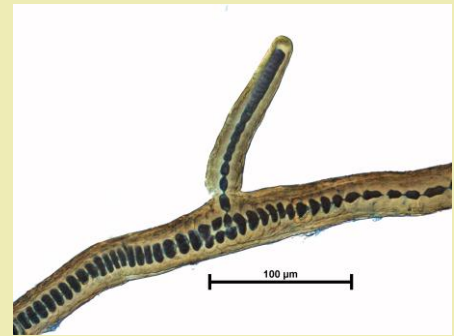
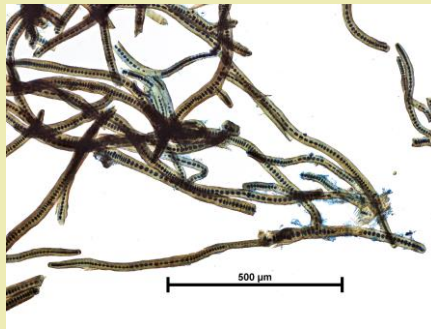
Far right: filament forming the false branch has a *basal heterocyte* (arrowed); filament sheath *frayed* at tips




VB. THREADS WITH TRUE BRANCHING

40. *Stigonema* sp
Bogong High Plain, Falls
Creek, Mt Beauty area,
Victoria

filaments frequently with a single row of cells, coloured sheaths, cells *discoid*, connected by a protoplasmic strand similar to that in the Red algae, and heterocytes are rare and inconspicuous.



41. *Nostochopsis* sp 
in a small saline spring, Lake
Torrens, arid SA

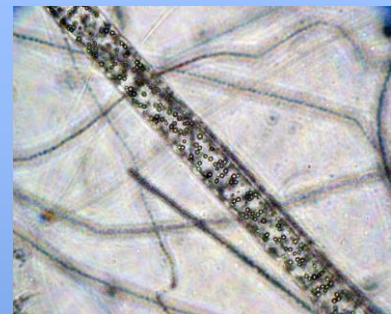
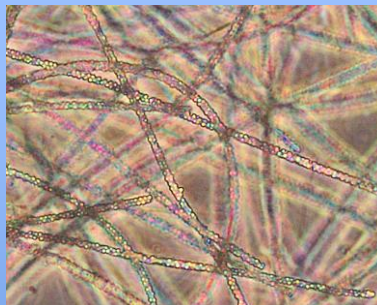
Right:
sediment stained green with the
alga

Far right:
cylindrical cells, filaments
branched



BLUE-GREEN ALGAE LOOK-ALIKES

Sulfur bacteria: from black, odorous
sediments at St Kilda intertidal, SA:
colourless microscopic threads with
bright dots (sulfur particles) may glide
backwards and forwards



Keriochlamys styriaca
A Golden-brown alga
consisting of several small
cells in a thick sculptured
sheath



Coscinodiscus
A Golden-brown diatom with
plastids similar to encapsulated cells
of Blue-green algae



Gloeocystis gigas
A Golden-brown alga with golden plastids. pairs of cells
within common sheath, larger than similarly shaped Blue-
greens such as *Gloeocapsa*

APPENDIX: list of genera described

Anabaena
Arthrospira
Calothrix
Chondrocystis
Chroococcus
Gloeocapsa

Gloeotrichia
Entophysalis
Jaaginema
Leibleinia
Lyngbya
Microcoleus

Microcystis
Nostoc
Nostochopsis
Oscillatoria
Phormidium
Rivularia

Sacconema
Scytonema
Spirulina
Stigonema
Synechococcus
Tolypothrix