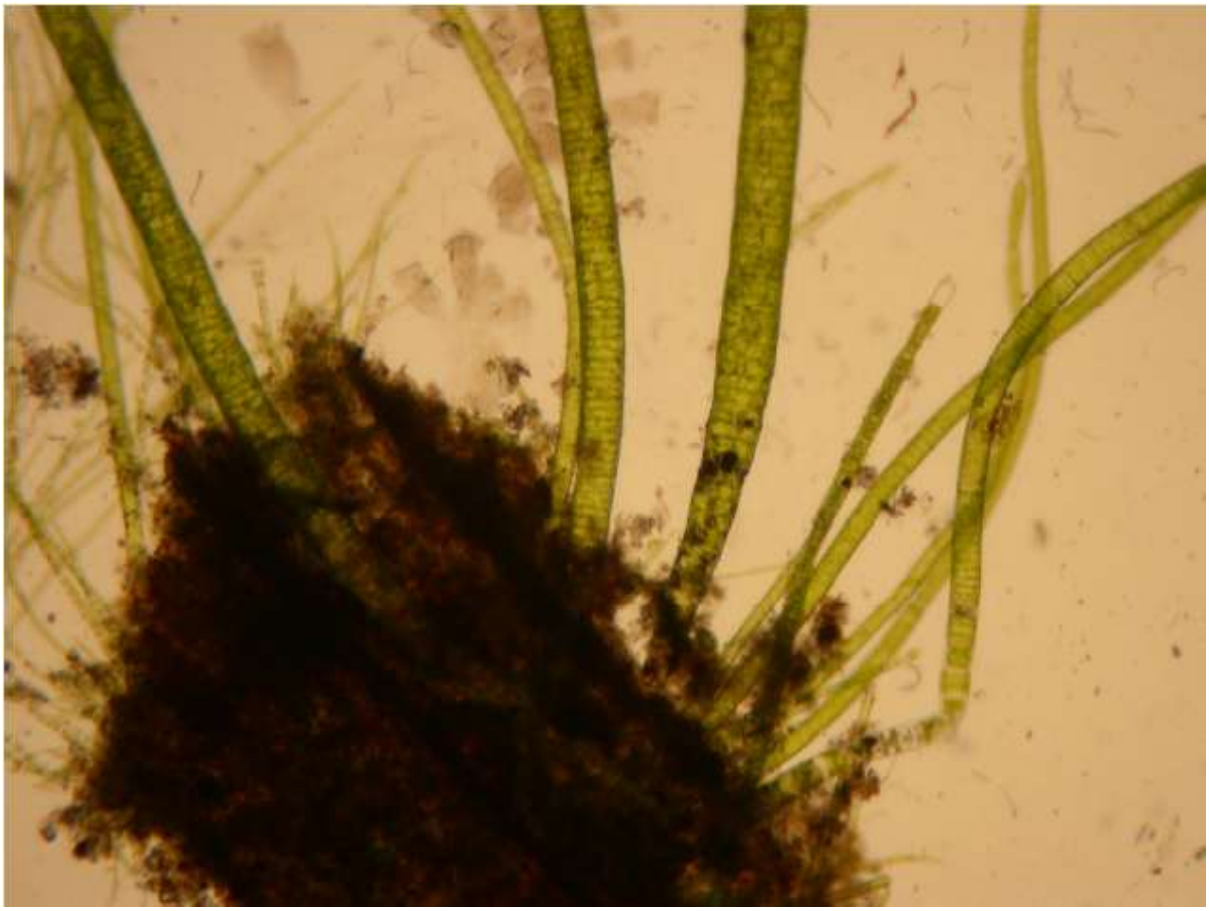
Filamentous Freshwater Algae of the ACT, a preliminary list



Schizomeris leibleinii from the bathtub ring on sedges in Lake Tuggeranong.

Preamble

This annotated list of filamentous algae of many kinds is based on the collections which have been made, coincident with either Waterwatch Southern ACT work or with the Murrumbidgee Riverine Vegetation Survey (2007-2008) by Research & Monitoring (Parks, Conservation & Lands). Some earlier records are also included. The area covered is more accurately the Upper Murrumbidgee Catchment rather than just waterways within the Territory. A proposal for a **growth** form and **tolerance** rating for filamentous algae, similar to the macroinvertebrate SIGNAL 2 score, is put forward. The work has been supported by an NAP Small Grant, *Good Algae, Bad Algae*.

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Contents

INTRODUCTION

Filamentous algae in waterways are often treated as bad organisms, the cause of 'pollution' in a cascade or on the concrete spillway of a Gross Pollution Trap. They may well be less than aesthetically pleasing to view. They may confront the nose. They may be hazardous to walk on. But they occur as a symptom, not the cause of problems in riparian systems. And frequently they are not even that, just an unfamiliar (to the perceiver) seasonal phenomenon or a normal function of the system.

This dissertation is a defence and a clarification of the good and the bad filamentous algae in the ACT and adjacent waterways. There is a description of the annual cycle of filamentous algal phenomena and correlation to water quality data at one of those causeways where their presence is always noted. A proposal for a tolerance scale for filamentous (visible) algae, similar to the SIGNAL Score for Macroinvertebrates is put forward. And, using the records of collections over the last few years, there is a first attempt at a local listing of taxa and occurrences.

'Filamentous Algae' is a carpet-bag term for numerous groups of photosynthetic organisms with little differentiation of anatomy commonly encountered in riparian habitats. Most people, including many aquatic environmental scientists, assume that '*filamentous algae*' is enough to describe the many and varied manifestations of these organisms. There are also attitudes and assumptions that tend to regard the presence of *filamentous algae* as indications of disturbance at least and eutrophication at worst.

Filamentous algae are rarely truly planktonic. They live attached to structures in the waterways they inhabit. They form rafts and submerged pontoons in the water column when free-floating. Their filaments include many more than 20 cells, and may be branched or fasciculate to increase bulk.

There are **Cyanoprokaryota**, organisms with cells that are bacterial in structure, physiology and reproduction. These are commonly referred to as *blue-green algae*, or a little more appropriately as *cyanobacteria*. Many of these are not visible as individual filaments, but rather form encrustations, sheets or gelatinous structures readily visible with the naked eye.

There are organisms that belong to the **Rhodophyta**. They demonstrate a reproductive cycle with a tetrasporic phase and a sexual phase where the donor or male propagules are non-motile single cells. They also have blue and red biliproteins as their subsidiary photosynthetic pigments, along with Chlorophyll A.

A few members of the brown pigmented aquatic photosynthetic organisms with siliceous skeletons form large enough aggregations to be noticeable in the riparian environment. These are usually classified as *diatoms* (**Bacillariophyceae**)

Likewise there are a few, but common, representatives of the group called Golden Green Algae (**Xanthophyceae**), although the most visible ones are referred to as *velvet moss.*
The most numerous and well represented groups are those usually referred to as the *Green Algae*. The group which shows physiological and reproductive affinity with

other protists is called the **Chlorophyta**, and includes most of the green seaweeds as well as a range of forms of freshwater planktonic and filamentous photosynthetic organisms. It is not a very homogenous collection but shows enough physiological and reproductive commonalities to be retained as a Division among Protists.

The group which has physiology in common with most land plants and reproductive mechanisms clearly related to those of land plants are often referred to as the **Charophyta**, although other terms have been used. For the present purpose the stoneworts will be treated as organisms distinct from the filamentous algae and beyond the scope of this paper, but the *silkweeds* (*Spirogyra* and friends) and the filamentous and pulvinate associated algae (*Klebsormidium* and *Coleochaete*) will be included.

The collections of algae have been stored in 90% ethanol and 5% glycerine, and in some cases semi-permanent slides in 40% Karo have been made. The proposed growth and tolerance ratings are interpreted from local collections and with reference to the New Zealand scale (Biggs 2000). Chapter 2b. can be extracted and used as a field guide for inclusion of algae in water quality data collection until a more precise rating can be established. For this reason organism groups are given a thumbnail sketch for form and likely habitat, and known occurrences in catchment areas will be tabulated.

Chapter 1. A year at the causeway on Lower Tuggeranong Creek

Lower Tuggeranong Ck is one of the major tributaries of the Murrumbidgee in the southern ACT. It is a base flow creek system fed from the overflow from Lake Tuggeranong and is the main tributary on the eastern side of the river below Gigerline Gorge and above Red Rocks Gorge. The water inputs are derived from mainly urban run-off, with a little rural input east of Tuggeranong Homestead, Richardson and Theodore. The waterway is permanent, and the causeway at the ford provides a useful platform to observe the dynamics of creek life.

Table 1. Water Quality and Algal Occurrence, Lower Tuggeranong Ck ford, 2007-2008

month	**Flow**	**Turbidity** NTU	**EC** µS/cm	**Temp.** ºC	**pH**	**Algae**
M	fast	15	300	12.1	9.1	no visible filamentous algae
J	fast	15	92	8.1	9.0	*Phormidium autumnale* complex; *Vaucheria* sp; *Melosira varians*; *Botryococcus braunii*.
J	moderate	<10	72	6.7	8.8	*Vaucheria* sp;
A	slow	10	140	14.7	8.1	*Phormidium* sp.; *Vaucheria* sp; *Melosira varians*;
S	A trickle	<10	230	17.1	10.2	*Phormidium* sp aff *perornata*; *Melosira varians*;*Synedra* sp; *Klebsormidium* sp; *Spirogyra singularis/juergensii*
O	fast	18	101	22.0	7.8	*Oedogonium capillare*; *Spirogyra singularis/juergensii*;
N	*	*	*	*	*	*
D	fast	20	96	17.0	8.0	*Cladophora glomerata* as streamers.
J	Very slow	<10	508	30.0	8.3	*Hydrodictyon reticulatum* as a bloom.
F	moderate	<10	94	21.0	8.4	*Hydrodictyon reticulatum*; *Pithophora oedogonia* as tufts; *Spirogyra* aff. *fluviatilis*; *Botryococcus braunii*
M	nil	<10	532	20.0	7.8	*Hydrodictyon reticulatum*; *Pithophora oedogonia*; *Cladophora glomerata*.
A	slow	<10	145	8.0	8.3	*Melosira varians*; *Cladophora glomerata*.
M	fast	<10	118	9.0	8.6	*Melosira varians*; *Cladophora glomerata*.
J	fast	10	*	6.0	8.2	*Phormidium* sp.
J	fast	12	95	8.8	8.2	*Phormidium* sp; *Cladophora glomerata*.

There does appear to be a clear seasonality in the algal flora around the causeway: the diatom *Melosira* and the encrusting cyanobacterium *Phormidium* re-emerging as the visible components with the drop in temperature from autumn to winter and then

being replaced by what may be a succession of green algae from spring, through summer and into early autumn.

There may be a correlation between the *Hydrodictyon* bloom and the jump in electrical conductivity, but this remains to be demonstrated. New Zealand studies suggest that *Hydrodictyon* can exploit rather low N and P but that it thrives on inorganic Nitrogen (Wells et al. 1999; Hall & Payne 1997).

The retention of *Oedogonium capillare* and *Spirogyra singularis* in times of fast flow may possibly have a little to do with basal attachment in *Oedogonium* and occasional rhizoid formation in *Spirogyra*.

It would be foolhardy to make any further observations from these few data. There is a need to gather similar data correlations at several other sites in the Upper Murrumbidgee Catchment, and continuing data collection at this site. What Table 1 does indicate is that correlations can be established if the information is forthcoming.

Water Net (*Hydrodictyon reticulatum*) bloom in Tuggeranong Creek.

Chapter 2: Tolerant and Sensitive Freshwater Algae

Filamentous freshwater algae are hard to use as indicator species because we have little Australian data on their distribution and seasonality, and we have almost no experimental work relating their local occurrences to local water regimes (but note Taylor et al. 2004 use chlorophyll a levels). Much work has been done in New Zealand, and while the flora may be comparable, the environmental conditions in most cases are not so easily compared (Biggs 2000; Biggs and Price 1987; Biggs & Smith 2002).

Biggs (2000) describes and codifies periphyton communities (those that form as coatings on submerged surfaces) according to habitat condition and primary, secondary and understorey taxa. Biggs (2000) works very well where you have constantly flowing waterways with reliable rainfall. It separates the condition of the waterway –oligotrophic, mesotrophic and eutrophic- from the algal form, and is designed for periphyton rather than the general macroalgae.

Dr Jacob John of Curtin University has been working towards something similar, based largely on the diatom flora, for Australian conditions (John 2006). Such a scheme, using diatoms, is suitable for laboratory based analysis, but is outside the scope of community organisations and those surveys where inspection and field sampling is the usual practice.

2a. Sensitivity of filamentous algae in ACT collections.

We can make a few sensible observations from the collections lists in Appendix 1 and 2, which may provide the basis for a starting hypothesis to be tested by both further collection and field observation, and reassessed in the near future.

Sensitive:

- Riffles and snags in very bright water, particularly in upland areas, have the Cyanoprokaryotic *Tolypothrix* sp; *Rivularia* and *Gloeotrichia*, and both *Nostoc pruniforme* and *N. verrucosum* along with *Chaetophora* spp and *Draparnaldriopsis*.

Moderately Sensitive:

- Urban lakes and storm water pondages will support a similar range of raft/cloud forming algae as farm dams and the embayments of rivers or the ponds of base-flow creeks. There may be a turbidity based species gradient with these, but much further work would be needed. Low turbidity taxa include *Parallela novae-zealandiae*, *Draparnaldia mutabilis*, *Zygnema* spp and on suitable hosts *Chaetophora attenuata*. Higher turbidity is tolerated by *Stigioclonium tenue*. *Spirogyra* species and many *Oedogonium* spp appear to show little preference.
- Where there is stability of depth and emergent, particularly sedge-like, aquatic vegetation, bathtub-ring formation will be visible, and usually includes a range of Cyanoprokaryotic and green algal taxa (including *Schizomeris*), and the velvet moss, *Vaucheria*.

Tolerant:

- Chutes, riffles and cascades will usually support a healthy population of attached green algae, especially if there is little or no riparian shading. The likely species in these localities in the ACT are *Rhizoclonium riparium*, *Cladophora glomerata* and a rhizoid forming species of *Spirogyra*, with four chloroplasts per cell that fits the *S. fluviatilis* complex. In spring these may be joined by *Stigioclonium tenue* or *S. helveticum*.
- The concrete walls and gutters of Gross Pollution Traps and similar structures in waterways in the ACT provide suitable substrates and water regimes (high dissolved salts and nutrient levels, with shallow but more or less permanent hydration) for Cyanoprokaryotic mat formers (*Phormidium* spp; *Oscillatoria* spp; *Microcoleus* spp) and *Cladophora aegagropila* and *Pithophora oedogonia*. However, the Cyanoprokaryotic mat formers also turn up in less altered conditions.
- Causeways, like that in Tuggeranong Ck, display a succession, including diatoms that might otherwise only be observed as part of a biofilm on rock or aquatic plants and debris, difficult to describe or characterise on inspection.

Table 2: Listing of algae for habitat sensitivity.

	Cyanoprokaryota	**Greens**	**Others**
Sensitive	*Rivularia spp.*	*Chaetophora elegans*	
	Nostoc pruniforme	*Draparnaldiopsis*	
Moderately Tolerant		*Chaetophora attenuata*	
		Draparnaldia mutabilis; Stigeoclonium helveticum; Klebsormidium spp	
		Zygnema spp; Paralella novae-zealandiae	
Tolerant	*Nostoc commune*	*Rhizoclonium riparium*	*Tabellaria flocculosa*
	Microcoleus paludosus; Oscillatoria spp.	*Stigeoclonium tenue; Spirogyra fluviatilis complex; Hydrodictyon reticulatum; Cladophora glomerata*	
Very Tolerant	*Phormidium*	*Cladophora aegagropila; Pithophora oedogonia*	*Melosira varians*

See below for a proposal for a SIGNAL 2-like scheme for both growth form and tolerance in locally occurring species. This is designed to be extracted and used by Waterwatchers and others interested in adding algal information to water quality data.

2b. Using Algae to add to Water Condition data.

A Field Key to Freshwater Macroalgae in the Upper Murrumbidgee Region.

1. Algal material either encrusting or attached to the substrate
    a. Encrusting
        i. Slimy or greasy, more or less robust, drying in flakes
            Cyanoprokaryotic crusts
        ii. Gritty or gelatinous, fragile, drying as a white powder
            Bacillariophyceae (diatoms)
    b. Attached
        i. Discrete cushions or balls
            1. Dark green or black *Rivularia* or *Nostoc* (Cyanoprokaryota)
            2. Bright green or glassy *Chaetophora* or *Coleochaete* (green algae)
        ii. Tufts or streamers
            1. Apple green, slippery, fragile *Stigeoclonium* or *Draparnaldia*
            2. Dull green to yellow, coarse, robust
                a. Like a blanket, smell of wet wool or tom cat
                    Cladophoraceae
                b. Full of silt, fishy or geosmin smell *Vaucheria*

    If it is a small 'conifer-like' free standing plant, then it's a stonewort, probably *Chara* or *Nitella*.

1. Algal material free floating
    a. Coarse to feel, often yellowish or brownish grey
        i. Fragile, little or no small *Oedogonium*
        ii. Robust, wet wool or tom cat smell Cladophoraceae
    b. Fine to feel, often bright or bottle green or bluish
        i. Silky to feel, green Zygnemaceae
        ii. Slimy to feel, sometimes bluish *Compsopogon* or filamentous desmids
        iii. Bulky, and either tubular or net-like
            1. Net-like *Hydrodictyon reticulatum*
            2. Tubular, like bait-weed *Enteromorpha* sp
    c. Tubular and compact, usually with a whitish end Duck poo!

At low power, under a dissecting microscope, or even with a good hand lens you can go further with some of the groups.

Cyanoprokaryotic Crusts: If the long straight filaments of very similar cells are very thin and very mobile you have found *Geitlerinema* or a close relative; filaments in bundles, quite narrow and with cells longer than wide you have *Phormidium* or *Microcoleus*; filaments quite wide and cells much wider than long (looks like a tiny ruler) *Oscillatoria* or *Lyngbya* (has a tube to live in).

Diatoms: Long rows of barrels indicates *Melosira varians*; zigzags of little glass open books *Tabellaria* sp. ...and the rest need specialist help.

Green Algae: *Stigeoclonium* has irregular branching, *Draparnaldia* has whorls of branches.
Chaetophora is often rigid and hard to spread out under a coverslip; *Coleochaete* tends to collapse.
The Cladophoraceae or Blanket Weeds are relatively easy to tell apart: *Rhizoclonium* doesn't have branches and has more or less regular cells with 2 pearls (nuclei) in each; *Cladophora* does branch, new branches coming out at an acute angle, and cells of all kinds of sizes; *Pithophora* has branches at right angles, and very long cells (it's the tom cat).

The Zygnemaceae: *Mougeotia* has single straps of chloroplast; *Zygnema* has a pair of green stars for chloroplasts; *Spirogyra* has one or more spiralling chloroplasts and *Sirogonium* has 4 or 5 straps.

Compsopogon (Rhodophyta) looks like chains of tires in stacks that become all overgrown with small cells.

There are pictures of all of these in Entwisle, Sonneman and Lewis (1997) and most of them in Mitrovic (1997) but it does take a bit of practice to pick them up. The pictures in ***What Scum is That?*** (Mitrovic 1997) will also identify most planktonic blooms.

The Ginninderra Algal Assessment Reference Photographs (www.ginninderralandcare.org.au/content.php?id=25 and open 16) will help, especially with site familiarity and practice.

A SIGNAL 2 -like rating system for macroalgae, for Waterwatchers.

In the Southern Tablelands of New South Wales and the ACT, most waterways are either 'flood & dry' systems, where most of the time the creek-line contains no flowing or standing water, or 'base flow' systems, where much of the year the flow is ground flow and the creek-line is a series of pools or billabongs.

The CAMPFIRE Algal rating system (A1 to A5), adapted as it was from the Tasmanian cyanobacterial bloom watch, could be modified to get rather more information by changing to A-E and adding a second column with a number for each algal form in the key above. Waterwatchers would ring one letter and then one number to signify their assessment of macroalgal condition:

Table 3**: Growth Rating of Algae:**

Score	Category	Description
A	No growth observed	Conditions vary from on algae to only very small populations
B	Thin layer present	A thin layer of algae visible, either floating suspended or covering some submerged surfaces
C	Rafts and plumes	Sufficiently concentrated that rafts or balls of algae are visible, and starting to move across the water column
D	Crusts or coatings	All submerged stones, snags covered
E	Carpets or blankets	Outlines of substrate hardly recognizable, algal growth often extending well into the water column

Table 4: **Tolerance Rating of Algae:**

Rating	Algal form	Descriptive notes
7/8	*Rivularia* or *Nostoc* 'snot balls'	Attached dark green or black cushions or balls on rocks or snags
6	*Chaetophora* or *Coleochaete* cushions	Attached bright green or glassy cushions or balls on vegetation, rock, or snags
5	Apple green tufts	Slippery and fragile (usually *Stigeoclonium* or *Draparnaldia*)
5	*Oedogonium*	Coarse, breaks up in the hand, often dirty grey or even purple, little or no smell. (Includes *Klebsormidium, Microspora*, and *Tribonema*)
4	Stoneworts	Small plants like Christmas trees, sometimes with orange and black decorations (*Chara* and *Nitella*)
3	*Vaucheria* (velvet moss) foxtails	Coarse, full of silt, fishy or geosmin smell. When on damp soil forms a dark green velvet.
2	Zygnemaceae	Silky, starts bright green or bottle green; when floating at surface may show yellow patches of sunburn. Grassy smell.
2	Cyanoprokaryotic Crust	Slimy or greasy, robust, dark coloured crust, drying to sheets or flakes (can float as ragged sheets)
2	Water-net	Wet grass look in water; nets visible in cupped hand (=*Hydrodictyon*) but if just tubes its bait-weed (=*Enteromorpha*)
1/2	Blanket weed streamers or blankets	Coarse, robust, dull green to yellow, attached (and often crinkled when stranded) or suspended 'blanket-weed', smells 'wet wool' or 'tom cat' (includes *Rhizoclonium*, *Cladophora* and *Pithophora)*
1	*Compsopogon*	Bluish green streaks on soil or in water, slimy; branching filament structure should be visible in hand
1	Diatom crust	Gritty or gelatinous, fragile, rusty brown or dirty grey crusts, drying to a white powder

A sensitive alga will have a high score, while tolerant ones will score close to 1.
For example:
*A riffle or causeway may have filaments and tufts beginning to form, and so C is the **growth rating** and the **tolerance rating** is 5, since its *Stigeoclonium helveticum* that is doing the tuft forming.
If all rocks and stones were to be covered with diatom ooze, then its **growth rating D and **tolerance rating** 1.

The comparable scheme for New Zealand, in Biggs (2000) separates the **condition of the waterway** –oligotrophic (O), mesotrophic (M) and eutrophic (E)- from the **algal form**, and is designed for periphyton (the attached organisms on rocks and snags) rather than the general macroalgae. You get a score of O3 or M2 or whatever.

This proposed scheme needs plenty of refining, but may be just as good as SIGNAL 2, as a quick 'spot check'. Getting the seasonality into the mix may be an interpretation (by the coordinator) rather than a report (by the Waterwatcher). For instance a cyanoprokaryotic crust (and accompanying floating flakes) [D, 2] in high summer is much more unwelcome than a regular mid-winter crust.

In the ACT, the large artificial lakes get plankton blooms occasionally, Ginninderra less frequently than most. **These blooms, especially in summer, are frequently made by the cyanobacteria *Microcystis* (which looks like green paint flecks or tiny strands of blue-green lace in the palm of your hand) and *Anabaena* (tiny, short, blue-green springs). These are both reportable organisms, and you should notify your Waterwatch Coordinator as soon as possible if they appear in your waterway.**

Farm dams where the stocking rate is too high, particularly where horses or cattle are involved, go blood red with *Euglena sanguinea*. This is hardly surprising as the half animal-half plant enjoys a rich diet, and so goes quickly to the sporing stage. The water repellent coat on the water is made principally of encysted cells waiting to be stranded, dried and blown off to another dam! Bright green scums are frequently *Botryococcus braunii*; it's a harmless green alga that just likes sunny still water with good nutrients (also the one that produces the precursor to crude oil!).

Chapter 3: Examples of the filamentous algae of the ACT.

3a. The riparian Cyanoprokaryota in the ACT

Although noxious 'blue-green algal blooms' are quite frequently reported for the ACT, more benign taxa are much more likely to be encountered. In general these fall into two 'visibility' categories, the sheet forming '**slimes**' and the bubble-like '**snots**'.

Slimes:

Almost any damp or submerged surface in a drainage line may support a coating of cyanoprokaryotes that make a skin on the surface. The skin may be variously blue-green (aeruginous), shades of green, brown, purple or black, and it may be matt or shiny. Often there is a texture to the sheet as well: slippery, felt-like, leathery; crumbly or gritty. Skins can have many small crests like a shag-pile carpet or undulations and bubbles, and as they dry may crack and fragment in distinctive forms. Some of these skins are quite capable of tearing off and floating as suspensions in the water body, forming part of the metaphyton or filamentous suspended algal clouds of many water bodies. The organisms that are most commonly responsible for these skins are filamentous cyanoprokaryotes that have a single kind of cells, very regular disc-like or cylindrical, in individual trichomes (regular arrays of prokaryotic cells) that form masses together. Generally these organisms have a gliding form of motility which means the skin may break-up and reform or spread and retract, or just disperse and form numerous copies.

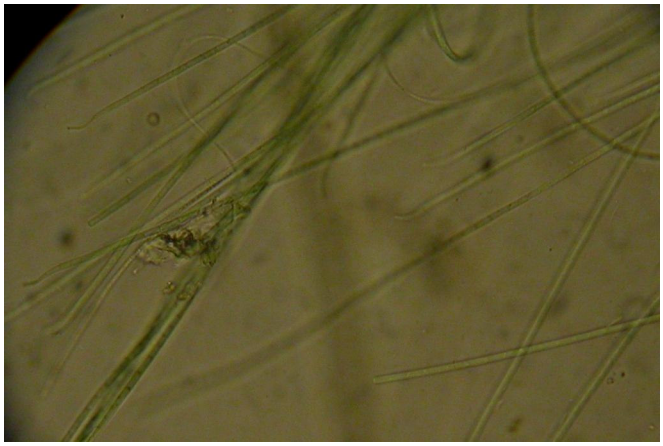
They were once all referred to the Oscillatoriales, but recent research, particularly into their microbiology has indicated that they are better grouped into three groups: the Pseudanabaenales with very narrow and usually cylindrical cells; the Phormidiales with rather wider cylindrical cells; and the Oscillatoriales sensu stricto with disc-like short but wider still cells. Although this appears very artificial, the classification does work at the behavioural (each order has a characteristic method of cell replication and trichome segmentation) and microbiological level.

The best recent treatment of Australian material is given in McGregor (2007) where detailed morphological descriptions of many of the taxa mentioned here will be found, as they can be both tropical (the coverage of McGregor) and temperate. Four examples of commonly encountered taxa will be presented here.

Pseudanabaenales:

Geitlerinema splendidum

The green or muddied green-grey skins of this organism are not uncommon in both rivers and ponds. The skin forms on rocks and aquatic vegetation or floats off as ragged fragments in the water column. It is slightly greasy and very friable, and if left in a saucer for a short while will display a green fringe as the organism seeks to exploit its new habitat.



Geitlerinema slpendidum

The thallus (mass of trichomes) has crowded filaments (trichome and outer coating) lying parallel but entangled; the trichome is more or less straight, with uniform narrow cylindrical cells (its often difficult to distinguish end walls) except for the terminal couple of cells, which taper into a conical and curved tip with a distinct button. The trichomes are very motile and appear like numerous small green rapiers at the edge of the thallus.

Specimens collected from Burra and Bunyan, but probably widespread.

Phormidiales:
Phormidium autumnale complex
This complex of similar species, in form and size and more is usually responsible for the shiny, slightly leathery, dark green through purple to blue-black sheets that form in the cooler months on rock or concrete especially in running water. The skin is quite strong when wet, and felty, and can be slippery; when dry it may become very shiny, but curls at the edges, and cracks in roughly rectangular pieces. It will form a quite neat blue-green fringe if left moist on a surface.
The thallus is thick, with interlacing, sometimes plaited but more or less parallel trichomes; each trichome is straight and moderately long, but similar to those its growing with; the cells are cylindrical, and without a distinct sheath, and the terminal cell is broadly conical. Individual cells are generally quite distinguishable. While motile the trichomes tend to glide quietly rather than wave about.

Specimens from Lower Tuggeranong Ck, but noted elsewhere in the river corridor.

Microcoleus paludosus
The muddy grey-brown flakes left behind in a drying flood-runner ate nearly always at least in part made from this species. When in shallow water, and extruded onto the thallus surface, the organism gives the mud a blue, green or aeruginous hue; as the pool, sandbar, flood-runner or creek bank dries, the organism retreats into its sheath complex in the mud. The sheets are quite fibrous and may resist tearing, and are felty and often gritty, more from the sand and mud than the organism. The organism may give the mud quite a strong geosmin (characteristic Cyanoprokaryote) smell. Left on a moist surface the edge of the sheets will show blue-green tufts.


Microcoleus mats in a Gross Pollution Trap outlet, Kambah Wetlands.

The thallus is a mat of sheath tubes, within which the individual filaments form a cord of 2-10 individuals. The sheath is open ended but tapering; the trichome has short cylindrical cells with [clearly distinguishable] end-walls, and the terminals cells are rounded. The individual trichomes are motile and tend to glide out away from one-another.

Microcoleus is common in flood-runners, creek banks, and even the damp soil patches round garden taps.

Oscillatoriales:
Oscillatoria limosa
Pale to dark green cotton-wool patches on rocks or snags or the wet parts of causeways frequently turn out to be species of *Oscillatoria*. The skin is very loose and rarely forms a thick, definite structure, but rather has the appearance of wet thread. When dried out it may almost appear to vanish into the substrate. The geosmin smell is usually detectable.
The thallus is a loose aggregation of individual trichomes, without any sign of sheaths. The straight trichomes may be of various lengths, and there may be numerous short cell groups or hormogones (these are the propagules of this genus, and most of the order) in the loose association. The individual disc-like cells often have granular concentrations at the end-walls, making them easy to distinguish; the terminal cells, where they have not been lost, are domed and may have slight thickening of the wall. The trichomes glide readily, and may tend to go in one direction.


Oscillatoria sp. aff. *limosa* from Cooma

Specimens are from the Numeralla River, but have probably been overlooked throughout the Murrumbidgee, wherever there is a bit of backwater formation.

'**Snots**'

In contrast to the regular cell form of the cyanoprokaryotes discussed above, the Snots have at least two and sometimes several cell shapes within each trichome. Each different cell form indicates specialisation in the behaviour of that cell while all cells contribute to the vitality of the whole organism. There are **vegetative** cells with dense pigmentation; **heterocytes** with thick walls, pearly cytoplasm and pit connexions to the next cells, that fix nitrogen; **akinetes** of various shapes, that form weatherproof propagules within one cell wall; **hair** cells that contain little or no cytoplasm but form the exposed ends of trichomes and several others. Many snots also have a colonial life style, from loose sheet-like aggregations, to interconnected sheath-networks or the organised arrays of individual filaments within a gelatinous matrix. A selection of species, not uncommon in the eastern states of Australia is discussed in Skinner & Entwisle (2001). Two examples will be discussed here.

Hydrocoryne sp.

The dark green goo that forms on reeds and rushes just at water level very often has a very high proportion of this organism. The 'bath-tub ring' is very important in the productivity of river systems, particularly in times of high turbidity, and while there are many diatoms and green algae in the mixture, where the ring has the feel and consistency of wet mid-green paint, and that geosmin smell, you are more than likely looking at *Hydrocoryne*.

The thallus is a three dimensional array of mostly straight moniliform (chains of beads) trichomes, most with numerous rounded cylindrical vegetative cells, scattered heterocytes (nitrogen fixers) and occasional runs of thick-walled akinetes. Each trichome is surrounded by a diffuse gelatinous sheath and so the whole thallus may coat an area of its substrate, generally a larger filamentous alga, stonewort or aquatic plant.

Although the collections are from the upper Monaro, the organism has been noted in both Lake Tuggeranong and Lake Ginninderra and is probably widespread.

Nostoc commune

This really is Snot, the scientific name translates as 'the widespread snot'. The colonies are usually billowing sheets of khaki to dark brown firmly gelatinous material that does look much like drying mucilage from the nose (snot). The sheets start off in waterlogged flood runners or drainage lines, or any patch of broken ground