TURF AND FOULING ALGAE: II. MAT & TURF SPECIES

What are they?

Some marine algae exist as low "mats" or "turfs" (also called "turfing" or "turf-like" algae by some workers). As the names imply, "mats" are flat and spreading, "turfs" are more upright like miniature mown lawns or grazed pastures, however, both terms are pretty subjective. Some mats heavily grazed by molluscs may be so low that they slip into the category of "crusts".

Generally, the term "turf" has been used to describe:

- ***communities*** **—** mainly intertidal some extending into shallow water — consisting of mixed species, all with a low profile. or
- ***a single species*** — its natural form, or a shape modified usually by heavy grazing.

Some workers expand their definition to include all those algae smaller than the brown algal canopy of a community. These algae should probably better be described as ***understorey*** species.

Mat & turf species described in this key

Edgar, G & Shepherd, S A (2013) in *The Ecology of Australian temperate reefs*, CSIRO, described turf algae as thread-like, or leafy species in early stages of growth, ~ 10-20 mm tall. The key below uses this definition where possible, but also describes larger leafy and filamentous plants that bloom seasonally on reefs and form dense, low mats a few cm high.

Where are they found?

Some turfs may suddenly appear seasonally, often as a response to increased water temperature, light and dissolved nutrients. Others occur as permanent zones in the intertidal distributed according to a balance between resistance to radiation/drying and the distribution of animal grazers. They can be used to define zones on reefs, related to tidal levels.

Limitations

Only macrophytes, plants that can be seen by the unaided eye are considered below. Unfortunately, microscopic investigation will also be needed for definitive identifications.

Images used below

Unless acknowledged otherwise, all images come from pressed specimens or the extensive slide collection of the algal unit, State Herbarium of S Australia, collections generated by Professor Womersley and his workers over some 60 years. Those with dark backgrounds have been taken using phase contrast or interference microscopy to highlight transparent structures. Other images may be stained dark blue.

Scale

The coin used as a scale is 24 mm or almost 1" across

Names

These follow Womersley, H.B.S. *The Marine Benthic Algae of southern Australia* as this continues to be the most comprehensive and accessible publication for southern algae. Recent name changes found in the Website ***Algaebase*** have been added.

KEY

1a. plants forming a broken band of growth a few mm high on rock just above high tide (the supra-littoral zone), kept wet by wave splash, crumbling when dry, heavily grazed by small blue snails at lower levels ……..…… marine lichens (combination of fungus and microscopic alga) ……. 2.

1b. not as above ……..…. 3.

2a. dry plants orange-yellow. Fig. 1. ……..*Caloplaca* spp

2b. dry plants black. Fig. 2. ……. *Lichina* spp

3a. plants bright green ……. 4.

3b. plants dark red, red, amber or brown ……..… 11.

4a. plants leafy or with narrow ribbon-like branches, bright yellow-green and with crinkled edges. Figs 3-7. ……..….. *Ulva* (Sea lettuce) (including species with hollow parts, once placed into *Enteromorpha*)

go to Southern Australian Groups at a glance: *Ulva*

4b. plants thread-like, yellowish, dark green or blue-green ……..….. 5.

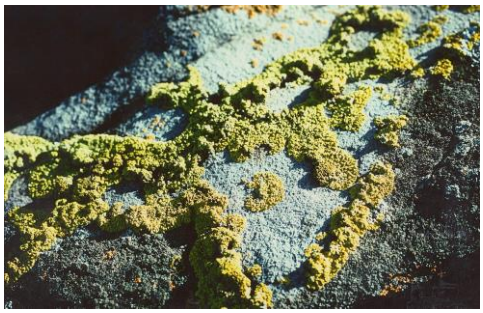


Fig. 1: *Caloplaca* on boulders at Petrel Cove, SA

Fig. 2: *Lichina pygmaea*, Yorke Peninsula, SA being grazed by blue, littorinid snails about 4 mm tall

Fig. 3: *Ulva* mats exposed at low tide on mud flats of the Port River, S Australia, plants attached to shell fragments

Fig. 4: *Ulva* (*Enteromorpha*) *compressa* mats at the edge of a flat reef, exposed at low tide during December, Rapid Bay, S Australia

5a. under the microscope, threads can be seen as rows and columns of many box-shaped cells forming hollow tubes. Figs 7-12.
..... *Ulva*
(Note: species with hollow parts were once placed into a separate genus, *Enteromorpha*)
See **Southern Australian Groups at a glance: *Ulva***

5b. under the microscope, threads can be seen as single lines of elongate cells
..... 6.

6a. cross-walls ***absent*** (except where reproductive organs form); plants form sparse turfs exposed at the edges of reefs or estuaries at low tide, amongst sand. Figs 13, 14.
.....*Vaucheria* species in the Xanthophyceae (Yellow-green Algae)

6b. cross-walls ***present*** ..... 7.

7a. threads branched …….... 8.

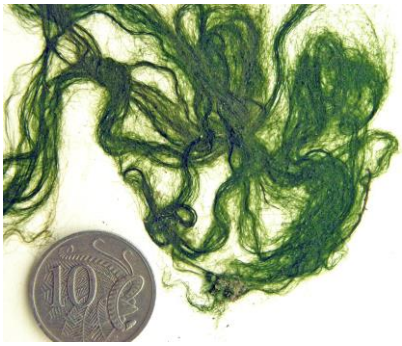
7b. threads unbranched …….... 10.

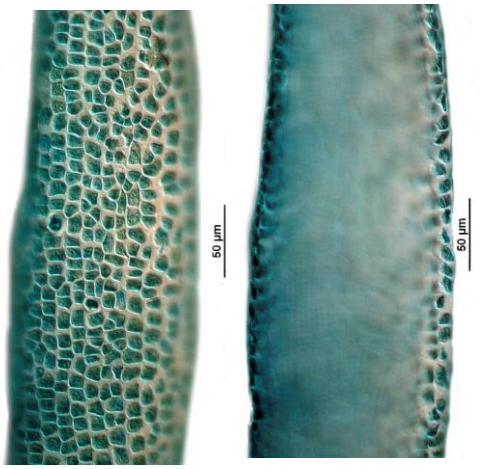
8a. branching regular or irregular, cross walls occur at branches
.....…… 9.

8b. branching irregular, contents of side branches ***continuous*** with parent cells; plants in dense mats or cushions. Figs 15-17, (next page).
……..…. *Cladophoropsis* 3spp, 1 rare, 1sp forms floating balls

9a. branching regular, cells usually elongate, hairs ***absent***, root-like rhizoids, if present, ***not*** tapering. Figs 18-22 (next page). 1 sp forms small floating balls,
……. *Cladophora*
See **Southern Australian Groups at a glance: *Cladophora* species groups I–III**

9b. branching irregular, cells irregularly shaped, often ***bulging***, hairs may be ***present***, root-like rhizoids tapering to a fine point. Figs 23, 24 (next page).
…… *Wittrockiella salina*





Figs 7-9: *Ulva* (*Enteromorpha*) *ralfsii*, plants
7. coarse hair-like appearance
8. surface view of cells
9. the hollow core seen after focusing through the surface

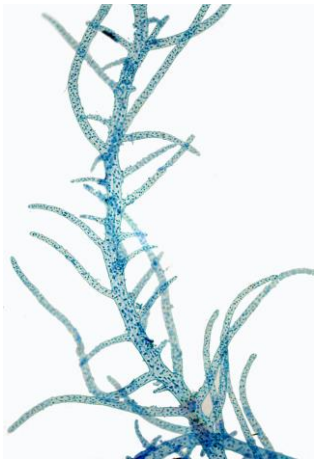


Fig. 10: *Ulva (Enteromorpha) clathrata*

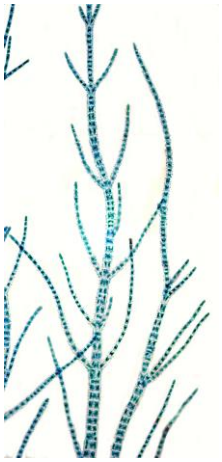


Fig. 11: *Ulva (Enteromorpha) paradoxa*

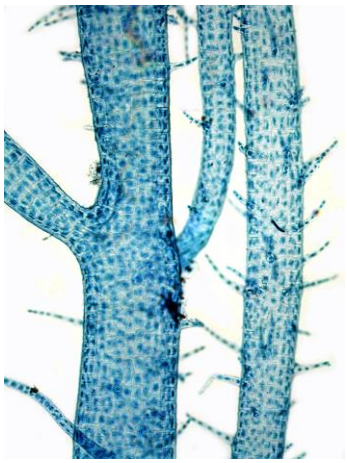


Fig. 12: *Ulva (Enteromorpha) paradoxa*

Fig. 13: *Wittrockiella salina* branched threads lacking cross walls, swollen ends

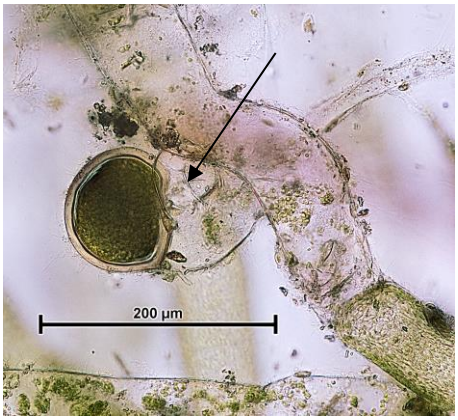


Fig. 14: *Vaucheria*: thick-walled female structure, twisted male structure (arrowed)

Fig. 15: *Cladophoropsis herpestica*, from Elliston, S Australia, in shaded parts of the lower intertidal

Fig. 16: *Cladophoropsis membranacea*, forming low cushions at Cape Lannes, S Australia

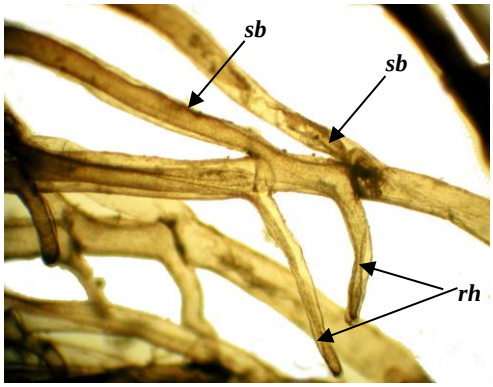


Fig. 17: *Cladophoropsis herpestica*, side branches (*sb*) lack cross walls at their bases, and rhizoids (***rh***) arise from the bases of axial cells

Fig. 18: *Cladophora coelothrix*

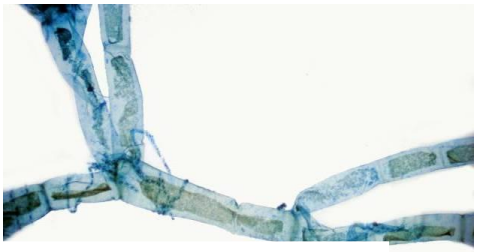


Fig. 19: *Cladophora coelothrix*, branching pattern

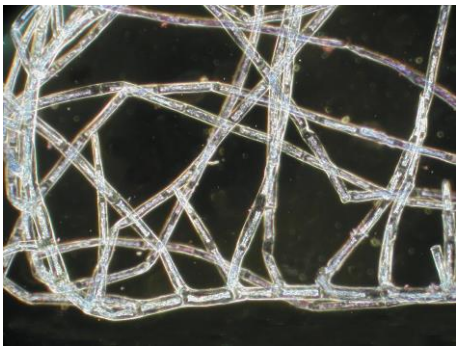


Fig. 20 *Cladophora subsimplex* branching pattern of horizontal and upright branches

Fig. 21: *Cladophora aegagropiloidea*: plants in rounded balls

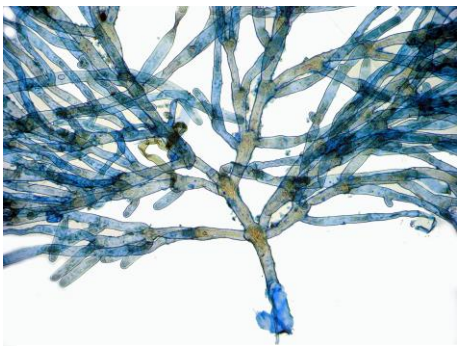


Fig. 22: *Cladophora aegagropiloidea*: microscope detail of branching cells

Fig. 23: *Wittrockiella salina*

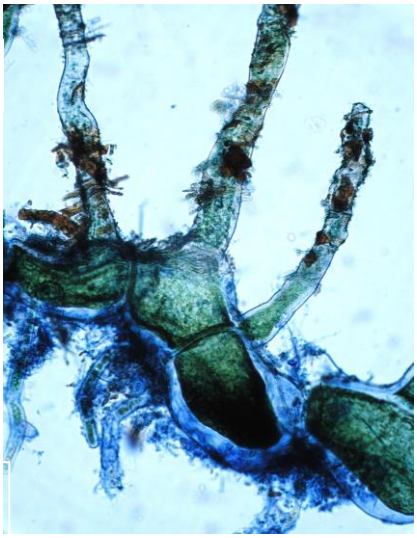


Fig. 24: *Wittrockiella salina*: microscope detail of irregularly shaped cells

10a. threads coarse (> 0.7mm wide) plants often loose lying. Figs 25-27.
……..…….. *Chaetomorpha* 8 spp
See **Southern Australian Groups at a glance: *Chaetomorpha***

10b. threads fine (< 0.6 mm wide), forming tangled mats or loose-lying strands. Figs 28-33.
……..… *Rhizoclonium* 4 spp
See **Southern Australian Groups at a glance: *Rhizoclonium***

Fig. 25: *Chaetomorpha linum*, detail of a thread

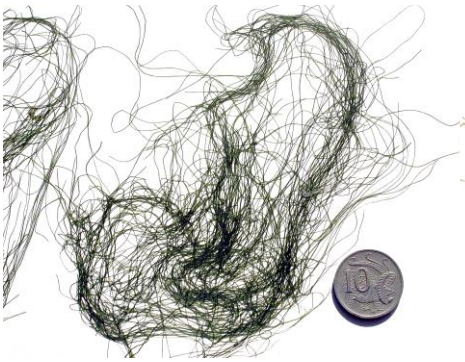


Fig. 26: *Chaetomorpha linum*

Fig. 27: *Chaetomorpha valida*

Fig. 28: *Rhizoclonium riparium*

Fig. 29: *Rhizoclonium tortuosum*, mixed with sea grass blades from intertidal mud flats

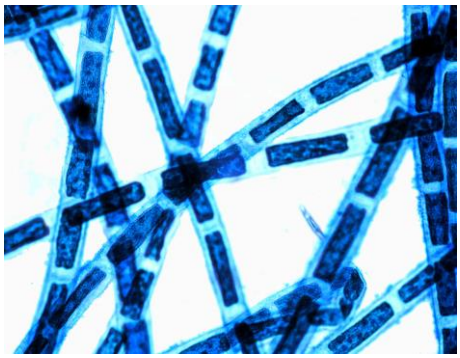


Fig. 31: *Rhizoclonium curvatum*

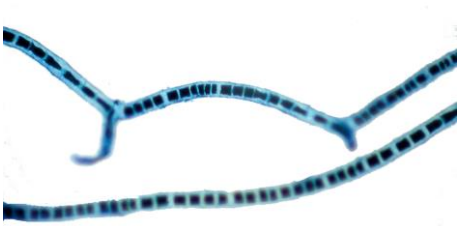


Fig. 32: *Rhizoclonium curvatum*, detail of threads in arcs between rhizoids

Fig. 33:*Rhizoclonium tortuosum*, detail of thread, net-like chloroplasts

11a. plants pink, red to red-brown ……... 12.
11b. plants brownish, bleaching yellowish ……..…….…..…..... 16.

12a. plants pink to red, some bleaching to white, all ***limey, brittle and jointed***; at outer edges of reefs. Figs 34-40. ……... coralline red algae
See **Pictured keys of common southern Australian marine plants: coralline red algae**
12b. hair-like or gristly, ***not*** limey; ……... 13.

13a. plants hair-like, of dark red threads; <1mm wide; cells in a single line, with girdles and coatings of microscopic cells; may be attached to other turf plants. Figs 41-45.
……..…… *Ceramium* spp, *Centroceros*, *Polysiphonia* spp
See **Pictured key to southern Australian algae: filamentous red algae Master key**
13b. plants red, some bleached to yellow, branches >1 mm wide, many cells wide ……...……...……...…… 14.

Fig. 34: *Cheilosporum sagittatum*, turf, shallow water, Aldinga reef edge, SA

Fig. 35: *Cheilosporum sagittatum* arrow-shaped sections of jointed branches

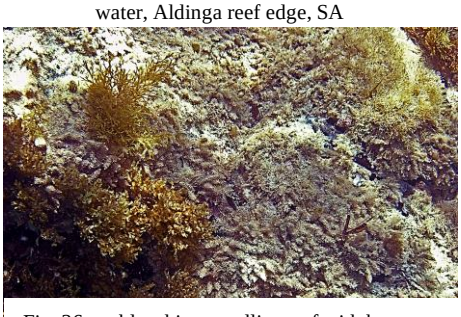


Fig. 36: bleaching coralline turf with brown algae, reef edge, Second Valley, SA

Fig. 37: *Corallina officinalis*

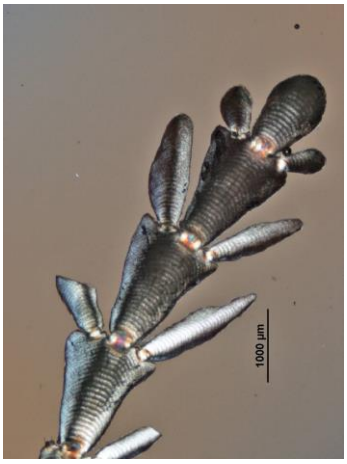


Fig. 38: *Haliptilon roseum*, Stokes Bay, SA. Photo: D Muirhead

Fig. 39: *Corallina officinalis*, detail of jointed branches

Fig. 40: *Haliptilon roseum*, detail of branches

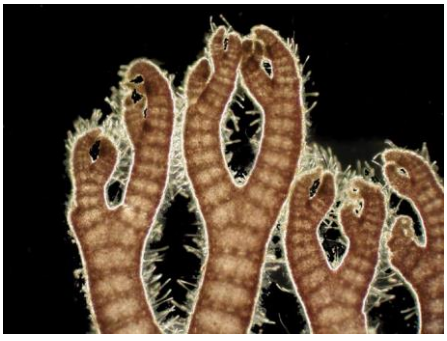


Fig. 41: *Ceramium pusillum*, branch tips, cell girdles showing beneath coatings of additional (corticating) cells

Fig. 42: *Ceramium cliftonianum* forms entangled masses

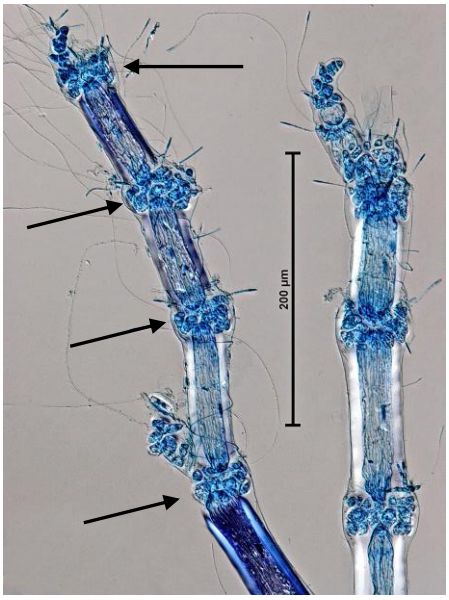


Fig. 43: *Ceramium cliftonianum* detail of thread-cells with girdles of smaller cells (arrowed)

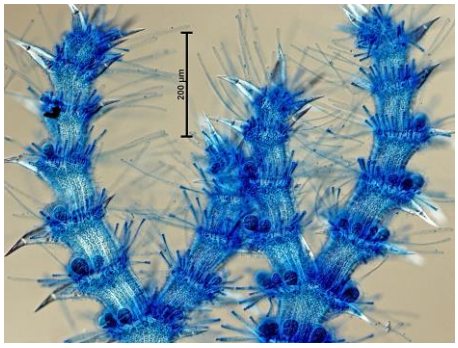


Fig. 44: *Poysiphonia isogona* turf

Fig. 45: *Centroceras clavulatum*, spiny tips

14a. plants forming tangled masses of somewhat flattened, ***hollow***, branches narrowed at the base; sporangia in minute circles in side branches. Figs 46- 48.
..... *Lomentaria monochlamydea*

14b. plants stubby or in tangled masses, hair-like or gristly, branches solid, cylindrical, tetrasporangia scattered in short side branches ..... 15.

15a. plants stubby or in tangled masses; cross sections show a core of rounded cells and, in some species, clusters of brightly-lit, minute, extremely thick-walled cells. Figs 49-55.
…… *Gelidium spp*, *Gelidiella* spp, *Capreolia implexa*, *Pterocladia* spp
See **Southern Australian species of Gelidiaceae at a glance**

15b. plants with tangled, thin branches or stubby, gristly branches; cross sections show a core of well-spaced, many-armed cells. Figs 57-59 (next page).
..... *Gigartina brachiata*, *G. densa*
See **Southern Australian species of Gigartinaceae at a glance**

Fig. 46: *Lomentaria monochlamydea*

Fig. 47: *Lomentaria monochlamydea*, detail of branching pattern

Fig. 48: *Lomentaria monochlamydea*, tetrasporangial clusters in scattered rings on side branches

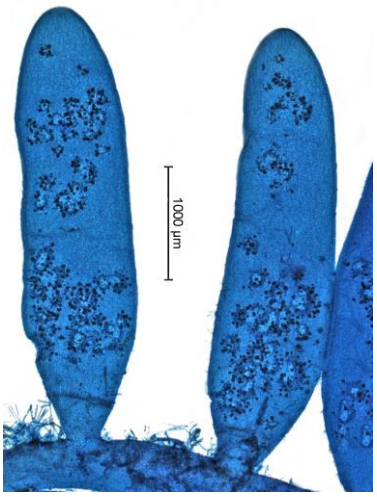


Fig. 49: *Gelidium crinale*, forming hair-like turfs bleaching at the tips

Fig. 50: band or zone of red algal turf, mainly *Gelidium*, exposed between waves on granite, West I., SA

Fig. 51 *Capreolia implexa*,
often mistaken for *Gelidium pusillum*

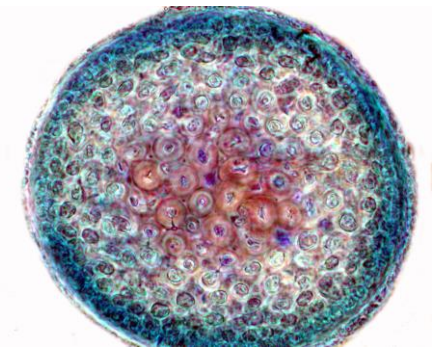


Fig. 52: *Gelidium* crinale, cross section

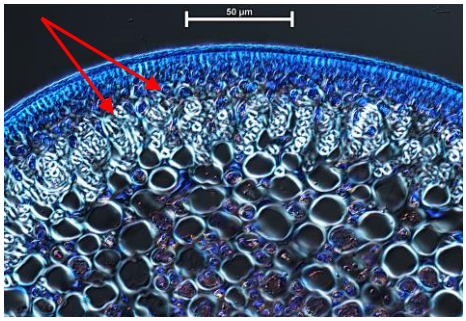


Fig. 53: *Gelidium asperum*, edge of a cross section with a core of rounded cells and brightly lit clusters of minute, extremely thick-walled cells (arrowed)

Fig. 54: *Gelidium pusillum*, with thin, gristly branches

Fig. 55: *Gelidiella ramellosa*

Fig. 56 *Gelidium australe*

Fig. 57: *Gigartina brachiata*, tangled masses, often with faint white bands on branches

Fig. 58: *Gigartina densa*, growing in stubby, gristly clumps at the lower edges of reefs in rough waters

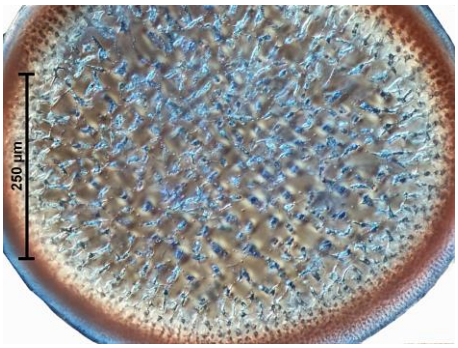
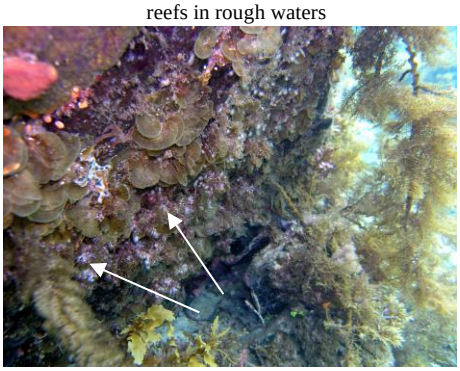


Fig. 59: *Gigartina brachiata*, cross section

16a. plants fan-shaped, fans ~ 20-40 mm across, lying flat on reefs, fluorescing blue under water Figs 60-64.
..... *Lobophora spp, Lobospira*
Padina spp., *Zonaria* spp
See **Southern Australian species of Dictyotaceae at a glance**

16b. plants thread-like, brown, drying black or bleaching green or yellow, forming tufts or mats or fouling other plants. Figs 65-67.
See **Turf and fouling algae I: Ectocarpaceae and *Sphacelaria***



Figs 60, 61: *Lobophora variegata*, two views of flat masses (arrowed) at the reef edge, Cape Jervis SA

Fig. 62: *Padina elegans*, fan-shaped blades, edges in-rolled, lie flat on reefs

Fig. 63: *Lobospira bicuspidata*

Fig. 64: *Zonaria spiralis* mat

Fig. 65: *Hincksia*, Whyalla, SA

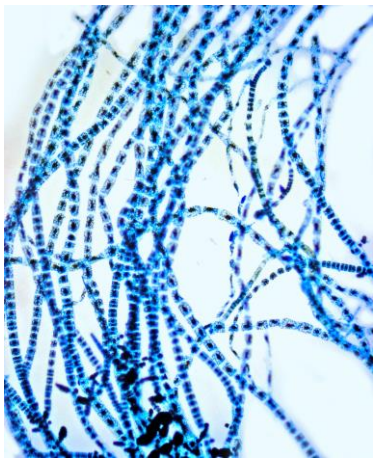


Fig. 66: *Feldmannia*, (stained blue) Whyalla, SA

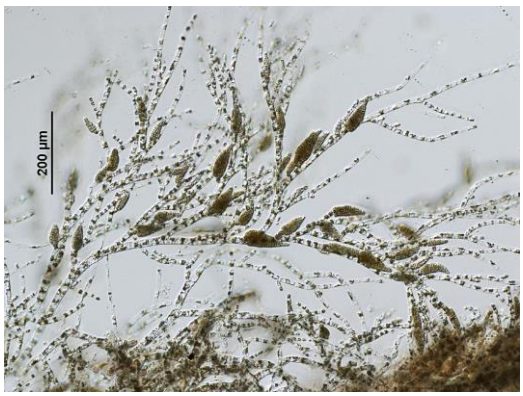


Fig. 67: *Ectocarpus*, with spore sacs

SPECIES ILLUSTRATED IN THE KEY with current name changes

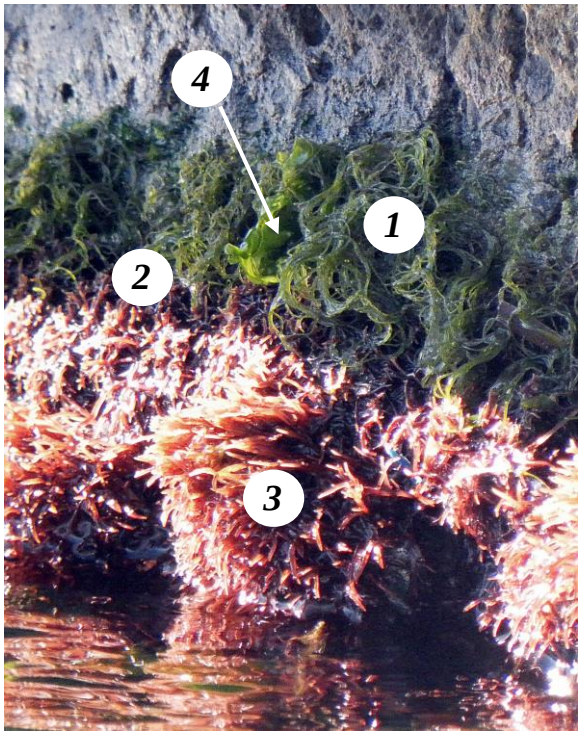
species	author/s	page	name in *Algaebase*	author/s
Caloplaca		1		
Centroceras clavulatum	(C. Agardh) Montagne	5		
Ceramium cliftonianum	J. Agardh	5		
Ceramium pusillum	Harvey	5	*Celeceras pusilla*	(Harvey) Barros-Baretto & Maggs
Chaetomorpha linum	(O.F. Müller) Kützing	4		
Chaetomorpha valida	(Hooker f. & Harvey) Kützing	4		
Cheilosporum sagittatum (syn.)	(Lamouroux) Areschoug	5	*Jania sagittata*	(Lamouroux) Blainville
Cladophora		2		
Cladophora aegagropiloidea	C. Hoek & Womersley	3		
Cladophora coelothrix	Kützing	3		
Cladophora subsimplex (syn.)	Kützing	3	*Rama falklandica*	(Hooker f. & Harvey) Boedeker, Wynne & Zuccarello
Cladophoropsis herpestica (syn.)	(Montagne) M. Howe	3	*Lychaete herpestica*	(Montagne) M.J.Wynne
Cladophoropsis membranacea	(Bang *ex* C. Agardh) Børgesen	3		
Corallina officinalis	Linnaeus	5		
Enteromorpha clathrata (syn.)	(Roth) Greville	2	*Ulva clathrata*	(Roth) C. Agardh
Enteromorpha compressa (syn)	(Linnaeus) Nees	1	*Ulva compressa*	Linnaeus
Enteromorpha linza (syn.)	(Linnaeus) J. Agardh	1	*Ulva linza*	Linnaeus
Enteromorpha paradoxa	(C. Agardh) Kützing	2	*Ulva paradoxa*	C. Agardh
Enteromorpha ralfsii (syn.)	Harvey	2	*Ulva ralfsii*	(Harvey) Le jolis
Feldmannia		7		
Gelidiella ramellosa	(Kützing) Feldmann & Hamel	6	*Huismaniella ramellosa*	(Kützing) G.H. Boo & S.M. Boo
Gelidium asperum	(C. Agardh) Greville	6		
Gelidium australe	J. Agardh	6		
Gelidium crinale	(Hare *ex* Turner) Gaillon)	6		
Gelidium pusillum	(Stackhouse) Le Jolis	6		
Gigartina brachiata	Harvey	7		
Gigartina densa	Edyvane & Womersley	7		
Haliptilon roseum	(Lamarck) Garbary & H.W. Johansen	5	*Jania rosea*	(Lamarck) Decaisne
Lichina pygmaea	(Lightfoot) C. Agardh	1		
Lobophora variegata	(Lamouroux) Womersley *ex* Oliveira	7		
Lobospira bicuspidata	Areschoug	7		
Lomentaria monochlamydea	(J. Agardh} Kylin	6		
Padina elegans	Koh *ex* Womersley	7		
Polysiphonia isogona	Harvey	5	*Vertebrata isogona*	(Harvey) Diaz-Tapia & Maggs
Rhizoclonium curvatum	V.J.Chapman	4		
Rhizoclonium riparium	(Roth) Harvey	4		
Rhizoclonium tortuosum	(Dillwyn) Kützing	4	*Chaetomorpha tortuosa*	(Dillwyn) Kleen
Vaucheria		2		
Vaucheria		2		
Wittrockiella salina	V.J.Chapman	2		
Zonaria spiralis	(J. Agardh) Papenfuss	7		

EXAMPLES OF TURF HABITATS IN SOUTH AUSTRALIA

Closely cropped turf of mixed species, greens (mainly *Ulva*) and reds (*Gelidium*) at the edge of the reef, Port Willunga

Red algal turf above green, at the edge of the reef, Port Willunga

Underwater view reef edge, Aldinga, turf of mixed red species and an emergent *Laurencia* plant (arrowed)



Zones on a concrete wall, West Beach marina, Adelaide: *1* =green *Chaetomorpha*; *2* = dark red *Gigartina brachiata*; *3* = bright red *Lomentaria monochlamydea*; *4* = *Ulva*

Broken red algal turf (arrowed) (*Gelidium*) bleached yellow, above the bead-like, brown canopy species, *Hormosira*, at low tide, Slipway reef, Robe

Slanting view of coralline turf (uppermost) and basal leaves of *Sargassum* on a granite boulder, exposed between waves, West Island

Seastar, *Petricia vernicina*, on turf including fan-shape *Lobophora*, characteristically fluorescing blue-green underwater, also sponges and pink, encrusting coralline red algae, 5m deep, Port Noarlunga