CYSTOPHORA

The genus *Cystophora*

Twenty-three species of this genus of large brown algae occur in southern Australia. Most of them are endemic (found nowhere else). They form the perennial canopy layer of many shallow water marine communities, providing food and refuges for invertebrates and fish, changing environmental conditions for understorey plants and animals. They can be used by ecologists to determine the health of ecosystems.

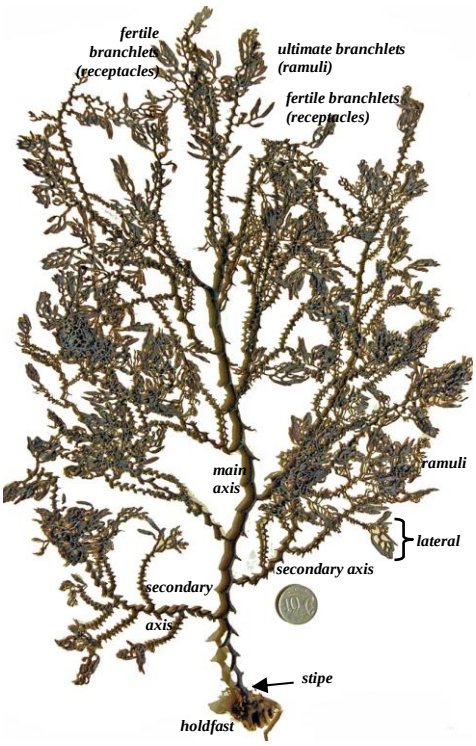
Identification can be difficult and should rely on reproductive structures (receptacles), however, these are not always present on specimens. For this reason, the key below attempts to separate species largely on vegetative shape in the hope you can make a quick, but tentative identification, then go to the more technical descriptions, found in the Flora, for verification. The key follows that of Womersley, H.B.S (1987) *The marine benthic Flora, of southern Australia* but where possible, commonest or more easily recognised species are generally treated first.

Common names These have been suggested in Edgar, H, J. (2008) *Australian Marine Life. The plants and animals of temperate waters*. New Holland Australia

Scale and artefacts The 10c piece in the images below is 24 mm across or almost 1 inch in diameter. ⚠ Pressed specimens may shrink, distort and become almost black when dried.

Appendices snapshots of easily recognised features of some species and fertile parts are illustrated at the end of the key.

Basic shape (morphology) of *Cystophora* species



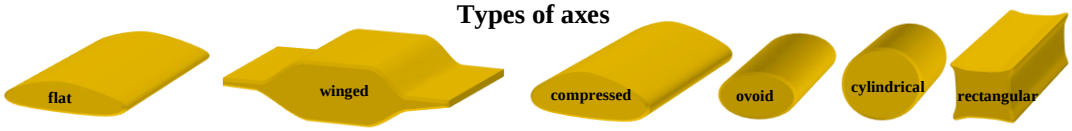
whole plant (*C. racemosa*)

wavy fertile branchlets (***receptacles***) (*C. siliquosa*)

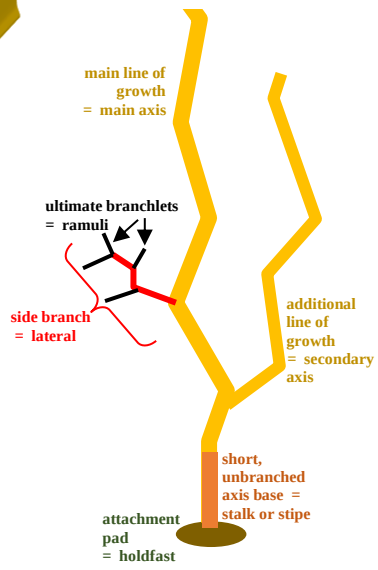
prominent floats (***vesicles***); bumpy fertile branchlets (***receptacles***) (*C. subfarcinata*)

fresh specimens (above, left) and a dried specimen (above, right) of *Cystophora moniliformis*

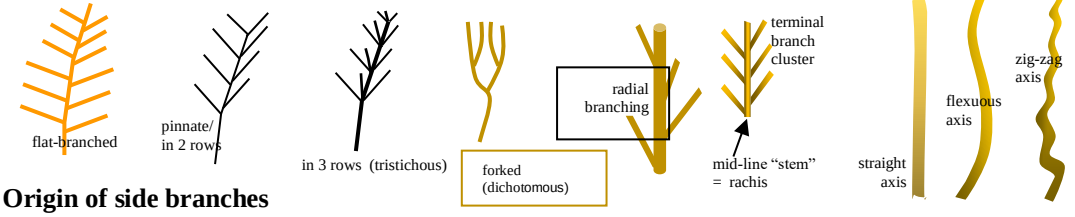
Types of axes



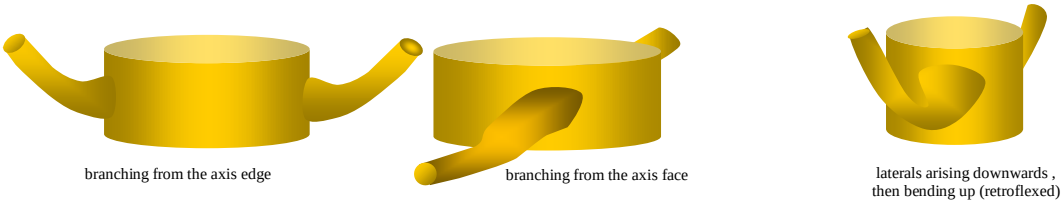
Terms used for branches



Branching pattern



Origin of side branches



KEY

1a. branching from the ***edges*** of flattened or ovoid axes, or from ***opposite sides*** of cylindrical axes ..... 2.

1b. branching from the ***faces*** of compressed, rectangular, winged or cylindrical axes ..... 5.

2a. axes broad, 5-15 mm wide ..... 3.

2b. axes cylindrical or ovoid in cross section, 2-6 mm wide ..... 4.

3a. axis ***strap-like***, flat, straight. Short, tree-like laterals spread outwards from the edges of the axis. Floats ***absent***. A common species growing over 1m long. Figs 1, 2.
……. *Cystophora moniliformis*
"Zigzag cystophora"

3b. axis more ovoid and zig-zag than strap-like. Laterals flat-branched twice over, their width only slightly less than that of the main axis. Floats ***large***, spherical, 5-15 mm wide. Fertile branchlets (receptacles) lance-shaped. A deepwater species in western parts, but sometimes washed up on beaches. Figs 3, 4.
..... *Cystophora platylobium*
"Flat-lobed cystophora"

4a. plants grow mainly in the zone between waves ("surge-zone") on rough-water coasts. Axes ***ovoid*** in cross section. Laterals often ***denuded*** of their ultimate, fine, tufted, cylindrical branches (ramuli). Floats ***absent***. Figs 5, 6.
..... *Cystophora intermedia*
"Shore cystophora"

4b. plants in deep water, (25 m). Axes ***cylindrical***, laterals open, spreading, flat-branched, ramuli long, thin, but fertile receptacles comb-like; floats ***single***, 5-12 mm wide. Figs 7-9.
..... *Cystophora grevillei*
"Greville's cystophora"

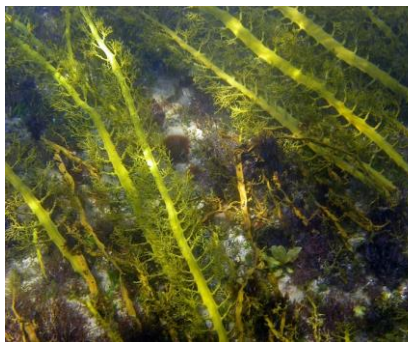


Fig. 1: underwater view of *Cystophora moniliformis* (above)

Fig. 2: dried, darkened specimen of *Cystophora moniliformis* (right)

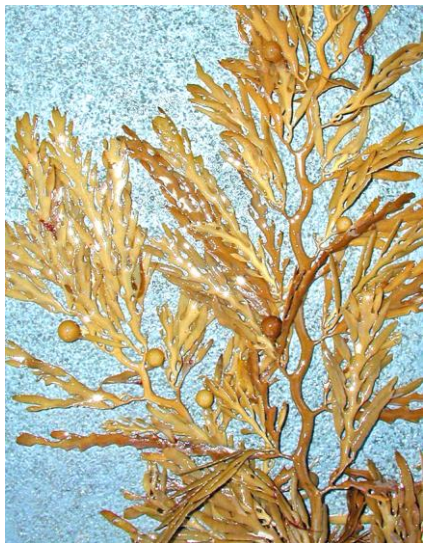


Fig. 3: *Cystophora platylobium*

Fig. 4: *Cystophora platylobium*, floats, lance-shaped fertile branchlets (receptacles, arrowed)

Figs 5, 6: denuded *Cystophora intermedia* exposed between waves, on granite boulders

Fig. 7: *Cystophora grevillei*, whole plant (left)

Fig. 8: ramuli and floats (right)

Fig. 9: comb-like fertile receptacles (far right)

5a. laterals with ***unbranched*** (rarely forked), ***sword-shaped*** and flat ultimate branchlets (ramuli), 20-60 mm long, 3-8 mm wide, that develop a row of fertile pits along each margin; floats ***absent***. From Tasmania and Cape Otway, Vic. ?only. Figs 10-12.
……. *Cystophora xiphocarpa* "Tasmanian cystophora"

5b. laterals with ***branched*** ramuli; floats absent or present ..... 6.

6a. laterals in 2 opposite (pinnate) and ***flat-branched*** rows. Fertile branchlets (receptacles) ***flat***, 1.5-4.0 mm wide ...…….…... 7.

6b. not as above ..... 8.

7a. axes ***ovoid*** in cross section. Laterals **comb-like**, of a central "stem" (rachis) and 2 opposite rows of ramuli each with a ***central ridge*** and ***wings*** running continuously from the ramuli into the rachis. Floats ***absent***. Figs 13-15.
……..... *Cystophora pectinata* "Fishbone cystophora"

7b. axes ***compressed***, laterals and ramuli without wings. Floats usually ***present***, almost spherical, 3-8 (-10) mm wide, single, replacing the basal ramulus of a lateral. Figs 16-18
……. *Cystophora racemosa*

Figs 10, 11: *Cystophora xiphocarpa*, whole plant, sword-shaped, unbranched ramuli
Fig. 12: receptacles with marginal pits

Fig. 13: *Cystophora pectinata*, comb-like (pinnate) branchlets (ramuli) (above, left)
Fig. 14 detail of comb-like branching pattern with winged central ridge and ramuli in 2 opposite rows, central ridges arrowed (above, right)
Fig. 15. *Cystophora pectinata*, whole plant (left)

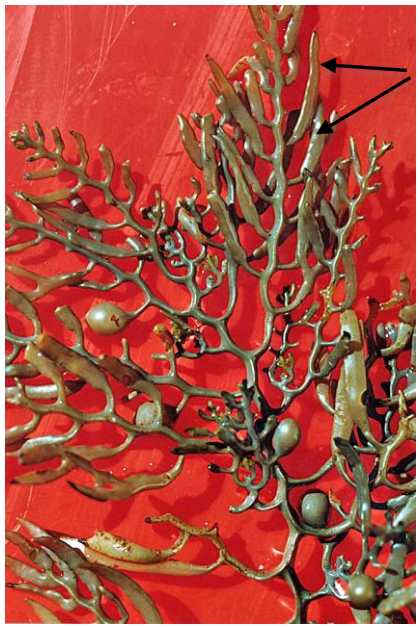


Fig. 16: *Cystophora racemosa*, underwater view (left).
Fig. 17: compressed axis with downward-pointing lateral stubs (above)
Fig. 18: branching of laterals, single floats, flattened fertile branchlets (arrowed)

8a. Floats numerous, ***clustered*** near the ***base*** of laterals ……..… 9.

8b. Floats (if present) single, ***or*** in pairs at the base of laterals, ***or*** scattered …….... 10.

9a. floats ***large***, spherical or slightly egg-shaped, 3-4 mm wide, in ***grape-like bunches*** at the base of laterals. Main branches (axes) with rounded edges. Figs 19, 20. …… *Cystophora botryocystis* "Grape cystophora"

9b. floats ***small***, ***tapering*** at both ends, 2-3 mm wide, ***loosely clustered*** towards the base of laterals. Mature axes ***rectangular***. Figs 22-26. …….. *Cystophora polycystidea*

10a. ramuli appear to be radially branched (strictly 3-sided, but this is only visible at plant tips). Ramuli ***slender***, 0.2-0.5 mm wide. Fertile branchlets (receptacles) characteristically bumpy or beaded ……..….. 11.

10b. branching ***flat or irregular***. Ramuli slender to robust, 0.5-4.0 mm wide. Receptacles various ……... 12.

Fig. 19: (above) *Cystophora botryocystis* whole plant (some ramuli are covered with encrusting coralline algae in this specimen and are lighter coloured), clusters of floats arrowed

Fig .20: (right) basal clusters of floats

Figs 22, 23: dried specimens of *Cystophora polycystidea*. Left: 4-sided axis. Centre: densely branched specimen. Right: sparsely branched specimen

Fig. 24: fresh but denuded specimen of *Cystophora polycystidea*. Only a few floats remain at the base of laterals making it difficult to separate this species easily from *C. expansa* using float features. Note, however, laterals mainly arise at right angles to axes (are not reflexed as in *C. expansa*)

Fig. 25: fresh specimen of *Cystophora polycystidea*, floats. Thin, radially arranged ramuli, thin fertile receptacles (arrowed)

Fig. 26: fresh specimen of *Cystophora polycystidea*, clustered floats and rectangular or 4-sided laterals

11a. floats ovoid with tapering ends, 3-7 mm long, 1-2 mm wide, ***scattered*** over laterals. Main branches (axes) compressed, ***retroflexed*** Figs 27-30. ..... *Cystophora expansa*
"Expansive cystophora"

11b. floats (if present) almost spherical, 3-6 (-8) mm wide, in lower parts of laterals. Axes compressed and ***prominently winged***. Figs 30-35. ..... *Cystophora monilifera*
"Three-branched cystophora"

Fig. 27: *Cystophora expansa*, dried specimen, scattered floats, downward-pointing stubs of denuded laterals

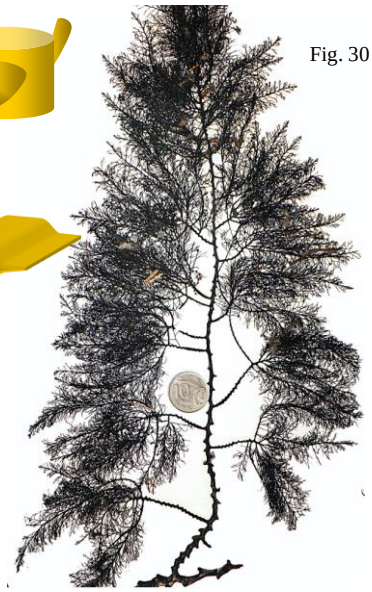


Fig. 28: *Cystophora expansa*, dried specimen

Fig. 30 (Right): *Cystophora expansa* receptacles

Fig. 29: *Cystophora expansa*, fresh specimen, floats forming along a lateral, branched ramuli

Fig. 32: *Cystophora monilifera*, detail of floats

Fig. 33: *Cystophora monilifera*, detail of axis with downward-pointing, ***winged*** lateral stubs

Fig. 31: *Cystophora monilifera*, whole plant

Figs 34, 35: *Cystophora monilifera*, ***fresh*** (left) and ***dried*** (right) receptacles with swollen fertile parts and a short end thread (awn)

12a. laterals dark, thick, unbranched and sausage-shaped, or forked 1-3 times. Ramuli mature into fertile branchlets: they are ***thick***, 2-3 mm wide, relatively smooth, cylindrical or slightly three-sided, sometimes curved, and ***clustered close to axes***. An eastern Australian species. Figs 36, 37.
…….. *Cystophora torulosa*
"Club-leafed cystophora"

12b. laterals much-branched ***flat-branched*** occasionally in 2 rows or irregularly branched. Receptacles ***thin***, 0.2-2.0 mm wide, ***not clustered*** close to axes
……. 13.

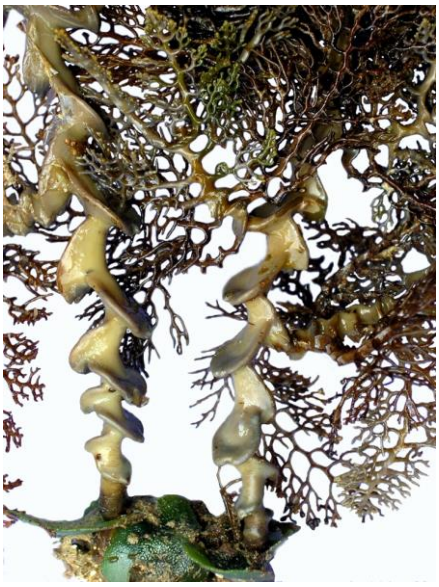
13a. laterals and ramuli ***rigid***, ramuli ***short***, 0.2-2.0 mm long. Stubs of denuded laterals are ***broad***, concave, backward-pointing with ***prominent wings*** that run down into the axes. Fertile branchlets are ***tiny***, with 2-3 bead-like fertile swellings. Figs 38-40. ..……..… *Cystophora brownii*
"Brown's cystophora"

13b. laterals slightly to very floppy. Stubs of denuded laterals smaller, and less prominent. Fertile branchlets larger, 2-60 mm long, hair-like, wavy-edged or bead-like and some with a long terminal thread (awn)
……..……..... 14.

14a. axes may be ***compressed***, 2-7 mm wide; laterals ***forked***. Floats ***rare***, elongate-egg-shaped and often ***asymmetrical***. Cross sections of fertile parts of receptacles have both sperms and eggs a difficult feature to find but which is needed to separate this species from *C. siliquosa*. Figs 41-45.
…….. *Cystophora retorta*
"Open-branched cystophora"

14b. axes various, laterals more irregularly branched, floats present or absent
……. 15.

Figs 36, 37: Above, *Cystophora torulosa*, whole plant at Tinderbox, Tasmania (Photo: Fiona Scott) and right, dried specimen (wrinkled); with forked laterals



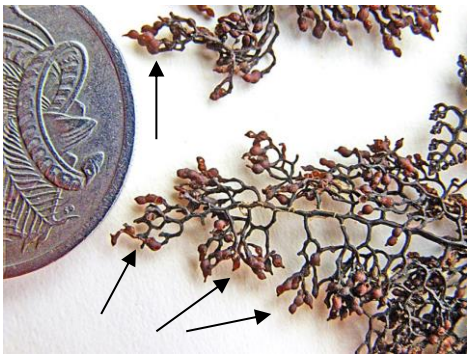


Fig. 38: *Cystophora brownii*, plant bases, prominent downward-pointing lateral stubs
Fig. 39: flat-branching pattern (upper, right)
Fig. 40: fertile branchlets (arrowed)

Fig. 41: *Cystophora retorta*, in 1 m of water

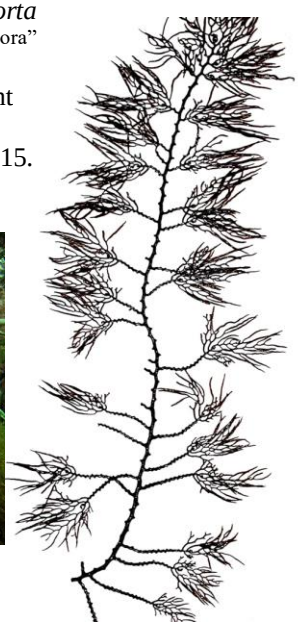
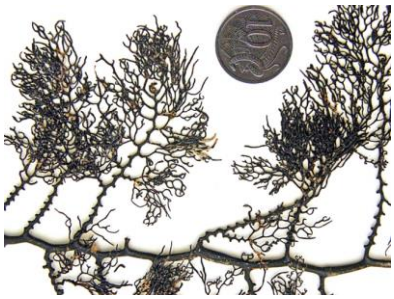
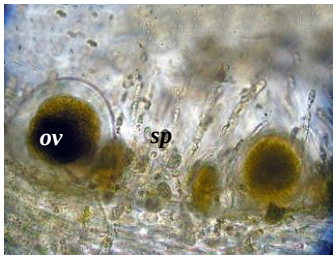


Fig. 42: *Cystophora retorta*, whole, dried, sparsely branched plant (left)
Fig. 43: detail of forked, flat-branched laterals (right)
Fig. 44: strap-like axis (***ax***) (below, left)
Fig. 45: cross section of fertile receptacle at high magnification, eggs (***ov***), and male structures (***sp***) (right)





15a. ***mature*** axis ***winged*** …… 16.
15b. ***mature*** axis not winged …..…… 17.

16a. ***mature*** axis with ***rounded mid-rib*** flanged by thin wings; laterals stiff and mainly cylindrical, ramuli straight or slightly wavy, about 30 mm long, in ***loose tufts***. Receptacles compressed and ***wavy***. Floats absent or dense, 1-2 basally on laterals, spherical, 4-10 mm wide. A mainly eastern species. Figs 46-48.
…… *Cystophora retroflexa*
"Labillardiere's cystophora"

16b. ***mature*** axis with broad flanges, running into laterals. Ramuli are prominently tufted, thin, 10-20 mm long. Receptacles are slightly compressed, 10-30 mm long. Floats usually dense, occasionally absent, 3-7 (-10) mm wide. Figs 49-51.
……..... *Cystophora congesta*
"Congested cystophora"

Fig 46: *Cystophora retroflexa*, portion of a whole plant (above)
Fig. 47: axis with rounded mid-rib and flanges, stiff laterals (above, right)
Fig. 48: dried specimen, collapsed floats, compressed and wavy receptacles

Fig 49: *Cystophora congesta*, whole plant, tufts of ramuli (far left)
Fig. 50: axis with flanges (left
Fig. 51: dried specimen, collapsed floats, (right)

17a. mature axis thin, 2-4 mm wide, ***flexuous*** except basally. Floats ***absent***, laterals mostly arise ***upwards*** from the axis
..... 18.
17b. mature axis thicker, > 4 mm wide. Floats present or absent; laterals arise downwards or upwards from the axis ……..… 19.

18a. axis ***ovoid*** to ***compressed*** in cross section, additional (secondary) axes occur mainly towards the plant base Well-spaced lateral stubs curve ***outwards*** or ***upwards*** from the axis face. A ***widespread*** but uncommon species. Figs 52-54.
…… *Cystophora gracilis*
"Womersley's cystophora"

18b. axis ***rectangular,*** additional (secondary) axes occur along the complete length of the main axis. Lateral stubs curve ***upwards*** from axes, and are ladder-like at the plant base. A species ***probably restricted*** to SW W Australia. Figs 55-58.
…… *Cystophora tenuis*

Fig. 52: *Cystophora gracilis*, whole plant

Fig. 53: *Cystophora gracilis*: narrow axis, ovoid in cross section, widely spaced lateral stubs pointing outwards or upwards

Fig. 54: *Cystophora gracilis*, compressed axis, lateral with fertile branchlets (receptacles)

Fig. 55: *Cystophora tenuis*, ladder-like lateral stubs on axes at the plant base

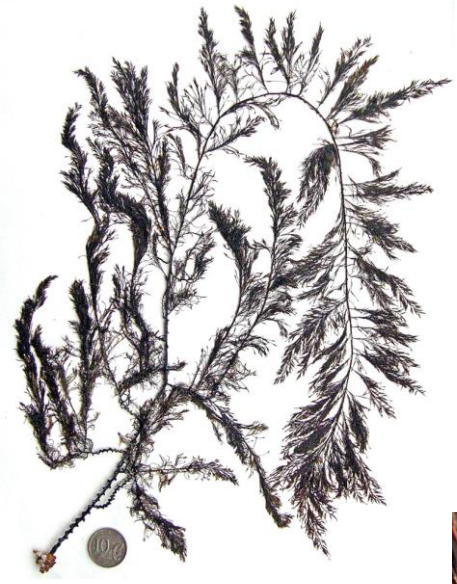


Fig. 56: *Cystophora tenuis*, whole plant, several secondary axes arising along the main axis

Fig. 58: *Cystophora tenuis*, fertile branchlets

Fig. 57: *Cystophora tenuis*, lateral arising upwards from a rectangular axis

19a. axis when fresh is ***lens-shaped***, drying strap-shaped, with button-like stubs of laterals on the face. Laterals arise outwards or upwards, their denuded bases crowded with stubs, producing a ***knobbly effect***. Probably restricted to SW W Australia. Figs 58-60.
……..... *Cystophora harveyi*
"Western cystophora"

19b. axis thin, flat ovoid or rectangular, denuded bases of laterals more widely spaced, pointing upwards or downwards ……...…..…….. 20.

20a. ***rare***, only known from Portland Bay, Victoria on the sea grass *Amphibolis*. Mature axis flat, laterals tufted, wiry; floats if present are egg-shaped, some coming to a point, fertile receptacles bead-shaped when dried.
Figs 61, 62
……... *Cystophora cymodoceae*

20b. relatively common, on rock. Mature axes flat or rectangular in cross section, floats can be present or absent
…….. 21.

21a. axes ***rectangular***. . Receptacles have either eggs or sperms (are unisexual) which separates this species from *C. retorta*, Fig 45)
Figs 63-65
…….. *Cystophora siliquosa*
"Slender cystophora"

21b. axes compressed …… 22.

Fig. 58: *Cystophora harveyi*, cross section of dried, lens-shaped axis (above)

Fig. 59: *Cystophora harveyi*, whole plant (left)

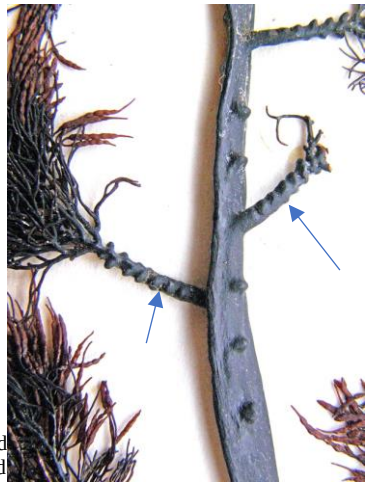


Fig. 60: *Cystophora harveyi*, dried button-like lateral stubs, d effect (arrowed)

Fig. 61: *Cystophora cymodoceae* whole plant

Fig. 62: *Cystophora cymodoceae*, wiry laterals, bead-like fertile branchlets (receptacles)

Fig. 63: *Cystophora siliquosa*, whole plant

Fig. 64: *Cystophora siliquosa*, rectangular axis

Fig. 65: *Cystophora siliquosa*, relatively long fertile branchlets (receptacles) with ***wavy*** edges

22a. a common species. ***Mature*** axis slightly ***wavy***, up to 7 mm wide, thin edged, sometimes with peg-like branch stubs. Laterals arising ***downwards*** in 2 rows from axes, with cylindrical (terete), unbranched or forked ramuli, 5-30 mm long, in ***dense tufts***. Floats absent, but numerous on plants growing in calm waters. Fertile branchlets (receptacles) up to 30 mm long, with fertile lumps (conceptacles) in ***2 marginal rows*** and long threads (***awns***) at their tips.
Figs 66-69.
…… *Cystophora subfarcinata*
"Bushy cystophora"

22b. ***rare***. Axes thin and straight, up to 6 mm wide. Laterals arising slightly ***upwards*** with ramuli 10-60 mm long. Floats ***absent***. Fertile branchlets (receptacles) 20-60 mm long; fertile lumps (conceptacles) are concentrated basally but separated by long gaps towards tips. Possibly a form of *Cystophora subfarcinata.* Figs 70-72.
……..…… *Cystophora cuspidata*
"Awled cystophora"

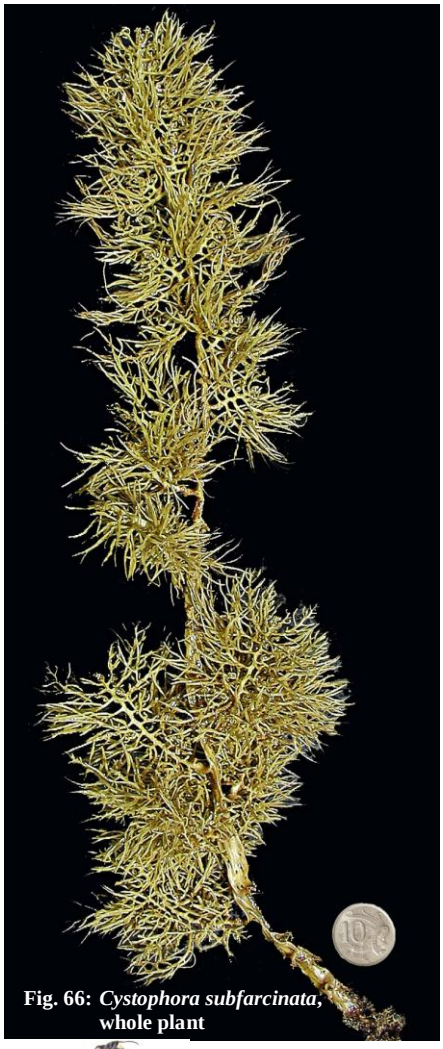


Fig. 66: ***Cystophora subfarcinata*, whole plant**

Fig. 67: wavy axis, dense laterals

Fig. 68: floats, receptacles

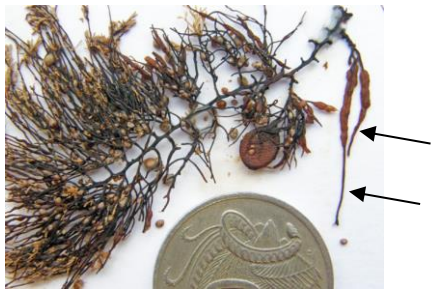
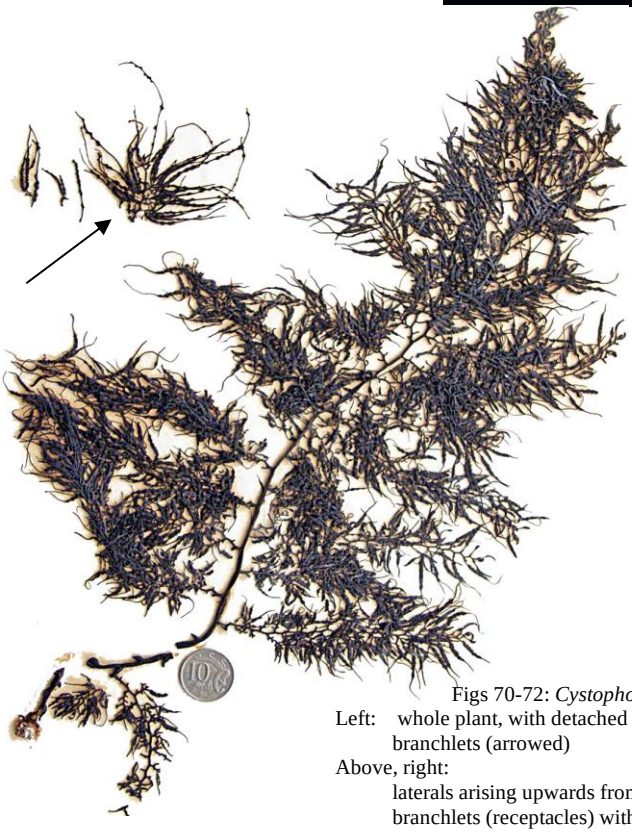
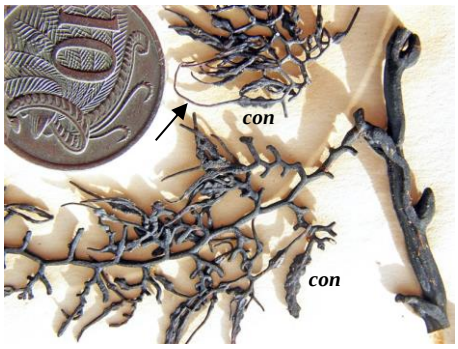


Fig 69: dried specimen, float, receptacles with bumpy margins and thread (awn) at tips (arrowed)



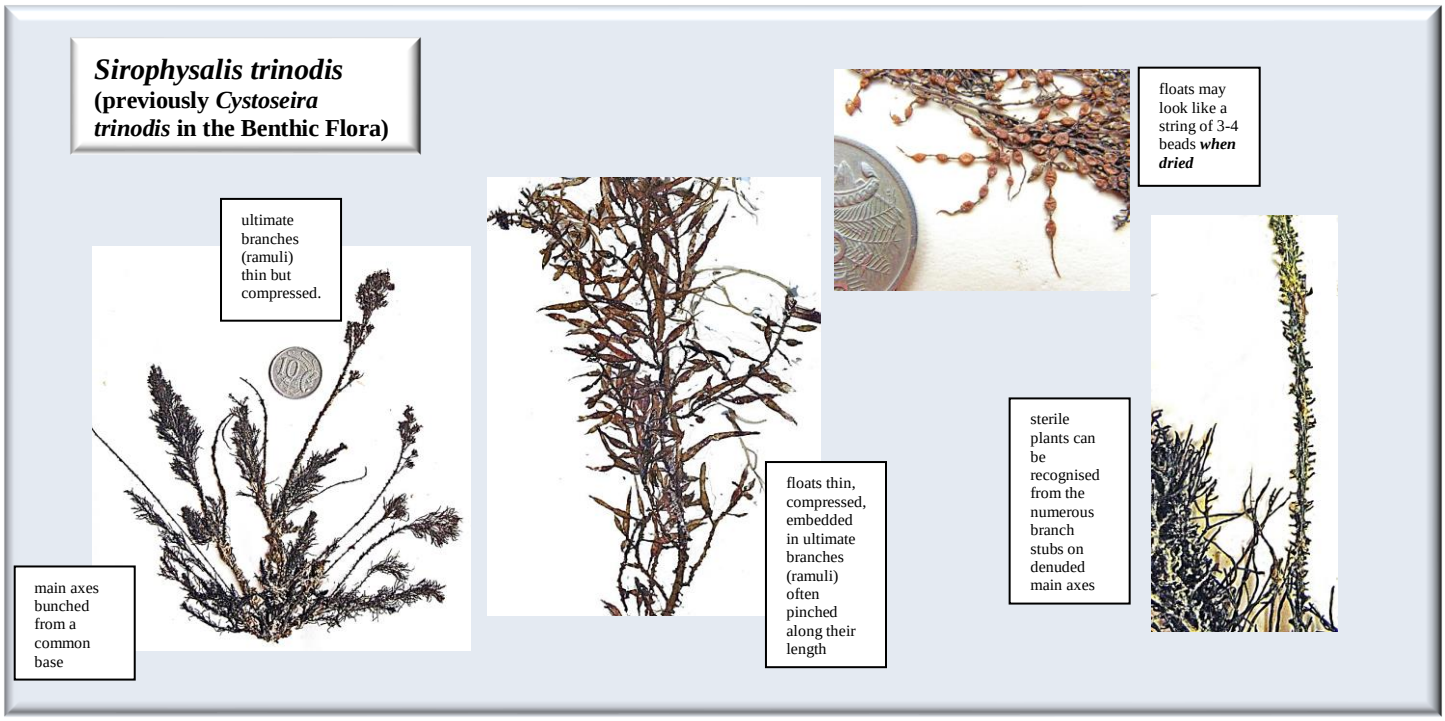


Figs 70-72: *Cystophora cuspidata*
Left: whole plant, with detached cluster of fertile branchlets (arrowed)
Above, right:
laterals arising upwards from an axis, fertile branchlets (receptacles) with fertile bumps (conceptacles) basally (***con***), apical awn (arrowed)
Below, right:
Variation in larger receptacles, large distances between conceptacles in upper parts (arrowed)

SPECIES IN THE KEY ABOVE

species	author(s)	page
C. botryocystis	Sonder	4
C. brownii	(Turner) J. Agardh	6
C. congesta	Womersley & Nizamuddin *ex* Womersley	7
C. cuspidata	J. Agardh	10
C. cymodoceae	Womersley & Nizamuddin *ex* Womersley	9
C. expansa	(Areschoug) Womersley	5
C. gracilis	Womersley	8
C. grevillei	(C. Agardh *ex* Sonder) J. Agardh	2
C. harveyi	Womersley	9
C. intermedia	J. Agardh	2
C. monilifera	J. Agardh	5
C. moniliformis	(Esper) Womersley & Nizamuddin *ex* Womersley	2
C. pectinata	(Greville & C. Agardh *ex* Sonder) J. Agardh	3
C. platylobium	(Mertens) J. Agardh	2
C. polycystidea	Areschoug *ex* J. Agardh	4
C. racemosa	(Harvey *ex* Kützing) J. Agardh	3
C. retorta	(Mertens) J. Agardh	6
C. retroflexa	(Labillardière) J. Agardh	7
C. siliquosa	J. Agardh	9
C. subfarcinata	(Mertens) J. Agardh	10
C. tenuis	Womersley	8
C. torulosa	(R. Brown *ex* Turner) J. Agardh	6
C. xiphocarpa	Harvey	3

APPENDIX I/III: *CYSTOPHORA* LOOK ALIKES



Caulocystis— floats attach directly to the main axis

Caulocystis uvifera — floats spherical –
Some workers consider this to be merely a single species (*C. cephalornithos*) with variation in float shape

Caulocystis cephalornithos — floats spindle-shaped (narrowed at both ends)

Acrocarpia — spirally arranged ultimate branches (ramuli). Floats absent

Acrocarpia robusta – from W. Australia

fertile ultimate branches cylindrical but bumpy and densely bunched

Wiry axes arise from a stumpy base.
Axes often covered with encrusting red algae

Acrocarpia paniculata

Sargassum — basal parts perennial, often leafy and different to upper fertile parts which are often shed annually. Floats often end in a thread or a small "leaf"

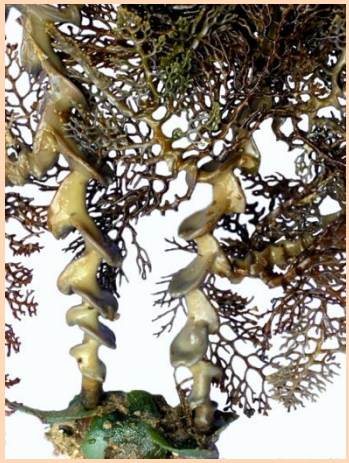
Sargassum lacerifolium —
basal "leaves" only prominent part present

Sargassum decipiens — all parts thread-like, and can be confused with *Caulocystis*

Sargassum verruculosum — basal divided "leaves" contrast with upper thread-like parts

APPENDIX II/III - *CYSTOPHORA* AT A GLANCE
Quick visual recognition guide to SOME southern Australian species with easily recognised features
Species are in alpha order and may appear several times within categories

SPECIES WITH SIDE BRANCHES DISTINCTLY FLAT-BRANCHED

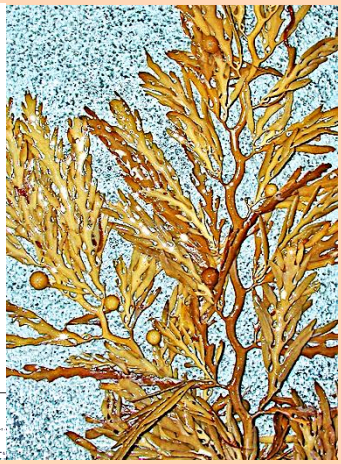


Cystophora brownii

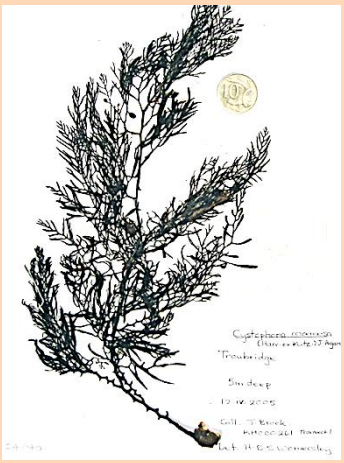
Cystophora grevillei

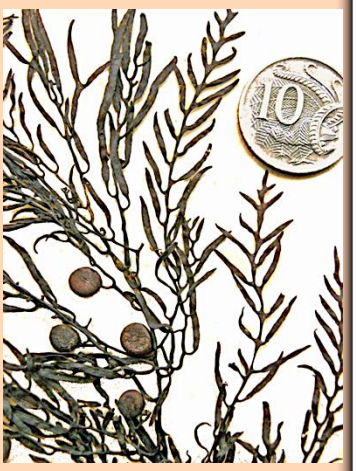
Cystophora intermedia
When denuded by strong wave action

Cystophora pectinata



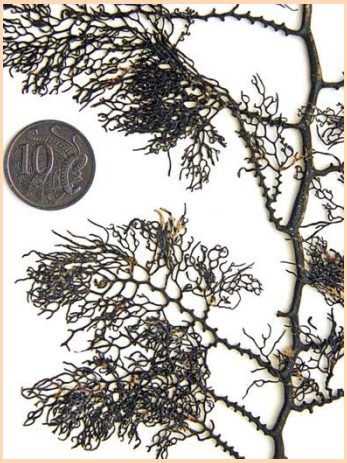
Cystophora platylobium





Cystophora racemosa

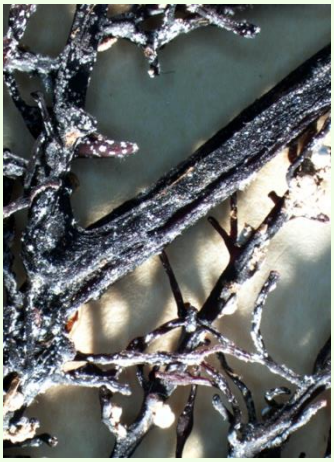
***Cystophora* continued next page**



Cystophora retorta

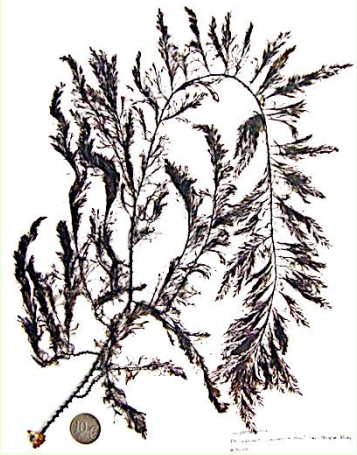
Cystophora siliquosa

MAIN BRANCHES (AXES) RECTANGULAR



Cystophora polycystidea

Cystophora siliquosa



Cystophora tenuis

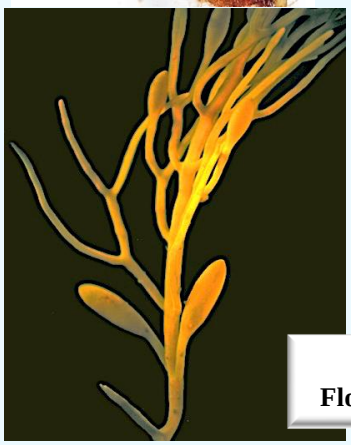
SPECIES WITH FLOATS (VESICLES) HAVING DIAGNOSTIC VALUE

Cystophora botryocystis

Floats in grape-like bunches

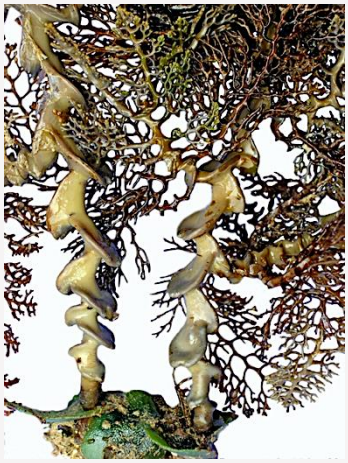
Cystophora congesta
Floats spherical, clustered towards the base of side branches

Cystophora polycystidea
Floats egg-shaped, clustered at the bases of side branches



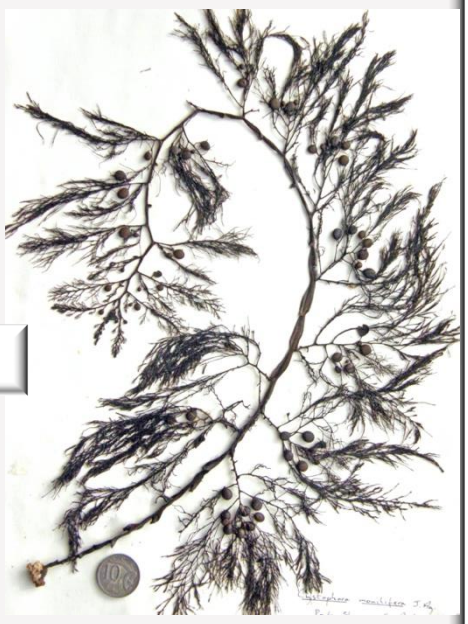
Cystophora expansa
Floats small, few and scattered along side branches

SPECIES WITH PROMINENT WINGS ON AXES



Cystophora brownii

Cystophora monilifera



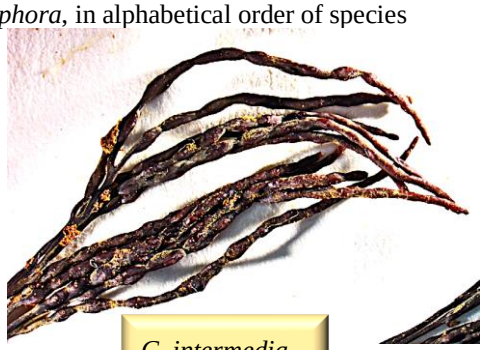
Cystophora monilifera

Cystophora subfarcinata
wings on axis base

APPENDIX III/III:
snap shots of fertile branchlets (receptacles) of mainly pressed specimens of *Cystophora*, in alphabetical order of species

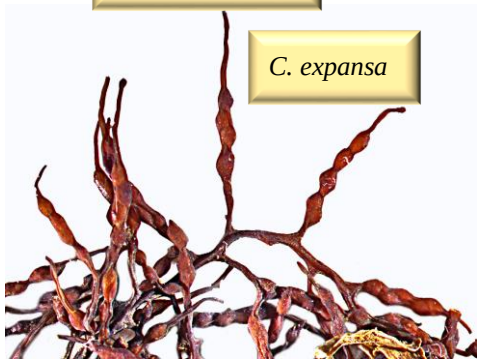
C. botryocystis

C. cymodoceae



C. intermedia

C. brownii



C. expansa

C. monilifera

C. congesta

C. gracilis

C. moniliformis

C. cuspidata

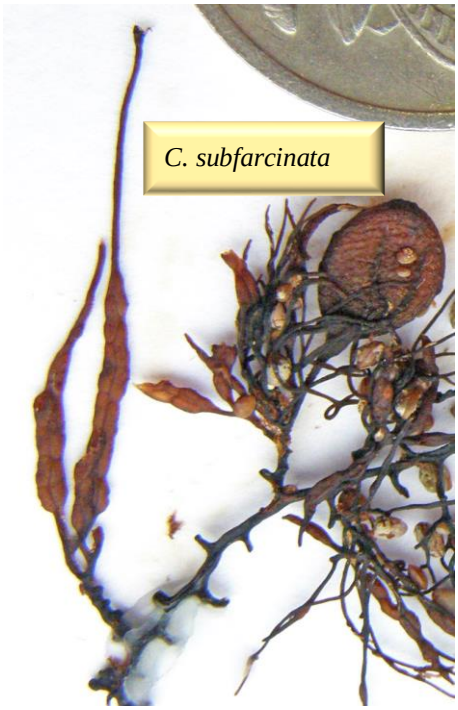
C. grevillei

C. pectinata

C. harveyi

C. platylobium

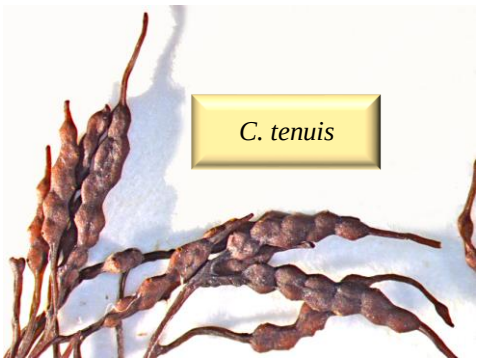
C. siliquosa



C. subfarcinata

C. polycystidea

C. racemosa



C. tenuis

C. retorta

C. torulosa

C. torulosa

C. retroflexa

C. xiphocarpa