

# CATAMI Classification Scheme for scoring marine biota and substrata in underwater imagery

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A pictorial guide to the Collaborative and Automated Tools for Analysis of Marine Imagery (CATAMI) classification scheme.

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6. WAM — Western Australian Museum
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## Note to users and future contributors:

The idea of this guide is to have a visual, printable overview of the CATAMI Classification Scheme, including their CAAB codes and with short descriptions of the rationale and identifying factors for each category within the CATAMI tree and a few *in situ* example images so someone new to the field can get their head around the classes – eventually more images will become available through searches in the CATAMI database ([www.catami.org](http://www.catami.org)) and/ or in the CAAB database (Codes for Australian Aquatic Biota; <http://www.cmar.csiro.au/caab/>).

This Version 1 is meant to be a work in progress and we welcome comments, additional descriptions and images for subsequent versions; please contact the CATAMI team ([catami@ivec.org](mailto:catami@ivec.org)). For further information refer to <http://catami.org/classification>

## Contents

Acknowledgements: .....	2
Citation: .....	2
Note to users and future contributors: .....	2
Contents .....	3
Background.....	7
Versions .....	8
PHYSICAL – CAAB 82 000000 .....	9
1 Substrate – CAAB 82 001000 .....	9
2 Substrate: Consolidated (hard) – CAAB 82 001001 .....	10
3 Consolidated (hard): Cobbles – CAAB 82 001004 .....	10
3 Consolidated (hard): Boulders – CAAB 82 001003 .....	10
3 Consolidated (hard): Rock – CAAB 82 001002 .....	11
2 Substrate: Unconsolidated (soft) CAAB 82 001005 .....	12
3 Unconsolidated (soft): Sand / mud (<2mm) – CAAB 82 001013 .....	12
4 Sand / mud (<2mm): Coarse sand (with shell fragments) – CAAB 82 001014 .....	12
4 Sand / mud (<2mm): Fine sand (no shell fragments) – CAAB 82 001015 .....	12
4 Sand / mud (<2mm): Mud / silt (<64um) – CAAB 82 001016 .....	13
3 Substrate: Unconsolidated (soft): Pebble / gravel – CAAB 82 001006 .....	13
1 Relief – CAAB 82 003000 .....	16
2 Relief: Flat – CAAB 82 003001 .....	16
2 Relief: Low / moderate – CAAB 82 003002 .....	17
3 Low / moderate: Low (<1m) – CAAB 82 003003 .....	17
3 Low / moderate: Moderate (1-3m) – CAAB 82 003004 .....	17
2 Relief: High – CAAB 82 003005 .....	18
3 High: High (>3m) – CAAB 82 003006 .....	18
3 High: Wall – CAAB 82 003007 .....	18
1 Bedforms – CAAB 82 002000 .....	19
2 Bedforms: None – CAAB 82 002001 .....	20
2 Bedforms: Bioturbated – CAAB 82 002005 .....	20
2 Bedforms: 2D – CAAB 82 002002 .....	21
3 2D: Ripples (<10cm height) – CAAB 82 002003 .....	21
3 2D: Waves (>10cm height) – CAAB 82 002004 .....	21
2 Bedforms: 3D – CAAB 82 002006 .....	22

3 3D: Ripples (<10cm height) – CAAB 82 002007.....	22
3 3D: Waves (>10cm height) – CAAB 82 002008.....	22
1 Biota – CAAB 80 000000 .....	23
2 Bacterial mats – CAAB 72 000901 .....	23
3 Bacterial mats: Cyanobacteria – CAAB 70 000901 .....	23
3 Bacterial mats: Other – CAAB 72 000902 .....	23
2 Macroalgae – CAAB 80 300000 .....	24
3 Macroalgae: Filamentous / filiform – CAAB 80 300930 .....	26
3 Macroalgae: Encrusting – CAAB 80 300926 .....	27
3 Macroalgae .....	28
3 Macroalgae: Sheet-like / membranous – CAAB 80 300922 .....	29
3 Macroalgae: Laminate – CAAB 80 300918 .....	30
3 Macroalgae: Erect fine branching – CAAB 80 300907 .....	32
3 Macroalgae: Large canopy-forming – CAAB 80 300901.....	36
2 Seagrasses – CAAB 63 600901.....	37
3. Seagrasses: Elliptical leaves – CAAB 63 600902 .....	37
3. Seagrasses: Strap-like leaves – CAAB 63 600903 .....	37
2 Sponges- CAAB 10 000000.....	39
2 Cnidaria – CAAB 11 500000 .....	40
3 Cnidaria: Hydroids – CAAB 11 001000.....	41
3 Cnidaria: Hydrocorals – CAAB 11 077000.....	42
3 Cnidaria: Corals – CAAB 11 168000 .....	43
3 Cnidaria: True anemones – CAAB 11 229000.....	55
3 Cnidaria: Tube anemones – CAAB 11 164000 .....	56
3 Cnidaria: Colonial anemones – CAAB 11 500901 .....	57
2 Jellies – CAAB 80 600903 .....	58
3 Jellies: Hydromedusae – CAAB 11 000901 .....	58
3 Jellies: Siphonophores – CAAB 11 090000.....	59
3 Jellies: Cubozoa – CAAB 11 150000 .....	59
3 Jellies: Ctenophores – CAAB 12 000000 .....	59
3 Jellies: Scyphozoa – CAAB 11 120000.....	60
3 Jellies: Pyrosomes – CAAB 35 101000 .....	60
3 Jellies: Salps – CAAB 35 100000.....	61
2 Worms – CAAB 80 600901.....	62
3 Worms: Flatworms – CAAB 13 000000.....	62
3 Worms: Penisworms – CAAB 15 400000 .....	62

3 Worms: Echiura – CAAB 17 020000.....	63
3 Worms: Sipuncula – CAAB 17 000000.....	63
3 Worms: Acorn worms – CAAB 36 110000 .....	63
3 Worms: Polychaetes – CAAB 22 000000 .....	64
2 Bryozoa – CAAB 20 000000 .....	65
3 Bryozoa: Hard – CAAB 20 000901.....	65
3 Bryozoa: Soft – CAAB 20 000905 .....	67
2 Ascidia – CAAB 35 000000 .....	68
3 Ascidians: Stalked – CAAB 35 000904.....	68
3 Ascidians: Unstalked – CAAB 35 000901 .....	70
2 Crustacea – CAAB 27 000000 .....	71
3 Crustacea: Barnacles – CAAB 27 500000 .....	72
3 Crustacea: Prawns / shrimps / mysids – CAAB 28 000901 .....	73
3 Crustacea: Lobsters – CAAB 28 000902 .....	73
3 Crustacea: Hermit crabs – CAAB 28 825901.....	74
3 Crustacea: Crabs – CAAB 28 000903 .....	75
2 Seaspiders – CAAB 33 000000 .....	76
2 Echinoderms – CAAB 25 000000 .....	77
3 Echinoderms: Feather stars – CAAB 25 001000 .....	78
3 Echinoderms: Ophiuroids – CAAB 25 160000.....	79
3 Echinoderms: Sea stars – CAAB 25 102000 .....	80
3 Echinoderms: Sea urchins – CAAB 25 200000.....	80
3 Echinoderms: Sea cucumbers – CAAB 25 400000 .....	81
2 Brachiopods – CAAB 19 100000 .....	82
2 Molluscs – CAAB 23 000000 .....	83
3 Molluscs: Chitons – CAAB 23 100000 .....	83
3 Molluscs: Bivalves – CAAB 23 3199000 .....	84
3 Molluscs: Gastropods – CAAB 24 000000 .....	84
3 Molluscs: Cephalopods – CAAB 23 590000 .....	84
2 Fishes – CAAB 37 000000 .....	86
3 Fishes: Eels – CAAB 37 990025 .....	86
3 Fishes: Elasmobranchs – CAAB 37 990082 .....	87
3 Fishes: Bony fishes – CAAB 37 990083 .....	88
2 Bioturbation – CAAB 81 000000 .....	89
References and useful links .....	90
General Identification Guides:.....	90

*CATAMI Classification Scheme Version 1.3*

Substrate / Bedform References & Websites:.....	90
Algal References & Websites:.....	90
Seagrass References & Websites:.....	91
Sponge References & Websites:.....	91
Coral References & Websites:.....	91
Jellies References & Websites:.....	91
Fishes References & Websites:.....	92
Bioturbation References & Websites: .....	92
Contributing institutions: .....	93

## Background

This document provides definitions and examples for the categories described in Version 1.2 of the CATAMI Classification Scheme for marine biota and substrata in underwater imagery (CATAMI Technical Working Group, 2013). It is envisaged that imagery from a range of sources, including video and digital stills and hence spanning a range in resolution and quality, will be scored using this system. Actual methods for scoring, however, may vary according to researchers' needs and could include scoring of dominant biota, point counts or a complete census.

The classification scheme was designed to allow images from shallow waters to abyssal depths and from the tropics to Antarctic / Arctic waters to be classified using the same labels, i.e. a set of consistent identifiers. For ease of tracking and data-basing, each standardised label was also assigned a CAAB 'code'. CAAB stands for Codes for Australian Aquatic Biota and is a numerical code that is listed, described and maintained through a CSIRO website at (<http://www.cmar.csiro.au/caab/>). Originally CAAB were only used for taxonomic classification of biota, but the system was adapted to encompass both the physical and the biota classes of the CATAMI classification.

Additional codes were necessary to indicate where a point/ image was *not considered* by the scorer (might have been missed or simply not yet labelled), is *unscorable* because of e.g. lighting issues or image quality, was *not of interest* to the current scorer (i.e. deliberately not considered) or had *no visible biota*.

For data-basing purposes these scores needed a numeric, 8-digit code mimicking the published CAAB. In the CATAMI database the following codes were used:

Not considered	CAAB 00 000000
Unscorable	CAAB 00 000001
Not of interest	CAAB 00 000002
No visible biota	CAAB 00 000003

Because the classification was designed to cover a wide range of habitats, it encompasses phyla and/or taxon groups that may have a restricted depth range or distributional range. Scoring of the various classes should be done in context of the depth and region where the images were collected – for example an organism that may be confused between a macroalgal class and a bryozoan class can be identified with confidence as a bryozoan if the image was taken below the photic zone.

The classification is hierarchical, with scorers scoring to the lowest level distinguishable or needed for their own purposes. The level of detail targeted within the hierarchy may vary between scored data sets and between categories within a scored data set. The metadata for each scored data set should state the minimum level within the classification tree that was endeavoured to be scored. Where specific genera, species or taxa are scored at a more detailed level than provided within this hierarchy the relationship of the taxa to the lowest level within the CATAMI hierarchy should be documented. CAAB for taxonomic identifications beyond the CATAMI classification scheme (family, genus, species) can be found on the CAAB website.

In addition to the classification standardised 'modifiers' are included to give additional context or detail to the classification category where relevant.

## Versions

**Versions 1.0 - 1.1** contained various iterations that were updated through 2012 and early 2013. At AMSA 2012 it was discussed (<http://catami-australia.blogspot.com.au/2012/07/hobart-reflections-draft-documents.html>) and October 2012 (<http://catami-australia.blogspot.com.au/2012/10/classification-update.html>) a draft was circulated. Version 1.0 was released in late February 2013 (<http://catami-australia.blogspot.com.au/2013/02/release-of-catami-classification-scheme.html>) and Version 1.1 was released in April 2013.

**Version 1.2** was released in August 2013, this was the first version to be documented in a pictorial guide. The classification was a product of several workshops and extensive discussions among scientists interested in scoring marine underwater imagery. The classification was also presented and discussed at AMSA 2013. There were changes to coral, physical categories, seagrasses, worms from Version 1.1.

**Version 1.3** released in December 2013. This version contains two changes from V1.2:

- (1) An update in the hierarchical structure of the 2 Sponges- CAAB 10 000000 which reflects the updated 'Cheat Sheet' of functional sponge morphologies finalised by Schönberg & Fromont 2013 after the 9<sup>th</sup> World Sponge Conference 2013, Fremantle (<http://www.spongeconference2013.org/home>).
- (2) Addition of a sub-division (i.e. additional branches in the tree) in the Macroalgae: 4 Encrusting: Red – CAAB 80 300929 category – two sub-categories: Macroalgae: Encrusting: Red: Calcareous – CAAB 80 3000934 and Macroalgae: Encrusting: Red: Non-calcareous – CAAB 80 3000935

## PHYSICAL – CAAB 82 000000

The physical description of images encompasses three groups: substrate, relief and bedform.

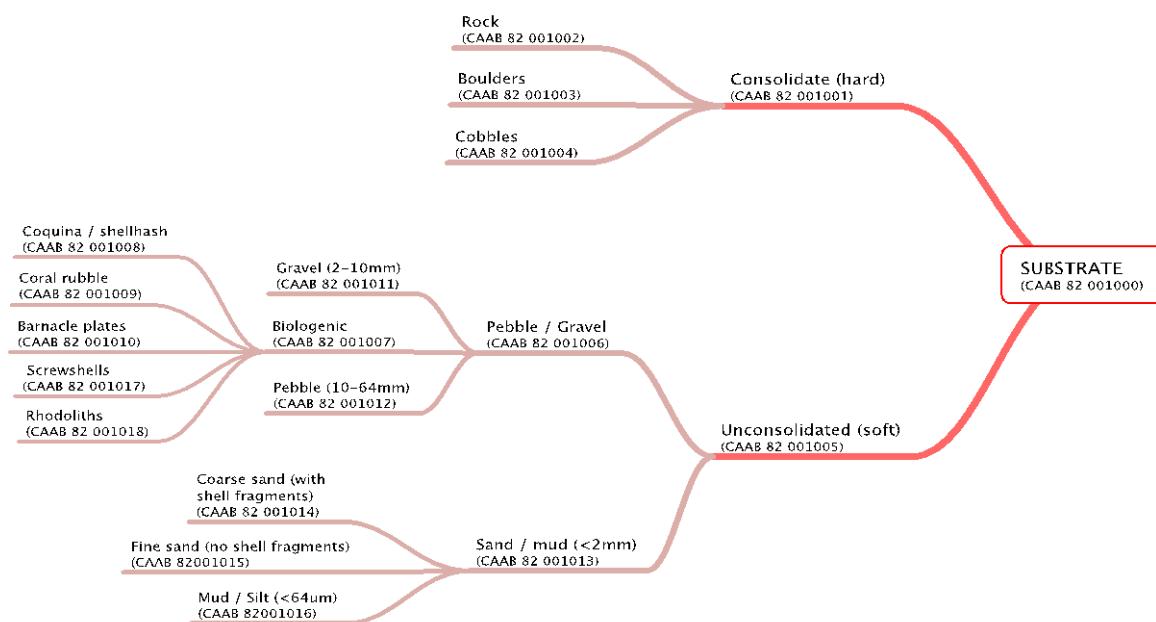
### 1 Substrate – CAAB 82 001000

**Authors:** Franziska Althaus, Rachel Przeslawski, Maggie Tran

Substrate refers to the types of bottom that are visible in the area to be scored. It has two major subdivisions: (1) unconsolidated (i.e. soft substrates) and (2) consolidated (i.e. hard substrates). In aquatic environments sand or mud can often form a relatively thin cover (veeeneer) on hard substrates. In such cases, only the visible substrate is scored using the main hierarchical classification (e.g. unconsolidated or sand) but the nature of the underlying hard substrate may be implied from the type of biota. Where this is the case, additional information based on interpretation of the substrate can be added using standardised modifiers.

Modifiers available for substrate include:

- Veneer – where rocky substrates are covered in a thin layer of unconsolidated substrate, often indicated by numerous attached sessile biota (e.g. sponges, gorgonians) present on seemingly unconsolidated substrate
- Iceberg scour
- Storm damage
- Urchin barren
- Turf mat – where consolidated rock within the photic zone is covered by mats of turfing algae.



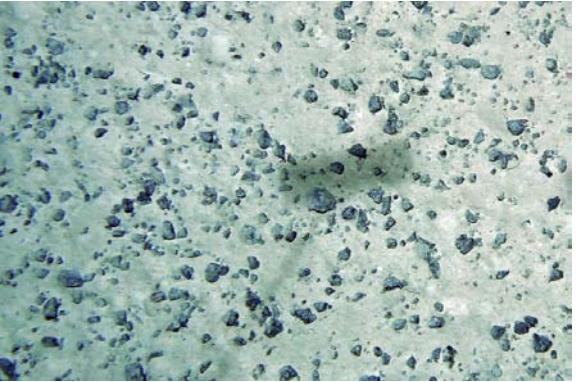
Hierarchical structure for the Substrate branch of the CATAMI Classification Scheme

## 2 Substrate: Consolidated (hard) - CAAB 82 001001

Consolidated or hard substrates are divided into three groups, cobbles, boulders and bedrock based on size. Where rock can be inferred from edges rather than fauna but a sediment veneer is present the 'veneer' modifier can be used.

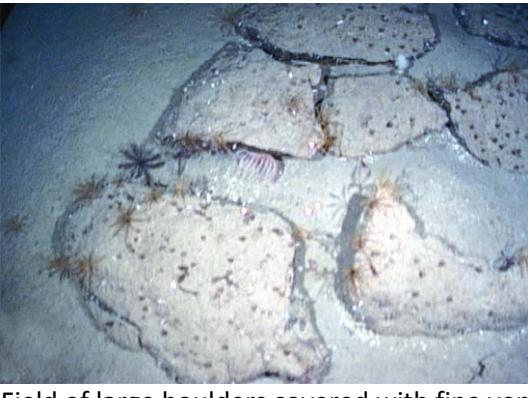
### 3 Consolidated (hard): Cobbles - CAAB 82 001004

Cobbles are distinct rocks of approximately 65-255 mm in diameter.

 © CSIRO	 © GA
Field of cobbles	Cobbles over unconsolidated sediment

### 3 Consolidated (hard): Boulders - CAAB 82 001003

Boulders are large rocks (>255 mm) where clear edges can be determined.

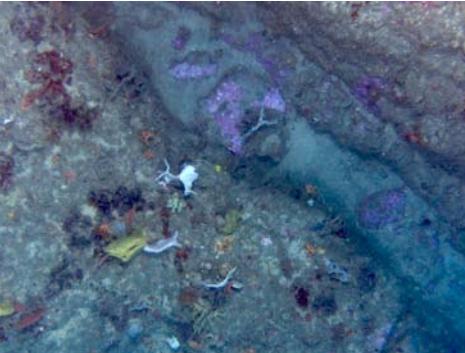
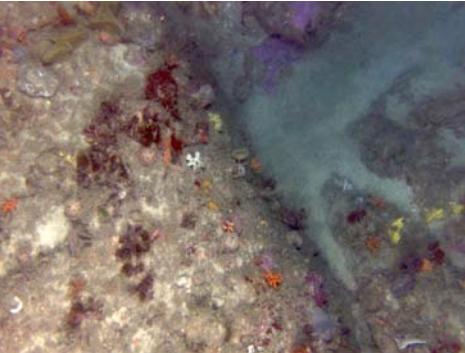
 © GA	 © CSIRO
Distinct boulders on unconsolidated substrate	Field of large boulders covered with fine veneer of sediments

 © CSIRO	 © CSIRO
Distinct slab-boulder	Large, bare boulder

### 3 Consolidated (hard): Rock – CAAB 82 001002

Bedrock visible as a flat plane, outcropping ledge or cliff face; this can be covered in biota and/or a veneer of sediments.

<p>© NERP / CSIRO</p>  <p>Outcropping bedrock covered in biota</p>	<p>© NERP / CSIRO</p>  <p>Bedrock covered in <b>veeर</b> of muddy sediments identified by the ledge visible in the background</p>
<p>© CSIRO</p>  <p>Ledge of outcropping bedrock covered in biota</p>	<p>© CSIRO</p>  <p>Bedrock covered in very thin <b>veeर</b> of sediments; parallel drag marks of fishing gear</p>
<p>© CSIRO</p>  <p>Outcropping bedrock</p>	<p>© NERP / ACFR</p>  <p>Bedrock covered in biota, including a mat of turfing algae (<b>Turf mat</b>)</p>
<p>© NERP / ACFR</p>  <p>Bedrock covered in biota, including a mat of turfing algae (<b>Turf mat</b>)</p>	<p>© NERP / ACFR</p>  <p>Bedrock covered in biota, including a mat of turfing algae (<b>Turf mat</b>)</p>

## 2 Substrate: Unconsolidated (soft) CAAB 82 001005

Unconsolidated or soft substrates are primarily divided into two groups at grainsize of 2 mm. In images it is often difficult to visually determine the different grainsizes. Where the fauna in the image indicates that hard substrate is underlying what appears to be unconsolidated mud, sand or gravel the 'vee' modifier can be used

### 3 Unconsolidated (soft): Sand / mud (<2mm) - CAAB 82 001013

Substrates with little graininess in imagery; grainsizes are defined to be <2 mm in diameter.

<p>© AAD</p>  <p>Unconsolidated sediments unable to be characterised further due to compaction by an iceberg scour</p>	<p>© GA</p>  <p>Unconsolidated sediments unable to be characterised further due to low quality video capture</p>
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### 4 Sand / mud (<2mm): Coarse sand (with shell fragments) - CAAB 82 001014

Fine substrate with a grainy look, often with fragments of different coloured materials such as shell fragments.

<p>© GA</p>  <p>Sand with shell fragments</p>	<p>© GA</p>  <p>Sand with shell fragments in small depressions</p>
--	--

### 4 Sand / mud (<2mm): Fine sand (no shell fragments) - CAAB 82 001015

Fine substrate with a slightly grainy look in imagery and few obvious shell fragments

<p>© GA</p>  <p>Fine sandy substrate with some bioturbation</p>	<p>© CSIRO</p>  <p>Fine sandy substrate veneer over bedrock (vee' implied by presence of large sponges)</p>
--	---

**4 Sand / mud (<2mm): Mud / silt (<64um) – CAAB 82 001016**

Very fine muddy or silty appearance, no grain structure visible

© CSIRO



Mud / silt, some bioturbation

© GA



Muddy deep-sea sediments

**3 Substrate: Unconsolidated (soft): Pebble / gravel – CAAB 82 001006**

Substrates that have clearly grainy structure, with grainsize of >2 mm and up to 64 mm diameter

**4 Pebble / gravel: Biogenic – CAAB 82 001007**

Biogenic gravels often are made up of fragments or shells of particular organisms, where this is clearly visible, the biogenic substrate can be defined in more detail

**5 Biogenic: Coquina / shellhash – CAAB 82 001008**

Gravel substrate composed of shell fragments that are on average >2mm in size

©GA



Gravel composed of shell fragments

©GA



Gravel composed of mostly shell fragments and some rhodoliths  
(see 5 Biogenic: Rhodoliths – CAAB 82 001018)

**5 Biogenic: Coral rubble – CAAB 82 001009**

Gravel substrate composed of loose fragments (~<10 cm) of dead corals

© CSIRO



Rubble of dead coral skeletons

©GA



Rubble of dead coral skeletons (~ 1000 m depth)

**5 Biogenic: Barnacle plates – CAAB 82 001010**

Gravel substrate composed of discarded / dead barnacle plates

© Advanced Imaging and Visualization Laboratory Woods Hole Oceanographic Institution. (Tasmanian Seamounts Survey)



Accumulation of large barnacle plates

**5 Biogenic: Screwshells – CAAB 82 001017**

Gravel substrate composed of discarded / dead screwshells (gastropod)

© NERP / ACFR



Accumulation of screwshells on sand

© NERP / ACFR

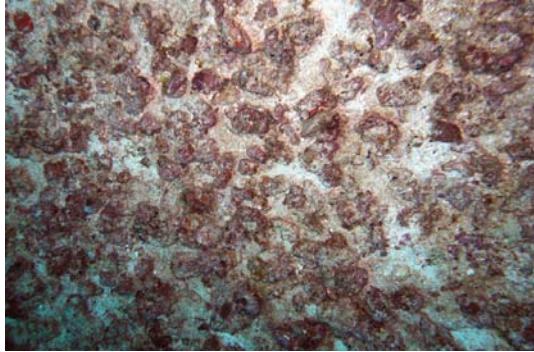


Close-up of screwshell substrate

**5 Biogenic: Rhodoliths – CAAB 82 001018**

Gravel, pebble or cobble substrate composed of rhodoliths (dead or live). See also Encrusting red macroalgae (4 Encrusting: Red – CAAB 80 300929).

© GA



Rhodoliths (coralline algae) over sand / mud

© GA



Rhodolith bed as shown from a screen capture from a video transect

**4 Pebble / gravel: Gravel (2-10mm) - CAAB 82 001011**

Inorganic, granules between 2 and 10 mm in diameter

©AAD



Gavel over predominately sand / mud

©AAD



Gravel with some sand / mud

**4 Pebble / gravel: Pebble (10-64mm) - CAAB 82 001012**

Small rocks or pebbles of 10-64 mm in diameter.

©GA



Pebbles interspersed with mud

©GA

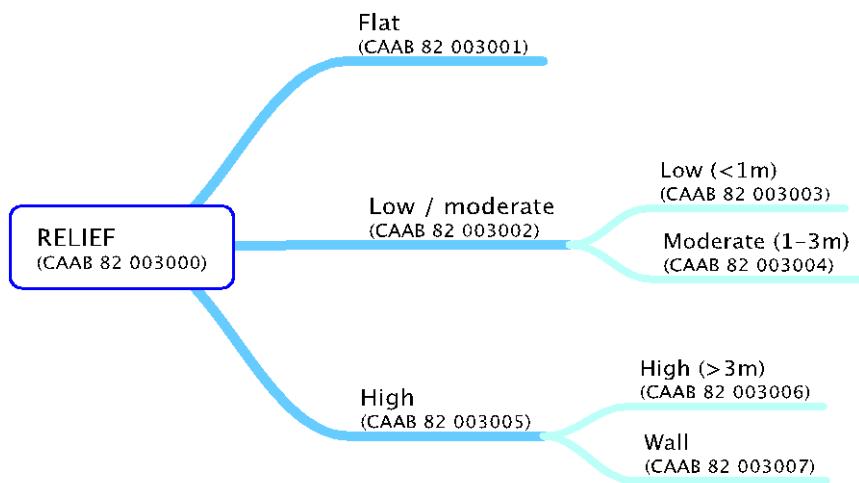


A mix of pebbles (small rocks) and cobbles (larger rocks) on sand

## 1 Relief – CAAB 82 003000

**Authors:** Franziska Althaus, Rachel Przeslawski, Maggie Tran

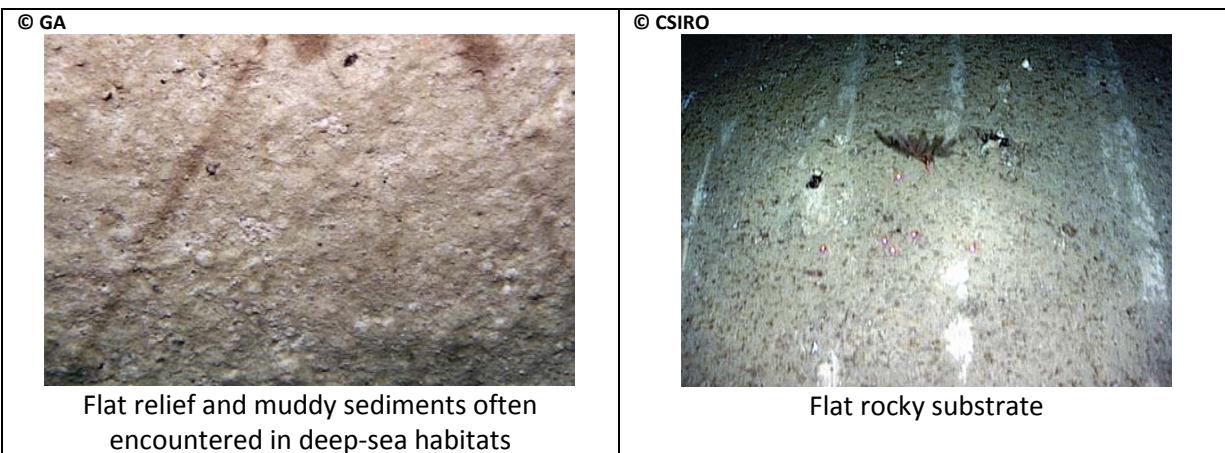
Relief describes the height and rugosity structure of the substrate; generally this category is for scoring of an entire image or a sequence of images rather than a point within an image, as the height and rugosity of a location can only be interpreted in relation to its surrounding. Relief as scored from images may not be useful if high-resolution bathymetry is available.



Hierarchical structure for the Relief branch of the CATAMI Classification Scheme

## 2 Relief: Flat – CAAB 82 003001

Flat substrate, without any features.



## 2 Relief: Low / moderate – CAAB 82 003002

Features of a height of <3m, these can be steps, outcrops

## 3 Low / moderate: Low (<1m) – CAAB 82 003003

Features of a height of <1m, these can be low steps or outcrops

© CSIRO



Low ledges formed by boulders

© CSIRO



Low rocky ledge over sand / mud

## 3 Low / moderate: Moderate (1-3m) – CAAB 82 003004

Features of a height of >1m and <3m, these can be steps, outcrops

© CSIRO



Moderate relief with ~ 1 m steps of rock

© GA



Moderate relief with ~ 2 m steps of rock

## 2 Relief: High – CAAB 82 003005

Features of a height of >3m, these can be high steps, outcrops, rockwalls, cliffs, etc.

## 3 High: High (>3m) – CAAB 82 003006

Features of a height of >3m, these can be high steps, outcrops or small rockwalls/ drop-offs.

© CSIRO



High relief rocky ledge

© GA



High relief rocky ledge

## 3 High: Wall – CAAB 82 003007

Rockwalls, cliffs or drop-offs of a height of >>3m, difficult to determine from a single image; a sequence of images or continuous video is generally needed to confidently identify this relief type.

© CSIRO



Rock wall of &gt; 5 m as confirmed by associated video

© GA



Rock wall of &gt; 5 m as confirmed by associated video

© Renata Ferrari



Coral reef wall &gt;5 m

© Renata Ferrari

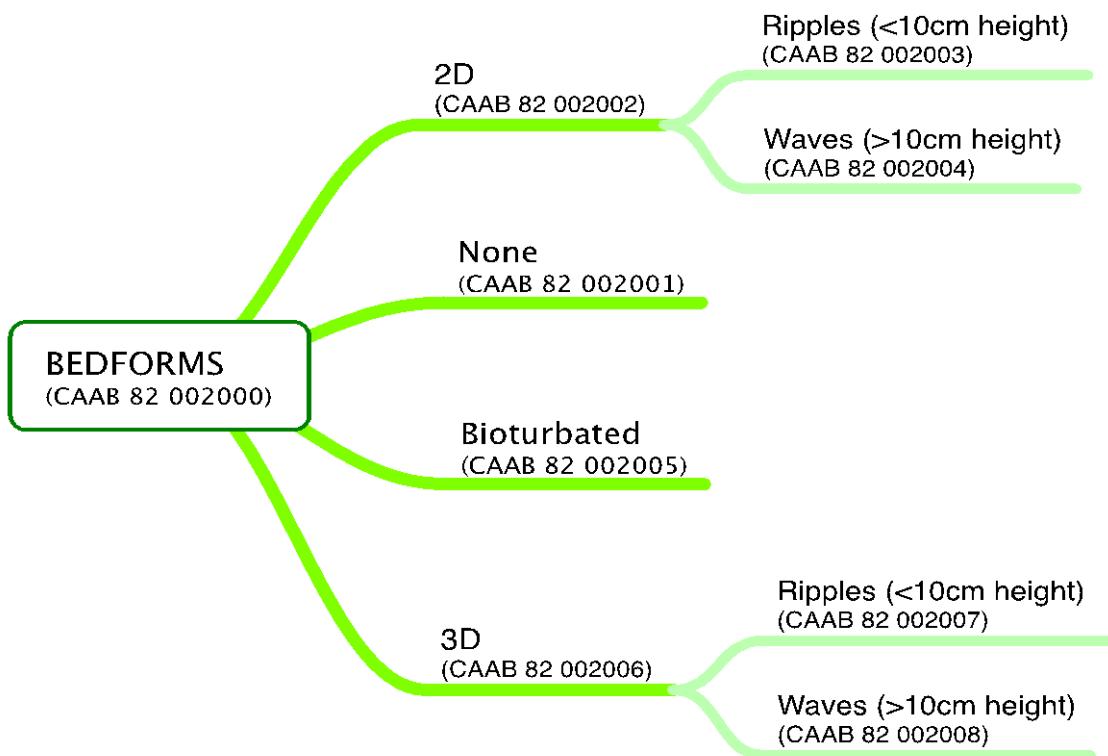


Coral reef wall &gt;3 m

## 1 Bedforms – CAAB 82 002000

Authors: Rachel Przeslawski, Scott Nichol, Franziska Althaus

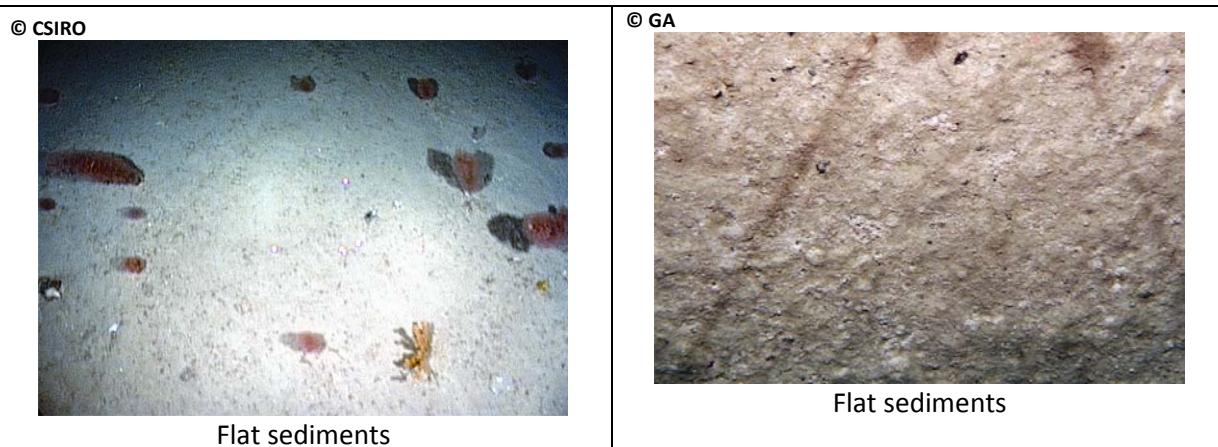
Bedforms are caused by the transport of sediment over the seabed as a result of water movement (although here we also include features caused by bioturbation). Although some rocky seabed features may form as a result of sedimentary processes (including lithification) over long periods of time, this is not possible to infer from imagery alone. As such, bedforms here are described for only unconsolidated substrates.



Hierarchical structure for the Bedforms branch of the CATAMI Classification Scheme

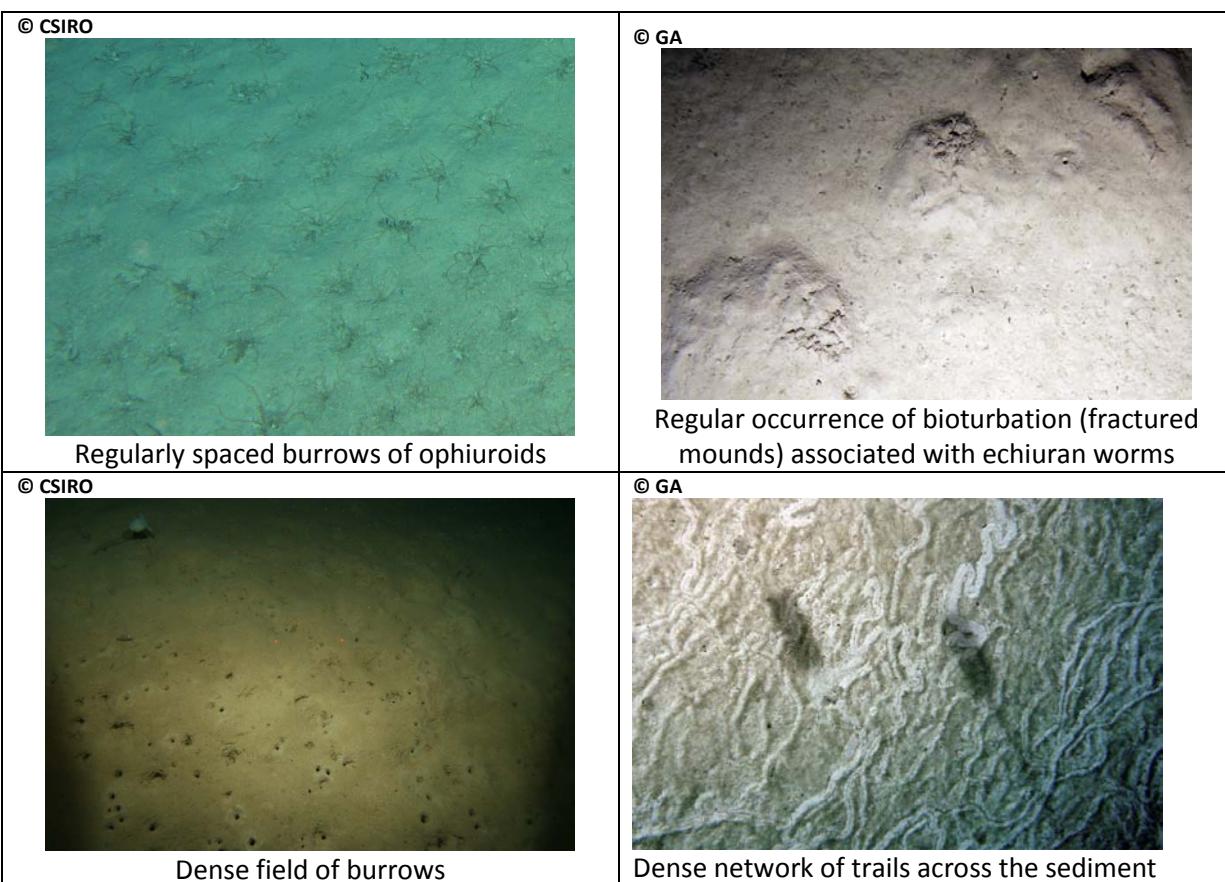
## 2 Bedforms: None – CAAB 82 002001

Flat, featureless unconsolidated substrate; a lack of bedforms is typical of many deep-sea habitats.



## 2 Bedforms: Bioturbated – CAAB 82 002005

Substrate regularly structured by burrows and/or tracks formed by biota. Note that isolated bioturbation marks should not be included here since they do not affect the substrate on the same scale as bedforms caused by physical processes. Instead, isolated bioturbation marks can be categorised in the ‘Biota: Bioturbation’ classification scheme (2 Bioturbation – CAAB 81 000000).



## 2 Bedforms: 2D – CAAB 82 002002

Two dimensional bedforms are defined as straight-crested features in a planar view (Rubin 1987, Ashley et al. 1990).

### 3 2D: Ripples (<10cm height) – CAAB 82 002003

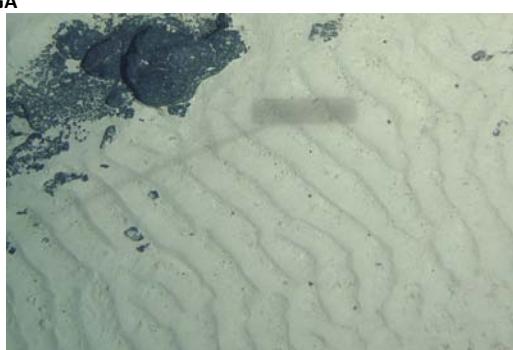
The 2-dimensional features are low (<10 cm height).

© CSIRO



Parallel crests of 2-dimensional ripples

© GA



Parallel crests of 2-dimensional ripples

### 3 2D: Waves (>10cm height) – CAAB 82 002004

The 2-dimensional features are high (>10 cm height).

Please note that wave height (> 10 cm) applies only to this image classification scheme and should not be used in other capacities. From a geological perspective, waves are generally considered far larger but are confined here to anything >10 cm due to the comparatively small field of view of most underwater imaging systems.

© CSIRO



Parallel crests of 2-dimensional waves

© GA



Parallel crests of 2-dimensional waves

## 2 Bedforms: 3D – CAAB 82 002006

Three-dimensional bedforms have sinuous to wavy crestlines with distinguishing scour pits (Rubin 1987, Ashley et al. 1990).

### 3 3D: Ripples (<10cm height) – CAAB 82 002007

The 3-dimensional features are low (<10 cm height).

© CSIRO



Sinuous crests of 3-dimensional ripples

© GA



Sinuous crests of 3-dimensional ripples

### 3 3D: Waves (>10cm height) – CAAB 82 002008

The 3-dimensional features are high (>10 cm height).

Please note that wave height (> 10 cm) applies only to this image classification scheme and should not be used in other capacities. From a geological perspective, waves are generally considered far larger but are confined here to anything >10 cm due to the comparatively small field of view of most underwater imaging systems.

© GA



3-dimensional waves with distinctive scour pits into which biogenic material has settled

© GA



Transition between 2-dimensional waves (right and left) and 3-dimensional waves (centre)

## 1 Biota - CAAB 80 000000

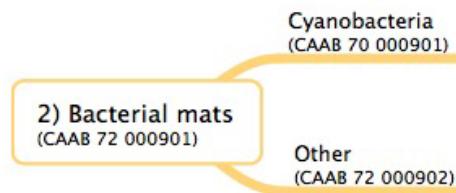
Biota here refers only to visible biota (epifauna / flora) and/or visible traces of biota (bioturbation), as we are interpreting data collected from imagery. Where there is no visible biota present this can be scored using a 'mimic' CAAB code of 00 000003 'No visible biota'.

## 2 Bacterial mats – CAAB 72 000901

**Authors:** Franziska Althaus

The identification of bacterial mats may be subject to additional information besides just images. Such information may include location and vicinity to e.g. chemical seeps.

Version 1 of the CATAMI classification has no detailed description of this class; suggested description of the visual appearance and example images for this class are welcomed by the CATAMI team ([catami@ivec.org](mailto:catami@ivec.org)).



Hierarchical structure for the Bacterial mat branch of the CATAMI Classification Scheme

### 3 Bacterial mats: Cyanobacteria – CAAB 70 000901

Mats of cyanobacteria may be observed in the photic zone.

<i>Selected images</i>	<i>Selected images</i>	<i>Selected images</i>
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### 3 Bacterial mats: Other – CAAB 72 000902

Other bacterial mats can be prominent around deepsea vents and chemical seeps.

<i>Selected images</i>	<i>Selected images</i>	<i>Selected images</i>
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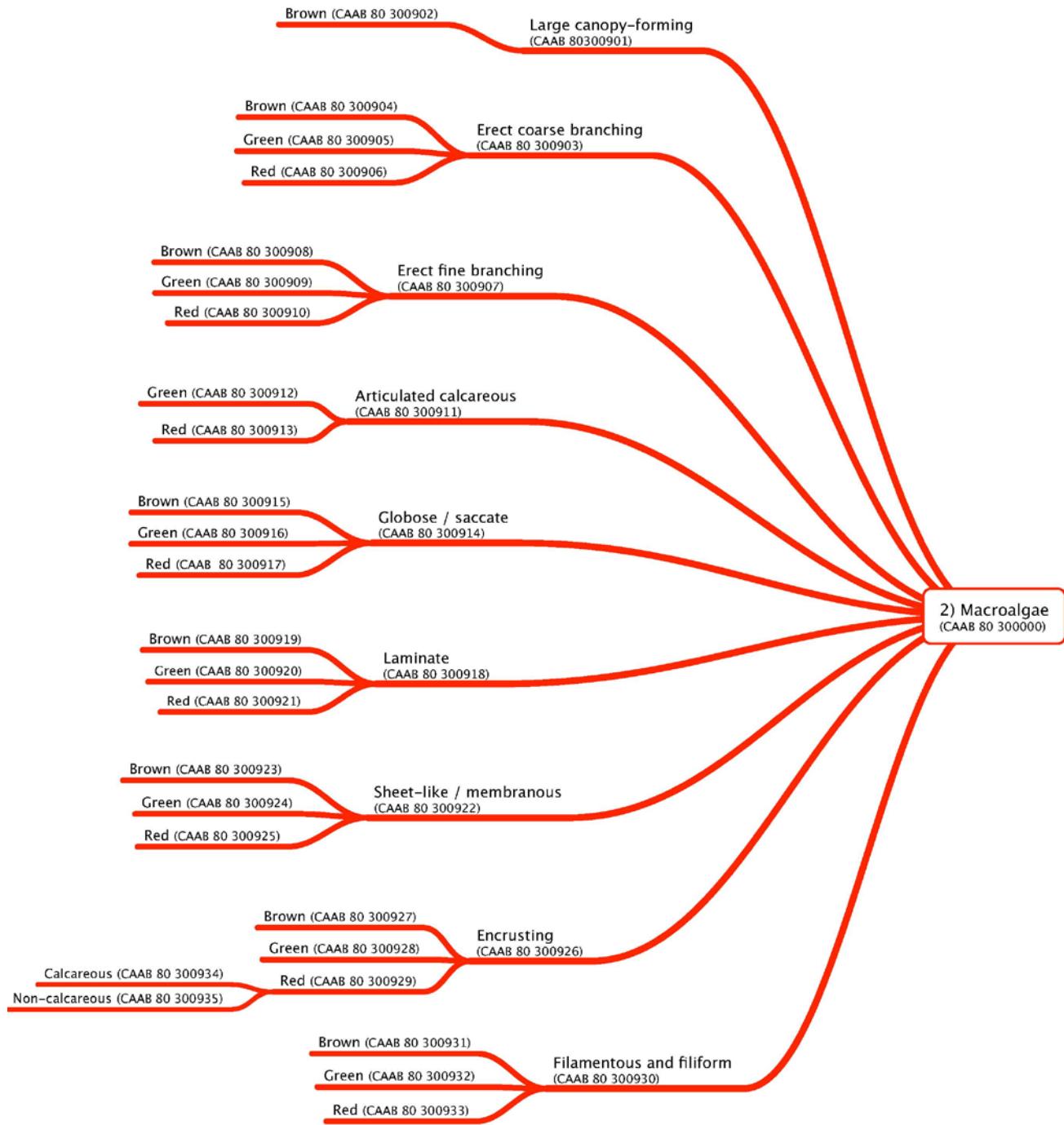
## 2 Macroalgae – CAAB 80 300000

**Authors:** Nicole Hill, Fiona Scott, Alan Jordan, Graham Edgar

Macroalgae are defined as multicellular algae capable of attaching to the seafloor and thus include all algae that are not unicellular (i.e. microalgae). Often it is easier to distinguish algal form in images than accurately assess whether an alga is ‘red’, ‘green’ or ‘brown’ and hence these divisions sit below form. The taxonomic hierarchy sits below these broad categories and is not shown here. Classification was based on a combination of algal form and function, taking guidance from previous schemes used in the literature (see references at end of document) and expert opinion. Algae should be ascribed to the category that captures the dominant visual form (noting that this may not always align with taxonomy). Different species from the same genus may well sit within different categories.

Three qualifiers are available for algae. These include:

- 1) Epiphytic: for any algae that are epiphytic
- 2) Drift: for any algae that do not appear to be attached to the substratum (e.g. kelp lying on an expanse of sand)
- 3) Rhodoliths: rubble-like structure made up of layers of crustose coralline algae. Therefore it only applies to ‘crustose / prostrat : red’.



Hierarchical structure for the Macroalgae branch of the CATAMI Classification Scheme.

**3 Macroalgae: Filamentous / filiform – CAAB 80 300930**

Appears very fine and thread- or hair-like but may not necessarily technically be a filament (elongate thread, usually one cell thick, composed of cells attached end to end).

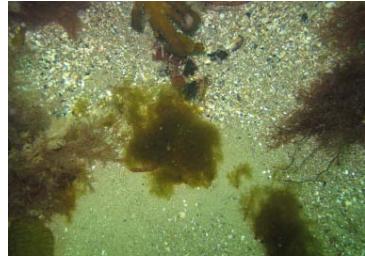
**4 Filamentous / filiform: Red – CAAB 80 300933**

<i>Ceramium sp.</i>	© Fiona Scott 	© Fiona Scott  <i>Polysiphonia infestans</i>	© Fiona Scott  <i>Asparogopsis armata</i> (appears filamentous in photos)
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**4 Filamentous / filiform: Green 80 300932**

© Graham Edgar 	© Graham Edgar  <i>Chaetomorpha spp.</i>	© Graham Edgar  <i>Apjohnia caulerpa</i>
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**4 Filamentous / filiform: Brown 80 300931**

© Fiona Scott  <i>Hincksia sordida</i>	© Fiona Scott  <i>Ectocarpus spp.</i>	<i>Sphacelaria spp.</i>
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**3 Macroalgae: Encrusting – CAAB 80 300926**

Crust-like; thin, (reds may be hard and brittle) form growing flattened and closely adhering to the substratum.

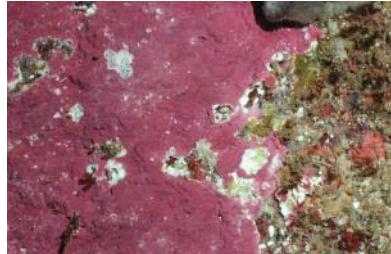
**4 Encrusting: Red – CAAB 80 300929**

Crust-like thin red algae.

**5 Encrusting: Red: Calcareous – CAAB 80 300934**

Coralline crustose red algae, including rhodoliths. Many appear to be bright pink or red in colour, but may also appear purple, blue or grey-green. These algae, especially the darker reds (Rodolith and non-calcareous), can easily be confused with encrusting sponge of the same color; distinguishing characteristics are the thickness (sponge tends to be thicker), patchiness (sponge tends to be more patchy than algae) and the texture (CCA is smoother, while sponge has a rougher surface). In some cases it is not possible to distinguish between both from an image.

© Graham Edgar



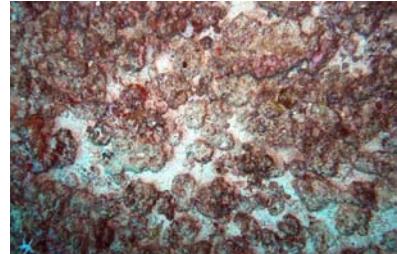
Crustose coralline

© NERP / ACFR



Crustose coralline

© GA

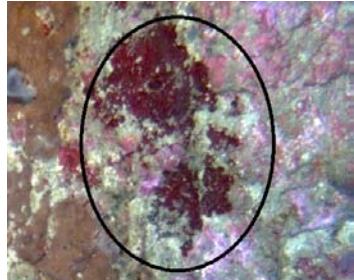


Rhodolith bed

**5 Encrusting: Red: Non-calcareous – CAAB 80 300935**

Non- coralline encrusting red algae.

© NERP / CSIRO



Encrusting: Red: Non-calcareous

*Hildenbrandia* sp.**4 Encrusting: Green – CAAB 80 300928**

© Graham Edgar

*Codium dimorphum***4 Encrusting: Brown – CAAB 80 300927***Ralfsia verrucosa*

**3 Macroalgae: Articulated calcareous – CAAB 80 300911**

Jointed or segmented, calcified algae.

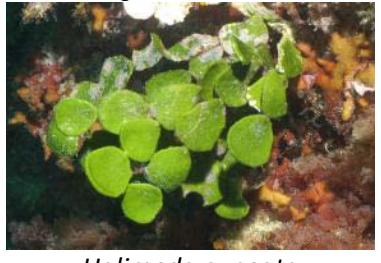
**4 Articulated calcareous: Red – CAAB 80 300913**

© Graham Edgar 	© Graham Edgar 	© Graham Edgar 
Corallina spp.	Amphiroa anceps	Rhodopeltis spp.

© Graham Edgar 	© Graham Edgar 	© Graham Edgar 
Metagoniolithon spp.	Haliptalon spp.	Jania pulchella

**4 Articulated calcareous: Green – CAAB 80 300912**

© Graham Edgar 		
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**3 Macroalgae: Sheet-like / membranous - CAAB 80 300922**

Thin, delicate and often translucent. A flattened and sheet-like structure. May have some, generally ill-defined branching.

**4 Sheet-like / membranous: Red - CAAB 80 300925**

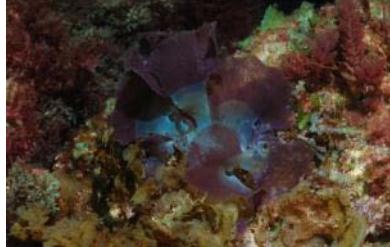
© Graham Edgar

*Porphyra lucasii*

© Fiona Scott

*Kallymenia cribosa*

© Graham Edgar

*Martensia australis*

© Graham Edgar

*Schizymenia spp.*

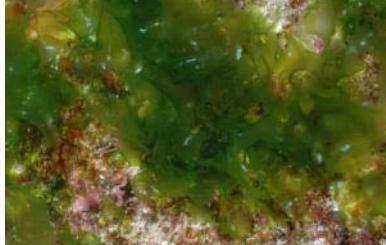
© Graham Edgar

*Grateloupia spp.*

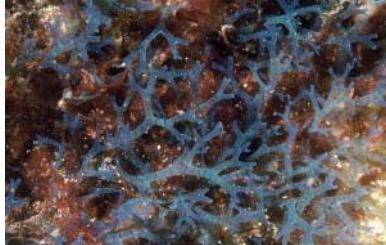
© Fiona Scott

*Schizoseris hymenena***4 Sheet-like / membranous: Green - CAAB 80 300924**

© Graham Edgar

*Ulva spp.**Microdictyon umbilicatum***4 Sheet-like / membranous: Brown - CAAB 80 300923**

© Graham Edgar

*Dictyota dichotoma*

© Graham Edgar

*Petalonia fascia*

**3 Macroalgae: Laminate – CAAB 80 300918**

Low profile, plate-like and lobed forms.

**4 Laminate: Red – CAAB 80 300921**

© Graham Edgar

*Sonderopelta coriacea*

© Graham Edgar

*Peyssonnelia spp.***4 Laminate: Green – CAAB 80 300920**

© Graham Edgar

*Rhipiliopsis spp.*

© Graham Edgar

*Dictyosphaeria sericea*

© Graham Edgar

*Udotea spp.***4 Laminate: Brown – CAAB 80 300919**

© Graham Edgar

*Lobophora variegata*

© Graham Edgar

*Padina spp.*

© Graham Edgar

*Zonaria turneriana*

© Renata Ferrari

*Lopophora sp.*

**3 Macroalgae: Globose / saccate - CAAB 80 300914**

Has a spherical shape or balloon-like form.

**4 Globose / saccate: Red - CAAB 80 300917**

© Graham Edgar



*Gloiosaccion brownii*

**4 Globose / saccate: Green - CAAB 80 300916**

© Graham Edgar



*Codium pomoides*

© Graham Edgar



*Derbesia marina*

**4 Globose / saccate: Brown - CAAB 80 300915**

© Graham Edgar



*Colpomenia sinuosa*

© Graham Edgar



*Hydroclathrus clathratus*

© Graham Edgar



*Leathesia spp.*

### 3 Macroalgae: Erect fine branching – CAAB 80 300907

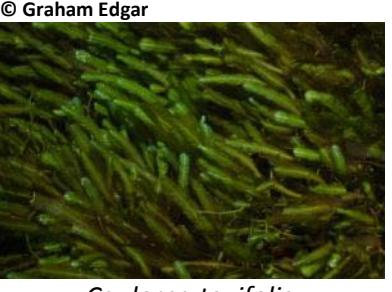
Distinct branching form with a vertical growth habit. Branches are small or narrow (not to be confused with filamentous which is very fine or hair-like).

#### 4 Erect fine branching: Red – CAAB 80 300910

A small number of red species in this group may actually be calcified (but not articulated), for example *Liagora* spp., *Ganonema* spp., *Trichogloea* spp., *Galaxaura* spp., although it is unlikely that this feature would be discernible in imagery.

 © Graham Edgar <i>Dasya</i> spp.	 © Graham Edgar <i>Dictyomenia sonderi</i>	 © Fiona Scott <i>Delisea pulchra</i>
 © Graham Edgar <i>Areschougia congesta</i>	 © Fiona Scott <i>Phacelocarpus pepercarpos</i>	 © Fiona Scott <i>Gracilaria cliftonii</i>
 © Fiona Scott <i>Galaxaura marginata</i>	 © Graham Edgar <i>Euptilota articulata</i>	 © Fiona Scott <i>Soleria roiusta</i>

#### 4 Erect fine branching: Green – CAAB 80 300909

 © Graham Edgar <i>Caulerpa taxifolia</i> (each blade finely branching)	 © Graham Edgar <i>Caulerpa obscura</i>	 © Graham Edgar <i>Caulerpa longifolia</i>
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**4 Erect fine branching: Brown – CAAB 80 300908**

© Graham Edgar



*Carpomitra costata*

© Graham Edgar



*Perithalia caudata*

© Graham Edgar



*Pachydictyon spp.*

© Graham Edgar



*Lobospira spp.*

© Fiona Scott



*Sporochnus radiciformis*

### 3 Macroalgae: Erect coarse branching – CAAB 80 300903

Distinct branching form with a vertical growth habit. Branches are more robust or have broader blades (greater than ~ 5mm diameter) than fine branching algae.

#### 4 Erect coarse branching: Red – CAAB 80 300906

© Graham Edgar 	© Graham Edgar 	© Graham Edgar 
Botryocladia spp.	Betaphycus spp.	Thamnocalonium dictomoma

#### 4 Erect coarse branching: Green – CAAB 80 300905

© Graham Edgar 	© Graham Edgar 	© Graham Edgar 
Codium duthiae	Codium fragile	Codium cuneatum
© Fiona Scott 	© Graham Edgar 	© Graham Edgar 
Caulerpa flexilis var. muelleri	Caulerpa cactoides	Caulerpa hodgkinsoniae
© Graham Edgar 	© Graham Edgar 	
Caulerpa racemosa	Caulerpa papillosa	

**4 Erect coarse branching: Brown – CAAB 80 300904**

 © Graham Edgar <i>Seirococcus axillaris</i>	 © Graham Edgar <i>Hormosira banksii</i>	 © Fiona Scott <i>Xiphophora chondrophylla</i>
 © Graham Edgar <i>Scaberia agardhii</i>	 © Graham Edgar <i>Caulocystis spp.</i>	 © Graham Edgar <i>All Sargassum spp.</i>
 © Fiona Scott <i>Cystophora moniliformis</i>	 © Graham Edgar <i>Cystophora torulosa</i>	 © Graham Edgar <i>Acrocarpia robusta</i>
 © Fiona Scott <i>Carpoglossum confluens</i>		

### 3 Macroalgae: Large canopy-forming – CAAB 80 300901

Large (generally >>50 cm when mature) and robust, habitat-forming species. Generally large and distinctive fucoids and kelps.

#### 4 Large canopy-forming: Brown – CAAB 80 300902

 <i>Phyllospora comosa</i>	 <i>Macrocystis spp.</i>	 <i>Durvillaea spp.</i>
 <i>Undaria pinnatifida</i>	 <i>Ecklonia radiata</i>	 <i>Lessonia corrugata</i>

## 2 Seagrasses – CAAB 63 600901

**Authors:** Nicole Hill, Fiona Scott, Alan Jordan, Graham Edgar

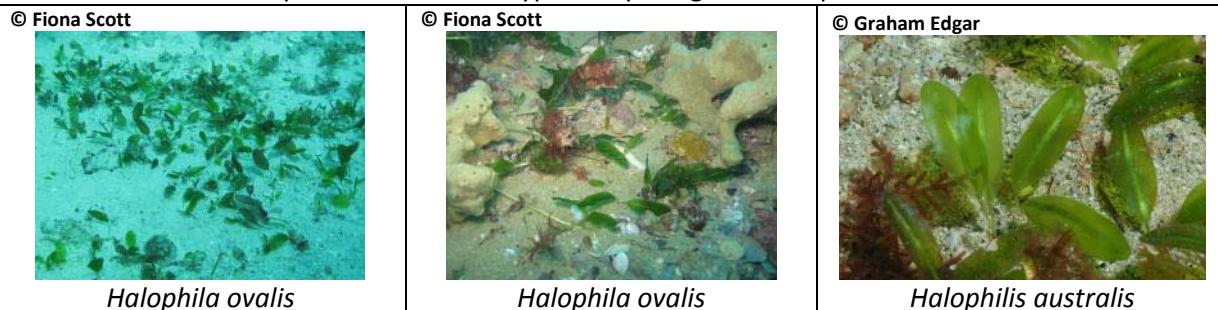
Seagrasses are flowering plants (phylum Magnoliophyta) that grow in marine environments. Seagrasses generally occur in sheltered environments, have elongated leaves and appear green due to their chlorophyll content and are unlikely to be confused with macroalgae. Approximately 30 species are found in Australia in one of four families: Posidoniaceae, Zosteraceae, Hydrocharitaceae, or Cymodoceaceae. Two gross morphologies can be recognised from imagery, based on the leaf shape: elliptical leaves and strap-like leaves.



Hierarchical structure for the Seagrasses branch of the CATAMI Classification Scheme

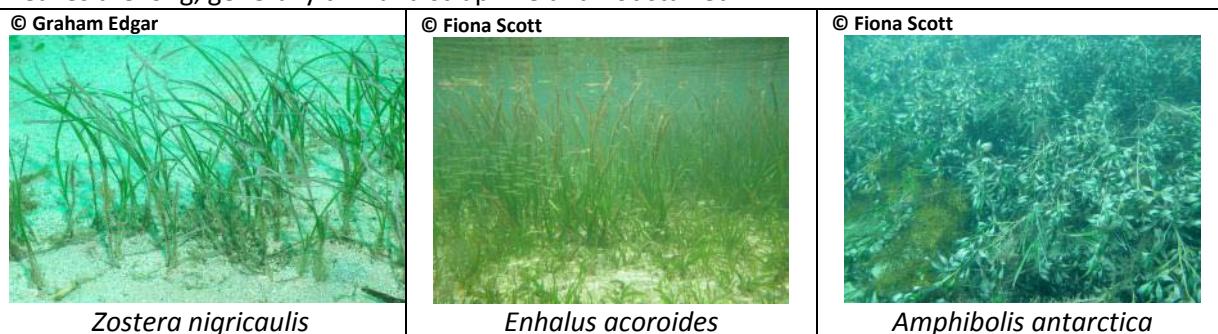
### 3. Seagrasses: Elliptical leaves – CAAB 63 600902

Leaves are ovate or elliptical and stalked. Typified by the genus *Halophila*



### 3. Seagrasses: Strap-like leaves – CAAB 63 600903

Leaves are long, generally thin and strap-like and not stalked.





*Posidonia australis*

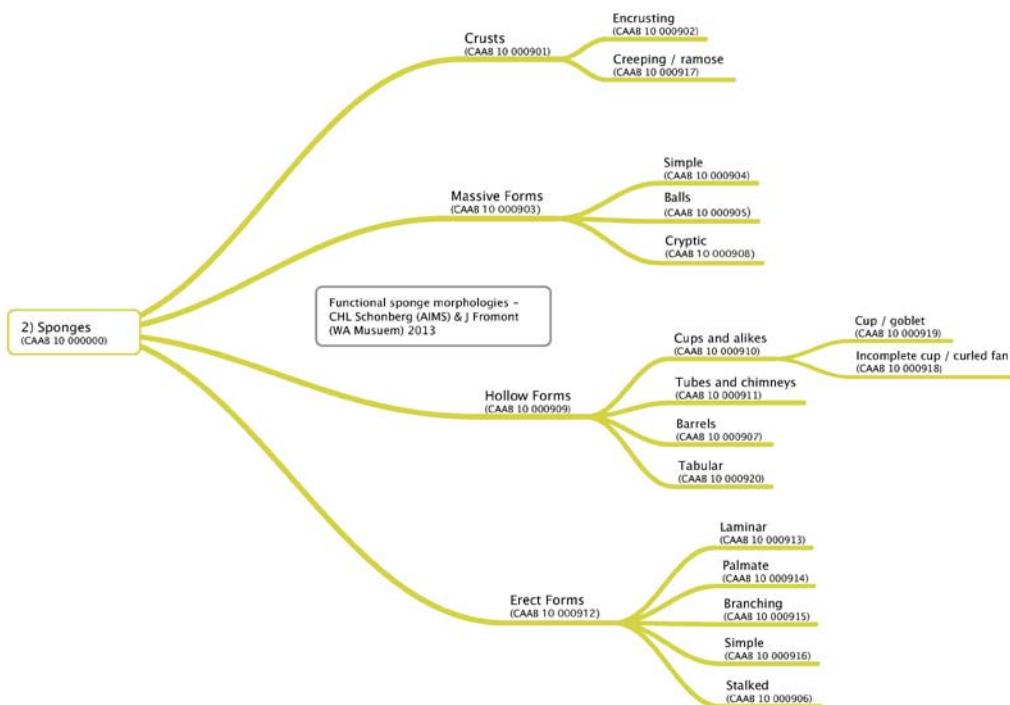
*Ruppia megacarpa*

## 2 Sponges- CAAB 10 000000

**Authors:** Christine Schönberg, Jane Fromont

Sponge taxonomy is difficult and challenging, it requires adequate laboratory facilities, experience and time, which are often not available. Moreover, not all habitats can be sampled (protected areas, deep sea), and for monitoring purposes video work is usually the preferred method. However, sponges cannot reliably be identified from imagery lacking samples, and we thus recommend using growth forms for quick classification. If the growth forms are described by clearly focusing on their function, they will represent environmental conditions. E.g. turbulence and crashing waves will select for crusts and cryptic sponges, stagnant waters for separation of inhalant and exhalant streams as is typical in 'hollow' growth forms, laminar forms provide information about prevailing currents, and sedimentation will favour erect forms. The idea behind this classification, however, is the function, not always the true form. E.g. a crust around a thinly erect substrate such as a gorgonian becomes a simple-erect growth form, endolithic bioeroding sponges and creeping forms are here classified as crusts, even if they are truly massive or branching along the surface, while layered 'kebab' sponges and massive sponges with many large holes may function as 'branching' sponges. Laminar sponges with holes count as 'palmate' and are scored together with hand-shaped sponges, i.e. having branches in one plane. There are many, many intermediate forms that make decisions difficult. Keep the function for any given situation the factor to make your choice.

Separate publications of functional morphology and on sponge growth forms including pictures are in preparation by Schönberg & Fromont. The hierarchical structure of the sponge classification was updated in this document, reflecting the updated 'Cheat Sheet' of functional sponge morphologies finalised by Schönberg & Fromont 2013 after the 9<sup>th</sup> World Sponge Conference 2013, Fremantle.



Hierarchical structure for the Sponges branch of the CATAMI Classification Scheme

## 2 Cnidaria - CAAB 11 500000

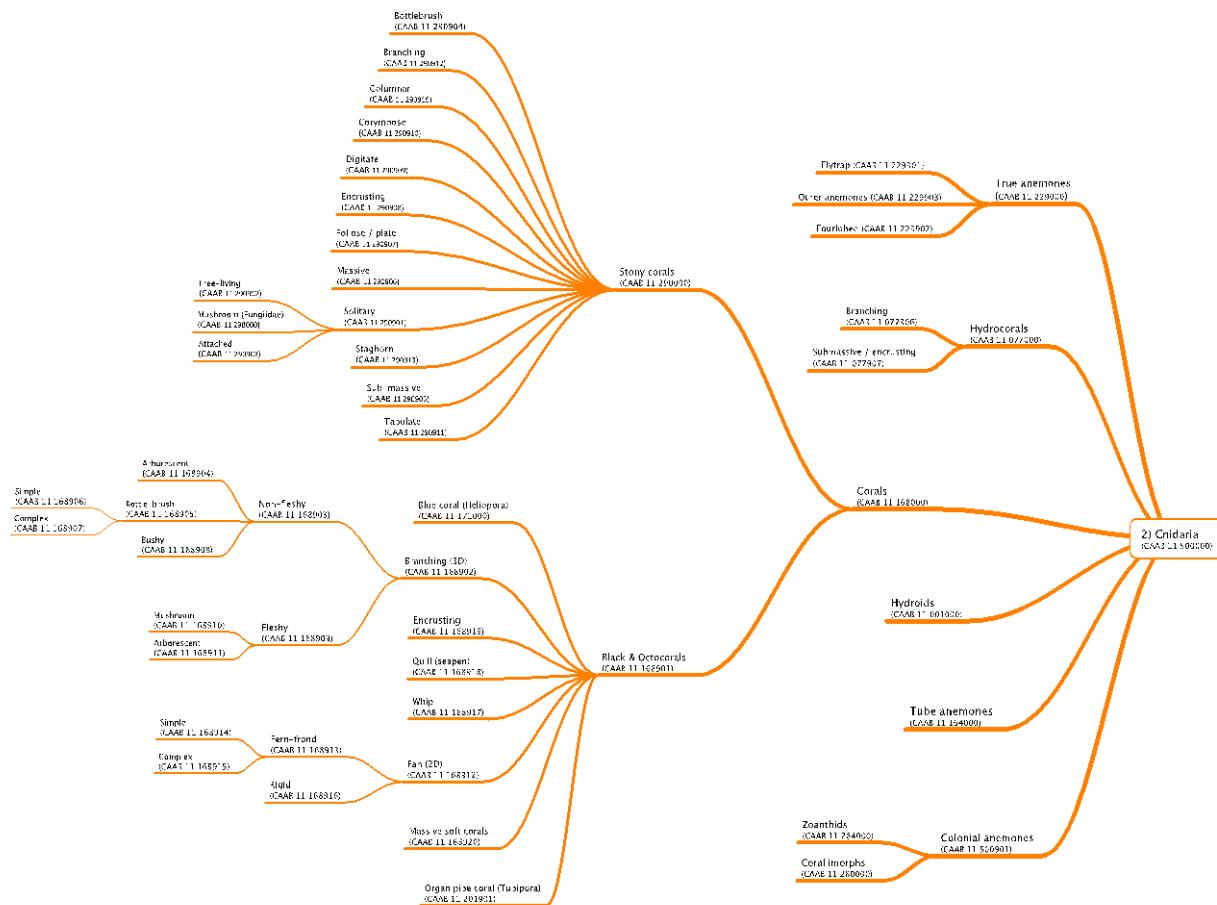
Authors: Authors: Karen Gowlett-Holmes, Jamie Colquhoun, Franziska Althaus, Renata Ferrari

Cnidaria is a large phylum that encompasses a variety of groups including different types of anemones, hydroids, hydrocorals and corals.

Four qualifiers are available so far for the corals within this group. More qualifiers may be added [in discussion with the CATAMI team] if the need arises.

These four included so far are:

1. Recruit
2. Bleached
3. Dead
4. Recently dead - applies mainly to deep-sea coral matrix (branching stony corals); recently dead skeleton is usually white without coloured polyps while long-term dead skeletons are blackened by a crust of manganese.



Hierarchical structure for the Cnidaria branch of the CATAMI Classification Scheme

### 3 Cnidaria: Hydroids - CAAB 11 001000

Feathery to fluffy, commonly planar, usually branched. They have generally less well defined structure than 2D-branching black- or octocorals (5 Black & Octocorals: Fan (2D) – CAAB 11 168912), but can be easily confused with (and often mixed with) soft bryozoans (3 Bryozoa: Soft – CAAB 20 000905). Solitary hydroids are translucent and usually cryptic but may be noticed in underwater images because of their shadow.

 © CSIRO	 © CSIRO	 © CSIRO
 © AAD		

### 3 Cnidaria: Hydrocorals – CAAB 11 077000

Two forms of hydrocorals are distinguished a hard, usually white, branching form and a massive or encrusting form.

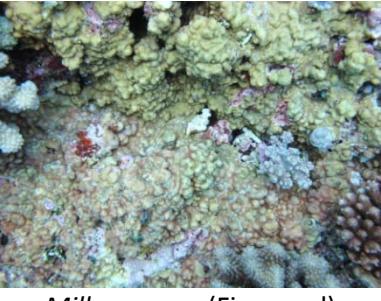
#### 4 Hydrocorals: Branching – CAAB 11 077906

Hard, branching often dichotomous, deepwater species generally has a characteristic ‘jagged’ look and is usually white. *Stylaster* sp. are common in caves and overhangs in shallow reef environments or in the deepsea. Branches are usually in one plane but are fine, tapered and delicate. Firecorals (*Millepora* sp.) are common on shallow reefs; they have a smooth green, cream, or yellow coloured skeleton with 2 sizes of pores to facilitate polyps with different functions with growth-forms can vary branching/ arborescent forms are included in this morphotype.

 © CSIRO	 © CSIRO	 © AIMS
 © AAD		 © AAD

#### 4 Hydrocorals: Submassive / encrusting – CAAB 11 077907

Submassive Firecorals (*Millepora* sp.) are common on shallow reefs; they have a smooth green, cream, or yellow coloured skeleton with 2 sizes of pores to facilitate polyps with different functions with growth-forms can vary submassive and encrusting forms are included in this morphotype.

 © AIMS	 © AIMS	 © AIMS
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### 3 Cnidaria: Corals - CAAB 11 168000

A large group within the cnidarians, including the octocorals (soft corals, gorgonians, and seapens), the black corals (antipatharians) and the stony corals (scleractinians).

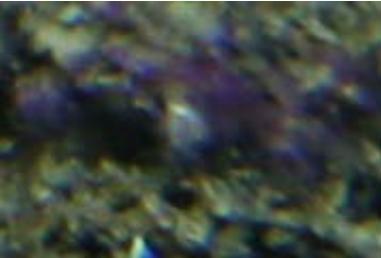
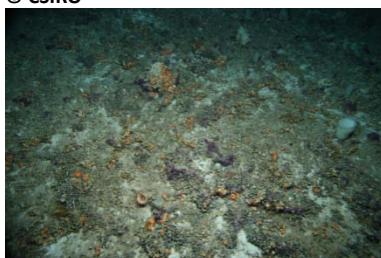
#### 4 Corals: Black & Octocorals - CAAB 11 168901

The black corals and octocorals are combined in this classification scheme, as they exhibit some similar morphologies and can easily be confused. Octocorals have often no clearly discernible skeleton (soft corals) and where the skeleton is obvious and appears hard (e.g. gorgonians) it is usually covered by coloured tissue. Black corals often appear similar to gorgonians.

Three types of octocorals can easily be confused with stony corals unless the viewer is familiar with the fauna in the region of study; these are the Organpipe corals, massive octocorals and Blue corals.

#### 5 Black & Octocorals: Encrusting – CAAB 11 168919

Polyps growing on or over a hard substrate such as rocks or dead coral skeletons. In shallow waters they can cover large areas forming a thick sheet.

© CSIRO 	© CSIRO 	
Purple encrusting coral	Purple encrusting coral (orange: solitary stony coral)	

Rhytisma sp.	Erythropodium hicksoni	
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#### 5 Black & Octocorals: Branching (3D) – CAAB 11 168902

Branching form, with branches in three-dimensional space.

#### 6 Branching (3D): Fleshy – CAAB 11 168909

Stems and branches thick, fleshy.

#### 7 Fleshy: Mushroom – CAAB 11 168910

Thick fleshy stem terminating in head with polyps.

© CSIRO 	© CSIRO 	© AAD 
Anthomastus sp. (open polyps)	Anthomastus sp. (closed polyps)	Anthomastus sp.

**7 Fleshy: Arborescent – CAAB 11 168911**

Thick fleshy stem with side-branches.

© CSIRO



Nephtheidae

© CSIRO



Nephtheidae

© CSIRO



Nephtheidae

**6 Branching (3D): Non-fleshy – CAAB 11 168903**

Stems and branches thin, ‘woody’ in appearance.

**7 Non-fleshy: Arborescent – CAAB 11 168904**

Sparse, woody looking branches polyps small giving a branching, tree-like appearance.

© CSIRO



Bamboo coral

© CSIRO

*Paragorgia* (Bubblegum coral)  
[with a snake star]

© CSIRO



Bramble coral

© CSIRO



Elisiidae

**7 Non-fleshy: Bushy – CAAB 11 168908**

Many short branches, polyps larger giving a fluffy, bushy appearance.

© CSIRO



Alcyonacea (Octocoral)

© CSIRO



Alcyonacea (Octocoral)

© CSIRO



Anthipatharia (Black coral)

 <p>© CSIRO</p> <p>Primnoidae</p>	 <p>© CSIRO</p> <p>Primnoidae</p>	
<p>7 Non-fleshy: Bottle-brush – CAAB 11 168905</p> <p>Main axis with short tight braches radiating from it</p>		
<p>8 Bottle-brush: Simple – CAAB 11 168906</p> <p>Only one axis.</p>		
 <p>© CSIRO</p> <p><i>Chrysogorgia</i> sp.</p>	 <p>© CSIRO</p> <p>Chrysogorgiidae</p>	
<p>8 Bottle-brush: Complex – CAAB 11 168907</p> <p>Multiple axes.</p>		
 <p>© CSIRO</p> <p><i>Narella</i> sp.</p>	 <p>© CSIRO</p> <p><i>Thouarella</i> sp.</p>	 <p>© CSIRO</p> <p>Antipatharia (Black coral)</p>

**5 Black & Octocorals: Fan (2D) – CAAB 11 168912**

Branching form, with branches generally in a single plane. Skelton more clearly defined than in for hydroids (3 Cnidaria: Hydroids – CAAB 11 001000)

**6 Fan (2D): Fern-frond – CAAB 11 168913**

Main axis with side-branches in single plane.

**7 Fern-frond: Simple – CAAB 11 168914**

Only one axis. These may be confused with ‘quill shaped’ corals (below) however they do not have a bulbous attachment and the central axis is never fleshy.

© CSIRO



Antipatharia (Black coral)

© CSIRO



Antipatharia (Black coral)

**7 Fern-frond: Complex – CAAB 11 168915**

Multiple axes but remaining in one plane.

© CSIRO



Alcyonacea (Octocoral)

© CSIRO



Alcyonacea (Octocoral)

© CSIRO



Primnoidae

**6 Fan (2D): Rigid – CAAB 11 168916**

Rigid complex branched fan (in single plane).

© CSIRO



Corallium sp.

© CSIRO



Gorgonian fan

© CSIRO



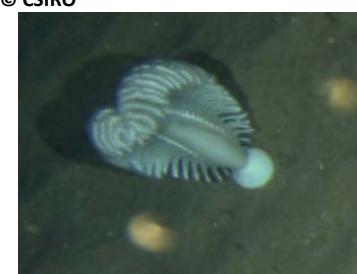
Gorgonian fan

**5 Black & Octocorals: Whip – CAAB 11 168917**  
Single stem, polyps small, clustered on main stem.

				
Slender seafen	Slender seafen	Alcyonacea whip (corkscrew)	Pleurogorgia sp.	Lepdisis sp.

**5 Black & Octocorals: Quill (seafen) – CAAB 11 168918**

Single stem with polyp leaves, base bulbous. Stem NEVER branched. Usually the classic ‘feather quill pen’ look, but also very long stem and tapering bulb with polyp leaves clustered on end of stem; and also very short polyp leaves so look like whip corals. Mostly in sediments, but deepsea ‘rockpen’ on reef. Quill shapes are differentiated from fern-frond by the thicker stem and the bulbous attachment.

		
Seafen	Seafen	Rockpen ( <i>Anthoptilum gowlettholmesae</i> )

**4 Black & Octocorals: Organ-pipe coral (*Tubipora*) – CAAB 11 201901**

Single genus, *Tubipora*: the skeleton is permanently coloured dark red. Growth-forms range from hemispherical and massive, to thick and encrusting made up of vertical, red hard calcareous tubes (organ pipes), each tube occupied by a single polyp. When the colony is flourishing the skeleton can be hidden by the tentacles of the extended polyps; restricted to photic zone (zooxanthellate). When the polyps are closed this octocoral is easily confused with massive stony corals (5 Stony corals: Massive – CAAB 11 290906).

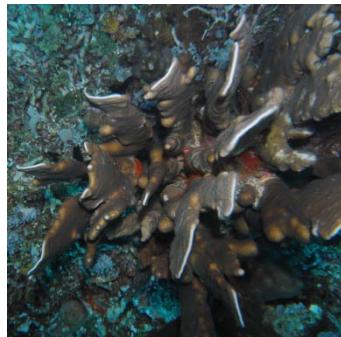
		
Tubipora sp.	Tubipora sp.	

#### 4 Black & Octocorals: Massive soft corals – CAAB 11 168920

Forming low tabular mounds that can have lobate, digitate or ridged surfaces, includes the genera referred to as ‘leather corals’. They are all members of the family Alcyoniidae, and are restricted to photic zone (zooxanthellate); includes genera *Sinularia*, *Sacrophyton*, *Lobophyton* (the leather corals), as well as *Dampia* and *Cladiella*. Easily confused with massive stony corals (5 Stony corals: Massive – CAAB 11 290906).

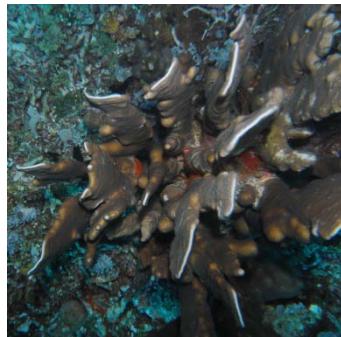
© NERP / ACFR 	© Renata Ferrari 	© Renata Ferrari 
<i>Sarcophyton</i> sp.	<i>Sarcophyton</i> sp.	<i>Sarcophyton</i> sp.

© AIMS 	© AIMS 	© AIMS 
<i>Lobophyton</i> sp.	<i>Dampia</i> sp	<i>Cladiella</i> sp

#### 4 Black & Octocorals: Blue coral (*Heliopora*) – CAAB 11 171000

*Heliopora coerulea* is the only member of the Order Helioporacea. Blueish / green aragonite skeleton underwater and colonies have variable growth-forms from columnar to sub-massive, depending on depth and/or exposure. Restricted to photic zone (zooxanthellate). Easily confused with sub-massive stony corals (5 Stony corals: Sub-massive – CAAB 11 290905).

© AIMS 	© AIMS 	© AIMS 
<i>Heliopora coerulea</i>	<i>Heliopora coerulea</i>	<i>Heliopora coerulea</i>

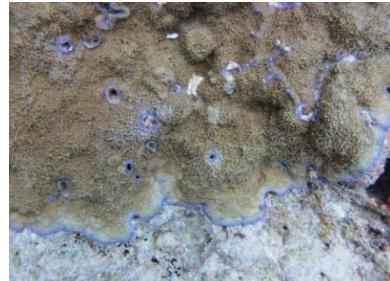
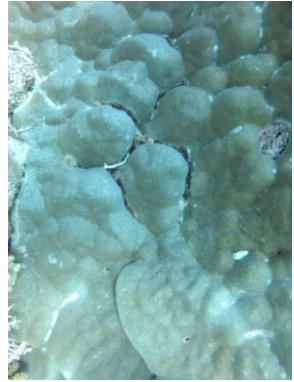
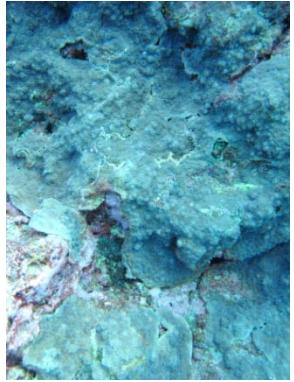
**4 Corals: Scleractinian Stony corals – CAAB 11 290000**

Stony corals are hexacorallids with an external skeleton. They have a wide variety of growth forms and are found from cold-temperate to tropical temperatures and from the shallows into the deep sea.

Three types of octocorals can easily be confused with stony corals unless the viewer is familiar with the fauna in his/her region; these are the Organpipe corals, massive octocorals and Blue corals (see previous section)

**5 Stony corals: Encrusting – CAAB 11 290908**

When coral colonies become flatter than they are tall they are termed encrusting. They are lichen like in form and low, thin, spreading and adhering to the substrate. Small encrusting stony corals may be confused with encrusting sponges.

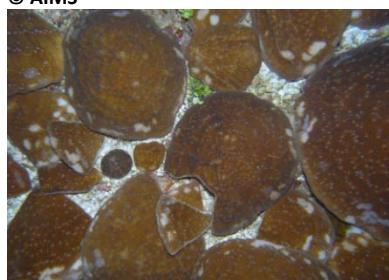
 © AIMS	 © AIMS	 © AIMS
<i>Montipora</i> sp.	<i>Porites</i> sp.	<i>Montipora</i> sp.
Example small encrusting form.		

**5 Stony corals: Solitary– CAAB 11 290901**

Solitary/ mushroom corals can be attached or free-living, they can be round, oval, elongate, dome shaped, or irregular and can be domed in the centre, where a thin slit-like mouth may be seen

**6 Solitary: Mushroom (Fungiidae):– CAAB 11 298000**

Fungiidae corals are hermatypic and form solitary discs up to 30 cm in diameter, which are attached as a juvenile but become free-living as it grows. Most free-living (unattached) corals on reefs are fungiids and can be round, oval, elongate, dome shaped, or irregular and can be domed in the centre, where a thin slit-like mouth may be seen. They are usually found in sediment and when tentacles are extended they can be mistaken for sea anemones.

 © AIMS	 © AIMS	 © AIMS
<i>Fungiidae</i>	<i>Halomitra</i> sp.	<i>Fungiidae</i>

**6 Solitary: Free-living - CAAB 11 290902**

Solitary free-living corals associated with soft sediments that have no zooxanthellae. They can be shaped disk or purse-shaped with or without rootlets; septa are very fine and numerous and columellae are absent or nearly so. Polyps are extended day and night and are large.

© CSIRO

*Flabellum sp.*

© CSIRO

*Flabellum sp.*

© CSIRO

*Stephanocyathus platypus***6 Solitary: Attached – CAAB 11 290903**

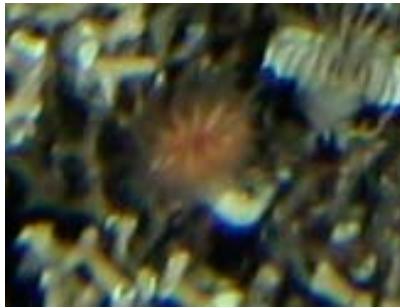
Solitary corals attached to substrate – sometimes in groups but normally obviously not a colony. They are mostly cylindrical or horn-shaped, the septa are thin and straight with smooth margins; they usually have no zooxanthellae.

© AAD



Solitary attached stony coral

© CSIRO

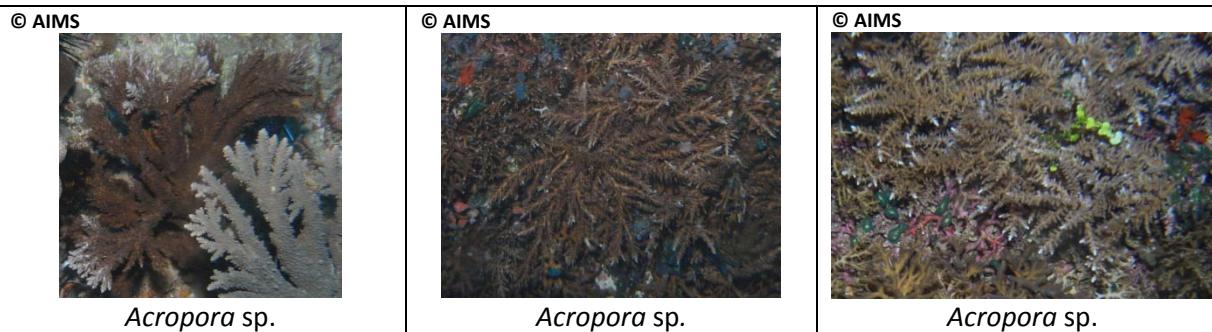
*Desmophyllum dianthus*

© CSIRO

*Caryophyllia diodemae*

### 5 Stony corals: Bottlebrush – CAAB 11 290904

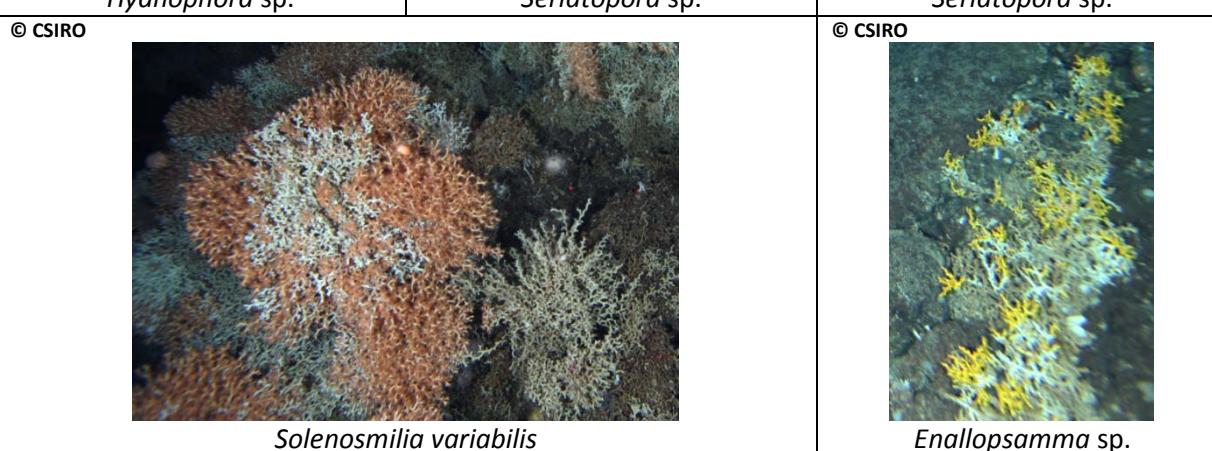
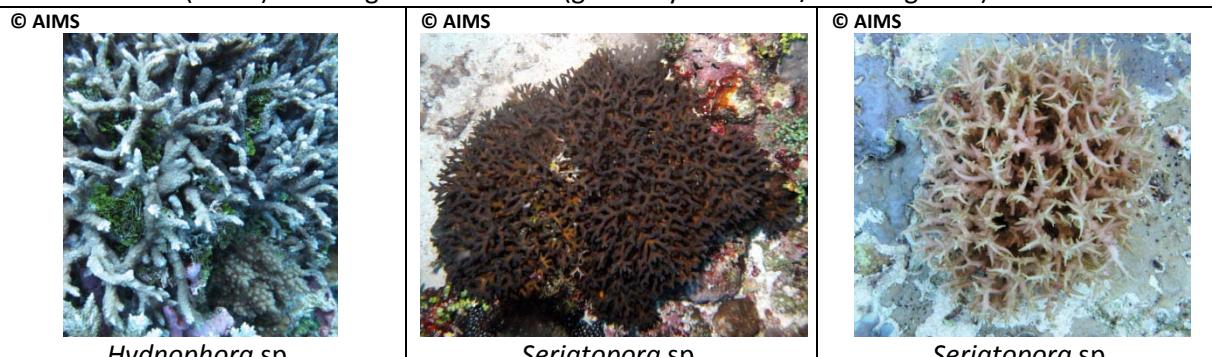
Bottlebrush corals have branches with a bottlebrush appearance and branches are sometimes intertwined. With bristles on all sides of a central stem.



### 5 Stony corals: Branching – CAAB 11 290912

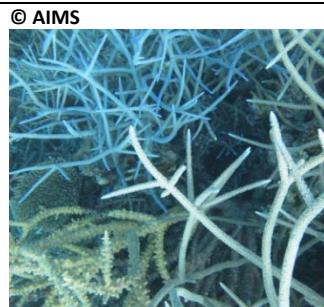
Branching corals (also called arborescent, arboreal or ramosae corals) branch like a tree. They grow from a base or trunk and their branches have projections of their own. Branching corals are very diverse but generally the term branching describes colonies that have secondary branches coming off the first branch. Forms that don't have the secondary branches are generally classed as digitate or columnar forms. The tips of branches can be used to differentiate between similar genera.

*Acropora* species having an axial polyp at the tip of the branches, *Pocillopora* species have branches that are tapered at the tip, *Seriatopora* species branches taper to a needle point and *Stylophora* branches are sub-rounded or blunt. These growth forms include shallow as well as deepsea forms. In deepsea forms three regions can be identified in the coral matrix, live polyps (coloured), recently dead skeleton (white) and long-dead skeleton (generally black and/or overgrown).



### 5 Stony corals: Staghorn – CAAB 11 290913

Staghorn growth-form is branching with cylindrical branches from a few centimetres to branches over 2 metres long or high. They can somewhat resemble antlers.



*Acropora sp.*



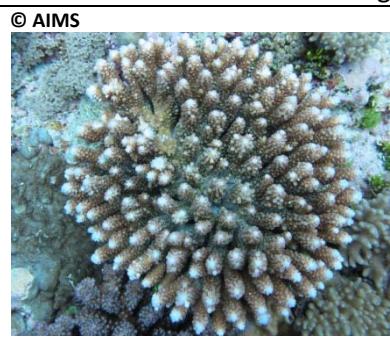
*Acropora sp.*



*Acropora sp.*

### 5 Stony corals: Corymbose – CAAB 11 290910

Corymbose growth-forms are sometimes described as ‘crazy’ branching, irregular, dense and bushy. Grows in lots of small branching corals with the branches having many smaller offshoots.



*Acropora sp.*



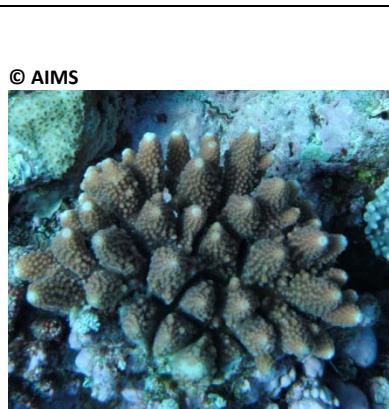
*Acropora sp.*

### 5 Stony corals: Digitate – CAAB 11 290909

Digitate growth-forms have small, non-splitting branches which resemble fingers or digits. No secondary branches are visible. Often provide important nursery areas for juvenile reef fishes. The colonies extend their size through adding more branches, whereas the height of the colony generally does not change.



*Acropora sp.*



*Acropora sp.*



*Acropora sp.*

### 5 Stony corals: Columnar – CAAB 11 290915

Columnar corals start from a massive base in a pillar form and do not branch. Digitate refers to colonies showing finger-like projections like an upturned hand. Where these fingers become thicker and taller they may be referred to as sub-massive or columnar. Note sub-massive may be used to describe lumpy massive colonies or knobbly columns.

© Renata Ferrari



Columnar stony coral

### 5 Stony corals: Foliose / plate – CAAB 11 290907

Foliose corals have a coral growth-form that is highly variable. The skeletal form approximates that of a broad, flattened plate growing into a range of intricate and often delicate forms. Foliaceous corals form horizontally flattened, unifacial plates or lobes that are attached to the reef substrate from the basal (ventral) surface. The plates may form tiers, whorls or vases, which can stacked in a complex, multi-layered arrangement. Their flattened shape results from a strong tendency for radial (edge) rather than vertical extension. Where plates are near-vertical they may be described as leafy or lettuce-like or where the plates are narrow, as flutes and spires. Similar to the open petals of a flower.

© AIMS



*Echinopora* sp.

© AIMS



*Pachyseris* sp.

© AIMS



*Pavona* sp.

### 5 Stony corals: Tabulate – CAAB 11 290911

Tablulate corals are flat table-like structures of fused branches.

© AIMS



*Acropora* sp.

© AIMS



*Acropora* sp.

© AIMS



*Acropora* sp.

### 5 Stony corals: Sub-massive – CAAB 11 290905

Similar to massive but has protrusions or a lumpier structure or can be plate-like with protrusions or columnar growth forms from the plate. Sub-massive corals can have knobs, columns or wedges protruding from an encrusting base.

Note: Blue corals (4 Black & Octocorals: Blue coral (*Heliopora*) – CAAB 11 171000) may be misclassified as this category.

© AIMS

*Isopora* sp.

© AIMS

*Porites* sp.

© AIMS

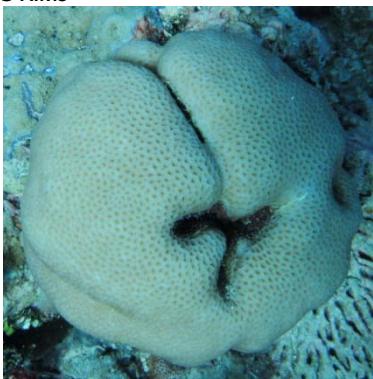
*Pavona* sp.

### 5 Stony corals: Massive – CAAB 11 290906

Massive corals are generally hemispherical ball- or boulder-shaped and relatively slow growing with a very stable profile. Massive refers to colonies which are solid with roughly similar dimensions in all directions and may also be described as domed or mound-shaped. If colonies form lumpy surfaces they may be called sub-massive.

Note: organ-pipe and massive octocorals (4 Black & Octocorals: Organ-pipe coral (*Tubipora*) – CAAB 11 201901 and 4 Black & Octocorals: Massive soft corals – CAAB 11 168920) may be misclassified as this category.

© AIMS

*Goniastrea* sp.

© AIMS

*Favia* sp.

© AIMS

*Porites* sp.

© AIMS

*Goniopora* sp.

© AIMS

*Porites* sp.

© AIMS

*Porites* sp.

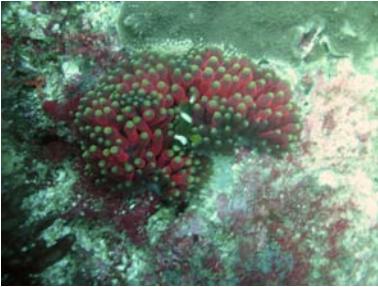
**3 Cnidaria: True anemones – CAAB 11 229000**

True anemones have a leathery body with a central mouth surrounded by a ring of tentacles.

**4 True anemones: Other anemones – CAAB 11 229903**

Classical anemone with a fleshy base (may be buried) and ring of tentacles around a central mouth.

Some can reproduce by cloning resulting in patches of many individuals. Note: clownfish are always associated with true anemones.

 © CSIRO True anemone	 © CSIRO True anemone	 © CSIRO True anemone with tentacles retracted
 © CSIRO True anemone	 © CSIRO True anemone	 © CSIRO True anemone
 © Renata Ferrari True anemone	 © Renata Ferrari True anemone	 © Renata Ferrari True anemone
 © Renata Ferrari True anemone (Actiniidae) Note: easily confused with massive soft coral (5 Stony corals: Massive – CAAB 11 290906)		

**4 True anemones: Flytrap - CAAB 11 229901**

Two large lobes with the tentacles on the edge, resembling a venus flytrap.

© CSIRO



Flytrap anemone

© CSIRO



Flytrap anemone

**4 True anemones: Fourlobed - CAAB 11 229902**

Four fleshy lobes surrounding the mouth each with the tentacles on the edge of the lobe.

© CSIRO



Fourlobed anemone

**3 Cnidaria: Tube anemones - CAAB 11 164000**

Anemones with very numerous thin tentacles arranged in 2 rings – very long outer ones and much shorter inner ones that are often a different colour. Can withdraw into a leathery tube – tube usually extending above surface so it looks stalked. In sediments only.

© CSIRO



Tube anemone extended

© CSIRO



Tube anemone retracted

© CSIRO



Tube anemone extended

### 3 Cnidaria: Colonial anemones – CAAB 11 500901

Colonial anemones include two groups, the corallimorphs and the zoanthids.

#### 4 Colonial anemones: Corallimorphs – CAAB 11 280000

Colonial anemones – often cover large areas. In tropical, shallow waters they are generally zooxanthellate; the deeper cold-water species are azooxanthellate, often brightly coloured and have bubbles on end of tentacles – almost identical to some azooxanthellate stony corals, e.g. *Culicia*.

*Discosoma* sp.

*Amplexidiscus* sp.

*Corynactis* sp.

#### 4 Colonial anemones: Zoanthids – CAAB 11 284000

Colonial anemones with an obvious basal mat or stolons, individuals often cylindrical.

Azooxanthellate species usually with elongate polyps, sessile species commonly in association with sponges or other sessile invertebrates. Hermit zoanthids have an obligate relationship with hermit crabs, forming a cnidosarc for the crab, and are carried around. Shallow water zooxanthellate species can form large sheets, elongate species usually curved over during day.

© CSIRO



Hermit zoanthids

© CSIRO

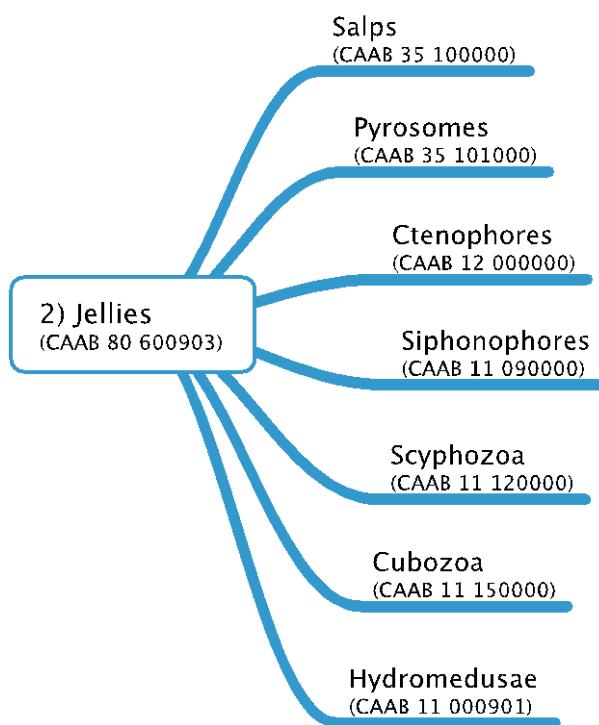


*Epizooanthus* sp.

## 2 Jellies – CAAB 80 600903

Authors: Karen Gowlett-Holmes, Lisa-ann Gershwin, Franziska Althaus

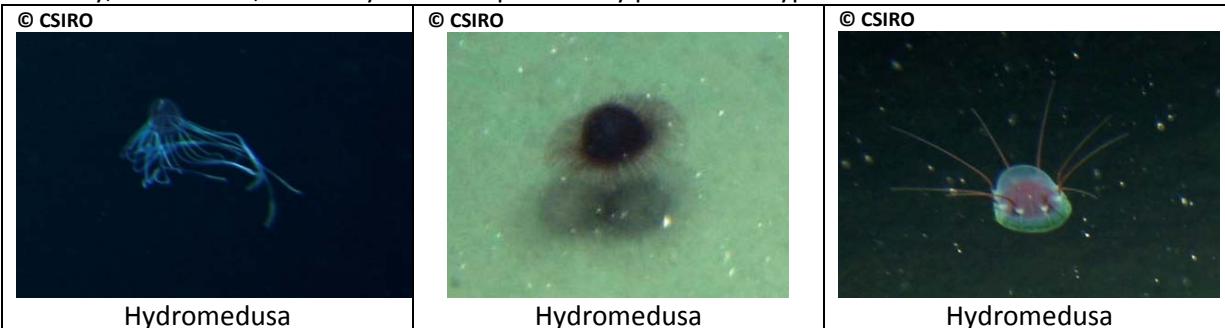
The category 'Jellies' encompasses a variety of phyla that all are translucent and gelatinous in appearance. We combined these groups into one category at the highest level of the hierarchy because to the untrained eye it may be difficult to determine the difference between phyla. Lisa-ann Gershwin and colleagues at the CSIRO are currently working on the compilation of a series of guides describing pelagic and midwater invertebrates which will describe these animals in more detail (Gershwin et al. in prep).



Hierarchical structure for the Jellies branch of the CATAMI Classification Scheme

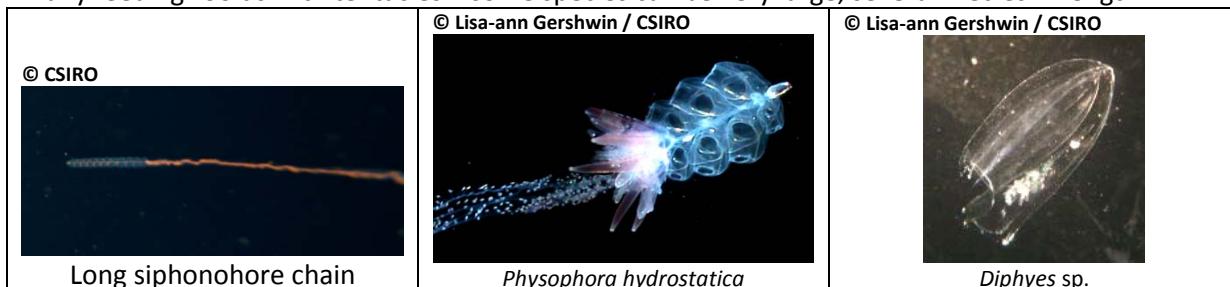
## 3 Jellies: Hydromedusae – CAAB 11 000901

Solitary, often small, relatively more simple in body plan than scyphozoan medusae.



### 3 Jellies: Siphonophores – CAAB 11 090000

Colonial, usually with defined propulsive section (swimming bells), commonly with a gas float, and many feeding zooids with tentacles – some species can be very large, several metres in length.



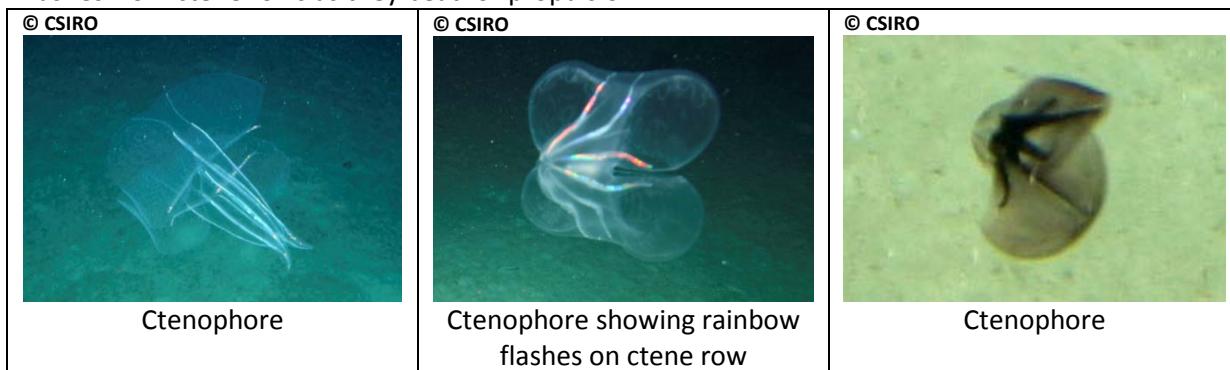
### 3 Jellies: Cubozoa – CAAB 11 150000

Solitary, bell box-shaped – four sides, tentacles (single or a cluster) attached to four corners of bell only.



### 3 Jellies: Ctenophores – CAAB 12 000000

Comb jellies – very delicate, often bioluminescent, many with elaborate lobes. Commonly rainbow flashes from ctene rows as they beat for propulsion.



**3 Jellies: Scyphozoa – CAAB 11 120000**

Solitary, classic jellyfish shape; can be large, generally more elaborate structures compared with hydromedusae.

		
© Lisa-ann Gershwin <i>Aurelia</i> sp. (Moon jelly)	© Lisa-ann Gershwin <i>Catostylus</i> sp.	© Lisa-ann Gershwin <i>Pelagia</i> sp.

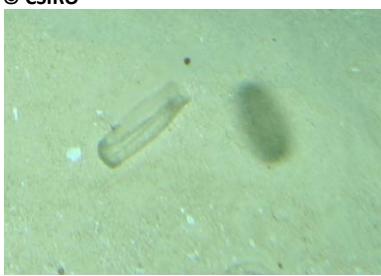
**3 Jellies: Pyrosomes – CAAB 35 101000**

Firm jelly tubes, sealed at one end. Often bioluminescent. Smaller species tube fairly rigid. Large species (>5m) tube more flexible.

	
© CSIRO Long, skinny pyrosome	© Eaglehawk Dive Centre <i>Pyrosoma spinosum</i> (check it out on YouTube – <a href="https://www.youtube.com/watch?v=5EQGA_4BZ5s">https://www.youtube.com/watch?v=5EQGA_4BZ5s</a> )

**3 Jellies: Salps - CAAB 35 100000**

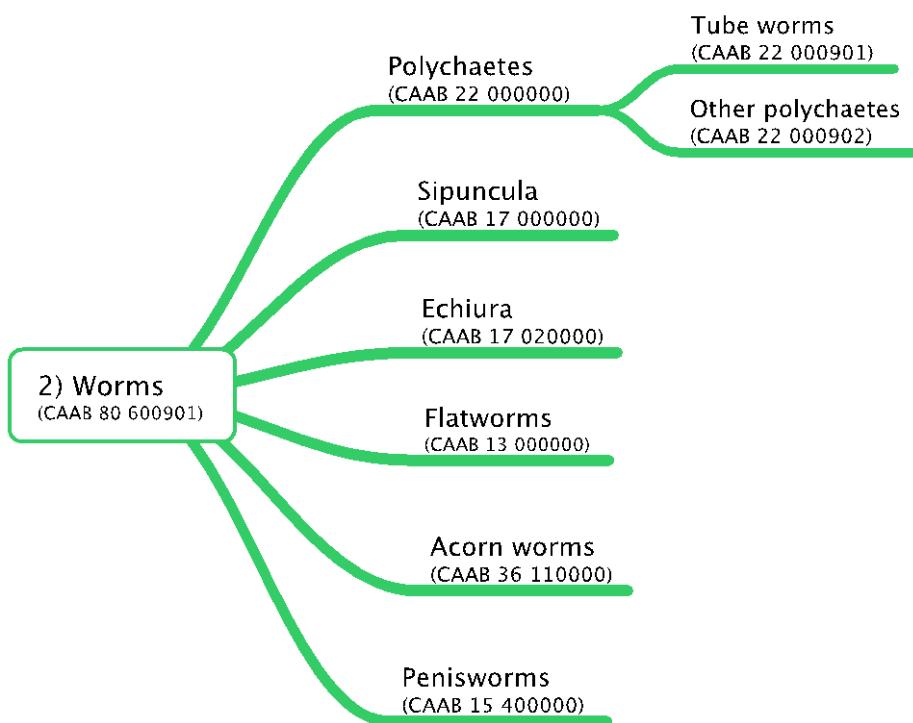
Solitary and colonial. More common in upper water column. Colonies can form long chains. Capable of very rapid growth and can be present in very dense numbers.

 © CSIRO Solitary salp (small)	 © CSIRO Solitary salp (small)	 © NERP / CSIRO <i>Thetys vagina</i>
 © NERP / CSIRO Salp chain	©	©

## 2 Worms – CAAB 80 600901

Authors: Karen Gowlett-Holmes, Franziska Althaus

The category ‘Worms’ encompasses a variety of phyla that all worm-like in appearance. We combined these groups into one category at the highest level of the hierarchy because to the untrained eye it may be difficult to determine the difference between phyla.



Hierarchical structure for the Worms branch of the CATAMI Classification Scheme

### 3 Worms: Flatworms – CAAB 13 000000

Small, extremely flat; free-living species often brightly coloured and can be confused with molluscan sea slugs.

Flatwom		
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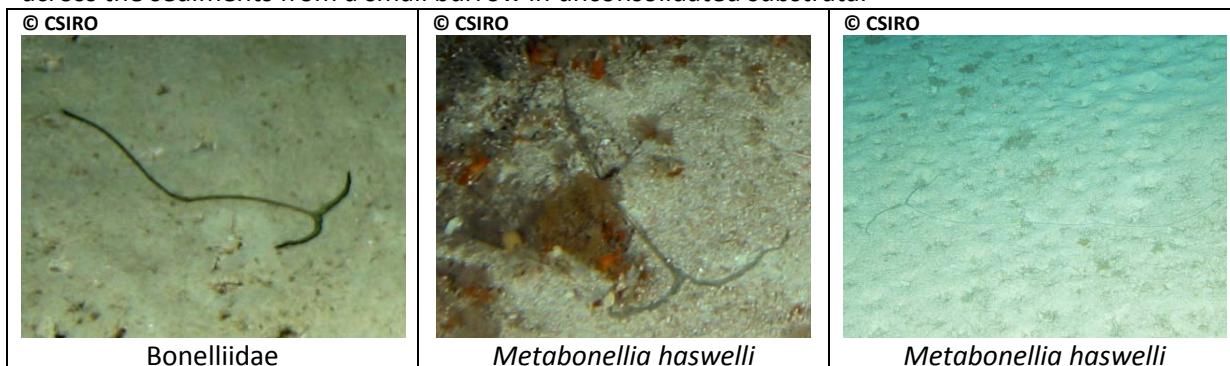
### 3 Worms: Penisworms – CAAB 15 400000

Priapulids are generally sediment infauna, and rarely seen on surface.

Penisworm		
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### 3 Worms: Echiura – CAAB 17 020000

Generally only the proboscis (often T-shaped) of the echuran worm is visible in images, extending across the sediments from a small burrow in unconsolidated substrata.



### 3 Worms: Sipuncula – CAAB 17 000000

Sipunculans are generally sediment infauna, and rarely seen on surface. One group inhabit small dead gastropod shells, and can be mistaken for hermit crabs.

Sipuncula		
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### 3 Worms: Acorn worms – CAAB 36 110000

Acorn worms are generally infaunal and are only their castings are seen (scored under bioturbation – CAAB 81002000) in the deepsea acorn worms are sometimes seen on the sediments, they have a distinctive widened edge of the head and are typically dark coloured; they are usually seen associated with characteristic spiral waste casts (see 2 Bioturbation – CAAB 81 000000, spiral waste casts - CAAB 81002007).



### 3 Worms: Polychaetes – CAAB 22 000000

Segmented worms with chetae – extremely variable. Most species are infauna or cryptic.

#### 4 Polychaetes: Tube worms – CAAB 22 000901

Polychaetes that live in tubes, tubes sometimes calcified, but many are leathery, built from mucus and chetae, sometimes reinforced with sand grains. Often only the tubes are visible in images.

		
© CSIRO Serpulidae	© CSIRO Serpulidae	© CSIRO Fanworm

		
© CSIRO Tube worm	© Advanced Imaging and Visualization Laboratory Woods Hole Oceanographic Institution. (Tasmanian Seamounts Survey) Fanworm	© NERP / CSIRO Soft tube worm tubes of cemented sand

#### 4 Polychaetes: Other polychaetes – CAAB 22 000902

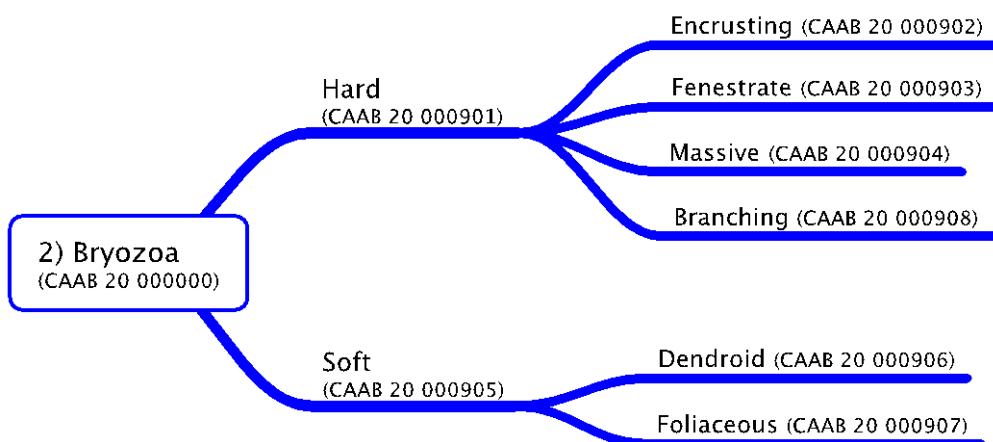
Segmented worms with chaetae or bristles. They can be various shapes and forms. Those visible in images are generally larger predatory species. Also seen are epitokes – detached sections packed with gametes that swim in the water column before releasing the gametes – these are often attracted to lights.

		
© CSIRO Polychaete	© CSIRO Polychaete	© CSIRO Polychaete

## 2 Bryozoa – CAAB 20 000000

Authors: Karen Gowlett-Holmes, Franziska Althaus, Nicole Hill

Bryozoans or ‘lace corals’ are subdivided into two broad categories, soft or articulated bryozoans and hard, rigid bryozoans. They can be confused with some macroalgae, corals and / or hydroids. Distinction from macroalgae can generally be based on knowledge of the depth where the image was taken: bryozoans are usually found below the photic zone.



Hierarchical structure for the Bryozoa branch of the CATAMI Classification Scheme

### 3 Bryozoa: Hard – CAAB 20 000901

Hard bryozoans are calcified and have a rigid structure that can be confused with certain corals.

#### 4 Hard: Encrusting – CAAB 20 000902

Forming a thin crusting layer, generally on hard substrates.

Encrusting bryozoa

#### 4 Hard: Massive – CAAB 20 000904

Rigid, not mesh-like. Generally form irregular erect masses or irregularly branched vanes.

Occasionally reef building. Can be on sediment as well as reef. Can be confused with some corals.

© CSIRO



*Celleporaria* sp.

**4 Hard: Fenestrate - CAAB 20 000903**

Rigid mesh-like structures that often grow as erect fans or as lamellar structures, some may be confused with gorgonian fans (6 Fan (2D): Rigid – CAAB 11 168916).

© CSIRO



Fenestrate bryozoa

© CSIRO



Adeona grisea

© CSIRO



Adeona grisea

**4 Hard: Branching - CAAB 20 000908**

Rigid, typically bi-furcated (dichotomous) branching pattern with short internodes, sometimes branching irregular. Note: this form may be confused with some macroalgae.

© CSIRO



Adenolopsis sp.

© CSIRO



Branching hard bryozoa

© CSIRO



Branching hard bryozoa

© AAD



Branching hard bryozoa

### 3 Bryozoa: Soft – CAAB 20 000905

Soft bryozoans are very lightly calcified or uncalcified, with an articulated branching structure. Some species can be confused with hydroids and some macroalgae.

#### 4 Soft: Dendroid – CAAB 20 000906

Flexible bryozoans where branches are clearly visible, often hard articulated branches with flexible internodes. Generally much thinner branches and more bushy than the Hard-Branched category above.

Note easily confused with hydroids (3 Cnidaria: Hydroids – CAAB 11 001000)

		
© CSIRO Dendroid soft bryozoa	© CSIRO Dendroid soft bryozoa	© CSIRO Flustridae

#### 4 Soft: Foliaceous – CAAB 20 000907

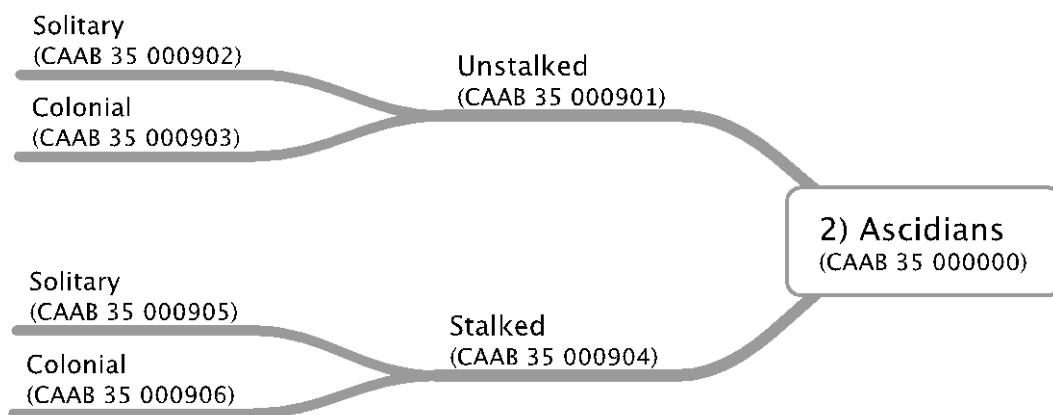
Soft, uncalcified species with a ‘fluffy’ appearance – fine, numerous, branches, usually bushy; often difficult to see individual branches. Can be confused with some hydroids (which they are often growing with) (3 Cnidaria: Hydroids – CAAB 11 001000) and also some macroalgae.

		
© CSIRO Foliaceous soft bryozoa	© CSIRO Foliaceous soft bryozoa	© CSIRO Foliaceous soft bryozoa

## 2 Ascidia – CAAB 35 000000

Authors: Karen Gowlett-Holmes, Franziska Althaus

Ascidians occur solitary and in colonial form, stalked and unstalked. The primary subdivision in this group is based on the stalk because being elevated off the substrate on a stalk implies a different ecology to being directly attached to the substrate.



Hierarchical structure for the Ascidiants branch of the CATAMI Classification Scheme

### 3 Ascidiants: Stalked – CAAB 35 000904

Ascidiants that are elevated off the substrate by a stalk.

#### 4 Stalked: Colonial – CAAB 35 000906

Colonial ascidiants that have a distinct stalk between the colony and the substrate. Colony ‘head’ normally at the top of the stalk. Some elongate species can be confused with sea whips and similar octocorals (5 Black & Octocorals: Whip – CAAB 11 168917). Note: some species have a persistent stalk but a seasonal colony ‘head’, and can change appearance at different times of the year.

© CSIRO



*Sigillina cyanaia*

© CSIRO



*Sycozoa sp.*

© NERP / CSIRO



*Sycozoa sp.*

 <p>© AAD Stalked colonial ascidian</p>		
<p><b>4 Stalked: Solitary – CAAB 35 000905</b></p> <p>Solitary ascidians that have a distinct stalk between the main test ('head') and the substrate. Ascidian 'head' has two distinct siphons. Note: commonly overgrown with sponges and encrusting colonial ascidians. Can be confused with Stalked: Colonial ascidians, and also with some sponges.</p>		
 <p>© AAD Solitary stalked ascidian</p>	<p>© Advanced Imaging and Visualization Laboratory Woods Hole Oceanographic Institution. (Tasmanian Seamounts Survey)</p>  <p>Carnivorous ascidian</p>	<p>© Karen Gowlett-Holmes</p>  <p><i>Pyura spinifera</i></p>
 <p>© Karen Gowlett-Holmes <i>Pyura australis</i></p>		

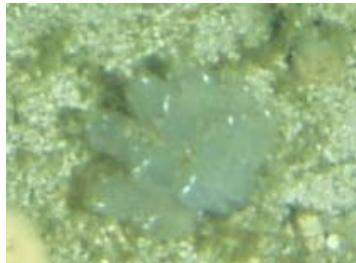
**3 Ascidians: Unstalked – CAAB 35 000901**

Colonial and solitary ascidians that are directly attached to the substrate.

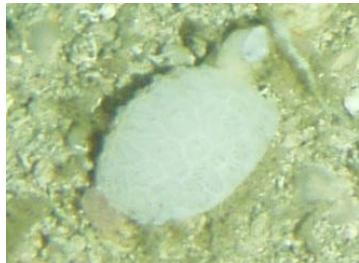
**4 Unstalked: Colonial – CAAB 35 000903**

Colonial ascidians attached directly to the substrate with no distinct stalk. Often have a glossy, semi-translucent look; often multiple siphons can be visible. Many species can easily be confused with sponges.

© CSIRO

*Clavellina sp.*

© CSIRO



Unstalked colonial ascidian

© CSIRO



Unstalked colonial ascidian

**4 Soft: Unstalked: Solitary – CAAB 35 000902**

Solitary ascidians attached directly to the substrate. Generally have the classic ‘seasquirt’ form of a test with two siphons at or near the top.

© CSIRO



Unstalked solitary ascidian

© CSIRO



Unstalked solitary ascidian

© CSIRO



Unstalked solitary ascidian with elongate siphons

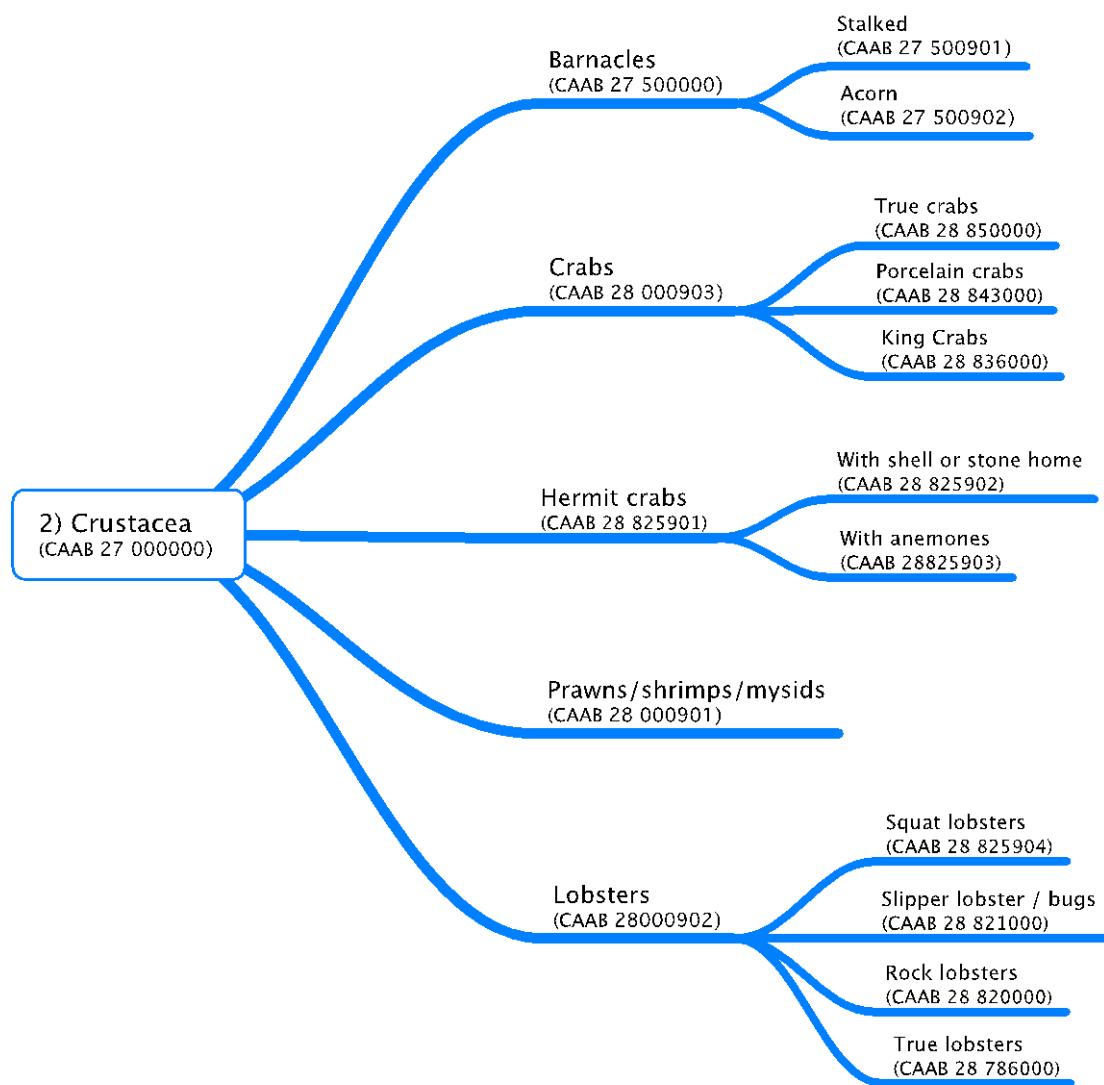
© Karen Gowlett-Holmes

*Phallusia obesa*

## 2 Crustacea - CAAB 27 000000

Authors: Karen Gowlett-Holmes, Franziska Althaus

The classification of the crustaceans is basically taxonomic, here we describe a few basic forms that easily can be distinguished in imagery.



Hierarchical structure for the Crustacea branch of the CATAMI Classification Scheme

### 3 Crustacea: Barnacles – CAAB 27 500000

Barnacles in general; they can be further divided into unstalked or acorn barnacles and stalked or goose barnacles.

#### 4 Barnacles: Acorn – CAAB 27 500902

Sessile barnacles with rigid plates, fixed directly to the substrate.

© Advanced Imaging and Visualization  
Laboratory Woods Hole Oceanographic  
Institution. (Tasmanian Seamounts Survey)



*Tetrachaelasma tasmanicum*

© Advanced Imaging and Visualization  
Laboratory Woods Hole Oceanographic  
Institution. (Tasmanian Seamounts Survey)



*Tetrachaelasma tasmanicum*  
(close-up image)

#### 4 Barnacles: Stalked – CAAB 27 500901

Barnacles with a distinct stalk attaching them to the substrate; often in groups. Some species have lightly calcified plates. Commonly epizoic on benthic arthropods and pelagic animals, including jellyfish, turtles and whales. Stalked barnacles are often referred to as goose barnacles.

© CSIRO



Scalpellidae

**3 Crustacea: Prawns / shrimps / mysids – CAAB 28 000901**

Shrimp-like benthic free-living and pelagic crustaceans.

		
Prawn	Prawn	Pennaeidae

		
Shrimp	Shrimp	Pennaeidae

**3 Crustacea: Lobsters – CAAB 28 000902**

Benthic lobsters – have a muscular tail used to swim to escape.

**4 Lobsters: Rock lobsters – CAAB 28 820000**Also called spiny lobsters and crayfish – family Palinuridae – no pincers; 1<sup>st</sup> antenna bases large, horn-like; carapace usually spiny.

		
<i>Jasus edwardsii</i> (crayfish)		

**4 Lobsters: True lobsters – CAAB 28 786000**True lobsters and scampi – family Nephropidae – obvious large pincers, no horn-like base to 1<sup>st</sup> antennae. Scampi burrow in sediment and are often seen in the mouth of the burrow.

		
<i>Nephropidae</i>		

**4 Lobsters: Slipper lobsters / bugs - CAAB 28 821000**

Family Scyllaridae – dorso-ventrally flattened – carapace and 1<sup>st</sup> antennae usually expanded into ‘shovel-nosed’ front. Bugs usually burrow in sediments.

© CSIRO

*Ibacus* sp.

© CSIRO

*Ibacus* sp.

© CSIRO

*Ibacus* sp.**4 Lobsters: Squat lobsters - CAAB 28 825904**

Small, with pincers on elongate ‘arms’, tail folded under body. Often cryptic. Includes species epizoic and commensal on sessile invertebrates, particularly octocorals, black corals, and sponges. Eyes often large and reflect light – often revealed by the bright reflection of the eyes.

© CSIRO



Squat lobster

© CSIRO



Squat lobster

**3 Crustacea: Hermit crabs - CAAB 28 825901**

Hermit crabs have a soft, unarmoured tail, and live in an object to protect it. Most use gastropod shells, but not all.

**4 Hermit crabs: With shell or stone home - CAAB 28 825902**

Most hermit crabs use a gastropod shell as a ‘home’ these easily be confused with gastropods, unless the crab is clearly visible in the aperture of the shell. Some hermit crabs use a single bivalve shell or a tusk shell as a home, or even an excavated soft pebble – these can be very difficult to distinguish from dead shells or normal pebbles unless the crab is visible.

© CSIRO



Hermit crab with a gastropod shell

© NERP / CSIRO



Hermit crab with a gastropod shell

Hermit crab with a stone

#### 4 Hermit crabs: With anemones - CAAB 28 825903

Hermit crabs with large anemones on the shell or using zoanthids as 'home' – the zoanthid colony forms a cnidosarc – a spiral space for the hermit crab to live in. Normally only the zoanthid colony is visible, obscuring the crab underneath – generally seen out on sediments. These are deepsea, particularly at depths approaching the carbonate compensation depth, where dead gastropod shells readily dissolve.

© CSIRO 	© CSIRO 	© NERP / CSIRO 
Small hermit crabs with anemone on shell	Small hermit crabs with anemone on shell	Small hermit crabs with anemone on shell
Hermit crab with zoanthid		

#### 3 Crustacea: Crabs - CAAB 28 000903

True crabs and crab-like anomurans – benthic, tail reduced to small ventral flap under carapace – usually cannot be used to swim with.

#### 4 Crabs: True crabs - CAAB 28 850000

Crabs with 4 pairs of walking legs plus claws, large variety of shapes and sizes. Note: there are a few groups in which 1 or 2 pairs of walking legs have been secondarily reduced, e.g. sponge crabs (Dromiidae), antlered crabs (Latreilliidae), Cyclodorippidae, Dorippidae, Palicidae.

© CSIRO 	© CSIRO 	© CSIRO 
Ovalipes molleri (swimmer crab)	Dagnaudus petterdi (antlered crab)	Pseudocarcinus gigas (giant crab)
© CSIRO 	© CSIRO 	© CSIRO 
Leucosiidae	Majidae	Chaceaon sp.

**4 Crabs: Porcelain crabs - CAAB 28 843000**

Small crabs with 3 pairs of walking legs plus claws – body usually flattened, claws held close to body, can use tail flap to swim to escape; also includes half crabs.

© Renata Ferrari



Porcelain crab

**4 Crabs: King crabs - CAAB 28 836000**

King Crabs – Lithodidae – crabs with 3 pairs of walking legs plus claws – tail reduced to fleshy flap under carapace, cannot be used to swim with. Carapace often spiny. Resemble majoid spider crabs but with less walking legs.

Lithodidae

**2 Seaspiders - CAAB 33 000000**

Authors: Karen Gowlett-Holmes, Franziska Althaus

Pycnogonids – very reduced body, often with a large proboscis, and very long, thin, legs. Deepsea species can be very large and obvious. Most shallow water species are small and cryptic. There is no subdivision of this branch in the CATAMI Classification Scheme.

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Colosseidae

© AAD

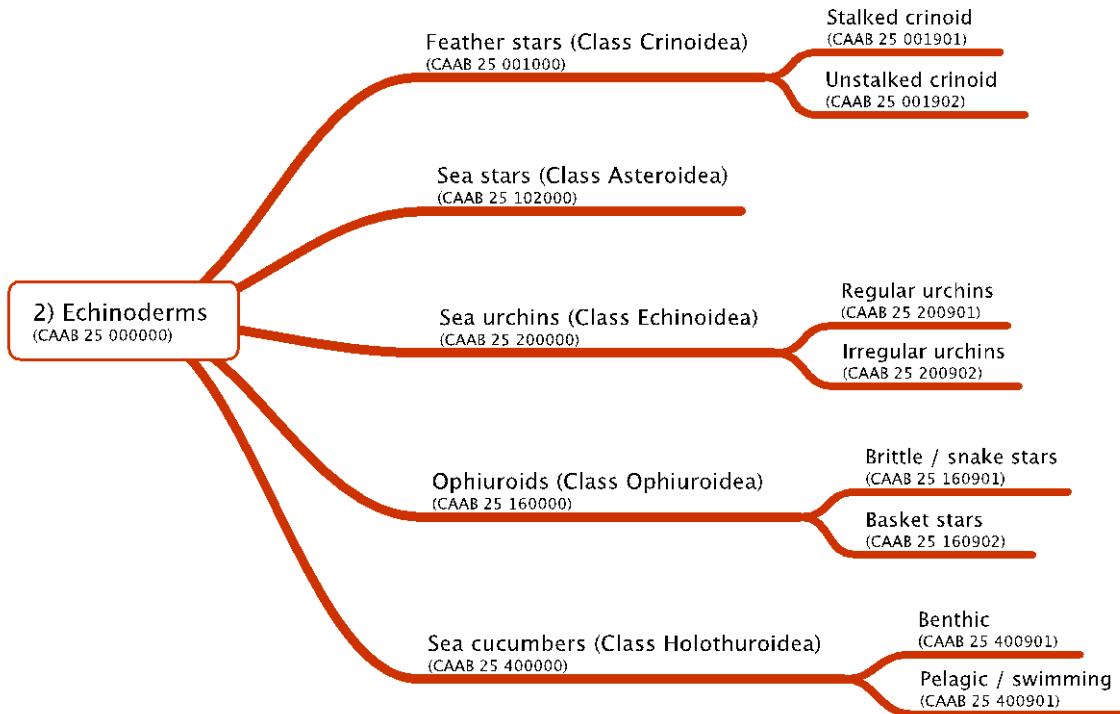


Colosseidae

## 2 Echinoderms – CAAB 25 000000

Authors: Karen Gowlett-Holmes, Franziska Althaus

The classification of the echinoderms is basically taxonomic to class-level, here we describe a few basic forms that easily can be distinguished in imagery.



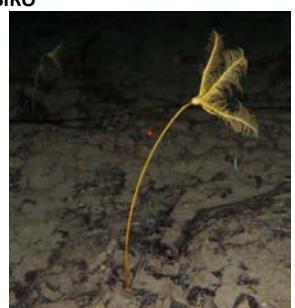
Hierarchical structure for the Echinoderms branch of the CATAMI Classification Scheme

### 3 Echinoderms: Feather stars – CAAB 25 001000

The feather stars represent the class Crinoidea that have many feathered arms radiating from a central disk. There are two basic forms of crinoids: stalked and unstalked, each containing several families.

#### 4 Feather stars: Stalked crinoids – CAAB 25 001901

Stalked crinoids have distinct stalk between the disc and arms, and the substrate. In some, the stalk is bare (no cirri), and the animal is fixed to the reef. Others have cirri down the stalk – while often fixed to the reef, these can actually walk on the cirri on the stalk and use the cirri to attach themselves – these can sometimes be seen moving over soft sediment.

© CSIRO 	© CSIRO 	
Pentacrinitidae	Anachalypsicrinus sp.	

#### 4 Feather stars: Unstalked crinoids – CAAB 25 001902

Classic featherstars – no stalk, cirri attached directly to base under disc and arms. Use cirri to hold on to substrate. Often epizoic on sessile animals and on plants.

© CSIRO 	© CSIRO 	© CSIRO 
Unstalked crinoid on sediments	Unstalked crinoids on a sponge	Ptilomeridae

© AAD 	© Renata Ferrari 	
Unstalked crinoid	Unstalked crinoid	

### 3 Echinoderms: Ophiuroids – CAAB 25 160000

Ophiuroids have a small central disk with five arms radiating off it.

#### 4 Ophiuroids: Basket stars – CAAB 25 160902

In basketstars the five main arms sub-divide (normally dichotomously) into many branches. Often epizoic on sessile invertebrates, particularly octocorals and sponges.

© CSIRO 	© CSIRO 	© CSIRO 
Gorgonocephalidae	Gorgonocephalidae	Gorgonocephalidae

#### 4 Ophiuroids: Brittle / snake stars – CAAB 25 160901

Britlestars are the ‘classic’ ophiuroids with five unbranched arms, they can be free moving or semi-buried in soft substrates; many species are cryptic. Snakestars are, like basketstars always epizoic on sessile invertebrates (particularly octocorals), but the five main arms are unbranched.

© CSIRO 	© CSIRO 	© CSIRO 
Free moving ophiuroid	Semi-buried ophiuroid	Ophiotrichidae

© CSIRO 	© CSIRO 	© CSIRO 
Snake star on bubblegum coral	Snake star on fan coral	Snake star on branched coral

### 3 Echinoderms: Sea stars – CAAB 25 102000

Seastars encompass the class Asteroidea the shapes range from the classical five-armed seastar to quite fleshy biscuitstars and seastars with many more arms. They can be distinguished from ophiuroids and crinoids by the fleshiness of the arms.

 © CSIRO	 © CSIRO	 © CSIRO
Goniasteridae	Asterinidae-	Brisingid
 © CSIRO		
Asteriidae		

### 3 Echinoderms: Sea urchins – CAAB 25 200000

Seaurchins include regular urchins with hard tests and spines of various length and thickness and irregular urchins that are modified for burrowing.

#### 4 Sea urchins: Regular urchins – CAAB 25 200901

Regular sea urchins are round in outline when viewed from the top, and generally look like a slightly flattened ball appearance (exception is *Dermechinus* which becomes very elevated with age). A distinct top and bottom, but no front and back. Always have clearly visible spines, often quite long or large, evenly around the test (although usually longer on the top). Most regular urchins have a rigid test, but pancake urchins have lightly calcified plates and are flexible.

 © CSIRO	 © CSIRO	 © CSIRO
<i>Diadema savignyi</i>	<i>Caenopedia sp.</i>	<i>Dermechinus horridus</i>

 © CSIRO	 © CSIRO	 © CSIRO
 © AAD		

#### 4 Sea urchins: Irregular urchins – CAAB 25 200902

Irregular sea urchins include the heart urchins, and sand-dollars. They are generally dorso-ventral flattened, and irregular in shape with a front and back, which often have distinctive spines. Most spines usually very short. Heart urchins and sand-dollars are burrowing species, the dead tests are often seen on the surface of the sediments where they live.

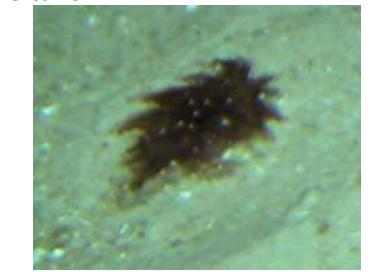
Sand dollar	Heart urchin	
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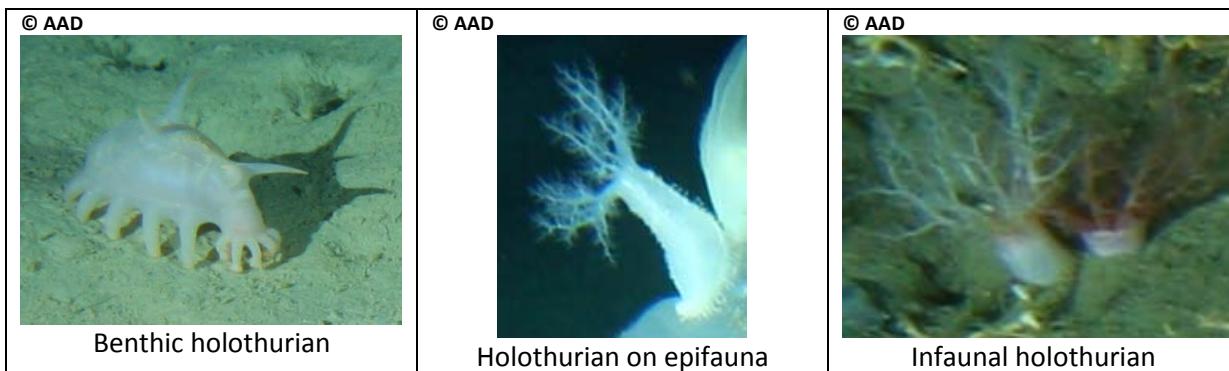
#### 3 Echinoderms: Sea cucumbers – CAAB 25 400000

Sea cucumbers or holothurians are usually cylindrical and flexible – very rarely do they have obvious plates in the skin. Some burrowing species only have the tentacles exposed, which can be confused with tube worms, tube anemones and octocorals.

#### 4 Sea cucumbers: Benthic – CAAB 25 400901

Classic holothurians on (and in) the substrate or on other epifauna..

 © CSIRO	 © CSIRO	 © CSIRO
Large benthic holothurian	<i>Holothuria nigralutea</i>	Benthic holothurian



#### **4 Sea cucumbers: Pelagic / swimming – CAAB 25 400902**

Deepsea species which feed on the substrate but can swim if disturbed.



#### **2 Brachiopods – CAAB 19 100000**

Authors: Karen Gowlett-Holmes, Franziska Althaus

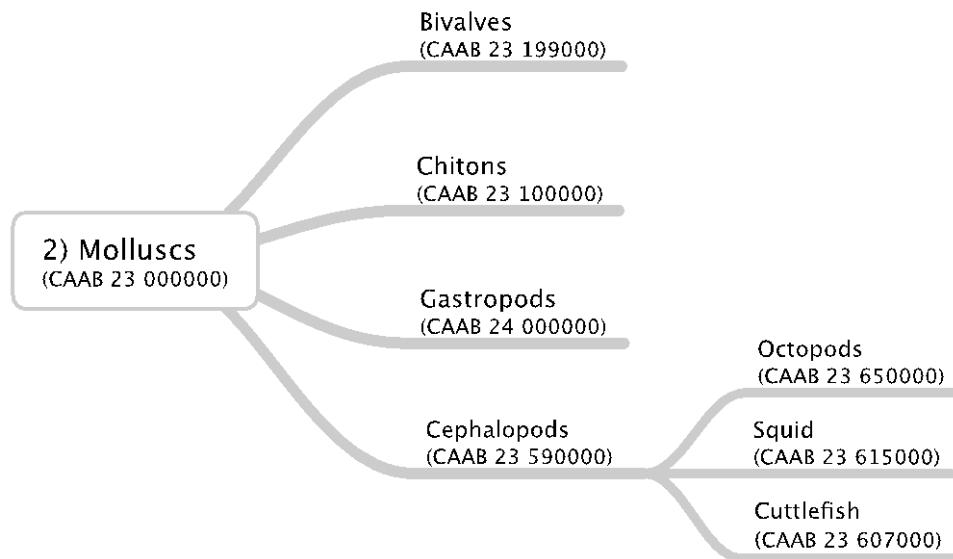
Brachiopods or seed shrimps are easily confused with bivalve molluscs (3 Molluscs: Bivalves – CAAB 2 3199000). There is no subdivision of this branch in the CATAMI Classification Scheme.



## 2 Molluscs – CAAB 23 000000

Authors: Karen Gowlett-Holmes, Franziska Althaus

The classification of the echinoderms is basically taxonomic to class-level, here we describe a few basic forms that easily can be distinguished in imagery.



Hierarchical structure for the Molluscs branch of the CATAMI Classification Scheme

### 3 Molluscs: Chitons – CAAB 23 100000

Chitons encompass the class Polyplacophora – benthic, 8 dorsal plates and a fleshy girdle. Mostly cryptic.

Chiton		
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### 3 Molluscs: Bivalves – CAAB 2 3199000

The bivalves are classic, two-shelled molluscs. Mostly infaunal, but some species are free-living, or attach using a byssus.

 © NERP / CSIRO <b>Bivalve</b>	 © CSIRO <b>Sponge scallop</b>	
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### 3 Molluscs: Gastropods – CAAB 24 000000

These molluscs include the classic snails with spiral shells, but also limpets and shell-less sea slugs.

 © CSIRO <b>Spindleshell</b>	 © CSIRO <b>Ericusa sowerbyi</b>	 © CSIRO <b>Marginellidae</b>
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### 3 Molluscs: Cephalopods – CAAB 23 590000

Cephalopods include the octopods, squids and cuttlefish, and nautilus.

#### 4 Cephalopods: Octopods – CAAB 23 650000

Cephalopods with no internal skeleton and 8 arms only. Often benthic (Octopodidae).

 © CSIRO <b>Octopodidae</b>	 © CSIRO <b>Octopodidae</b>	 © CSIRO <b>Octopodidae</b>
 © CSIRO <b>Octopodidae</b>	 © CSIRO <b>Octopodidae</b>	

**4 Cephalopods: cuttlefish - CAAB 23 607000**

Cephalopods with 8 arms and 2 tentacles, with an internal buoyant cuttlebone. Benthic species often highly camouflaged.

© CSIRO

*Sepia sp.*

© CSIRO

*Sepia sp.*

© CSIRO



Cuttlefish

**4 Cephalopods: Squid - CAAB 23 615000**

Cephalopods with 8 arms and usually 2 tentacles, with an internal horny 'pen' but no buoyant cuttlebone. Extremely variable, all species are active predators. Includes the bottle-tailed/ dumpling squids.

© CSIRO



Squid

© CSIRO



Squid

©

© CSIRO



Ommastrephidae (flying squid)

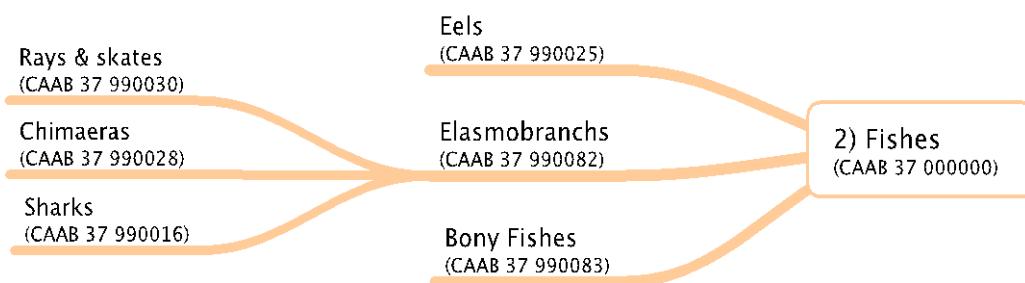
Dumpling squid

©

## 2 Fishes – CAAB 37 000000

**Authors:** Franziska Althaus

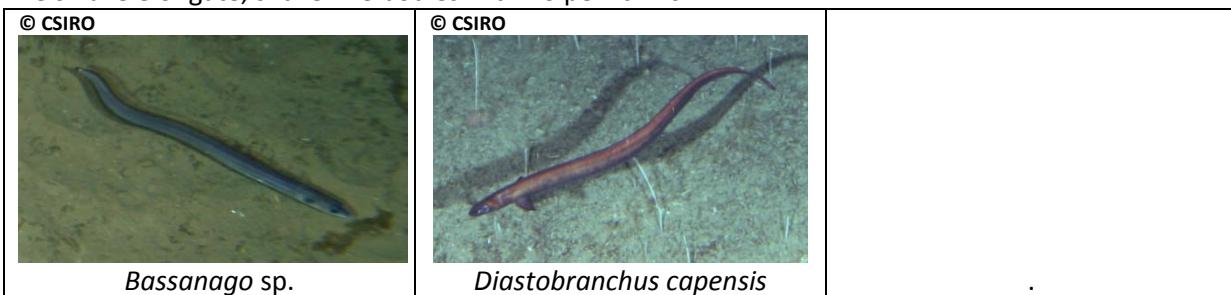
The classification of the fishes is basically taxonomic, here we describe three basic forms that easily can be distinguished in imagery, the eels or eel-shaped fish, elasmobranchs and the bony fish.



Hierarchical structure for the Fishes branch of the CATAMI Classification Scheme

### 3 Fishes: Eels – CAAB 37 990025

Eels have elongate, snake-like bodies with no pelvic fins.



**3 Fishes: Elasmobranchs – CAAB 37 990082**

Within the elasmobranchs, the cartilaginous fish, there are three groups that are easily distinguished visually: the rays and skates, the chimaera or ghost sharks, and the sharks.

**4 Elasmobranchs: Rays & skates – CAAB 37 990030**

Dorso-ventrally flattened, fins modified to form a disk.

© CSIRO 	© CSIRO 	© CSIRO 
Bathyraja sp.	Urolophus cruciatus	Rajidae

**4 Elasmobranchs: Chimaeras – CAAB 37 990028**

Chimaera or ghost sharks are distinct from other sharks by their beak-like jaw and usually elongate tail ending in a fine tip.

© CSIRO 		
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**4 Elasmobranchs: Sharks – CAAB 37 990016**

Classic shark bodyform.

© CSIRO 	© CSIRO 	© CSIRO 
Asymbolus sp. (catshark)	Cephaloscyllium sp.	Squalus sp.

**3 Fishes: Bony fishes - CAAB 37 990083**

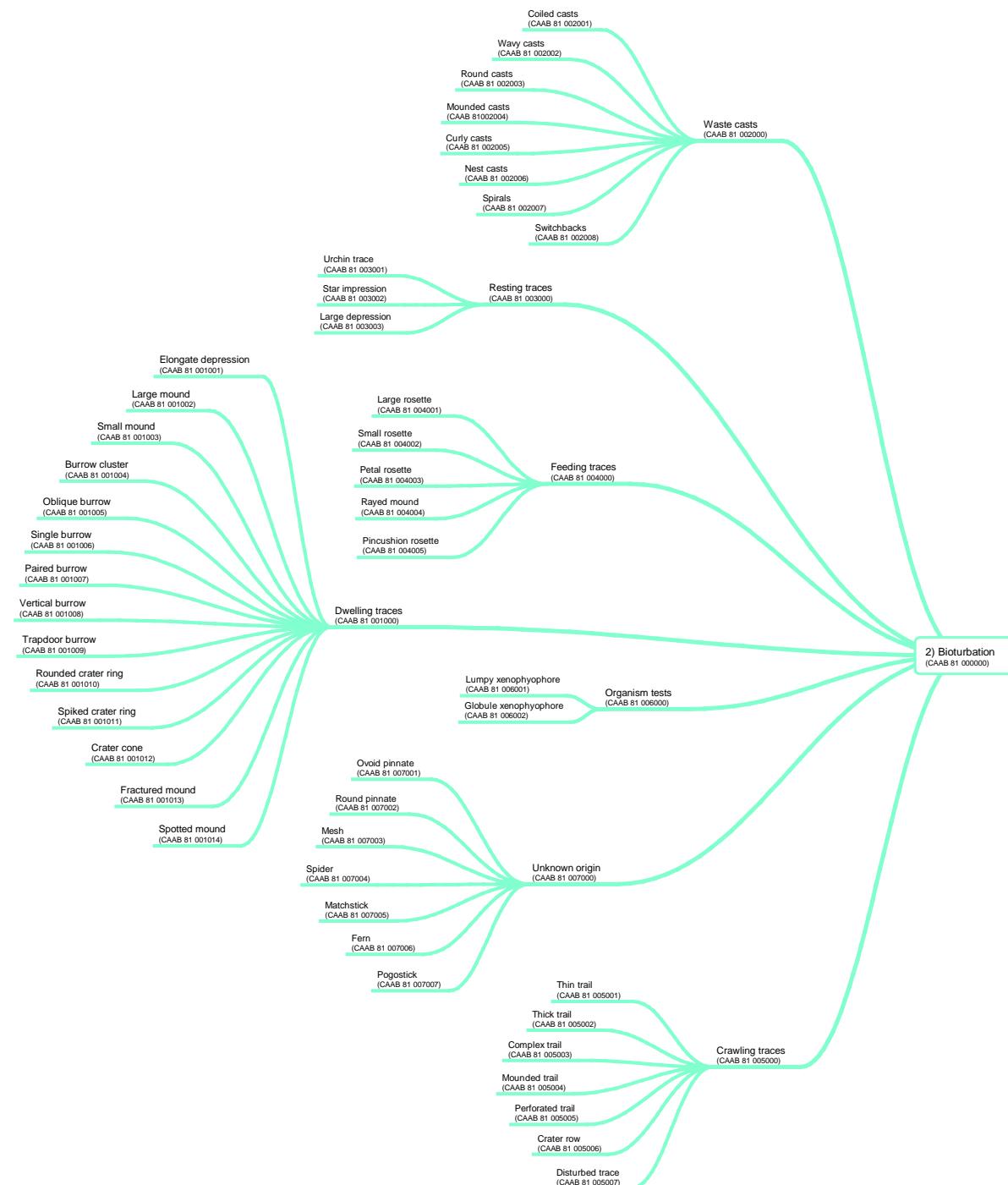
Classical fish, these can have a variety of body shapes.

 © CSIRO <i>Halagyreus</i> sp.	 © CSIRO Halosauridae	 © CSIRO <i>Hoplostethus atlanticus</i> (Orange Roughy)
 © CSIRO <i>Cyttus travesi</i> (Dory)	 © CSIRO Bothidae	 © CSIRO Macrouridae
 © NERP / ACFR Scorpaenidae		

## 2 Bioturbation - CAAB 81 000000

Authors: Rachel Przeslawski

Bioturbation or ‘Lebensspuren’ describes the signs and traces formed in soft-sediment habitats through the activities of macro- and meiofauna. The classes are described with example images in the supplementary information of Przeslawski et al. (2012).



Hierarchical structure for the Bioturbation branch of the CATAMI Classification Scheme

## References and useful links

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