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

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

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1. CSIRO — Commonwealth Science and Industrial Research Organisation
2. IMAS — Institute for Marine and Antarctic Studies, University of Tasmania
3. iVEC — The Hub of Supercomputing in Western Australia
4. University of Sydney - School of Biological Sciences & Australian Centre of Field Robotics (ACFR)
5. AIMS — Australian Institute of Marine Science
6. WAM — Western Australian Museum
7. AAD — Australian Antarctic Division
8. New South Wales Government, Department of Primary Industries
9. GA — Geoscience Australia

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Citation:

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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 though searches in the CATAMI database (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). For further information refer to http://catami.org/classification

Contents

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 9th 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

Version 1.4 released in December 2014. This version contains six changes from V1.3:

(1) Update of NERP Marine Biodiversity Hub logo on front page

(2) Correction of classification for example image pg 70 'Unstalked solitary ascidian with elongate siphons' was removed as incorrect identification – image moved to pg 59 Ctenophora (benthic) *Lyrocteis* sp. —with thanks to D. Lindsey (JAMSTEC) for the correction.

(3) Updated publication reference for Gershwin et al. in prep, now Gershwin et al. 2014a-d

(4) Added sentence to the introduction of the Cnidaria chapter, explaining the separation of gelatinous Cnidaria from this branch in the CATAMI classification.

(5) Update of sponge classification and publication reference now Schönberg & Fromont 2014; incorporated sponge classification example images into the CATAMI visual guide.

(6) Added 2 general references:

a. Glover, A.G., Higgs, N., Horton, T. (2014) World Register of Deep-Sea species. http://www.marinespecies.org/deepsea. Date accessed: 23 October 2014.
b. Neptune Canada 2012. Marine Life Field Guide. http://www.oceannetworks.ca/sites/default/files/pdf/Marine_Life_Field_Guide.pdf. Date accessed: 4 December 2014.

PHYSICAL – CAAB 82 000000

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

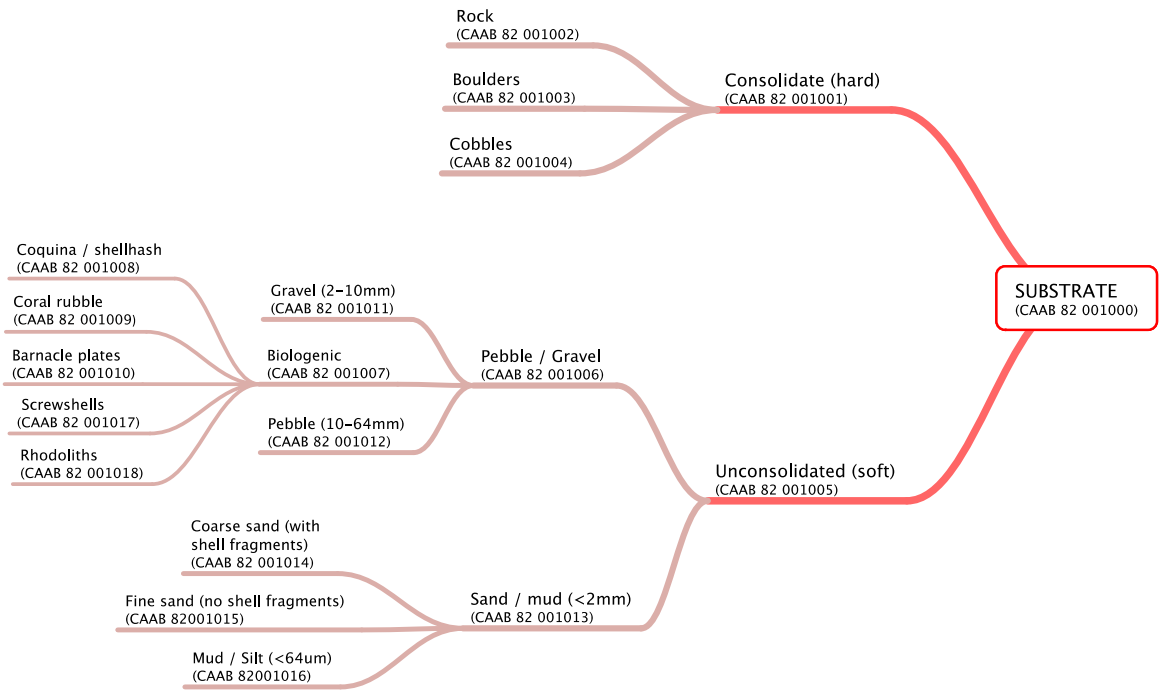
1 Substrate – CAAB 82 001000

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 (veneer) 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

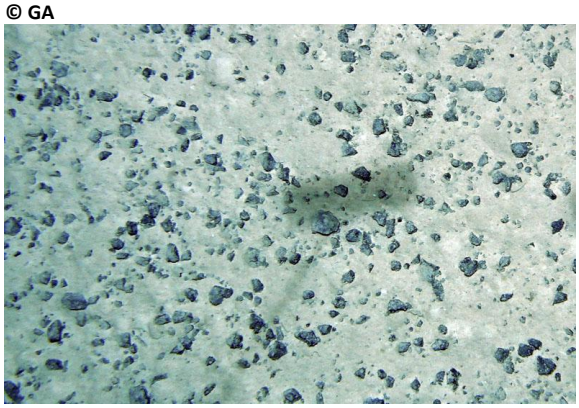
2 Substrate: Consolidated (hard) – CAAB 82 001001

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.

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.

Distinct boulders on unconsolidated substrate

Field of large boulders covered with fine veneer of sediments

Distinct slab-boulder

Large, bare boulder

3 Consolidated (hard): Rock – CAAB 82 001002

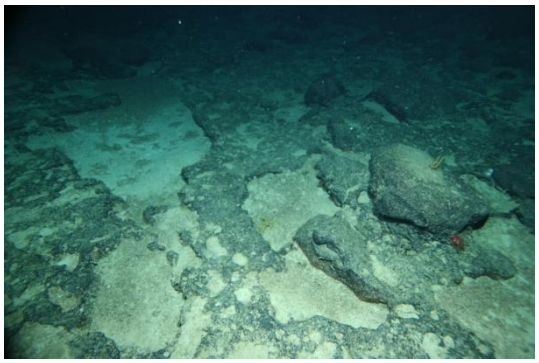
Bedrock visible as a flat plane, outcropping ledge or cliff face; this can be covered in biota and/or a veneer of sediments.

Outcropping bedrock covered in biota

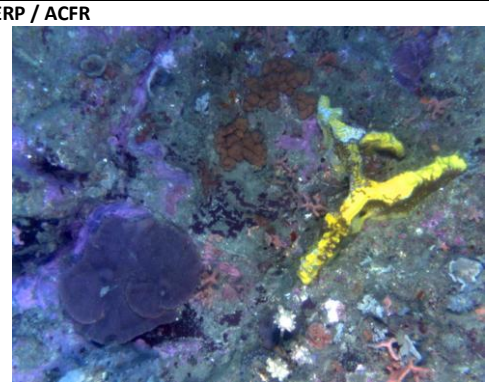
Bedrock covered in veneer of muddy sediments identified by the ledge visible in the background

Ledge of outcropping bedrock covered in biota

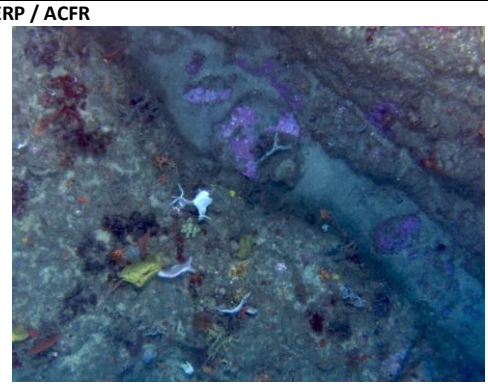
Bedrock covered in very thin veneer of sediments; parallel drag marks of fishing gear



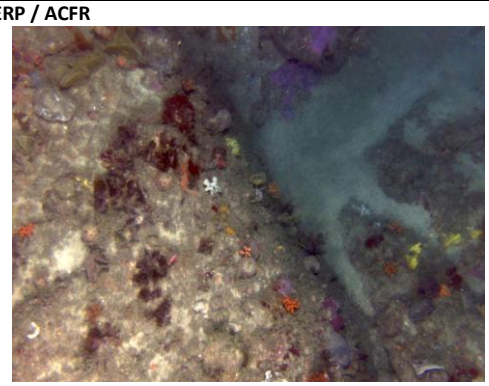
Outcropping bedrock



Bedrock covered in biota, including a mat of turfing algae (Turf mat)



Bedrock covered in biota, including a mat of turfing algae (Turf mat)



Bedrock covered in biota, including a mat of turfing algae (Turf mat)

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 'veneer' 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.

Unconsolidated sediments unable to be characterised further due to compaction by an iceberg scour

Unconsolidated sediments unable to be characterised further due to low quality video capture

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.

Sand with shell fragments

Sand with shell fragments in small depressions

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

Fine sandy substrate with some bioturbation

Fine sandy substrate veneer over bedrock (veneer implied by presence of large sponges)

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

Very fine muddy or silty appearance, no grain structure visible

Mud / silt, some bioturbation

Muddy deep-sea sediments

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

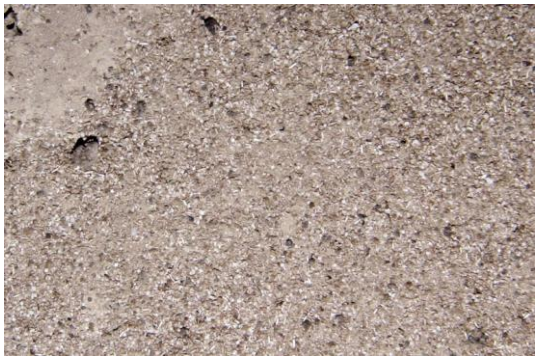
Substrates that have clearly grainy structure, with grainsize of >2 mm and up to 64 mm diameter

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



Gravel composed of shell fragments

Gravel composed of mostly shell fragments and some rhodoliths

(see 5 Biogenic: Rhodoliths – CAAB 82 001018)

5 Biogenic: Coral rubble – CAAB 82 001009

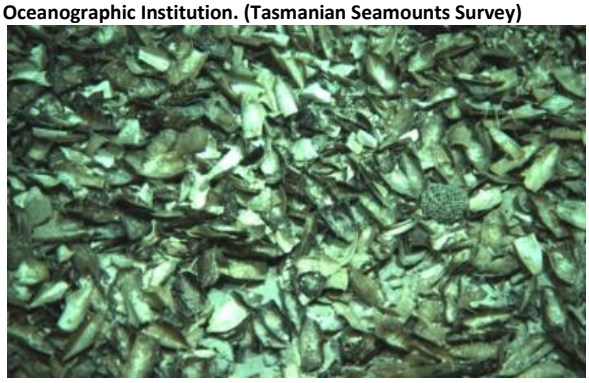
Gravel substrate composed of loose fragments (~<10 cm) of dead corals

Rubble of dead coral skeletons

Rubble of dead coral skeletons (~ 1000 m depth)

5 Biogenic: Barnacle plates – CAAB 82 001010

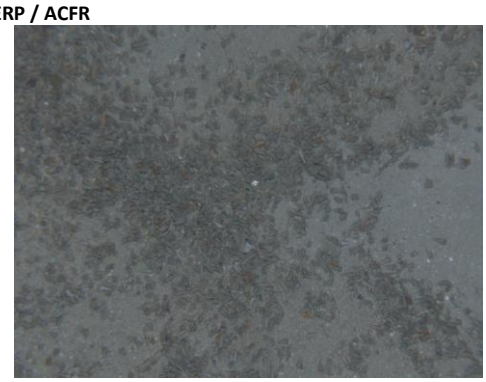
Gravel substrate composed of discarded / dead barnacle plates



Accumulation of large barnacle plates

5 Biogenic: Screwshells – CAAB 82 001017

Gravel substrate composed of discarded / dead screwshells (gastropod)

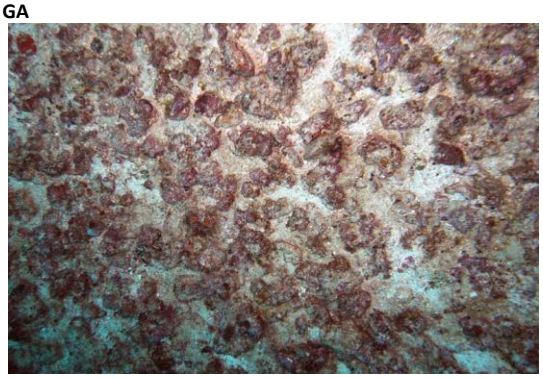


Accumulation of screwshells on sand

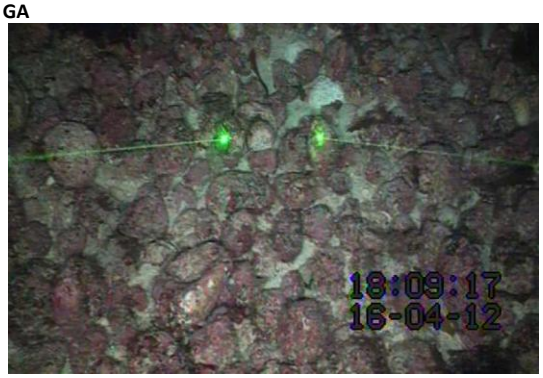
Close-up of screwshell substrate

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).



Rhodoliths (coralline algae) over sand / mud

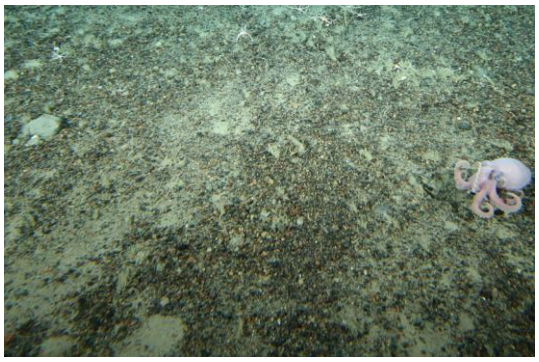


Rhodolith bed as shown from a screen capture from a video transect

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

Inorganic, granules between 2 and 10 mm in diameter

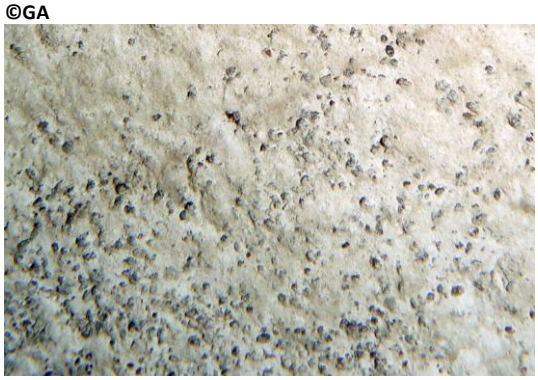
Gavel over predominately sand / mud



Gravel with some sand / mud

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

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



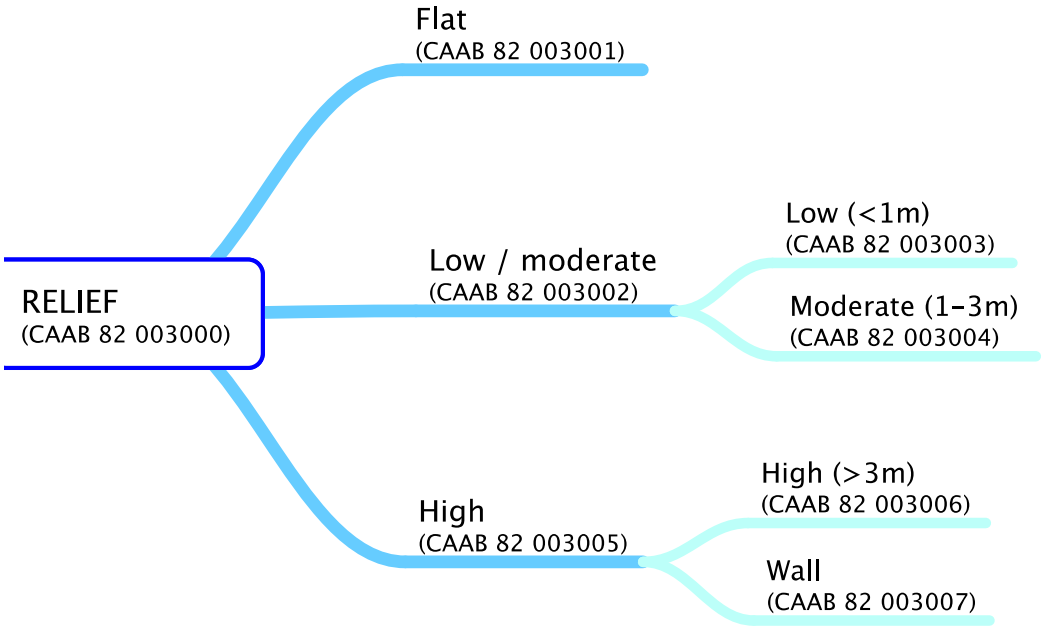
Pebbles interspersed with mud

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.

Flat relief and muddy sediments often encountered in deep-sea habitats

Flat rocky substrate

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

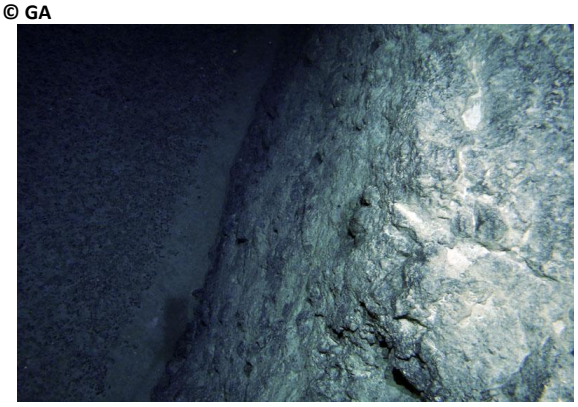
© CSIRO  Moderate relief with ~ 1 m steps of rock	© GA  Moderate relief with ~ 2 m steps of rock

2 Relief: High – CAAB 82 003005

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

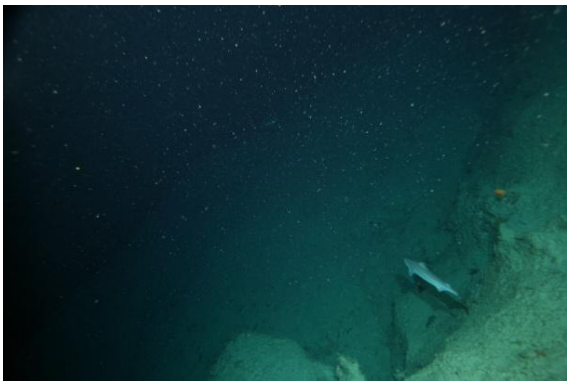
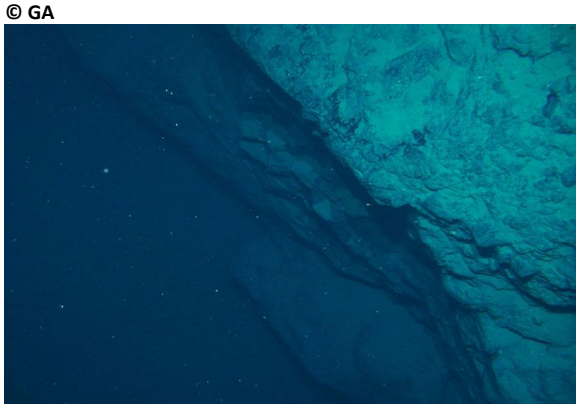
3 High: High (>3m) – CAAB 82 003006

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

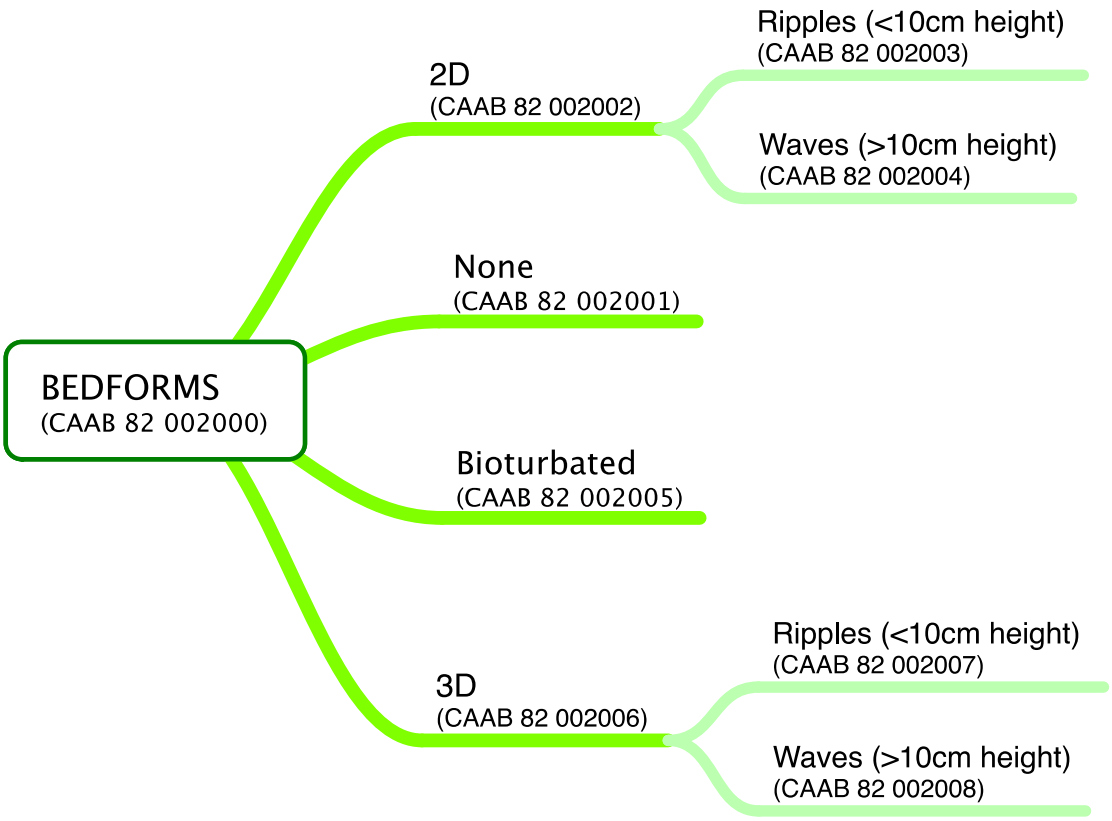
Rockwalls, cliffs or drop-offs of a height of >>3m, difficult to determine from a single image; a sequence of images or continuous video is generally needed to confidently identify this relief type.

© CSIRO  Rock wall of > 5 m as confirmed by associated video	© GA  Rock wall of > 5 m as confirmed by associated video
© Renata Ferrari  Coral reef wall >5 m	© Renata Ferrari  Coral reef wall >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.

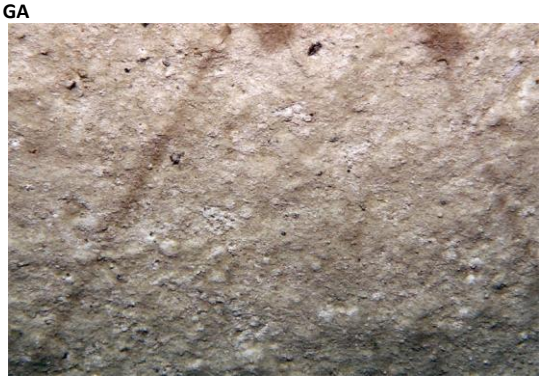


Hierarchical structure for the Bedforms branch of the CATAMI Classification Scheme

2 Bedforms: None – CAAB 82 002001

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

Flat sediments



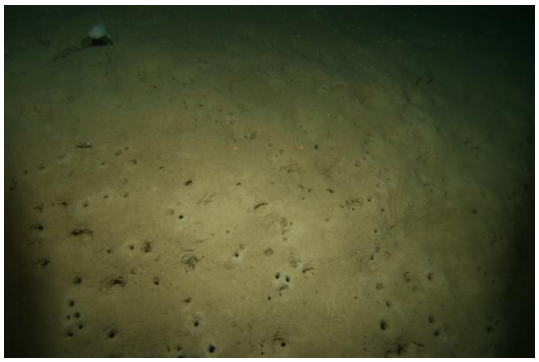
Flat sediments

2 Bedforms: Bioturbated – CAAB 82 002005

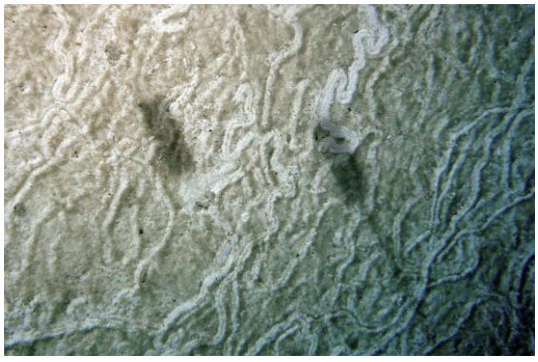
Substrate regularly structured by burrows and/or tracks formed by biota. Note that isolated bioturbation marks should not be included here since they do not affect the substrate on the same scale as bedforms caused by physical processes. Instead, isolated bioturbation marks can be categorised in the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

Regularly spaced burrows of ophiuroids

Regular occurrence of bioturbation (fractured mounds) associated with echiuran worms



Dense field of burrows



Dense network of trails across the sediment

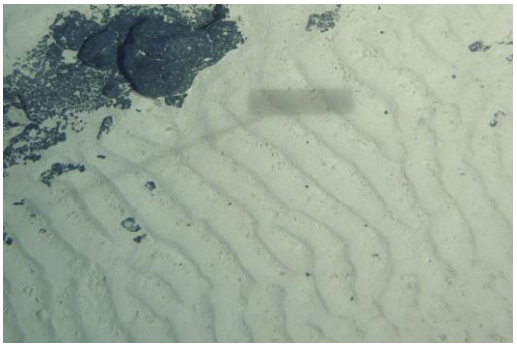
2 Bedforms: 2D – CAAB 82 002002

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).

Parallel crests of 2-dimensional ripples



Parallel crests of 2-dimensional ripples

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

The 2-dimensionalfeatures 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.

Parallel crests of 2-dimensional waves

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).

Sinuous crests of 3-dimensional ripples

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.

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

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

1 Biota – CAAB 80 000000

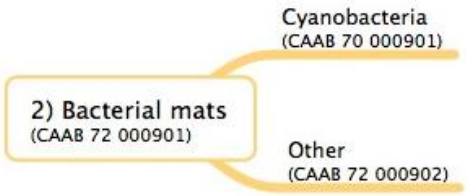
Biota here refers only to visible biota (epifauna / flora) and/or visible traces of biota (bioturbation), as we are interpreting data collected from imagery. Where there is no visible biota present this can be scored using a 'mimic' CAAB code of 00 000003 'No visible biota'.

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).



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.

Selected images	*Selected images*	*Selected images*

3 Bacterial mats: Other – CAAB 72 000902

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

Selected images	*Selected images*	*Selected images*

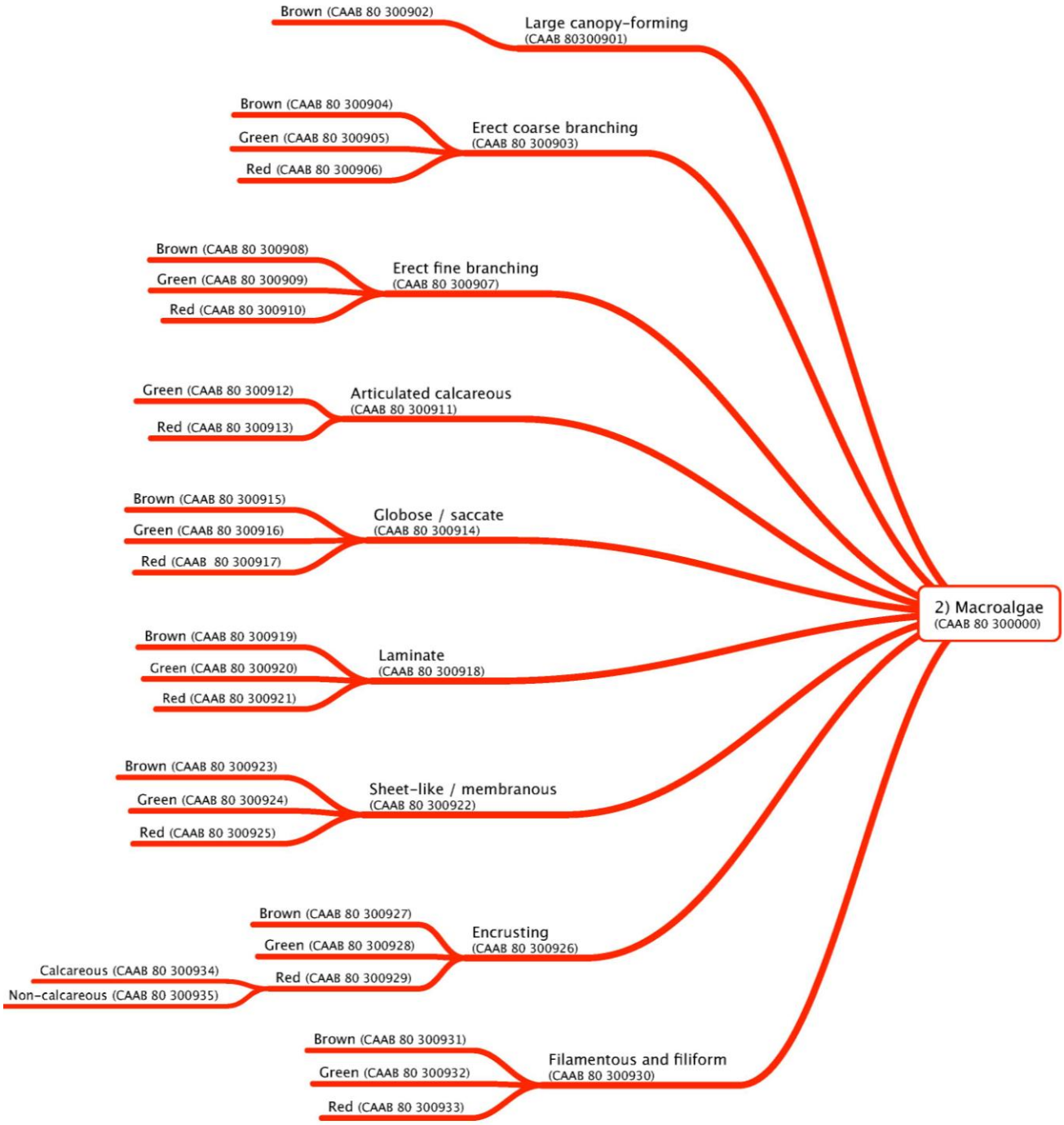
2 Macroalgae – CAAB 80 300000

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'.

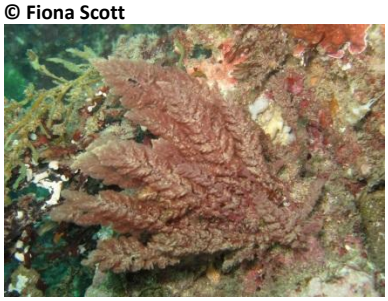


Hierarchical structure for the Macroalgae branch of the CATAMI Classification Scheme.

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).

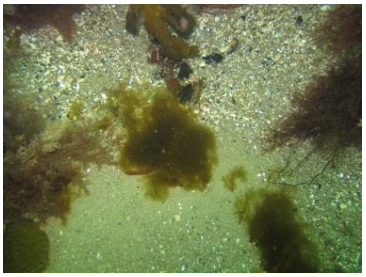
4 Filamentous / filiform: Red – CAAB 80 300933

	© Fiona Scott 	© Fiona Scott 
Ceramium sp.	*Polysiphonia infestans*	*Asparogopsis armata* (appears filamentous in photos)

4 Filamentous / filiform: Green 80 300932

© Graham Edgar 	© Graham Edgar 	© Graham Edgar 
Cladophora spp.	*Chaetomorpha* spp.	*Apjohnia caulerpa*

4 Filamentous / filiform: Brown 80 300931

© Fiona Scott 	© Fiona Scott 	
Hincksia sordida	*Ectocarpus* spp.	*Sphacelaria* spp.

3 Macroalgae: Encrusting – CAAB 80 300926

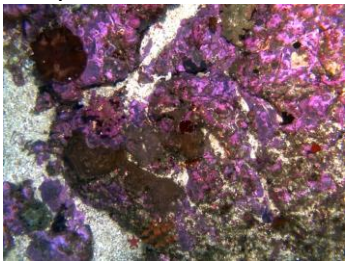
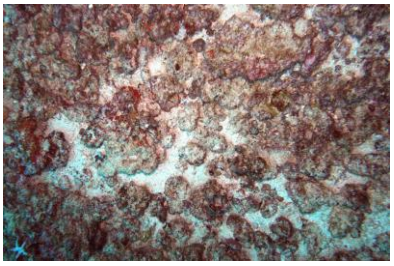
Crust-like; thin, (reds may be hard and brittle) form growing flattened and closely adhering to the substratum.

4 Encrusting: Red – CAAB 80 300929

Crust-like thin red algae.

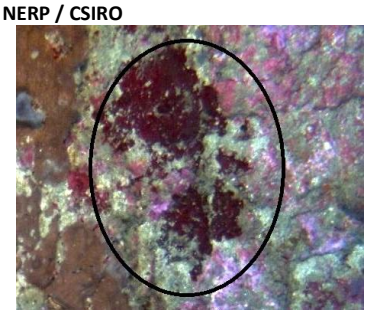
5 Encrusting: Red: Calcareous – CAAB 80 300934

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 me 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.

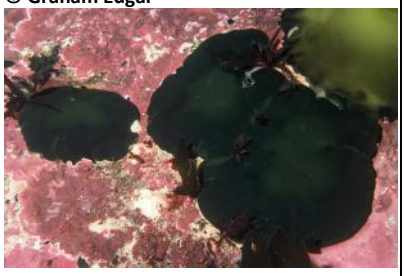
© Graham Edgar  Crustose coralline	© NERP / ACFR  Crustose coralline	© GA  Rhodolith bed

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

Corallina spp.

Amphiroa anceps

Rhodopeltis spp.

Metagoniolithon spp.

Haliptalon spp.

Jania pulchella

4 Articulated calcareous: Green – CAAB 80 300912

Halimeda cuneata

3 Macroalgae: Sheet-like / membraneous – CAAB 80 300922

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

4 Sheet-like / membraneous: Red – CAAB 80 300925

Porphyra lucasii

Kallymenia cribosa

Martensia australis

Schizymenia spp.

Grateloupia spp.

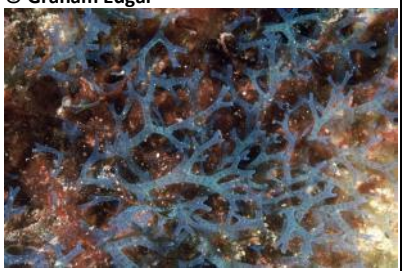
Schizoseris hymenena

4 Sheet-like / membraneous: Green – CAAB 80 300924

Ulva spp.

Microdictyon umbilicatum

4 Sheet-like / membraneous: Brown – CAAB 80 300923



Dictyota dichotoma

Petalonia fascia

3 Macroalgae: Laminate – CAAB 80 300918

Low profile, plate-like and lobed forms.

4 Laminate: Red – CAAB 80 300921

Sonderopelta coriacea

Peyssonnelia spp.

4 Laminate: Green – CAAB 80 300920

Rhipiliopsis spp.

Dictyosphaeria sericea

Udotea spp.

4 Laminate: Brown – CAAB 80 300919

Lobophora variegata

Padina spp.

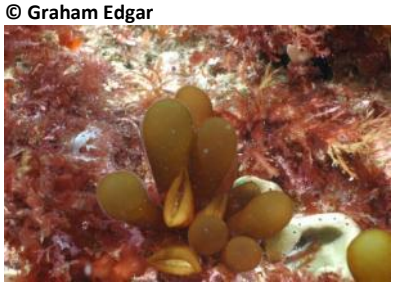
Zonaria turneriana

Lopophora sp.

3 Macroalgae: Globose / saccate – CAAB 80 300914

Has a spherical shape or balloon-like form.

4 Globose / saccate: Red – CAAB 80 300917



Gloiosaccion brownii

4 Globose / saccate: Green – CAAB 80 300916

Codium pomoides

Derbesia marina

4 Globose / saccate: Brown – CAAB 80 300915

Colpomenia sinuosa

Hydroclathrus clathratus

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.

Dasya spp.

Dictyomenia sonderi

Delisea pulchra

Areschougia congesta

Phacelocarpus pepercarpos

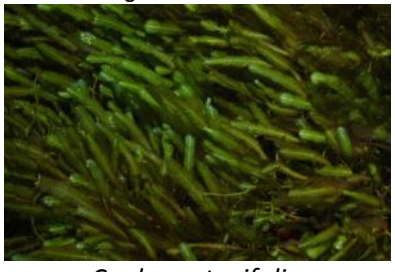
Gracilaria cliftonii

Galaxaura marginata

Euptilota articulata

Soleria roiusta

4 Erect fine branching: Green – CAAB 80 300909



Caulerpa taxifolia
(each blade finely branching)

Caulerpa obscura

Caulerpia longifolia

4 Erect fine branching: Brown – CAAB 80 300908

Carpomitra costata

Perithalia caudata

Sporochnus radiciformis

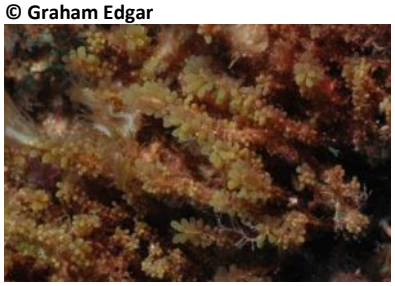
Pachydictyon spp.

Lobospira spp.

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



Botryocladia spp.

Betaphycus spp.

Thamnoclonium dictomoma

4 Erect coarse branching: Green – CAAB 80 300905

Codium duthiaea

Codium fragile

Codium cuneatum

Caulerpa flexilis var. *muelleri*

Caulerpa cactoides

Caulerpa hodgkinsonidae

Caulerpa racemosa

Caulerpa papillosa

4 Erect coarse branching: Brown – CAAB 80 300904

Seirococcus axillaris

Hormosira banksii

Xiphophora chondrophylla

Scaberia agardhii

Caulocystis spp.

All *Sargassum* spp.

Cystophora moniliformis

Cystophora torulosa

Acrocarpia robusta

Carpoglosum confluens

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

Phyllospora comosa

Macrocystis spp.

Durvillaea spp.

Undaria pinnatifida

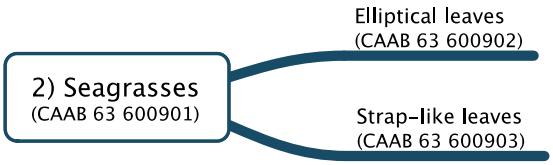
Ecklonia radiata

Lessonia corrugata

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

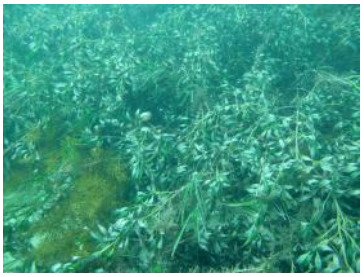
3. Seagrasses: Elliptical leaves – CAAB 63 600902

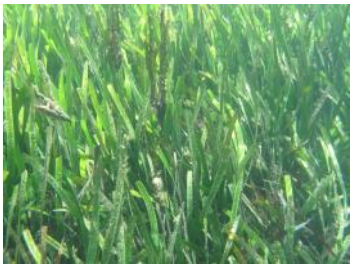
Leaves are ovate or elliptical and stalked. Typified by the genus *Halophila*

© Fiona Scott	© Fiona Scott	© Graham Edgar
		
Halophila ovalis	*Halophila ovalis*	*Halophilis australis*

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

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

© Graham Edgar	© Fiona Scott	© Fiona Scott
		
Zostera nigricaulis	*Enhalus acoroides*	*Amphibolis antarctica*

© Fiona Scott  *Posidonia australis*	**© Graham Edgar**  *Ruppia megacarpa*	

2 Sponges- CAAB 10 000000

Authors: Christine H.L. Schönberg, Jane Fromont, Franziska Althaus

The sponge classification in CATAMI is based on the AIMS/WAM 'Sponge Cheat Sheet' available at http://ningaloo-atlas.org.au/ (Schönberg & Fromont 2014), to which this classification should be referenced.

Schönberg & Fromont (2014) state: "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 physically sampled (e.g. 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 therefore we recommend using growth forms as a quick classification. If the growth forms are described by clearly focusing on their function, they will represent environmental conditions, e.g.

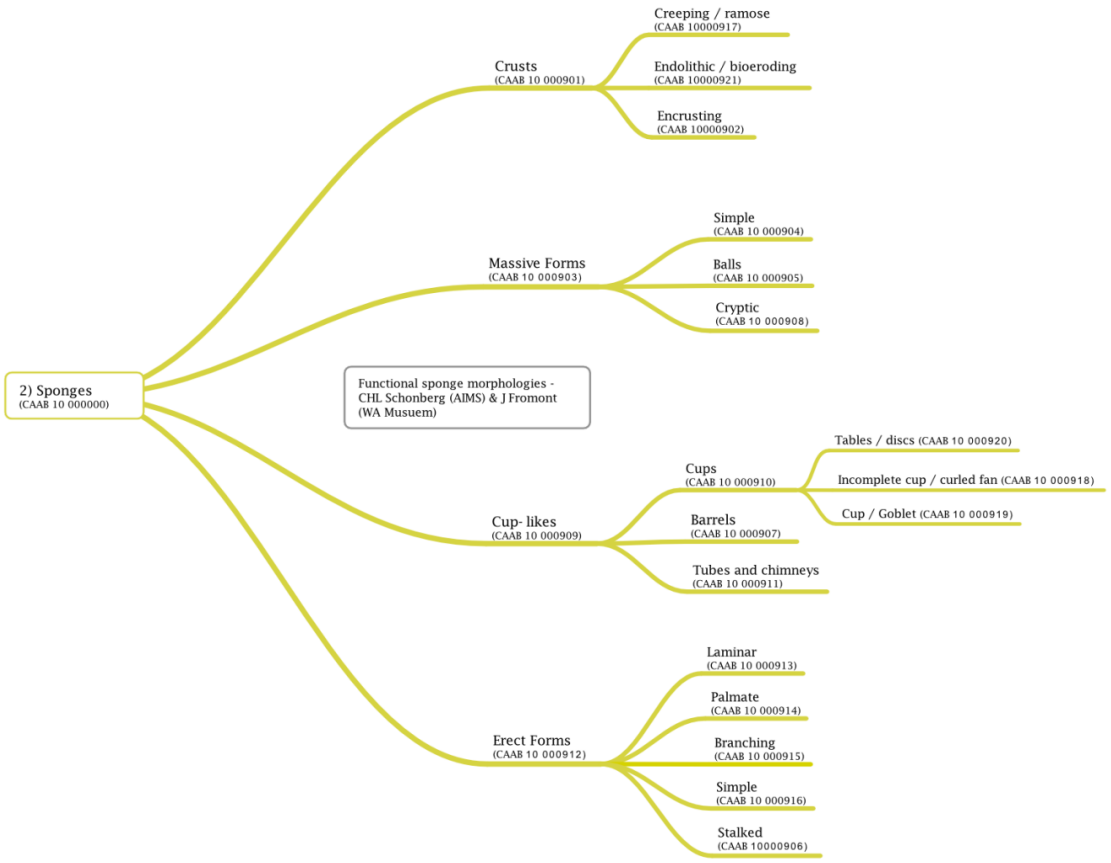
- turbulence and crashing waves will select for crusts and cryptic sponges,
- stagnant waters for separation of inhalant and exhalant streams as is typical in e.g. barrels,
- laminar forms provide information about prevailing currents, and
- sedimentation will favour erect and cryptic-massive forms.

The idea behind this classification is therefore the function, not always the growth morphology. E.g. a crust around a thinly erect substrate such as a gorgonian becomes a 'simple-erect' growth form and a ball on a gorgonian a 'stalked' 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 'kebap' sponges and massive sponges with many large holes and complex forms may sometimes function as 'branching' sponges. Lattice-like 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. Focus on the function for any given situation to choose a morphology."

Distinction at the first level below Sponges – CAAB 10 000000 provides basic information on the general shape and function, while the next level in the hierarchy (except for the Crusts – CAAB 10 000901) provides a good balance between effort and output detail (Schönberg & Fromont 2014)

In this Version 1.4 of the CATAMI guide the hierarchical structure of the sponge classification was updated, reflecting the final 'Cheat Sheet' of functional sponge morphologies finalised by Schönberg & Fromont after the 9th World Sponge Conference during a sponge classification workshop at the University of Western Australia (Schönberg & Fromont 2014).

For this chapter we added a compilation of example images of sponge functional morphotypes and descriptions paraphrased from (Schönberg & Fromont 2014). For easy cross-referencing we included the numbering and abreviated labels from the 'Cheat sheet' at each classification step.



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

3 Sponges: Crusts – CAAB 10 000901

The functional morphotype Crusts include both sponges that form a crust over a substrate (truly encrusting) and sponges that grow mostly following the ground (creeping and/or ramose). The colony width extending across the substrate surfacer is significantly greater than its height. In Schönberg & Fromont (2014): 1 EN

4 Crusts: Creeping / ramose – CAAB 10 000917

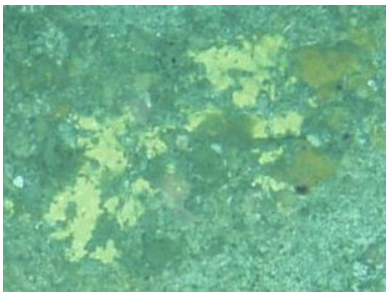
Creeping / ramose functional morphotype sponges are generally branching but grow mostly following the ground. They are attached at several points and can have some erect parts. If the erect parts become more dominant than the parts following the substrate surface, the morphology will be scores as 'erect'. In Schönberg & Fromont (2014): 1.1 EN-cg

©CSIRO  Creeping	©CSIRO  Creeping	

4 Crusts: endolithic / bioeroding – CAAB 10 000921
Endolithic or bioeroding sponges that have single papillae or look sheet-like on the surface. Distinguished by the ratio of exposed to hidden tissue, the function is similar to thinly encrusting. Endolithic can be difficult to distinguish from images only. In Schönberg & Fromont (2014): 1.2 EN-en

© [Image to be added] Endolithic	©	

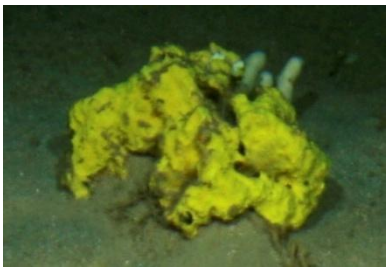
4 Crusts: Encrusting – CAAB 10 000902
Encrusting sponges form a crust over a substrate; this class may be subdivided based on the thickness of the crust into thinly (<0.5mm thick) and thickly (0.5-2mm thick) encrusting. In Schönberg & Fromont (2014): 1.3 EN-cr

©CSIRO  Encrusting	©CSIRO  Encrusting	©CSIRO  Encrusting

3 Sponges: Massive forms – CAAB 10 000903

The massive sponge functional morphotype includes various shapes and sizes (massive does not imply large), where the colony width and height are roughly similar; they usually project from the substrate, except for cryptic massive forms. In Schönberg & Fromont (2014): M

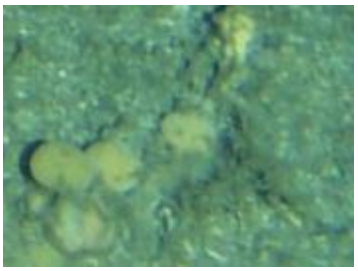
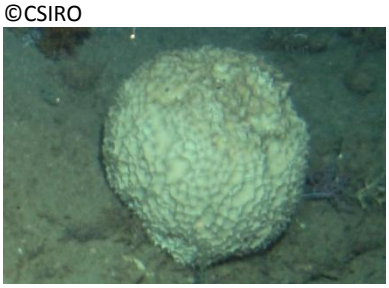
4 Massive forms: Simple – CAAB 10 000904
Massive or lumpy irregularly shaped sponges, generally quite large. If structural diversity becomes very large, sponges may be scored as functionally branching morphologies. In Schönberg & Fromont (2014): 2 M-s

©CSIRO  Massive: simple	©CSIRO  Massive: simple	©CSIRO  Massive: simple

©CSIRO  Massive: simple, may be considered 4 Erect forms: Laminar - CAAB 10 000913	©CSIRO  Massive: simple, may be considered 4 Erect forms: Laminar - CAAB 10 000913	

4 Massive forms: Balls – CAAB 10 000905

Round ball-shaped sponges; can be quite small. In Schönberg & Fromont (2014): 3 M-bl

©CSIRO  Ball	©CSIRO  Ball	©CSIRO  Ball
©CSIRO  Ball	©CSIRO  Ball	©CSIRO  May be considered 4 Cups: Tables / discs - CAAB 10 000920

4 Massive forms: Cryptic - CAAB 10 000908

Main body of cryptic massive sponges are usually buried in the sediments with only the 'snorkels' elevated above the sediment, may not easily be recognised in images – snorkels may be classed as simple erect sponges. In Schönberg & Fromont (2014): 3 M-crp

©CSIRO  Cryptic-massive – base is usually buried in sediments	©CSIRO  Cryptic-massive – main body entirely or largely buried)	©CSIRO  Cryptic-massive – main body entirely or largely buried)

3 Sponges: Cup-likes – CAAB 10 000909

Cups and barrels usually have a smaller attachment area than their girth. Many have separate outer and inner surfaces, locally separating in- and exhalant pores to avoid uptake of exhaled water. They include cups, funnels, barrels and tubes/ chimneys. In Schönberg & Fromont (2014): C

4 Cup-likes: Cups – CAAB 10 000910

Cups and alike usually have a slimmer base than top and are concave, they include classical funnels, cup and goblet shapes, but also incomplete cups formed by laminar shapes that curl onto themselves forming a funnel-like shape. In Schönberg & Fromont (2014): 5

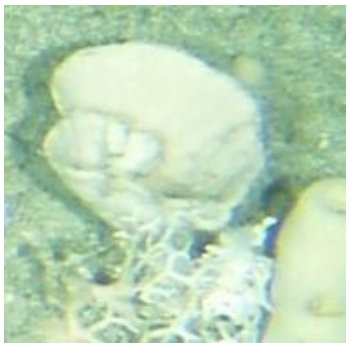
4 Cups: Tables / discs - CAAB 10 000920

Tables or discs may be viewed as extremely shallow cups, they can be unattached. In Schönberg & Fromont (2014): 5.1 C-tab

© [Image to be added] Table	© [Image to be added] Disc	©

5 Cups: Incomplete cup / curled fan – CAAB 10 000918

Intermediate form to erect: laminar but the body is curled in on itself into a funnel. In Schönberg & Fromont (2014): 5.2 C-inc

©CSIRO  Curled fan	©	©

5 Cups: Cup / goblet – CAAB 10 000919

Concave cup-shape sometimes with short stalk. In Schönberg & Fromont (2014): 5.3 C-wd

©CSIRO  Cup	©CSIRO  Cup	

4 Cup-likes: Barrels - CAAB 10 000907

Generally large roughly cylindrical forms with one or multiple exhalent pores at the often concave apex. In Schönberg & Fromont (2014): 6 C-b

Barrel

4 Cup-likes: Tubes and chimneys - CAAB 10 000911

Tubes and chimneys can have nearly the same dimension from top to bottom but their cross-sections are clearly hollow. There may be some overlap with erect branching forms. In Schönberg & Fromont (2014): 7 C-nr

Tube - glass sponge

Tube - glass sponge

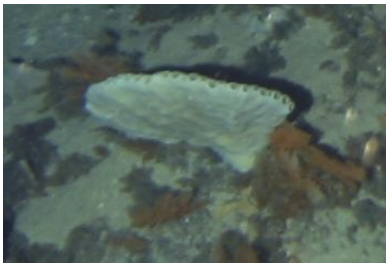
Cluster of tubes

3 Sponges: Erect forms – CAAB 10 000912

Erect forms clearly stand up from the substrate; the colony height is significantly greater than its width and it appears to be solid in cross-section. In Schönberg & Fromont (2014): E

4 Erect forms: Laminar - CAAB 10 000913

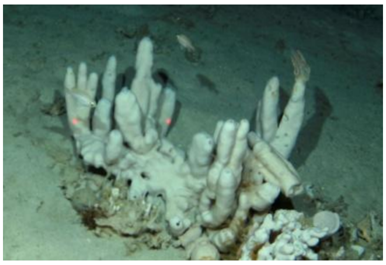
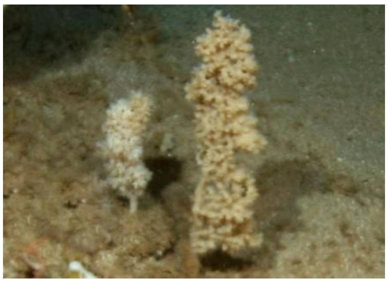
Flattened into a roughly 2-dimensional coherent surface, including fan and spatula shapes. They can have a slight stalk. In Schönberg & Fromont (2014): 8 E-lam



©CSIRO 	©CSIRO 	©CSIRO 
©CSIRO  May be considered 4 Massive forms: Simple – CAAB 10 000904, depending on thickness and area of attachment		
4 Erect forms: Palmate- CAAB 10 000914 Branching hand/ finger-like in a roughly 2-dimensional plane, from a small base or stalk. Branches fanning out In Schönberg & Fromont (2014): 9 E-pal		
©CSIRO  Palmate sponge branching in 2D plane	Lattice-like braching fan	©CSIRO  Palmate glass sponge branching in 2D plane

4 Erect forms: Branching – CAAB 10 000915

Erect branching forms are three-dimensional; they can have an arborescent or bushy appearance and sometimes are marginal to other erect forms. This functional morphotype includes some special forms (e.g. tiered – kebap sponge) that function similarly. In Schönberg & Fromont (2014): 10 E-br

©CSIRO  Erect: branching	©CSIRO  Erect: branching	©CSIRO  Erect: branching
©CSIRO  Erect: branching	©CSIRO  Erect: branching	©CSIRO  Erect: branching
©CSIRO  Bottlebrush-like branching	©CSIRO  Bottlebrush-like branching	

Note that the classification is not necessarily clear-cut

©CSIRO  Has laminar elements, but the 3-D 'branching' effect is considered more prominent	©CSIRO  Could be classed as laminar but the 3-D 'branching' effect is considered more prominent	©CSIRO  Could be classed as tubes but the 3-D 'branching' effect is considered more prominent

4 Erect forms: Simple - CAAB 10 000916

Generally thin rod, column or whip In Schönberg & Fromont (2014): 11 E-s

Erect: simple

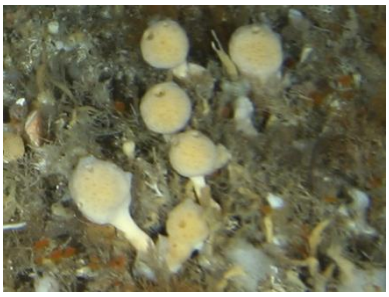
Erect: simple

4 Erect forms: Stalked – CAAB 10 000906

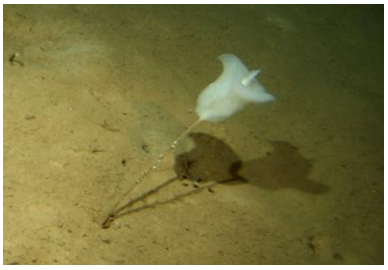
Stalked sponges have a thin/ narrow stem significantly elevating the main part of the body up from the sediments; the main body is usually ball or club-shaped, but can also take the form of a stalked cup or funnel. In Schönberg & Fromont (2014): 12 E-st

Erect: stalked

Erect: stalked



Erect: stalked



Halonema sp.

Erect: stalked - glass sponge

Erect: stalked

2 Cnidaria – CAAB 11 500000

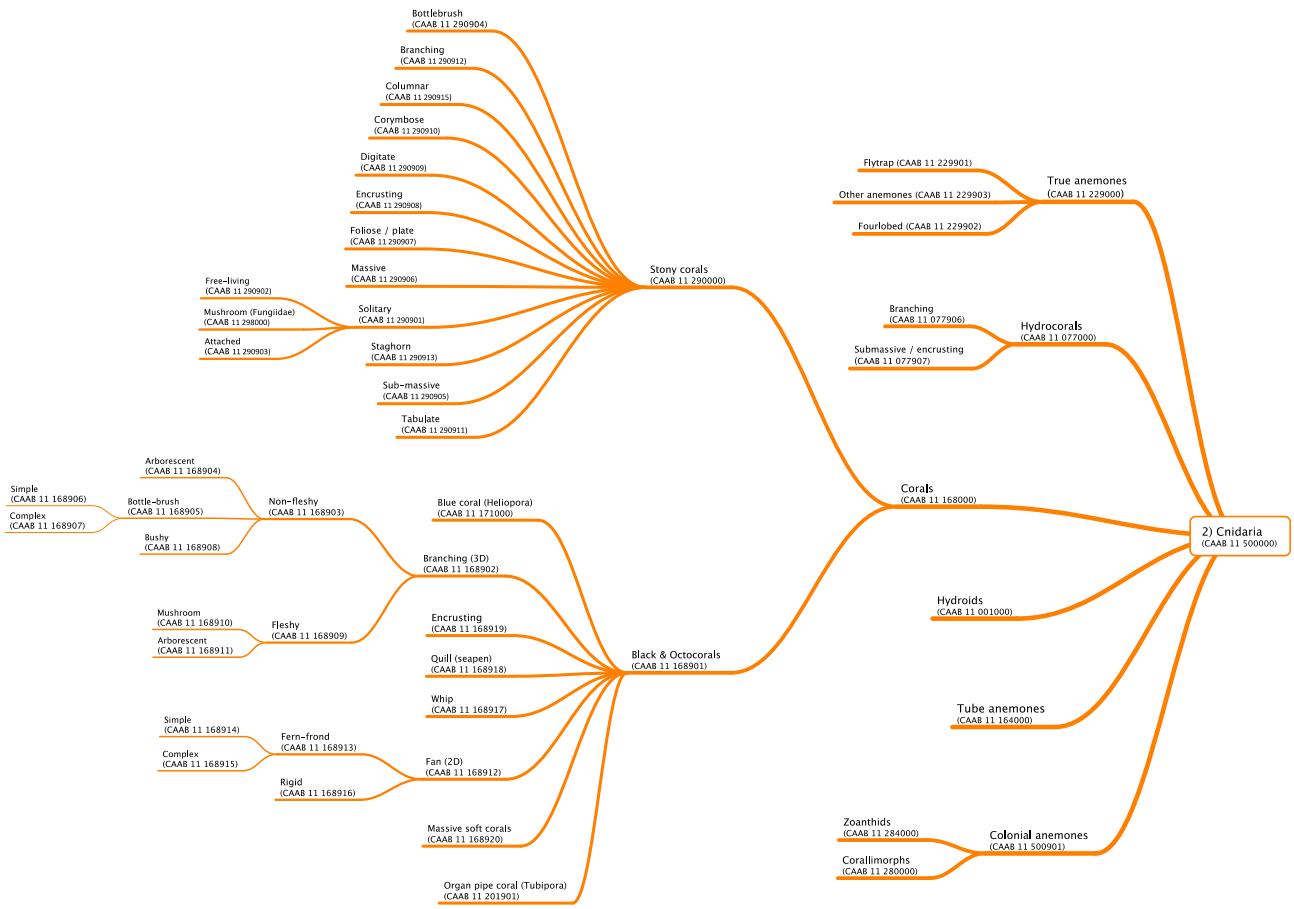
Authors: Authors: Karen Gowlett-Holmes, Jamie Colquhoun, Franziska Althaus, Renata Ferrari

Cnidaria is a large phylum that encompasses a variety of groups including different types of anemones, hydroids, hydrocorals and corals. Gelatinous, mostly pelagic forms of the Cnidaria are included under 2 Jellies – CAAB 80 600903, as they are difficult to distinguish from other gelatinous groups for the untrained eye.

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:

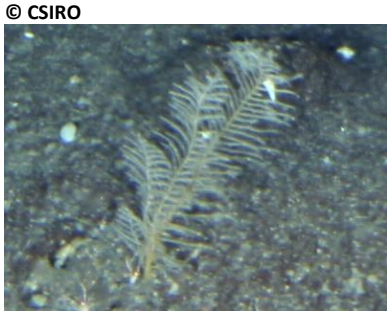
1. Recruit
2. Bleached
3. Dead
4. Recently dead - applies mainly to deep-sea coral matrix (branching stony corals); recently dead skeleton is usually white without coloured polyps while long-term dead skeletons are blackened by a crust of manganese.



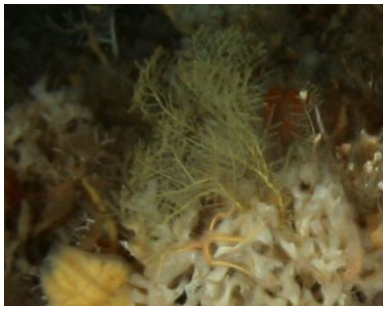
Hierarchical structure for the Cnidaria branch of the CATAMI Classification Scheme

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.



Sertulariidae



Hydroid growing on a sponge

Hydroid in sand

Solitary hydroid

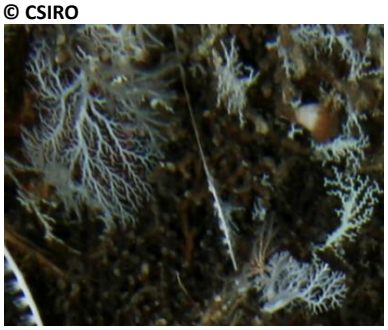
3 Cnidaria: Hydrocorals – CAAB 11 077000

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

4 Hydrocorals: Branching – CAAB 11 077906

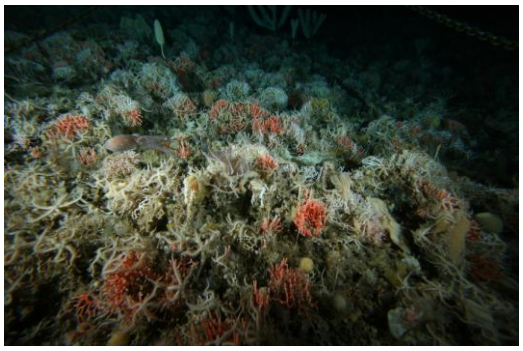
Hard, branching often dichotomous, deepwater species generally has a characteristic 'jagged' look and is usually white. *Stylaster* sp. are common in caves and overhangs in shallow reef environments or in the deepsea. Branches are usually in one plane but are fine, tapered and delicate. Firecorals (*Millepora* 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.

Stylaster eguchii



Stylaster eguchii

Millepora sp. (Fire coral)

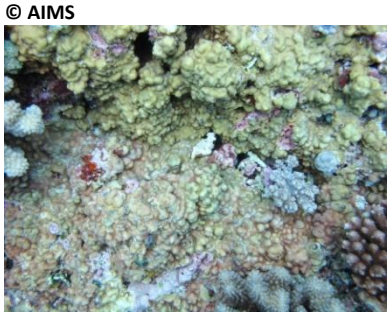


Errina sp. (overview)

Errina sp. (zoom)

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.



Millepora sp. (Fire coral)

Millepora sp. (Fire coral)

Millepora sp. (Fire coral)

3 Cnidaria: Corals – CAAB 11 168000

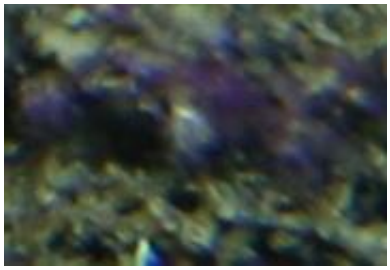
A large group within the cnidarians, including the octocorals (soft corals, gorgonians, and seapens), the black corals (antipatharians) and the stony corals (scleractinians).

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.



Purple encrusting coral

Purple encrusting coral
(orange: solitary stony coral)

Rhytisma sp.

Erythropodium hicksoni

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.

Anthomastus sp. (open polyps)

Anthomastus sp. (closed polyps)

Anthomastus sp.

7 Fleshy: Arborescent – CAAB 11 168911
Thick fleshy stem with side-branches.


Nephtheidae


Nephtheidae

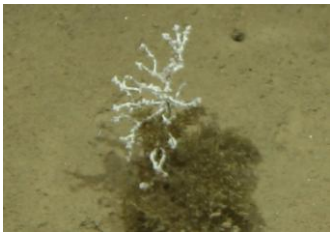

Nephtheidae

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.

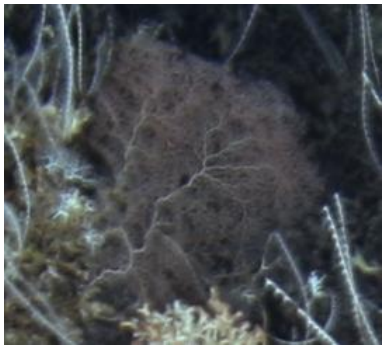

Bamboo coral


Paragorgia (Bubblegum coral) [with a snake star]

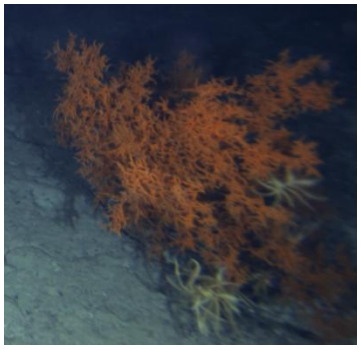

Bramble coral


Elisiidae

7 Non-fleshy: Bushy – CAAB 11 168908
Many short branches, polyps larger giving a fluffy, bushy appearance.


Alcyonacea (Octocoral)


Alcyonacea (Octocoral)


Anthipatharia (Black coral)

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

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.

Antipatharia (Black coral)

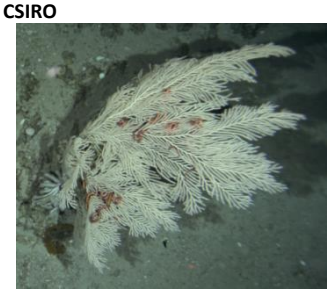
Antipatharia (Black coral)

7 Fern-frond: Complex – CAAB 11 168915

Multiple axes but remaining in one plane.

Alcyonacea (Octocoral)

Alcyonacea (Octocoral)



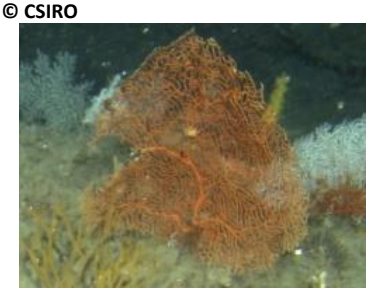
Primnoidae

6 Fan (2D): Rigid – CAAB 11 168916

Rigid complex branched fan (in single plane).

Corallium sp.

Gorgonian fan



Gorgonian fan

5 Black & Octocorals: Whip – CAAB 11 168917

Single stem, polyps small, clustered on main stem.


Slender seapen


Slender seapen


Alcyonacea whip (corkscrew)


Pleurogorgia sp.


Lepdisis sp.

5 Black & Octocorals: Quill (seapen) – 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.


Seapen


Seapen


Rockpen
(Anthoptilum gowlettholmesae)

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

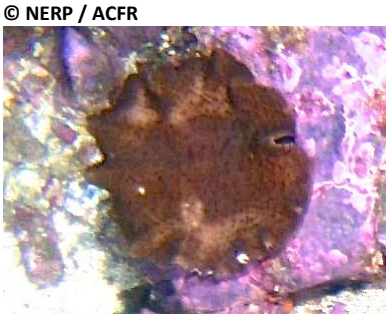
*S*ingle genus, *Tubipora*: the skeleton is permanently coloured dark red. Growth-forms range from hemispherical and massive, to thick and encrusting made up of vertical, red hard calcareous tubes (organ pipes), each tube occupied by a single polyp. When the colony is flourishing the skeleton can be 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  *Sarcophyton* sp.	© Renata Ferrari  *Sarcophyton* sp.	© Renata Ferrari  *Sarcophyton* sp.
Lobophyton sp.	*Dampia* sp	*Cladiella* 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  *Heliopora coerulea*	© AIMS  *Heliopora coerulea*	© AIMS  *Heliopora coerulea*

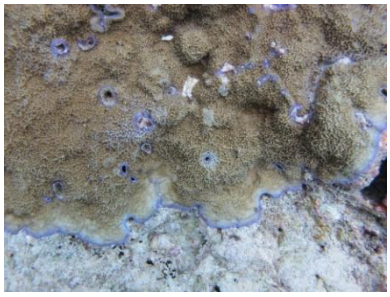
4 Corals: Scleractinian Stony corals – CAAB 11 290000

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)

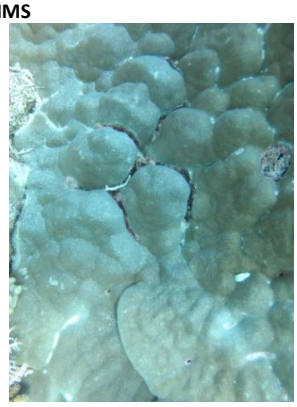
5 Stony corals: Encrusting – CAAB 11 290908

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.

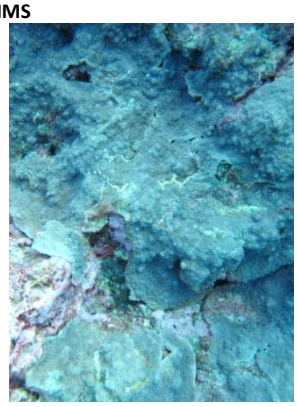


Montipora sp.

Example small encrusting form.



Porites sp.



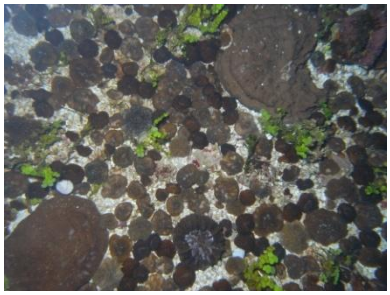
Montipora sp.

5 Stony corals: Solitary– CAAB 11 290901

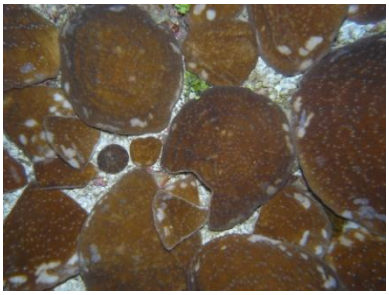
Solitary/ mushroom corals can be attached or free-living, they can be round, oval, elongate, dome shaped, or irregular and can be domed in the centre, where a thin slit-like mouth may be seen

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

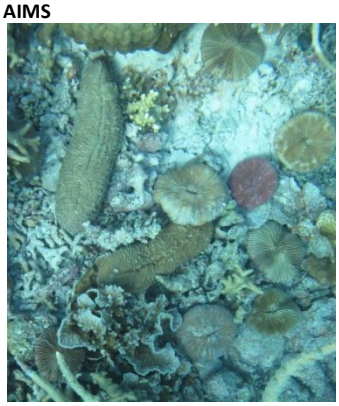
Fungiidae corals are hermatypic and form solitary discs up to 30 cm in diameter, which are attached as a juvenile but become free-living as it grows. Most free-living (unattached) corals on reefs are fungiids and can be round, oval, elongate, dome shaped, or irregular and can be domed in the centre, 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.



Fungiidae



Halomitra sp.



Fungiidae

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.

Flabellum sp.

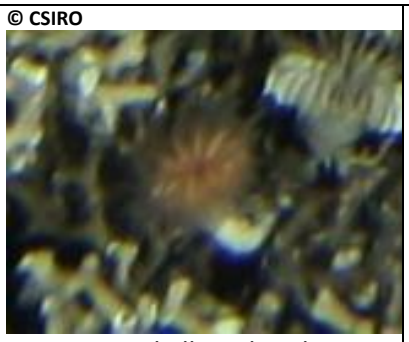
Flabellum sp.

Stephanocyathus platypus

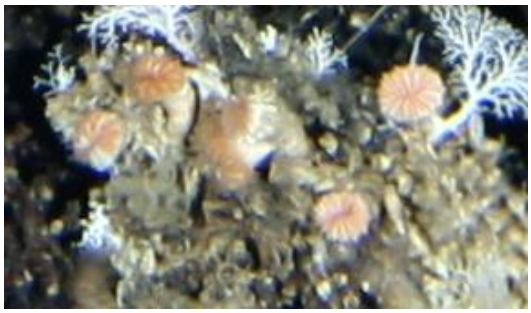
6 Solitary: Attached – CAAB 11 290903

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.

Solitary attached stony coral



Desmophyllum dianthus



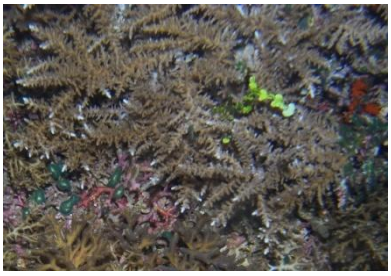
Caryophyllia diodemedae

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.

Acropora sp.

Acropora sp.



Acropora sp.

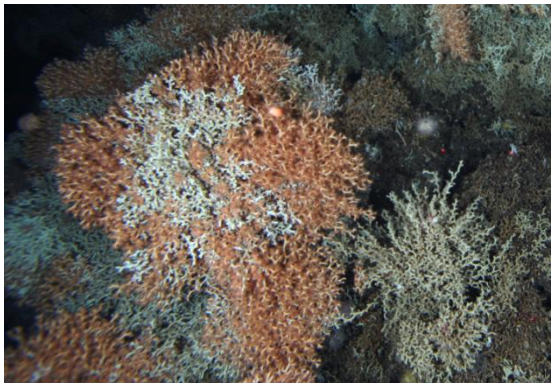
5 Stony corals: Branching – CAAB 11 290912

Branching corals (also called arborescent, arboreal or ramose 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, life polyps (coloured), recently dead skeleton (white) and long-dead skeleton (generally black and/ or overgrown).

Hydnophora sp.

Seriatopora sp.

Seriatopora sp.

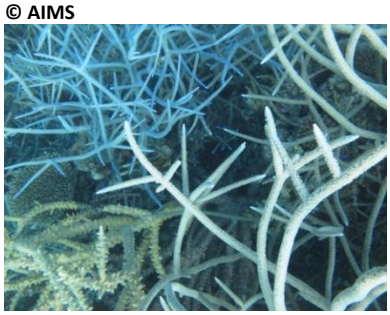


Solenosmilia variabilis

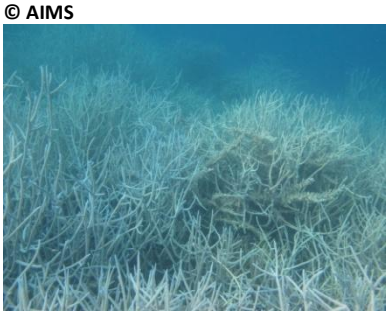
Enallopsamma sp.

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.

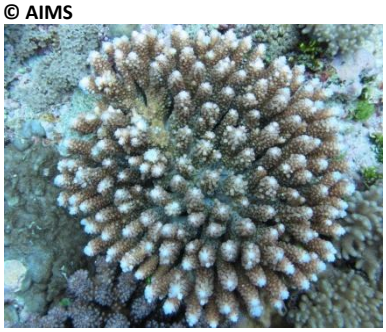


Acropora sp.

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

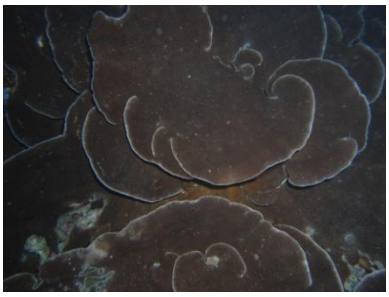
Columnar corals start from a massive base in a pillar form and do not branch. Digitate refers to colonies showing finger-like projections like an upturned hand. Where these fingers become thicker and taller they may be referred to as sub-massive or columnar. Note sub-massive may be used to describe lumpy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

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.

Echinopora sp.

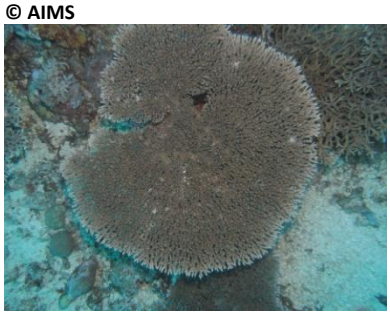


Pachyseris sp.

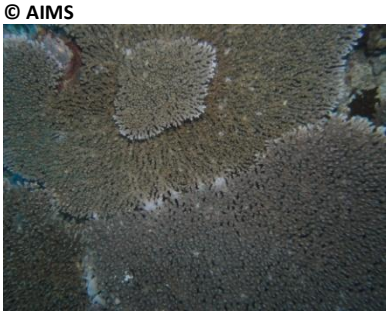
Pavona sp.

5 Stony corals: Tabulate – CAAB 11 290911

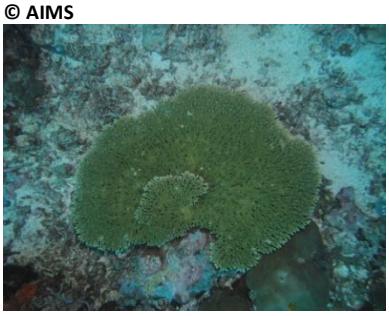
Tablulate corals are flat table-like structures of fused branches.



Acropora sp.



Acropora sp.



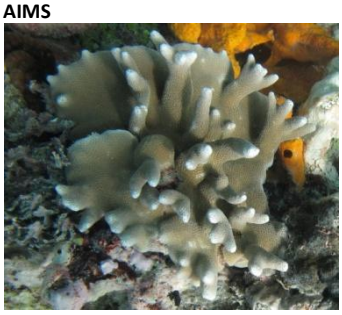
Acropora sp.

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.

Isopora sp.



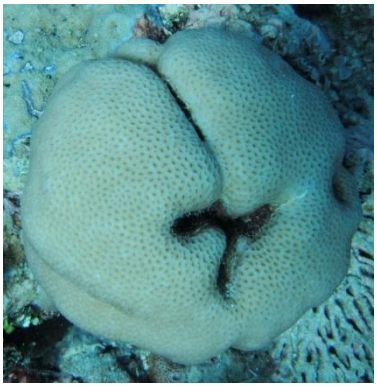
Porites sp.

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.



Goniastrea sp.

Favia sp.

Porites sp.

Goniopora sp.

Porites sp.

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.

True anemone

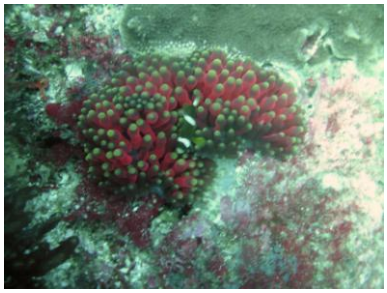
True anemone

True anemone with tentacles retracted

True anemone

True anemone

True anemone



True anemone

True anemone

True anemone

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.

Flytrap anemone

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.

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.

Tube anemone extended

Tube anemone retracted

Tube anemone extended

3 Cnidaria: Colonial anemones – CAAB 11 500901

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

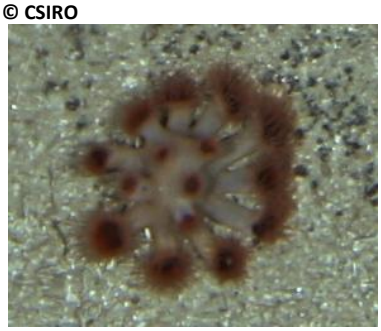
4 Colonial anemones: Corallimorphs – CAAB 11 280000

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 bobbles on end of tentacles – almost identical to some azooxanthellate stony corals, e.g. *Culicia*.

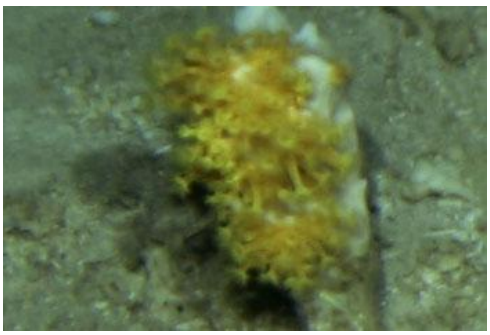
Discosoma sp.	*Amplexidiscus* sp.	*Corynactis* sp.

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.



Hermit zoanthids

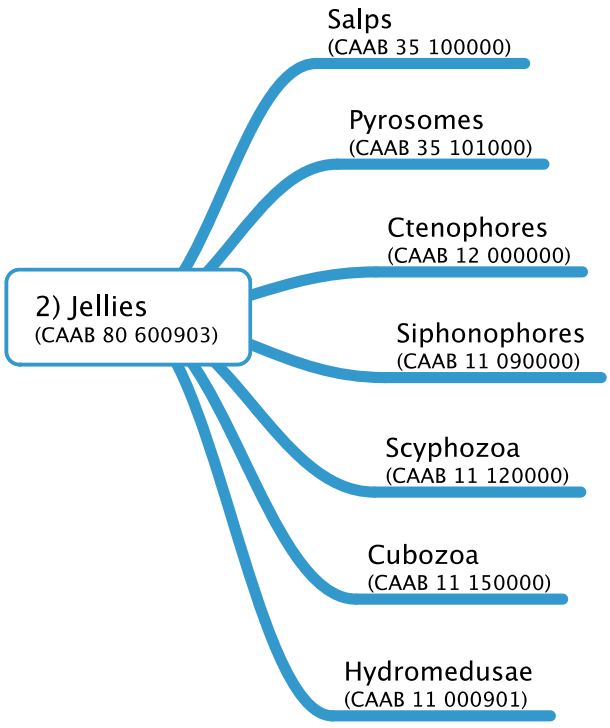


Epizooanthus sp.

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 compiling a series of guides describing pelagic and midwater invertebrates which describe these animals in more detail; to date 4 chapters: The Pelagic Tunicates, The Ctenophores, The Siphonophores, and The Medusae (Gershwin et al. 2014a-d) are available as separate documents from the CSIRO research Publications Repository (https://publications.csiro.au/rpr/home: search for Gerschwin).

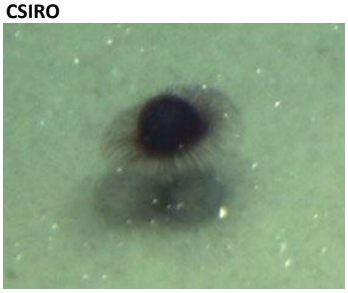


Hierarchical structure for the Jellies branch of the CATAMI Classification Scheme

3 Jellies: Hydromedusae – CAAB 11 000901

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

Hydromedusa

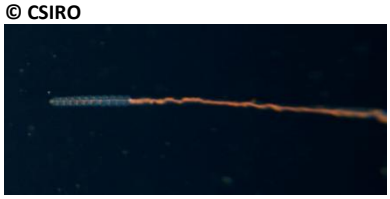


Hydromedusa

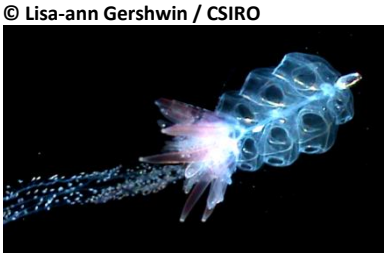
Hydromedusa

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.



Long siphonohore chain

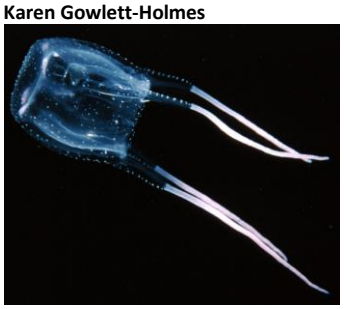


Physophora hydrostatica

Diphyes sp.

3 Jellies: Cubozoa – CAAB 11 150000

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



Carybdea rastonii

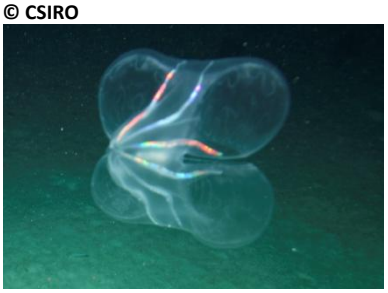
Carukia barnesi

Chironex sp.

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.

Ctenophore



Ctenophore showing rainbow flashes on ctene row

		Ctenophore(benthic) *Lyrocteis* sp.
© CSIRO  Ctenophore		

3 Jellies: Scyphozoa – CAAB 11 120000

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

© Lisa-ann Gershwin  *Aurelia* sp. (Moon jelly)	© Lisa-ann Gershwin  *Catostylus* sp.	© Lisa-ann Gershwin  *Pelagia* sp.
© Lisa-ann Gershwin  *Cyanea* sp.	© Lisa-ann Gershwin  *Rhopilema hispidum*.	

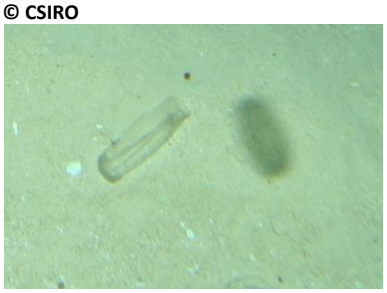
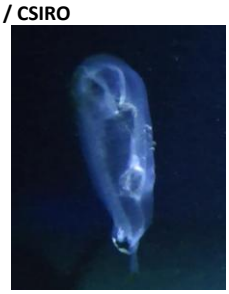
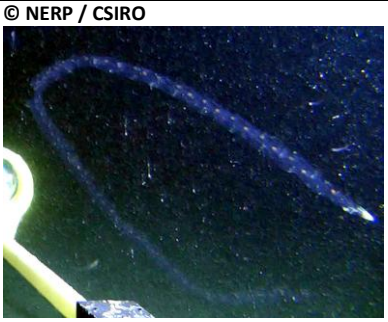
3 Jellies: Pyrosomes – CAAB 35 101000

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  *Pyrosoma spinosum* (check it out on YouTube – https://www.youtube.com/watch?v=5EQGA_4BZ5s)

3 Jellies: Salps – CAAB 35 100000

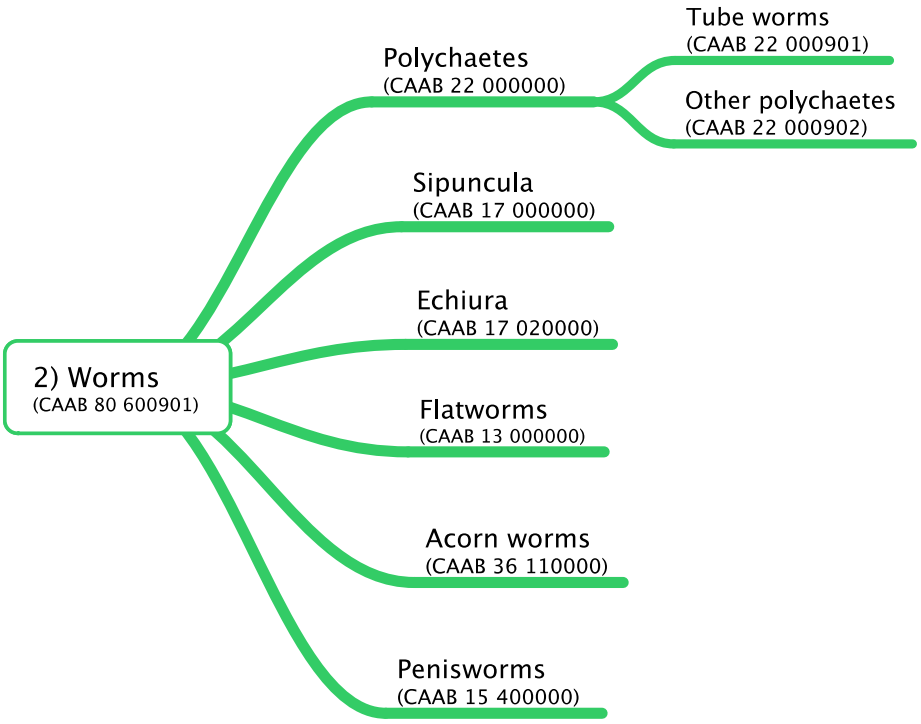
Solitary and colonial. More common in upper water column. Colonies can form long chains. Capable of very rapid growth and can be present in very dense numbers.

© CSIRO  Solitary salp (small)	© CSIRO  Solitary salp (small)	© NERP / CSIRO  *Thetys vagina*
© 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		

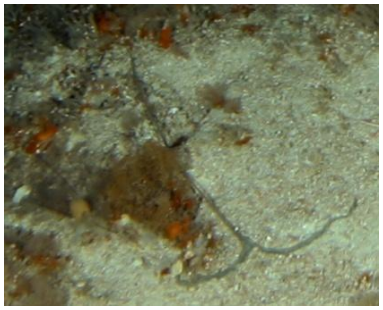
3 Worms: Penisworms – CAAB 15 400000

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

Penisworm		

3 Worms: Echiura – CAAB 17 020000

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

© CSIRO 	© CSIRO 	© CSIRO 
Bonelliidae	*Metabonellia haswelli*	*Metabonellia haswelli*

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		

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).

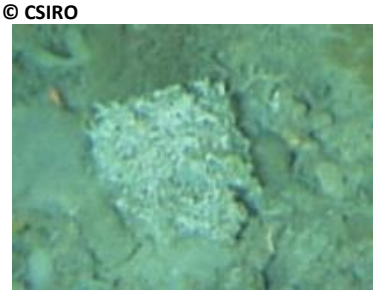
© Advanced Imaging and Visualization Laboratory Woods Hole Oceanographic Institution. (Tasmanian Seamounts Survey) 	© GA – GA2476 	© GA – TAN0713 
Deepsea acorn worm	Deepsea acorn worm	Deepsea acorn worm

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.



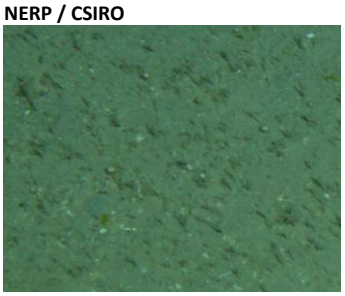
Serpulidae

Serpulidae

Fanworm

Tube worm

Fanworm



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.

Polychaete

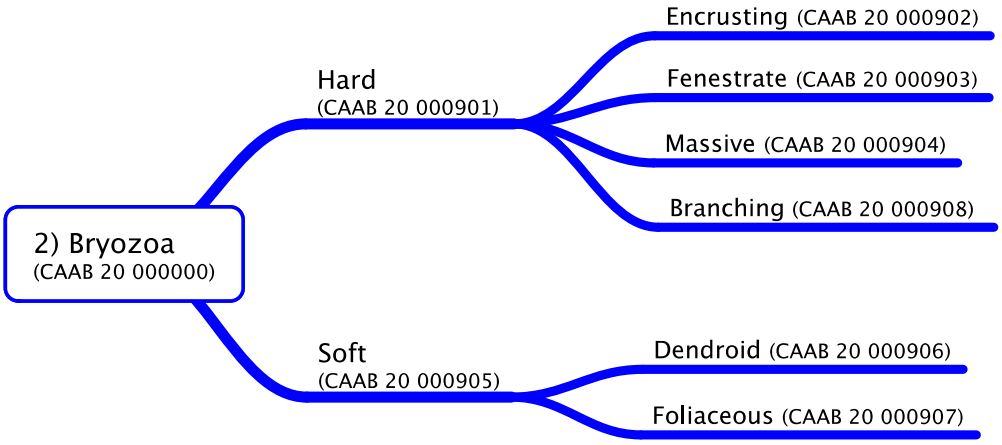
Polychaete

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.

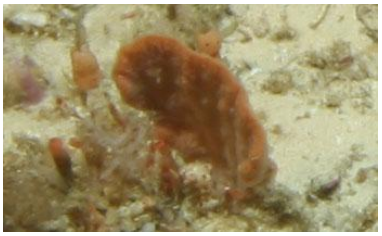
4 Hard: Encrusting – CAAB 20 000902

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.

 *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).

Fenestrate bryozoa

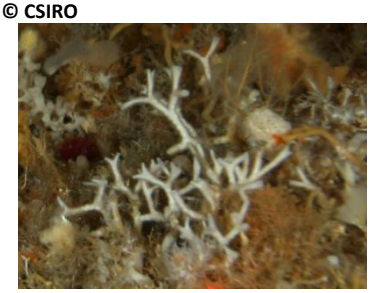
Adeona grisea

Adeona grisea

4 Hard: Branching – CAAB 20 000908

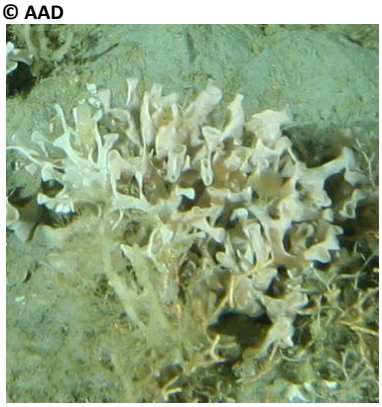
Rigid, typically bi-furcated (dichotomous) branching pattern with short internodes, sometimes branching irregular. Note: this form may be confused with some macroalgae.

Adenolopsis sp.



Branching hard bryozoa

Branching hard bryozoa



Branching hard bryozoa

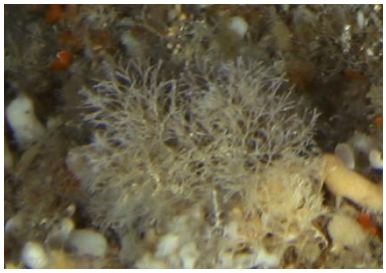
3 Bryozoa: Soft – CAAB 20 000905

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

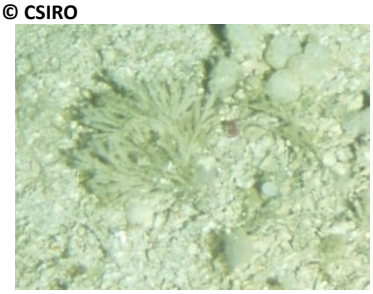
4 Soft: Dendroid – CAAB 20 000906

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)



Dendroid soft bryozoa

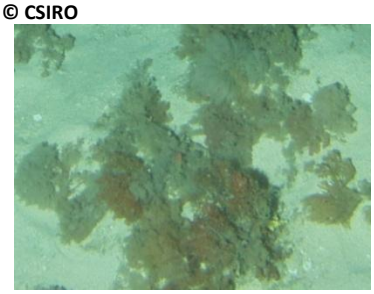


Dendroid soft bryozoa

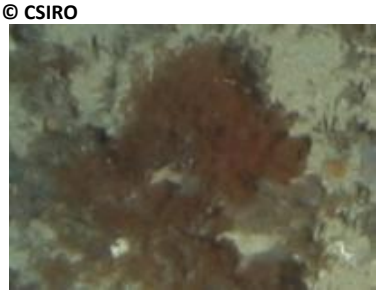
Flustridae

4 Soft: Foliaceous – CAAB 20 000907

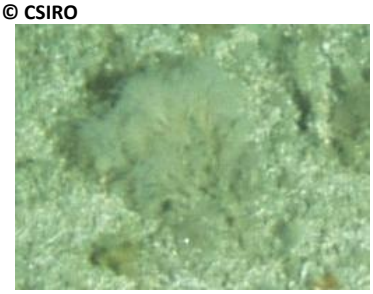
Soft, uncalcified species with a 'fluffy' appearance – fine, numerous, branches, usually bushy; often difficult to see individual branches. Can be confused with some hydroids (which they are often growing with) (3 Cnidaria: Hydroids – CAAB 11 001000) and also some macroalgae.



Foliaceous soft bryozoa



Foliaceous soft bryozoa

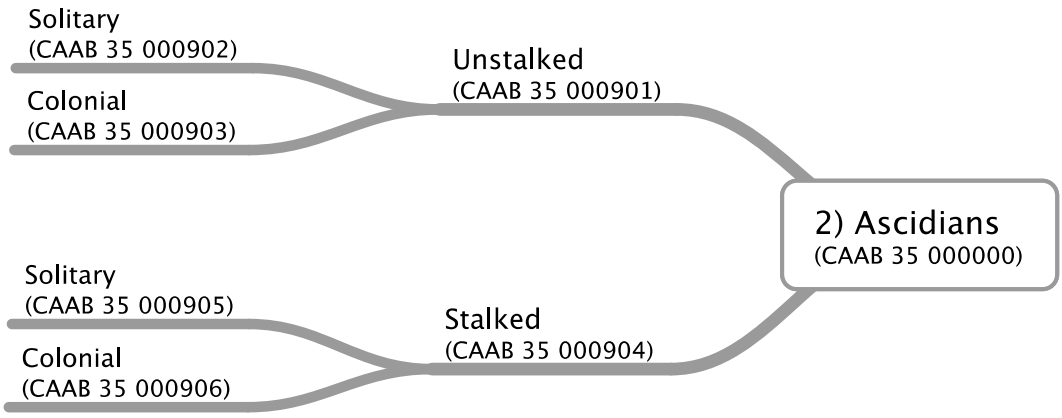


Foliaceous soft bryozoa

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 Ascidians branch of the CATAMI Classification Scheme

3 Ascidians: Stalked – CAAB 35 000904

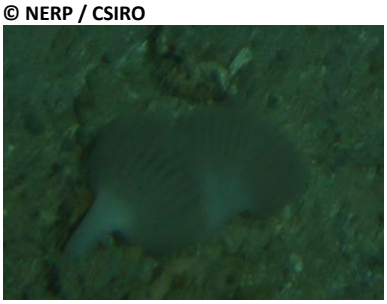
Ascidians that are elevated off the substrate by a stalk.

4 Stalked: Colonial – CAAB 35 000906

Colonial ascidians 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.

Sigilina cyania

Sycozoa sp.



Sycozoa sp.

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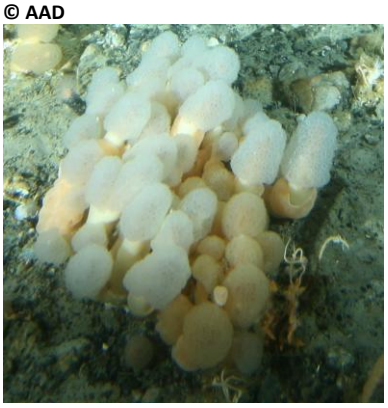
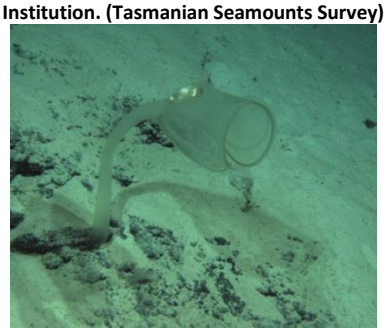
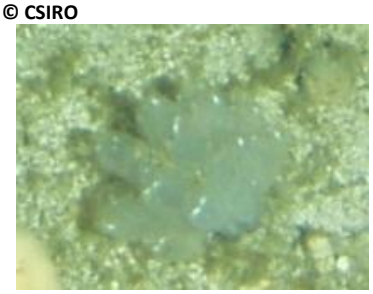
 
Stalked colonial ascidian</td><td></td><td></td></tr>
<tr><td colspan="3">4 Stalked: Solitary – CAAB 35 000905
Solitary ascidians that have a distinct stalk between the main test (‘head’) and the substrate. Ascidian ‘head’ has two distinct siphons. Note: commonly overgrown with sponges and encrusting colonial ascidians. Can be confused with Stalked: Colonial ascidians, and also with some sponges.</td></tr>
<tr><td>© AAD
 
Solitary stalked ascidian</td><td>© Advanced Imaging and Visualization Laboratory Woods Hole Oceanographic Institution. (Tasmanian Seamounts Survey)
 
Carnivorous ascidian</td><td>© Karen Gowlett-Holmes
 
Pyura spinifera</td></tr>
<tr><td>© Karen Gowlett-Holmes
 
Pyura australis</td><td></td><td></td></tr>
</table>

3 Ascidians: Unstalked – CAAB 35 000901

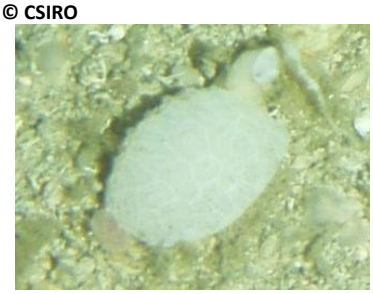
Colonial and solitary ascidians that are directly attached to the substrate.

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.



Clavellina sp.



Unstalked colonial ascidian

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.

Unstalked solitary ascidian

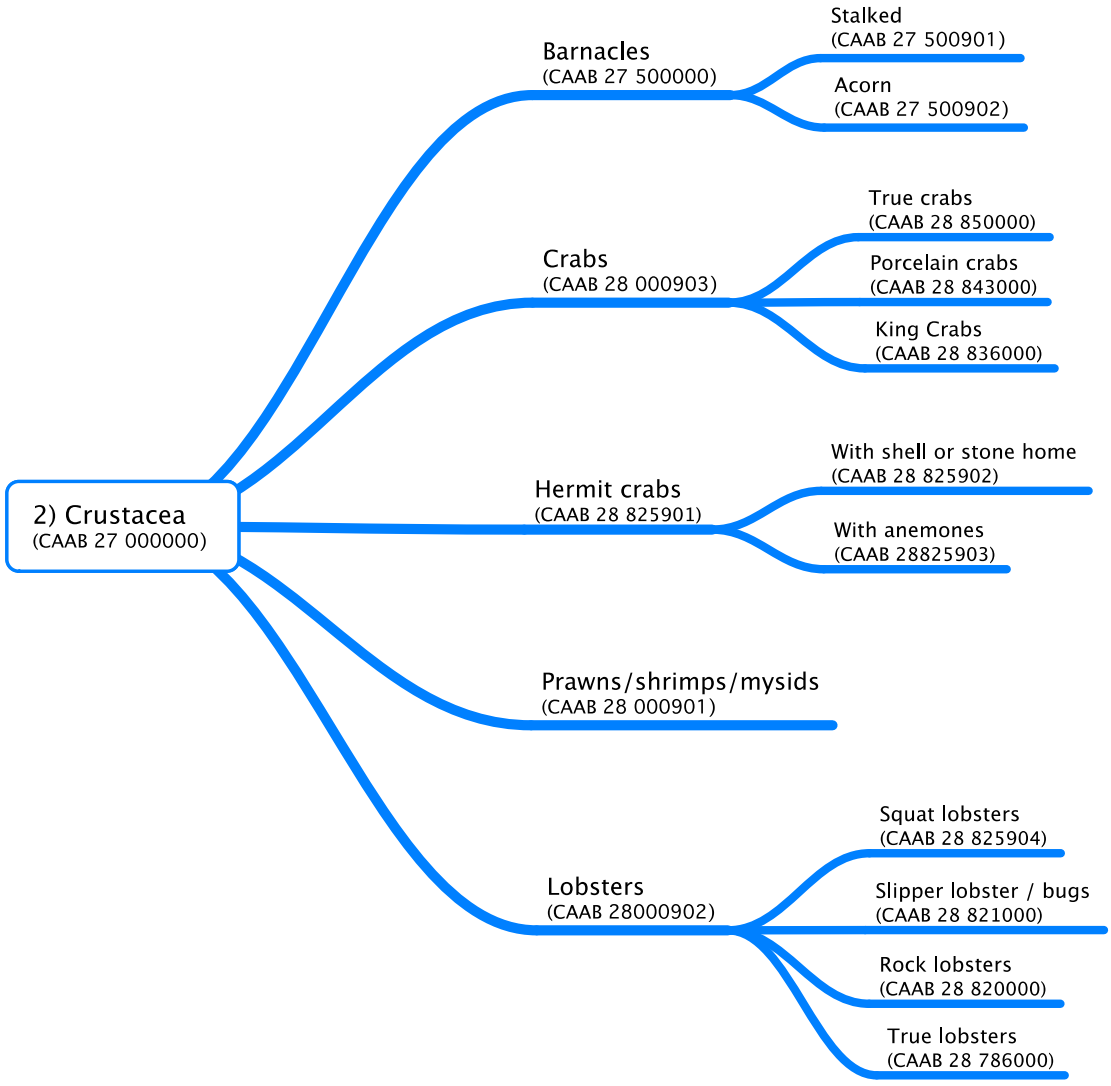
Unstalked solitary ascidian

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

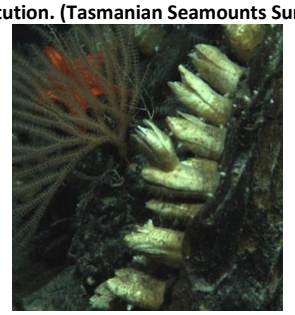
3 Crustacea: Barnacles – CAAB 27 500000

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.

Tetrachaelasma tasmanicum



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.

Scalpellidae

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

Shrimp-like benthic free-living and pelagic crustaceans.

© CSIRO  Prawn	© CSIRO  Prawn	© CSIRO  Pennaeidae
© CSIRO  Shrimp	© CSIRO  Shrimp	© CSIRO  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; 1st antenna bases large, horn-like; carapace usually spiny.

© CSIRO  *Jasus edwardsii* (crayfish)		

4 Lobsters: True lobsters – CAAB 28 786000

True lobsters and scampi – family Nephropidae – obvious large pincers, no horn-like base to 1st antennae. Scampi burrow in sediment and are often seen in the mouth of the burrow.

© CSIRO  Nephropidae	© CSIRO  Nephropidae	

4 Lobsters: Slipper lobsters / bugs – CAAB 28 821000

Family Scyllaridae – dorso-ventrally flattened – carapace and 1st antennae usually expanded into 'shovel-nosed' front. Bugs usually burrow in sediments.

Ibacus sp.

Ibacus sp.

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.

Squat lobster

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.

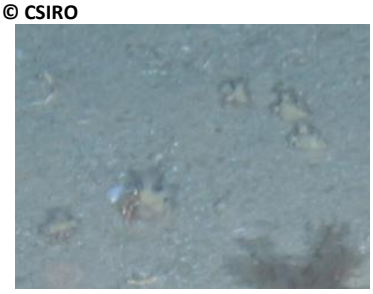
Hermit crab with a gastropod shell

Hermit crab with a gastropod shell

Hermit crab with a stone

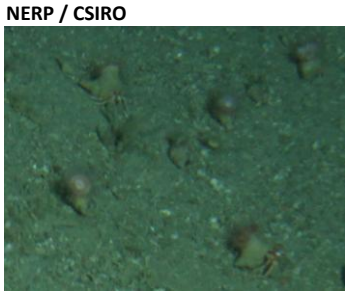
4 Hermit crabs: With anemones – CAAB 28 825903

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.



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.

Ovalipes molleri (swimmer crab)

Dagnaudus petterdi (antlered crab)

Pseudocarcinus gigas (giant crab)

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.

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.

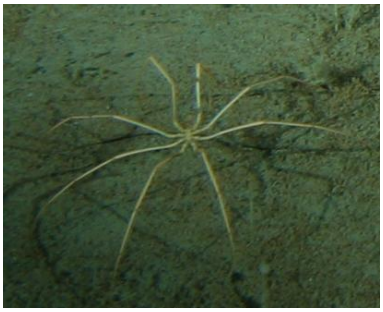
Lithodidae

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.

Colosseidae

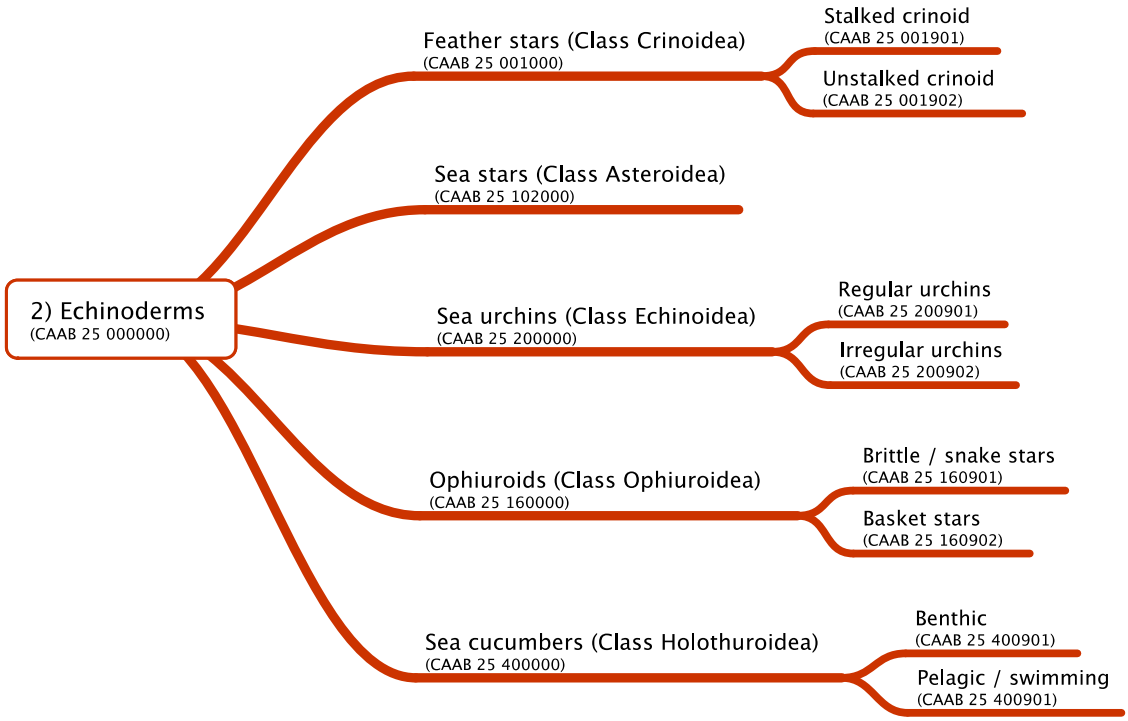


Colosseidae

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.

Pentacrinitidae

Anachalypsicrinus sp.

4 Feather stars: Unstalked crinoids – CAAB 25 001902

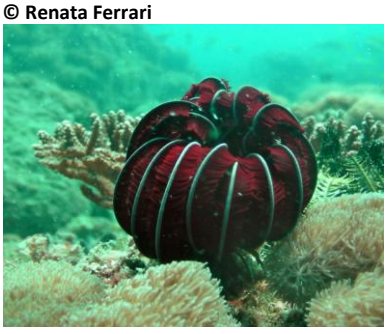
Classic featherstars – no stalk, cirri attached directly to base under disc and arms. Use cirri to hold on to substrate. Often epizoic on sessile animals and on plants.

Unstalked crinoid on sediments

Unstalked crinoids on a sponge

Ptilomeridae

Unstalked crinoid



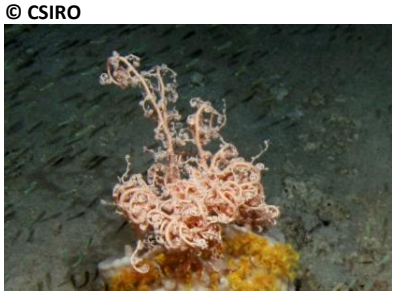
Unstalked crinoid

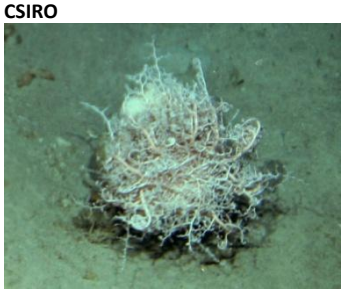
3 Echinoderms: Ophiuroids – CAAB 25 160000

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.


Gorgonocephalidae


Gorgonocephalidae


Gorgonocephalidae

4 Ophiuroids: Brittle / snake stars – CAAB 25 160901

Brittlestars 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.


Free moving ophiuroid


Semi-buried ophiuroid


Ophiotrichidae


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.

<table>
<tr>
<td>© CSIRO
 
Goniasteridae</td>
<td>© CSIRO
 
Asterinidae-</td>
<td>© CSIRO
 
Brisingid</td>
</tr>
<tr>
<td>© CSIRO
 
Asteriidae</td>
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</table>

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.

<table>
<tr>
<td>© CSIRO
 
Diadema savignyi</td>
<td>© CSIRO
 
Caenopedina sp.</td>
<td>© CSIRO
 
Dermechinus horridus</td>
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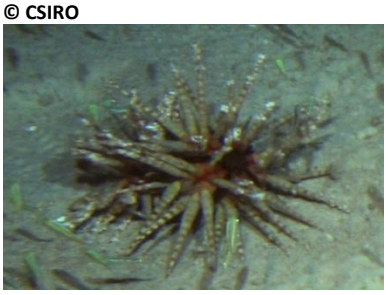
</table>

© CSIRO  Cidaridae	© CSIRO  Pancake urchin	© CSIRO  Pancake urchin *Phormosoma* sp.
© AAD  Pencil urchin		

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.

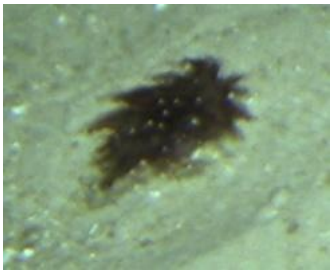
Sand dollar	Heart urchin	

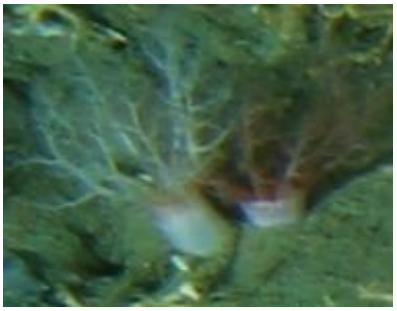
3 Echinoderms: Sea cucumbers – CAAB 25 400000

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  Large benthic holothurian	© CSIRO  *Holothuria nigralutea*	© CSIRO  Benthic holothurian

© AAD  Benthic holothurian	© AAD  Holothurian on epifauna	© AAD  Infaunal holothurian

4 Sea cucumbers: Pelagic / swimming – CAAB 25 400902

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

© CSIRO  *Enypniastes eximia*	© CSIRO  *Enypniastes eximia*	

2 Brachiopods – CAAB 19 100000

Authors: Karen Gowlett-Holmes, Franziska Althaus

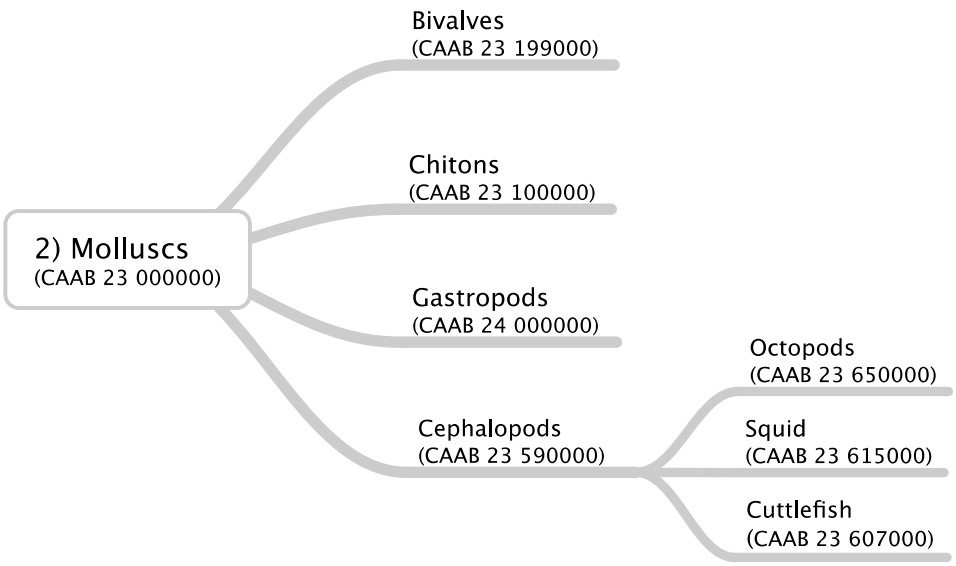
Brachiopods or seed shrimps are easily confused with bivalve molluscs (3 Molluscs: Bivalves – CAAB 2 3199000). There is no subdivision of this branch in the CATAMI Classification Scheme.

© CSIRO  *Jaffaia jaffaensis*		

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		

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.

Bivalve

Sponge scallop

3 Molluscs: Gastropods – CAAB 24 000000

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

Spindleshell

Ericusa sowerbyi

Marginellidae

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).

Octopodidae

Octopodidae

Octopodidae

Octopodidae

Octopodidae

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

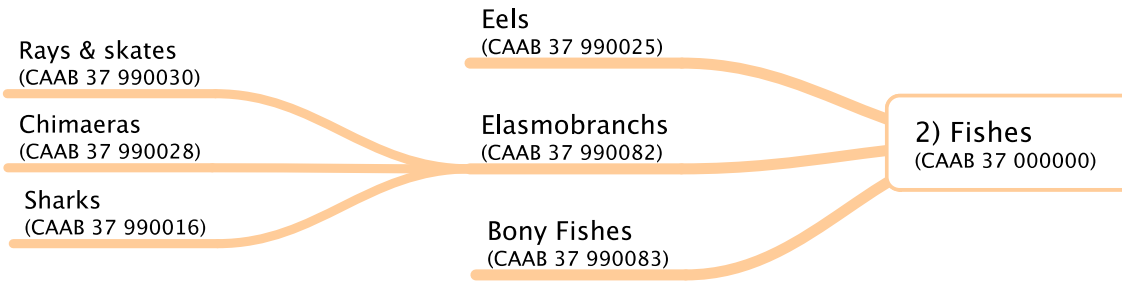
Cephalopods with 8 arms and usually 2 tentacles, with an internal horny 'pen' but no buoyant cuttlebone. Extremely variable, all species are active predators. Includes the bottle-tailed/ dumpling squids.

© 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.

© CSIRO  *Bassanago* sp.	© CSIRO  *Diastobranchus capensis*	.

3 Fishes: Elasmobranchs – CAAB 37 990082

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

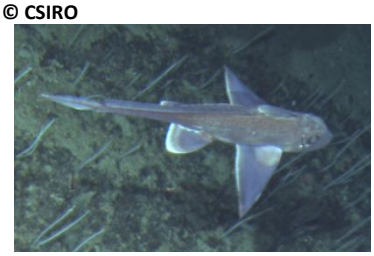
4 Elasmobranchs: Rays & skates – CAAB 37 990030

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

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

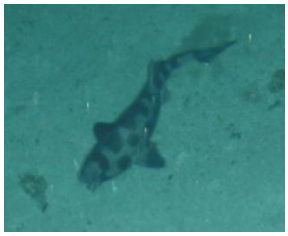
4 Elasmobranchs: Chimaeras – CAAB 37 990028

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

© CSIRO  Ghost shark		

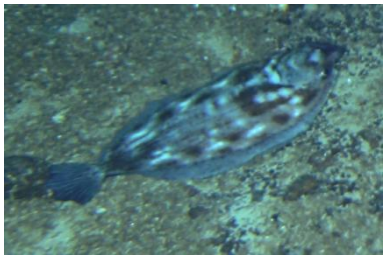
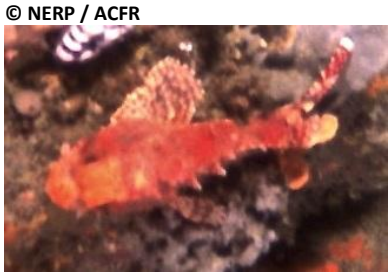
4 Elasmobranchs: Sharks – CAAB 37 990016

Classic shark bodyform.

© CSIRO  *Asymbolus* sp. (catshark)	© CSIRO  *Cephaloscylium* sp.	© CSIRO  *Squalus* sp.

3 Fishes: Bony fishes – CAAB 37 990083

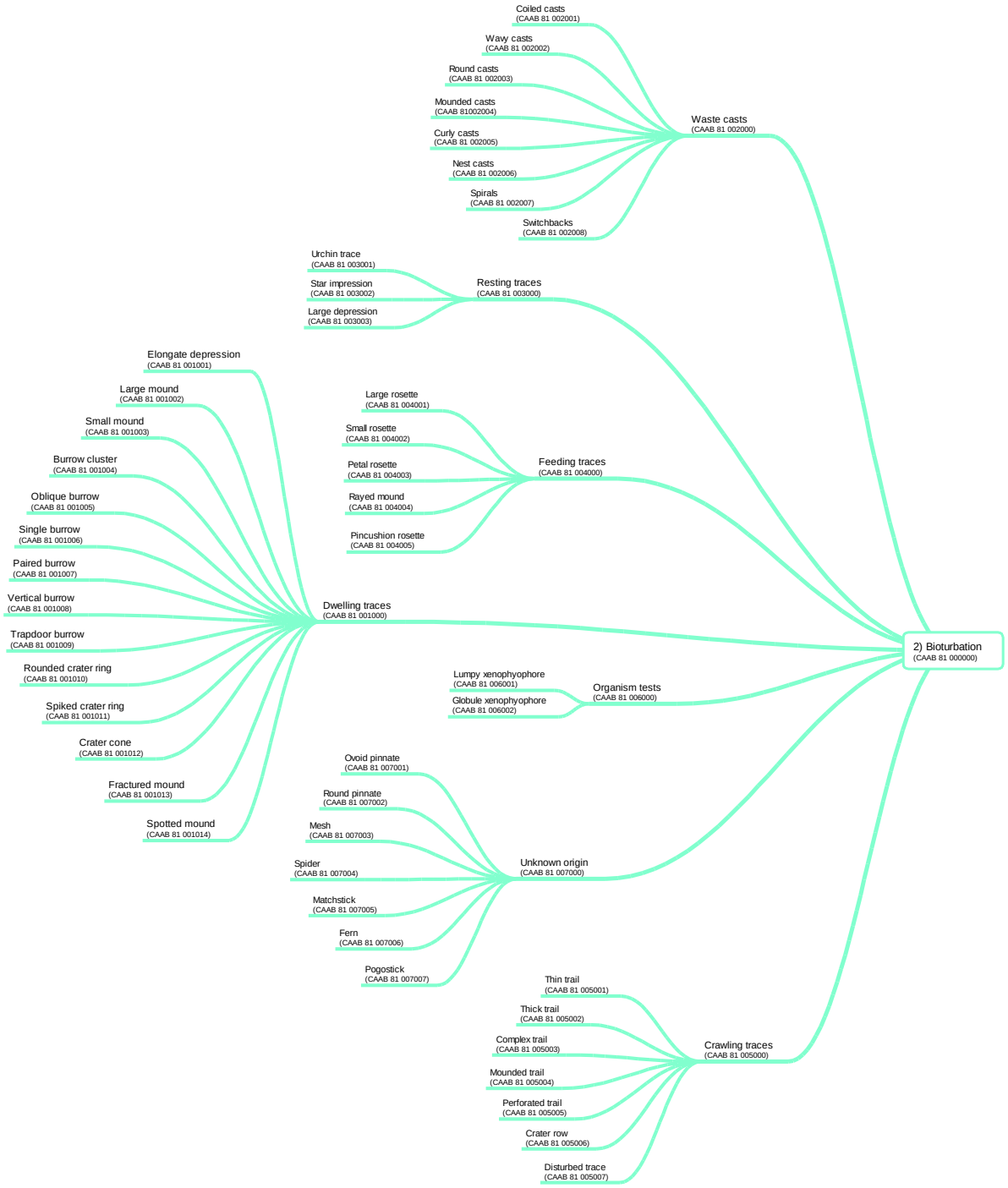
Classical fish, these can have a variety of body shapes.

© CSIRO  *Halagyreus* sp.	© CSIRO  Halosauridae	© CSIRO  *Hoplosthethus atlanticus* (Orange Roughy)
© CSIRO  *Cyttus travesi* (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

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