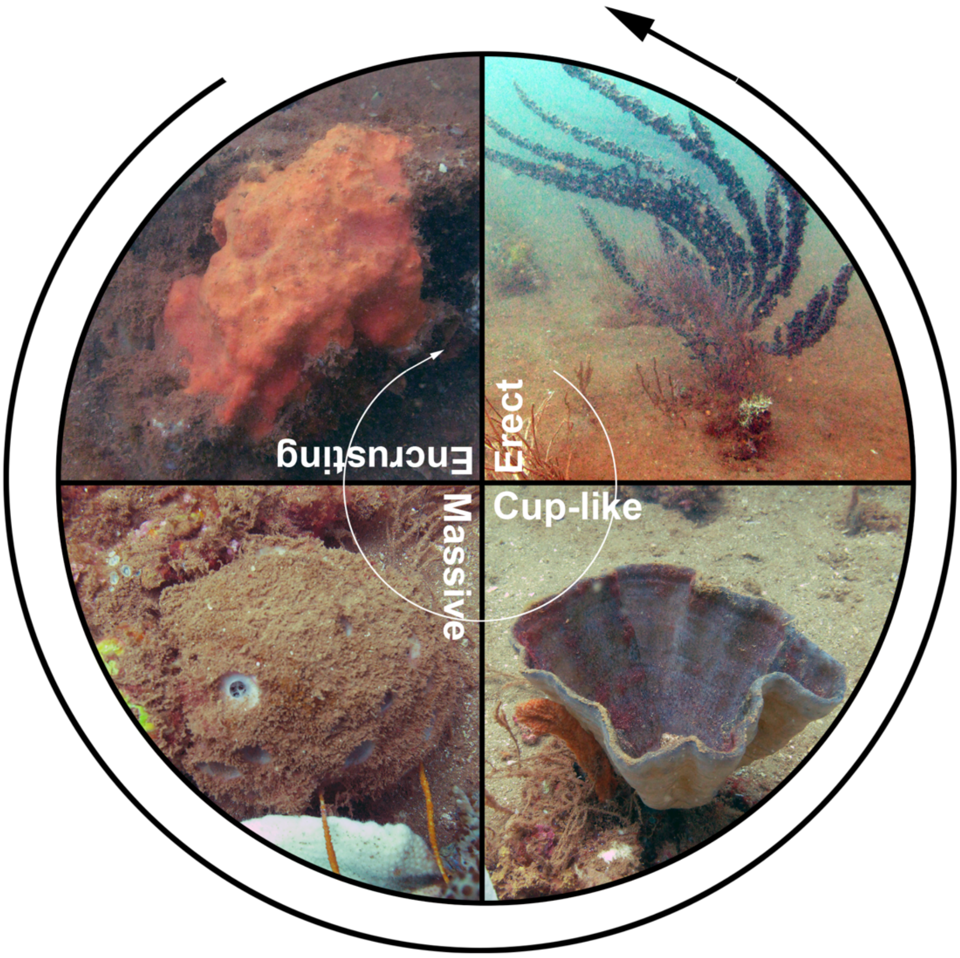
Supplementary material for

Schönberg, C. H. L. (2021). No taxonomy needed: sponge functional morphologies inform about environmental conditions. https://doi.org/10.1016/j.ecolind.2021.107806



Photographs Onslow, NW Australia, 10-14 m.

Supplement 1. The use of sponge growth forms in the literature in comparison to the present approach. Where matching of forms could not be ascertained, terms are marked with "?". See also Suppl. 4.

Schönberg (2012, unpubl. trial), Schönberg and Fromont, 2013 (pilot)	Schönberg and Fromont, 2014, 2019 (short, preliminary Internet publs.)		Schönberg, 2020 (Present publication; if you print this part and cut it out, you can slide it along the rest of the table as reference.)			Fry, 1979	Jackson, 1979 (6 basic forms for clonal invertebrates and sponges)	Van Soest, 1989
ENCRUSTING (EN)	**1 ENCRUSTING** (EN) CAAB 10 000901		**1-2 CRUST-LIKE** in function (EN) CAAB 10 000901			**CRUST-LIKE** in function		
Thinly encrusting (EN-thn)	1.3 Encrusting (EN-cr)	Thinly encrusting (EN-thn)	1 Encrusting *sensu lato* (EN-lat) CAAB 10 000922	1.1 True crusts *sensu stricto* (EN-cr) CAAB 10 000902	1.1.1 Thin crusts (EN-cr-tn) CAAB 00 000923	Encrusting, flat	Sheets	
Thickly encrusting (EN-thc)		Thickly encrusting (EN-thc)			1.1.2 Thick crusts (EN-cr-thn) CAAB 00 000924			Massively encrusting
Endolithic-bioeroding (EN-en)	1.2 Endolithic-bioeroding (EN-en) CAAB 10 000921			1.2 Endolithic-bioeroding (EN-be) CAAB 10 000921		Boring, infaunal	Boring (mentioned, but not part of Jackson's definitions)	
Creeping-ramose (EN-cg)	1.1 Creeping, ramose (EN-cg) CAAB 10 000917		2 Creeping, repent (EN-rep) CAAB 10 000917			Encrusting, clathriid, asconoid (if low-relief)	Runners, vines	Ramose (incl. erect forms)
MASSIVE (M) (then incl. stalked forms (M-st) and barrels (M-br), see below)	2-4 **MASSIVE** (M) CAAB 10 000903		**3-6 MASSIVE** in function (M) CAAB 10 000903			**MASSIVE** in function		
Simple-massive (M-s)	2 Simple-massive (M-s) CAAB 10 000904		3 Simple-massive (M-s) CAAB 10 000904			Solid, massive	Mounds	Massive structures (incl. some endopsammic forms)
Massive-balls (M-bl)	3 Balls (M-bl) CAAB 10 000905		4 Globular-massive, balls (M-bl) CAAB 10 000905			Globular		Globular, ball-shaped
			5 Composite-massive, dense meshes or clusters (M-c) CAAB 00 000925			Clathriid		
Cryptic-massive, endopsammic (M-crp)	4 Cryptic-massive (M-crp) CAAB 10 000908		6 Fistular, cryptic-massive, endopsammic (M-f) CAAB 10 000908			Papillate, infaunal		Fistulose (incl. massive-creeping with upright branches)
CUPS etc. (C)	**5-7 CUP-LIKES** (C) CAAB 10 000909		**7-9 CUP-LIKE** in function (C) CAAB 10 000909			**CUP-LIKE** in function		
Table-shaped or shallow disc (C-t)	5 Cups CAAB 10 000910	5.1 Tables, dics or very shallow cups (C-tab) CAAB 10 000920	7 Cups CAAB 10 000910	7.1 Tabular "cups" (C-tab) CAAB 10 000920		Free flat	Plates	Cups and tubs (incl. some stalked forms)
Incomplete cups, curled fans (C-inc)		5.2 Incomplete cup, curled fan (C-inc) CAAB 10 000918		7.2 Incomplete "cups", curled fans (C-inc) CAAB 10 000918				
Wide cup or goblet (C-wd)		5.3 Wide cup or goblet (C-wd) CAAB 10 000919		7.3 Complete, apically wide cups, vases (C-cmp) CAAB 10 000919		Vase, cup, calicular, incl. barrels	Mounds	
Narrow cup, funnel or tube (C-nr)	7 Narrow cup, slim funnel or tube (C-nr) CAAB 10 000911		8 Tube-like forms, "narrow cups" (C-n) CAAB 10 000926	8.1 Chimneys, proper tubes (C-t) CAAB 00 000911		Tubular, incl. barrels	Trees? Mounds?	Tubes and pipes (incl. tube clusters)
				8.2 Amphoras, sack-like sponges, bladders (C-a) CAAB 00 000927				
Barrels (M-br) – was the part of massives	6 Barrels (C-b) CAAB 10 000907		9 Barrels, "massive cups" (C-br) CAAB 10 000907			Included in tubular, vases and cups	Mounds	Cups and tubs (incl. some stalked forms)
ERECT (E)	**8-12 ERECT** (E) CAAB 10 0009130		**10-14 ERECT** in function (E) CAAB 10 0009112			**ERECT** in function		
Simple-erect (E-s)	11 Simple erect (E-s) CAAB 10 000916		10 One-dimensionally erect, simple erect (E-1D) CAAB 10 000916			Erect	Trees	
Erect-laminar, spatula, fan (E-fn)	8 Erect-laminar, spatulas, fans (E-lam) CAAB 10 000913		11 Two-dimensionally erect (E-2D) CAAB 00 000928	11.1 Erect-laminar, flabellate (E-lam) CAAB 10 000913		Erect fan-shaped		Fan-shaped
Erect-palmate, hand-shaped, branching in 1 plane (E-pal)	9 Erect-palmate, hand-shaped, branching in one plane (E-pal) CAAB 10 000914			11.2 Erect-palmate (E-pal) CAAB 10 000914		Erect-digitate?		
				11.3 Erect-reticulate (E-ret) CAAB 00 000929		Erect		
Erect-branching, branching in 3 dimensions (E-br)	10 Erect-branching (E-br) CAAB 10 000915		12 Three-dimensionally erect, branching (E-3D) CAAB 10 000915			Erect-digitate		Partly as ramose
Massive-stalked (M-st) – but was then part of the massives	12 With long stalk (E-st) CAAB 10 000906		13 Stalked (E-st) CAAB 10 000906			Pedunculate, stalked		
			14 Carnivorous (E-car) CAAB 00 000930					

Diaz et al., 1990	Madonado and Young, 1996	Boury-Esnault and Rützler, 1997	Barnes, 1999	Ginn et al., 2000	Barnes and Bell, 2002	Bell, 2002	Bell and Barnes, 2002d	Bell et al. 2002b	Neves and Omena, 2003	Wulff, 2006a
CRUST-LIKE in function										
Encrusting	Encrusting	Encrusting	Encrusting	Encrusting (incl. fistular sponges)	Encrusting	Encrusting	Encrusting	Encrusting		Encrusting
				Massive			Cushion?		Encrusting (partly with large, raised oscules)	Thick sheet
		Excavating						Burrowing*		Semi-cryptic
		Repent			Repent		Repent			
MASSIVE in function										
Large and small massive, cushions (incl. balls, barrels, tubes)	Massive		Lobate?	Massive (incl. fistular sponges)	Massive, lobate (latter massive-encrusting)	Massive (incl. clusters of walls and crusts)	Massive, cushion?	Massive, ridged	Massive, lobate?	Massive (incl. massive vases = barrels?)
		Globular, ficiform, ellipsoid	Spherical		Globular		Globulose			
						Massive (as clusters of walls and crusts), clathrate	Leaved?			
		Endopsammic, digitate	Buried	Massive	Papillate	Massive	Papillate	Massive/chimney, encrusting/chimney	Massive	Massive and semi-cryptic (incl. endolithic-bioeroding)
CUP-LIKE in function										
Erect (incl. creeping forms)	Cup-like				Infundibuliformis		Cuplike			
		Turbinate								Massive vase? (but in this approach under massive)
		Tubular	Tubular		Tubular	Tubular	Columns, tubular		Lobate (tube clusters)	
							Tubular?			
Large massive										Massive vase? (but in this approach under massive)
ERECT in function										
Erect (incl. creeping forms)	Erect	Flagellate, columnar		Upright						
		Flabellate, foliaceous	Leaved		Leaved		Flabellate, pedunculate?			
		Palmate		Upright	Palmate		Arborescent?			Erect-branching?
		Arborescent	Lobate?		Arborescent		Arborescent (incl. palmate?)		Lobate	Erect-branching (incl. some cups and palmate?)
		Pedunculate, clavate, stipitate, pinnate					Pedunculate?			

* "Burrowing" is not a good term for bioeroders of hard substrate and most commonly refers to motile sediment-dwelling organisms (see definitions in Schönberg et al., 2017)

Wulff, 2006d	Bell, 2007a	Bell, 2007b	De Voogd and Cleary, 2007	Freeman et al., 2007	Pitcher et al., 2007	Van Soest et al., 2007	Abdo et al., 2008	Ruzicka and Gleason, 2009	Ávila et al., 2011	Kelly and Przeslawski, 2012**
CRUST-LIKE in function										
Encrusting	Thin encrusting, thin encrusting conulose	Encrusting		Encrusting	Encrusting	Thin, small, hispid crusts	Encrusting	Encrusting	Encrusting	Encrusting
	Massive crust (incl. sponges with raised oscules)	Massive encrusting?	Massively encrusting							
Cryptic (incl. insinuating sponges)	Boring	Boring/ burrowing*							Boring	
Insinuating sponges counted as "cryptic"	Repent, repent-arborescent, flake?		Ramose (incl. erect forms)	Branching (incl. erect-branching)	Prostrate branching				Repent	
MASSIVE in function										
Massive-breakable,	(Conulose) massive upright, re-verse ficiform, cushions, domes	Massive upright?	Massive structures (incl. some endopsammic forms)	Amorphous	Nodules?	Massive (highly silicified; incl. barrels?)	Massive, submassive?	Amorphous (ridge-like?)	Massive, cushion-shaped (incl. barrels?)	Massive simple (incl. barrels)
Massive-tough										
	Globulose, oval-supported?	Globular/ globulose	Globular or ball-shaped	Globular	Globular, nodules?		Globular		Globular	
	Clathrate			Clathrate	Lobate?		Submassive?			
Cryptic	Fistulate, flake-digitate? Papillate?	Fistulose	Fistulose, massive- creeping with upright branches?	Digitate	Digitate?		Submassive?	Digitate	Fistulose	
CUP-LIKE in function										
	Horizontal plates? Massive plates?		Cups and tubs (incl. some stalked forms)		Plate					Massive hollow
					Vase, *Cymbastela*					
Vase	Cup, (conulose) infundibuliform	Infundibuliform								
Tube clusters	Massive chimneys? Massive tubes? Mini tubes	Tubular	Tubes and pipes (incl. tube clusters)	Vase			Tubular, massive	Vase		
						Hollow, bladder-like forms				
	Barrel	Barrel	Cups and tubs		Barrels, *Xestospongia*					Barrels (but scored as "massive"
ERECT in function										
	Flagelliform, single branch				Club?				Arborescent	Erect simple
Fan	Flabellate	Flabellate	Fan-shaped	Pedunculate	Fan, foliose, *Ianthella*		Flabellate	Pedunculate		Erect laminar
Erect-branching?			Branching?					Arborescent?		Erect laminar/branching
Erect-branching (incl. palmate?)	Multi-fat/multi-thin branch, multi-orientation plates, branched multiplate?	Arborescent	Branching (incl. repent and palmate?)		Branching, bushy?			Arborescent (incl. palmate?)	Arborescent?	Erect branching
	Stalked ficiform, mini/massive pedunculate?	Pedunculate?			Club?					Erect stalked

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** Following an unpublished, very preliminary pilot version of Schönberg (2012)

Berman et al., 2013	Te, 2013	Carroll et al., 2014***	Przeslawski et al., 2014**	Althaus et al., 2015****	Bertolino et al., 2015	Bewley et al., 2015***	Hadi et al., 2015	Kelly and Herr, 2015	Abdul Wahab et al., 2017a, 2017b, 2018**** (but incorrectly applied in 2017a)
CRUST-LIKE in function									
Encrusting	Encrusting	Encrusting	Encrusting	Encrusting	Encrusting, insinuating	Encrusting		Thin encrusting	Encrusting-crust thin (incl. thick crusts)
							Thickly encrusting	Thick encrusting	Encrusting-crust thick
Burrowing*	Boring			Endolithic-bioeroding					Encrusting-endolithic
				Creeping-ramose	Repent, ramose	Creeping/ramose	Repent, creeping massive	Meandering	Encrusting-creeping
MASSIVE in function									
Massive	Variable	Simple	Massive simple (incl. barrels)	Simple-massive	Massive, massive-lobate, cushion (incl. fistular)	Simple	Massive? Conus massive? Irregular massive, cushion	Amorphous, loaf, hemispherical	Massive-simple (incl. some barrels)
Globular		Radially organised		Balls		Radially organised	Spherical	Ball, spherical	Massive-ball
	Variable?						Irregular massive?	Amorphous, cormus, massive	Massive-simple, erect-branching
Papillate, repent		Cryptic		Cryptic-massive	Massive	Cryptic		Fingers, also: encrusting, hemispherical-massive, cushion	Massive-cryptic
CUP-LIKE in function									
		Cups and alikes	Massive hollow	Tables		Cups and alikes			Cup-tabulate
				Incomplete cups				Plate (*sensu* curled fan)	Cup-incomplete
				Wide cups				Bowl, cup, vase	Cup-wide
Tubular	Tube	Tubes and chimneys		Narrow cups, tubes		Tubes and chimneys	Tubular	Tube, tube cluster	Cup-narrow (incl. some thick crusts and incomplete cups)
								Sack, bulb, flask, egg?	
		Barrels	Barrels (but scored as "massive")	Barrels		Barrels (but scored as "massive")	Conus massive? Tubular massive?	Bulb	Cup-barrel
ERECT in function									
Arborescent	Finger?	Simple	Erect simple	Simple-erect	Uniramose	Simple	Columnar massive? Columnar, branch	Whip, club	Erect-simple (incl. some palmate and creeping)
Flabellate		Laminar	Erect laminar	Erect-laminar	Laminar	Laminar	Flabellate, foliose, laminar (all scored separately)	Fan, plate	Erect-laminar (incl. some branching sponges)
Arborescent?	Finger?	Palmate (incl. erect-reticulate?	Erect laminar/ branching	Erect-palmate		Palmate	Flabellate? Foliose? Laminar?	Hand, strappy, also: tree, shrubby	Erect-palmate
								Tube cluster?	
Arborescent (incl. simple-erect, also palmate?)	Finger?	Branching (incl. erect-reticulate?)	Erect branching	Erect-branching (3-dimensions)	Erect-branching, ramified	Branching	Busy branching?	Shrubby, tree	Erect-branching (incl. palmate, some creping)
Pedunculate		Stalked (but scored as "massive")	Erect stalked	Erect-stalked		Stalked (but scored as "massive")		Lollipop	Erect-stalked (function not always correctly scored)

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** Following an unpublished, very preliminary pilot version of Schönberg (2012)
*** Following Schönberg and Fromont (2013)
**** Following Schönberg and Fromont (2014)

James et al., 2017**** (but partly incorrectly applied)	Kelly and Bell, 2017	Rush et al., 2017	George et al., 2018**** (but incorrectly applied)	Otero et al., 2018 (referring to bycatch, so no crusts scored)	Bell et al.,2020	Gochfeld et al., 2020
CRUST-LIKE in function						
	Thin encrusting	Thin encrusting	Encrusting (incl. sponges with some vertical structure)		Encrusting	Encrusting, low-relief
	Thick encrusting	Thick encrusting		Partly as massives?		
	Boring				Bioeroding	Excavating
	Meandering, ramose, repent, fingers?			Arborescent		
MASSIVE in function						
Massive (but incl. barrels)	Amorphous, loaf, hemispherical	Amorphous, loaf, thick crust	Massive (but incl. barrels)	Massive	Massive	Massive (incl. cushions, simple-massives, tubes, vases, and other amorphous forms of medium relief)
Ball	Ball	Ball, spherical, globular		Globular		
Massive	Amorphous, lobate			Massive		
	Fingers? Also: encrusting	Fingers? Digitate? Thick crust				
CUP-LIKE in function						
Cup			Tabular	Lamellate to cup-shaped (differentiating tetractinellid rock sponges from others)		Massive (incl. cushions, simple-massives, tubes, vases, and other amorphous forms of medium relief)
	Plate (*sensu* curled fan)	Plate	Half and full cups			
	Bowl, cup, vase	Cup, vase				
Tubular	Tube, tube cluster		Massive	“Bird’s nest” and “felt vase” sponges	Upright (tubular sponges)	
	Volcano, sock-shaped					
Cup (but partly scored as “massive”)	Bulb, barrel				Massive?	
ERECT in function			**UPRIGHT**	**ERECT** in function		
	Whip, club, tangled branches?				Upright (incl. tubular and branching forms)	Upright (incl. branching and "rope" sponges)
	Fan, plate	Plate	Upright-simple, upright-laminar, foliaceous	Fans		
Palmate	Hand, strappy	Strappy	Digitate/branching?	Arborescent?		
	Tube cluster?					
Branching	Shrubby, tree, fingers? Tangled branches?		Digitate/branching	Arborescent		
			Stalked			

**** Following Schönberg and Fromont (2014)

Supplement 2. Environmental factors that have been reported in the science literature as selecting for certain sponge morphologies, or accounts of sponge distribution patterns in relation to environmental parameters. To facilitate information retrieval and locating different growth forms, the main function categories encrusting, massive, cup-like and erect have been highlighted in colour to match colours used in the scheme overview and to visualise strong patterns (e.g. "laminar flow" is yellow-dominated = (2D-)erect dominated). Please note that the terms for the morphologies used in the cited publications do not exactly correspond to the presently proposed sponge classification scheme. Especially definitions for "massive" sponges differ widely, and 2- and 3-dimensionally branching sponges were almost never differentiated (see Suppl. 1).

Environmental condition	Sponge morphologies	Reference
Hydrodynamics		
Strong, turbulent flow with high drag force of unpredictable direction	Calcified sclerosponges of low relief live at exposed sites at the reef edge but also often occur at deeper sites to about 100 m with reduced water movement. Their overall shape was described as massive, encrusting and tabular, but similar to corals they have only a thin veneer of living tissue on top of the skeleton they form and often function as encrusting sponges, depending on the overall shape.	Hartman and Goreau, 1970
	In a reef environment, no sponges were found at the shallowest sites, and endolithic-bioeroding sponges were detected at slightly deeper sites (in SCUBA diving depth).	Rützler, 1972
	Halichondria panicea develops a higher structural rigidity in times and at sites with stronger turbulent flow. At exposed sites this species also has a more massive, more compact body shape compared to in reduced flow. At low-energy sites the morphology is more delicate and can tend towards more branching shapes, including raised oscules that attain a fistular function. In general, oscules were at the outer edges of the sponges, where maximum flow was achieved.	Vogel 1974; Peattie and Hoare, 1981; Palumbi, 1984, 1986; Barthel, 1991; Schönberg and Barthel, 1997
	Jackson (1979) ranked expected success of sessile marine invertebrates in strong flow as creeping, encrusting, massive (here including cups) > rope sponges that are here understood as creeping (his "vines") > tabular, erect-branching. "Maintenance of relatively large areas of attachment […] should make mounds [= simple-massive] more resistant to strong water movements".	Jackson, 1979
	Encrusting sponges are resistant to turbulent flow, cup-like, simple-erect and erect-branching sponges less so.	Trammer, 1979
	Strong, unpredictable flow conditions select against more delicate and erect morphologies by causing damage, dislodgement, fragmentation, scouring and abrasion. As good mixing guarantees a good food supply, sponges do not have to spatially separate their in- and exhalants. Risk of smothering and clogging is reduced by strong flow, so that low-relief forms that are less feeding-efficient can settle under these conditions, and often encrusting forms dominate.	Hiscock, 1983
	The encrusting to massive *Pachymatisma johnstonia*, *Thymosia guernei*, *Tethyspira spinosa* and *Myxilla (Myxilla) rosacea* predominantly occurred at wave-swept sites.	Hiscock et al., 1984
	As a general rule, organisms in wave-swept or strong-current environments either reduce the effects of the fluid-dynamic forces by being small, having a low profile and large attachment area, or they are flexible and move with the forces. Some avoid wave force by seeking out concave shelters (e.g. sea urchins, snails; note by Schönberg: see also sponge balls). Morphologies may vary from crusts in the surf zone to erect forms in deeper water (e.g. *Millepora complanata*).	Denny et al., 1985; Denny, 1988
	In less than 10 m depth in a reef environment, sponges were generally smaller than fist-size, with the exception of some larger endolithic-bioeroding sponges.	Alcolado, 1990
	At sites in shallow water, the effect of turbulence, waves and storms was most pronounced and selected for a predominance of encrusting and endolithic-bioeroding sponges. The ball-shaped *Tectitethya crypta* (as *Tethya*) and the encrusting morphology of the rope sponge *Clathria (Thalysias) virgultosa* (as *Rhaphidophlus juniperinus*) were more common in the shallow water.	Schmahl, 1990

Environmental condition	Sponge morphologies	Reference
Ctd.: Strong, turbulent flow	The erect-branching, "ropy" *Agelas sceptrum* suffered a large rate of fragmentation during a hurricane, but many fragments also quickly re-attached and recovered.	Fenner, 1991
	Simplified summary: In experiments using objects of different shapes placed broadside to the tested current, a plate (erect-laminar) experienced higher drag forces than a cylinder (tube or barrel), than a shallow cone (mound, simple-massive), than a ball.	Denny, 1994
	In erect-branching sponges a high spongin content safeguards against physical tearing and fragmentation.	Wulff, 1997
	In comparison between an exposed and a sheltered reef site, the proportional distributions of sponge morphologies did not much vary between the two, but at both sites encrusting sponges dominated. The ball-shaped *Cinachyrella arabica* (as *C. voeltzkowii*) was the only sponge present and abundant on the upper shore.	Barnes, 1999
	The authors' exposed site had poor diversity of sponge morphologies, mostly reduced to encrusting and well-attached simple-massive sponges, lacking sponges with small attachment area. This was true for inclined, as well as for vertical surfaces.	Bell and Barnes, 2000a, 2000b
	Cliona cf. *celata* was encrusting and ridge-like simple-massive in strong, turbulent flow	Bell et al., 2002b
	The ball-shaped *Cinachyrella australiensis* was larger and rounder in stronger flow and had a higher content of inorganic skeleton, as well as thicker spicules.	MacDonald et al., 2002
	The ball-shaped *Tetilla* sp. had larger bodies in stronger, turbulent flow, a higher content of inorganic skeleton, and longer spicules.	Meroz-Fine et al., 2005
	When transplanted from 3 to 1 m, the thickly encrusting to creeping to tubular *Haliclona (Soestella) caerulea* developed a larger attachment area, smaller, but more oscules, a higher density, and a higher inorganic content (spicules, but also algal partner scaffold).	Carballo et al., 2006
	Compared to sheltered embayments, survey sites with ocean swells were dominated by encrusting morphologies (by % cover), with low diversity, but variability over time.	Roberts et al., 2006a
	Aplysina cauliformis commonly occurs in areas with strong waves, frequent exposure to storms and sedimentation. It is erect-branching, but it also has a high spongin content and is flexible. It furthermore tends to be repent. The broad base of the barrel-shaped *Spheciospongia vesparium* provides a good attachment and protection against storm damage.	Alcolado, 2007
	The often sack-like glass sponge *Aphrocallistes vastus* had a smaller, more compact morphology at more exposed sites.	Austin et al., 2007
	Rocky substrate at an exposed coast was predominately covered by encrusting sponges.	Carballo and Nava, 2007
	Ordination on a sponge community associated the thickly encrusting sponge *Placospongia melobesioides* and the fistular species *Oceanapia sagittaria* and *Coelocarteria singaporensis* with exposure, the thickly encrusting to creeping to erect-branching *Neopetrosia chaliniformis* (as *N. exigua*) with offshore habitats.	Cleary and de Voogd, 2007
	Globular sponges were more prevalent with exposure (stronger flow). Creeping, massive-creeping (with upright branches, i.e. in function fistular or erect-branching?) and thickly encrusting to massive sponges were found at shallow depth (where flow would be more turbulent than at depth).	De Voogd and Cleary, 2007
	Dislocated sponges that washed up on the beach by waves were mostly branching, massive and cushion-shaped. Encrusting species were never found washed up. While sponges with high spongin content occurred in the area, they were not found washed up.	Ávila et al., 2011
	Exposed coral reef sites with turbulent flow had more sponges with "irregular- massive" growth forms.	Hadi et al., 2015
	New Zealand intertidal sponges were dominated by encrusting, fistular and ball-shaped forms.	Rush et al., 2017

Environmental condition	Sponge morphologies	Reference
Strong, laminar flow	"There is a possibility that [fan-shaped sponges] are found always in a permanent current, on which they depend for subsistence. [… It] is possible that the fan-shaped form only occurs in response to the stimulus of a constant current […] across which its plane is extended." Bidder (1923) hazarded that cups result from constant flow that changes across all directions.	Bidder, 1923
	"Plates [= tabular sponges] cannot usually grow as high as trees [= erect-branching sponges] and thus may have less access to the water column [= resource limitation]. Depending on their orientation, however, their large, flattened surfaces may be more effective than the branches of trees in obtaining resources in unidirectional water regimes. A potential cost is a greater vulnerability to strong water movements." But such sponges usually have a high spongin content, see other listings.	Jackson, 1979
	Passive suspension feeders with erect-laminar bodies orient themselves at right angle to the predominant current.	Hiscock, 1983
	The thickly encrusting to branching *Halichondria panicea* and *Amphilectus fucorum* occurred at strong-current sites exposed to tidal flows.	Hiscock et al., 1984
	Erect, branching parts of the freshwater *Spongilla lacustris* could not be maintained when stream flow seasonally increased. Branches were detached, and crusts of the sponge remained behind.	Manconi and Pronzato, 1991
	Spongia (Spongia) agaricina had a cup-like to erect-laminar form and preferentially occurred at sites with laminar flow.	Pronzato et al., 1998
	Branching sponges have a higher branch complexity and more branches in stronger flow.	Abraham, 2000; Lawler and Osborn, 2008
	"The orientation of an individual sponge to the direction of the [tidal] current was […] dependent on its morphology, with [2-D and 3-D branching, flexible] species orientated across the current." More rigid, massive sponges were at right angle to the prevailing currents at lower flow speed and parallel to the current at high flow speeds. Encrusting sponges were less clearly oriented but mostly extended parallel to the current.	Ginn et al., 2000
	Cliona cf. *celata* was encrusting and ridge-like, simple-massive in strong flow and had more oscules per area than in low flow.	Bell et al., 2002
	In strong tidal currents *Spongia* sp. oriented itself with the broad face across prevailing currents. It grew faster in that orientation than when placed in parallel with the currents. This was explained as an optimisation for feeding by separation of in- and exhalant streams.	McDonald et al., 2003
	Erect-laminar Axinellidae were reported for northern Australian sites with strong tidal currents.	Alvarez and Hooper, 2009
	Predominant morphologies in elongated valleys between scarps were erect-branching (here: "arborescent"), fistular ("digitate") and erect-laminar ("pedunculate"). Geomorphology may suggest laminar flow.	Ruzicka and Gleason, 2009
	Laminar flow favours a high frequency of erect-laminar and palmate sponges, situated at right angle to the predominant flow direction; these sponges have a high spongin content and are flexible to bend in strong flow regimes.	Schönberg and Fromont, 2012
	The flexible, erect-laminar sponge *Ianthella flabelliformis* had "positive affinities for seabed current stress" at a northern Australian site with strong tidal currents (Torres Strait). The area also had a high frequency of ball-shaped sponges.	Pitcher et al., 2007
Strong to moderate, but predictable, steady flow	Sponges adapted to stronger flow with increased wall thickness (in tubes) or overall reinforcement.	Schmahl, 1990
	Modelling and transplantation showed that the branching, mostly erect-palmate sponge *Haliclona (Haliclona) oculata* produced thinner branches in reduced flow, and wider, more flattened branches under increased flow. With stronger flow the variation in branch spacing and the chance of branch fusion also grew.	Kaandorp, 1991; Kaandorp and de Kluijver, 1992; Kaandorp, 1999
	Crusts were by far most dominant overall, and especially in shallow water between ca. -90 and -170 m. All morphologies were most abundant in -90 m, with cups also being common around -370 m and dominant at about -520 m (here: astrophorines), which the authors interpreted as an adaptation to maximize feeding and sediment avoidance (presumably in reduced flow). Massives were dominant around -480 m. Erect, whip-like (simple-erect) and branching sponges only occurred to -140 m.	Maldonado and Young, 1996
	Of 3 local *Spongia* species, *S. (Spongia) officinalis* displayed the most variability in morphology and occurred across the widest range of habitats. It is mostly massive, but it has a slight separation of in- and exhalants (side and top, respectively). The distribution peak of *S. officinalis* did not match the highest sedimentation peak.	Pronzato et al., 1998

Environmental condition	Sponge morphologies	Reference
Ctd.: Strong to moderate flow	Branching sponges have an increased branch complexity and more branches in higher flow.	Abraham, 2000; Lawler and Osborn, 2008
	The predominantly massive *Rhopaloerides odorabile* occurred at more exposed locations with stronger flow. This is here interpreted as a necessity arising from its surface with mixed in- and exhalants that require good flow in order to prevent re-inhalation of exhaled water.	Bannister et al., 2007
	Cups were found at offshore sites with high wave energy and exposed to oceanic swells.	De Voogd and Cleary, 2007
	[… At sites] "where the current is strong and constant, tube- and vase-shaped sponges dominate."	Díaz, 2012
Reduced flow	In the encrusting sponge *Ophlitaspongia papilla* (as *O. seriata*) the "membranous contractile oscular papillae […] are much more strongly developed" at a flow-reduced than at a "hydrodynamically more violent" site. Sponges at the former site had a cuticle, at the latter not.	Fry, 1971
	Simple-erect and erect-branching sponges are more in danger of fragmentation in stronger, turbulent currents than other forms, but they reach into the water column to enter a better flow regime to transport nutrients to them. They require moderate flow regimes.	Trammer, 1979
	Weak water movement prevents physical damage and enables the survival of delicate and erect morphologies and selects against the usually strong space competitors with encrusting habit. Enhanced sedimentation leads to clogging and smothering and to the exclusion of morphologies with large horizontal surface area such as encrusting sponges, instead selecting for erect forms raised above the sediments or those with parts above the sediments (e.g. with fistules). Reduced mixing causes food and oxygen limitation, favouring erect forms. In fistular sponges, the exhalant fistules are well above inhalant structures to afford spatial separation (see Suppl. 4 and 5.2H, I and P – in clionaids the inhalant fields are usually at the bases of the closed fistules, the exhalants are usually bundled together and raised above the sponge's surface; Schönberg, pers. obs.).	Hiscock, 1983
	The ball-shaped *Suberites carnosus* and the ball-shaped to massive *Suberites ficus* were restricted to wave-sheltered sites. Larger and erect sponges such as axinellids and poecilosclerids were found at wave-sheltered sites or microhabitats and in the circalittoral at depths deeper than -10 m, where flow was reduced in comparison to shallower sites. Encrusting sponges were rare.	Hiscock et al., 1984
	Erect sponges in shallow water were more abundant at sheltered than at exposed sites. Some common tubular and more delicate cup-like sponges and barrels were restricted to deeper sites in 13 m.	Schmahl, 1990
	Hexactinellida can develop a symmetry in accordance to the predominant flow: "The dermal surface of these sponges is exposed to the water current, while the atrial surface is at the lee side." This means that these sponges are arranged so that the inhalants point into the arriving current, the exhalants are aligned with the leaving current, and the wastewater can be carried away more efficiently.	Tabachnick, 1991
	In a comparison between low-profile ("encrusting") and higher profile ("erect", here including e.g. cups) sponges, the latter became much more prevalent with depth (= reduced flow, finer sediments), while encrusting morphologies became less common.	Roberts and Davis, 1996
	Branching sponges have fewer branches in reduced flow.	Abraham, 2000; Lawler and Osborn, 2008
	Sponge morphological diversity increased with depth, sedimentation and with reduced flow (in shallow depths), the frequency of more delicate erect-branching forms increased; settling on vertical surfaces generated refuge for other forms. In three-dimensionally erect-branching sponges branching complexity was reduced with reduced flow.	Bell and Barnes, 2000a, 2000b; Bell et al. 2002a
	The simple-massive *Cliona* cf. *celata* produced the largest individuals in stable, low flow conditions.	Bell et al., 2002b
	Tubular individuals of *Callyspongia (Cladochalina) aculeata* (as *Callyspongia vaginalis*), *Agelas conifera* and *Aplysina fistularis* grew to higher total heights at deeper depth with reduced flow (25 m) compared to a site in shallower water (14 m). However, growth rates at depth were also higher due to a higher nutrient concentration.	Lesser, 2006; Trussell et al., 2006
	Compared to sites exposed to ocean swells, sheltered survey sites were dominated by "erect" morphologies (here including massives), with higher diversity and less variability over time (by % cover).	Roberts et al., 2006a

Environmental condition	Sponge morphologies	Reference
Ctd.: Reduced flow	Ordination on a sponge community associated *Clathria (Wilsonella) mixta* (erect?) and the thickly encrusting or creeping species *Iotrochota baculifera* with sheltered sites. The ball-shaped *Melophlus sarassinorum* that is slightly removed from the substrate by foot-like little stalks, and the ball-shaped *Diacarnus megaspinorhabdosa*, the creeping *Pseudoceratina verrucosa*, *Xestospongia mamillata* (thick crust? Species was originally described as fragment) and the tubular sponges *Haliclona (Reniera) fascigera* and *Niphates olemda* were found in deeper water with presumably reduced flow.	Cleary and de Voogd, 2007
	Barrels such as *Xestospongia testudinaria* and larger massive sponges occurred in deeper water, where wave energy would be reduced.	De Voogd and Cleary, 2007
	Balls are smaller with reduced flow.	Lawler and Osborn, 2008
	The thickly encrusting to composite-massive to tubular *Dysidea avara* became increasingly less compact and more erect and branching with water depth and reduced flow speed. At a calm-water site the oscules were particularly large, and the erect branches tube-like, achieving the best separation between inhaled and exhaled water and becoming more fistule-like. During intermittent high-flow periods, these large oscules were closed.	Mendola et al., 2008
	Occurrence of erect sponges in soft bottom environments moderately correlated with reduced clay in the substrate, suggesting that they required slightly elevated flow conditions. This was explained in a need for being provided adequate nutrients for filter feeding. The weak correlation of *Xestospongia* sp. barrels with mud was explained with their tolerance to reduced flow conditions.	Kelly and Przeslawski, 2012
	The morphologically variable *Halichondria (Halichondria) melanadocia* had larger volumes and much larger oscules in the more sheltered seagrass environment than in the mangrove system with slightly more flow. Larger oscules allow stronger exhalant flow, which reduces the risk of re-inhaling wastewater under stagnant conditions (Bidder, 1923). Both sites had similar sedimentation conditions. Sponge height was similar in both habitats.	Ávila and Ortega-Bastida. 2015
	Coral reef sites with reduced flow had more sponges with delicate (erect?) growth forms, including “breakable” ones.	Hadi et al., 2015
	The massive *Coscinoderma matthewsi* was more abundant and had larger individuals in 12 than in 6 m, where flow was halved; it had a simple-massive morphology in 6 m, and a more “lobed” composite-massive, or more erect morphology in 12 m, which was explained as an adaptation to increase access to food.	Duckworth, 2016
Low flow to stagnant water	Encrusting forms are very much governed by near-substrate conditions and cannot reach beyond that. Boundary layer resources are often restricted, while at the same time a comparatively large tissue area is exposed to possible disturbance.	Jackson, 1979
	At greater depth [= with finer sediments and reduced flow], sponges develop special morphological structures such stalks to be distanced from the substrate. While such stalks appear of similar length between younger and older sponges, the body size increases with age. This may relate to the need to reach a layer in the water column where flow regime is more favourable.	Burton, 1928
	The morphologically variable sponge *Halichondria panicea* develops an increasingly more tubular structure in more sheltered environments and is more encrusting and compact (=simple-massive) where it is more exposed.	Burton, 1928
	Larger encrusting sponges are not usually found in “continuously still water”. Separation of their in- and exhalants was assumed to be insufficient to prevent re-inhalation and thus to prevented them from growing into larger specimens.	Fry, 1979
	According to Trammer (1979), tubular and cup-shaped sponges can tolerate strongly reduced flow, as their inhalant and exhalant structures are separated. However, this does not yet take into account that reduced flow means increased sediment deposition and finer sediments, which will be a trade-off for these forms.	Trammer, 1979
	With distance into caves, flow reduction and darkness resulted in food limitation. Here, thin crusts “with a more efficient filtration surface ratio” dominated.	Bibiloni et al., 1989
	Fragile Hexactinellida cannot tolerate high-energy hydrodynamic conditions. To compensate for reduced filter-feeding efficiency, they have switched to osmotrophy, i.e. they are feeding on dissolved or colloidal materials and enhance absorption in stagnant waters by developing thin-walled morphologies with a high surface : volume ratio. Spicular veils can supplement the diet by becoming habitats for microbial communities.	Leinfelder, 1996; Krautter, 1998

Environmental condition	Sponge morphologies	Reference
Ctd.: Low flow to stagnant water	With bathymetry and reducing flow, incidence of erect-branching forms increases, including forms with short stalks.	Bell and Barnes, 2000a
	Haliclona caerulea transplanted from 3 to 5 m developed a larger surface area by growing many little erect extensions or branchlets (only in cages, which may have created stagnant and nutrient limited conditions).	Carballo et al., 2006
Substrate/sediment quality		
Prevailing hard = rocky or coral substrate	Even though creeping forms are probably the most versatile in using different substrates or even altering the growth direction from horizontal into a more vertical aspect, Jackson (1979) identified them as most vulnerable to substrate-related factors. He however allowed that possible damaging effects will rarely kill the entire animal, and regeneration will occur. Erect forms and cup-like forms with small attachment areas are most removed from substrate effects. He ranked expected success on instable substratum as creeping, encrusting, vines (=creeping rope sponges potentially with erect elements) > massive (including cup-like forms) > tabular, erect-branching.	Jackson, 1979
	Comparing Antarctic sponge communities, on muddy substrate Demospongiae with fistules or surface cleaning capability prevailed, while on hardground stalked Demospongiae and cup- and sack-like Hexactinellida dominated.	Barthel and Gutt, 1992
	Hard bottom had higher total, erect and massive or thickly encrusting sponge densities than cobble or gravel.	Ginn et al., 2000
	Morphological and species richness were correlated, but in the reef environment taxonomic diversity increased stronger with morphological diversity than in a soft sediment environment.	Bell and Barnes, 2002
	Rocky substrate at an exposed coast was predominately covered by encrusting sponges. Apart from that, bedrock (stable, in 2-3 m depth) was dominated by the massive *Haliclona caerulea*, and endolithic bioeroders were more common on boulders (occasionally overturned by storms? in 4-6 m).	Carballo and Nava, 2007
	[… In the present study] "there is a clear dominance of tubular, creeping, and massive sponges among conspicuous coral reef species, whereas thin and massive crusts predominate among mangrove species. […] On open reef habitats, the most conspicuous species are the massive large, creeping, tubular, fan, or vase sponges."	Díaz, 2012
	Sponge morphological and taxonomic diversity were correlated and increased with availability of dead coral substrate and decreased with abundance of coral rubble.	Hadi et al., 2015
Environment with rocky outcrops	On elevated, hard-bottom ridges the predominating sponges were encrusting and simple-massive. On the sandy valleys in between sponges were endopsammic (= fistular), erect-laminar or erect-palmate. Presumably the tops of the ledges represented a hydrodynamically exposed habitat, whereas the flow between the ledges valleys was reduced and predominantly laminar. In this case the distribution of sponge morphologies thus appeared to be more strongly influenced by currents than by substrate.	Freeman et al., 2007
Sediment-dominated environment, sandy bottom	The bioeroding-endolithic to simple-massive sponge *Cliona* cf. *celata* was more abundant on bottoms with low silt-clay content and a mean grain diameter in the medium sand range. The simple-massive form was most abundant on bottoms poor in dead shell material and more abundant on coarser sediments where stronger currents were assumed to provide nutrients.	Driscoll, 1967
	In a field survey, the fistular *Spheciospongia florida* (cf. *Spheciospongia vagabunda/inconstans* species complex) was only found on sand. *Spheciospongia* spp. are often endopsammic and tend to develop fistular morphologies (Schönberg, 2016). The ball-shaped *Cinachyrella arabica* and the fistular *Ciocalypta* sp. were only found on sand.	Barnes and Bell, 2002
	The endopsammic, fistular sponges *Oceanapia amboinensis*, *Biemna fortis*, *Spheciospongia solida* (as *Spirastrella*) and *Siphonodictyon mucosum* (as *Aka mucosa*) live (half-)buried in sediment, anchor themselves by being attached to or inhabiting buried rock and have erect parts or fistules that emerge from the sediment.	Cerrano et al., 2002
	Coscinoderma matthewsi was more abundant in 12 than in 6 m, where sediment occurrence was doubled, covering surfaces; the sponge has a simple-massive morphology in 6 m, and a more "lobed', more erect morphology in 12 m, which could be a reaction to sediment deposition.	Duckworth, 2016

Environmental condition	Sponge morphologies	Reference
Fine sediments in the environment, soft bottom	At greater depth [= with finer sediments and reduced flow], sponges, especially hexactinellids, develop special morphological structures such as basal spicule tufts for anchoring in fine sediments and stalks to be distanced from the substrate and avoid burial.	Burton, 1928; Tabachnick, 1991; Schönberg, 2016
	Fistular sponges such as *Ciocalypta penicillus* and *Polymastia mamillaris* were associated with soft sediments and were often partially buried in them.	Hiscock et al., 1984
	The often fistular sponge *Tedania (Tedania) ignis* was observed to occur in areas with soft, muddy bottom sediments.	Alcolado, 1990
	The fistular species *Tentorium papillatum* and *Polymastia invaginata* can survive in very muddy areas as long as there are boulders for initial settlement. Another species at this site, *Mycale acerata*, forms tube clusters. The most common species found at this site keep their surfaces sediment-free or have erect structures.	Barthel and Gutt, 1992
	The stalked glass sponge *Caulophacus (Caulophacus) arcticus* was found in deep sea mud environments, was usually fixed on stones in the mud, had a stalk and a disc-shaped, elevated body, on which inhalants pointed downwards and exhalants were on the upper surface. *Forcepia (Forcepia) topsenti* was small, spherical sponge that was observed to have endopsammic tendencies (= fistular), at times half buried in the sediment and agglutinating particles. *Forcepia* spp. were encrusting to massive and have been observed to develop fistular structures (see also van Soest, 2002; Lim et al., 2012). The thinly encrusting-creeping sponge *Hymedesmia (Hymedesmia) stylata* had 2 mm long, fistule-like papillae and appeared to have surface-cleaning capability. *Sycon abyssale* was tubular and had a short stalk.	Barthel and Tendal, 1993
	Thenea spp. often inhabit fine sediments. They are functionally between globular sponges and barrels by being small and rounded, but also separating in- and exhalants. Oscules can be extended into fistular structures. The spicule-anchored lower part of the body can be embedded in sediment, the spicule-screened inhalants are lateral, just above the sediment surface, the exhalant is apically, on the top of the sponge. *Tentorium semisuberites* has a very similar functional biology. Occurring in the same habitat as *T. semisuberites* was the ball-shaped *Radiella sol* (as *Trichostemma*).	Barthel and Tendal, 1993; Cárdenas and Rapp, 2012
	No stalked sponges were seen, but the morphology was interpreted as adaptations to soft abyssal bottoms.	Maldonado and Young, 1996
	Morphological and species richness were correlated, but in the reef environment taxonomic diversity increased stronger with morphological diversity than in a soft sediment environment.	Bell and Barnes, 2002
	The erect, tubular sponge *Liosina granularis* was able to live at a site with fine sediments and siltation. Its outer walls can be covered with a fine layer of silt.	Bell and Smith, 2004
	The often sack-like glass sponge *Aphrocallistes vastus* occurs at sites with soft sediments and sedimentation.	Austin et al., 2007
	Erect-branching sponges formed a significant part of the community where fine sediments were present, at the expense of encrusting and massive sponges. Overall sponge height was larger with fine sediments.	Lawler and Osborn, 2008
	Prevalence of muddy substrate correlated with the occurrence of erect-palmate sponges. Large erect-laminar sponges such as *Ianthella* spp. and barrels such as *Xestospongia* spp. were also common.	Kelly and Przeslawski, 2012
	An environment dominated by fine sediments, high turbidity and strong tidal flow supported a sponge community dominated by erect (50%, >30% 2D-erect) and fistular sponges (22%). Wide cups, barrels and crusts were each only around 5% of the counts.	Fromont et al., 2013; Schönberg pers. obs. 2013
	Many endolithic-bioeroding sponges can be smothered by fine sediments and do not well in muddy environments.	Schönberg et al., 2017; Schönberg pers. obs. 2013; Abdul Wahab pers. comm.
Biotic substrate	Sponges colonising living surfaces of other invertebrates are often encrusting.	e.g., Davis et al., 1996; Calcinai et al., 2013; Voultsiadou et al., 2010

Environmental condition	Sponge morphologies	Reference
Turbidity/sedimentation		
Clear water without much sedimentation, potentially nutrient-poor water	"Foliose", wide, shallow cups to erect-laminar sponges, with large horizontal surface area were the dominant sponge morphologies on clear-water coral reefs and most common between 10 and 30 m, and most were photosymbiotic. They were missing from more turbid inshore reefs with higher sedimentation rates and elevated nutrient concentration.	Wilkinson, 1988
	The low-relief, composite-massive *Axinella damicornis*, the encrusting *Scopalina lophyropoda*, the thickly encrusting to composite-massive sponge *Aplysilla rosea*, the thickly encrusting *Crambe crambe*, the thinly encrusting *Timea unistellata* and the endolithic-bioeroding *Pione* (as *Cliona*) cf. *vastifica* only occurred at sites with low levels of siltation, or on vertical surfaces and under stones or overhangs. The ball-shaped *Tethya aurantium* also appeared to prefer reduced sedimentation.	Carballo et al., 1996
	The pink vase sponge *Niphates digitalis* (cup) is usually associated with deep water and high water clarity.	Reeson et al., 2002
	Despite its tubular shape, *Aplysina fistularis* appears to prefer high water clarity.	Alcolado, 2007
	In clear water, massive, cup-shaped, massive-encrusting and tubular sponges were common. The cups were often photosymbiotic and had a higher proportion of horizontal surface.	De Voogd and Cleary, 2007
Turbid water	The ball-shaped *Cinachyrella australiensis* (as *Cinachyra porosa*) and the fistular sponges *Axinyssa mertoni* (as *Pseudaxinyssa pitys*) and *Biemna fortis* occurred in turbid water, also suggesting sedimentation pressure.	De Laubenfels, 1954
	Barrels of the genus *Xestospongia* (as *Sigmadocia*) were often observed to be more common in turbid water.	De Laubenfels, 1954; Wilkinson and Cheshire, 1989
	Ball-shaped, globular sponges have often been found in turbid waters with high sedimentation rates, e.g. *Tethya aurantium* and the Tetillidae in general.	Bell and Barnes, 2000b; van Soest and Rützler, 2002
	Ordination on a sponge community associated the sediment-resistant and ball-shaped species *Paratetilla bacca*, the creeping *Gelliodes fibulata* and the erect-laminar sponge *Lissodendoryx (Acanthodoryx) fibrosa* with turbidity, whereas e.g. the rope-like erect-branching to creeping *Callyspongia (Euplacella) biru* needed clearer water and stronger flow.	Cleary and de Voogd, 2007
	With reduced water transparency near human settlement, the abundance of globular, fistular and fan-shaped sponges increased.	De Voogd and Cleary, 2007
	Changes in predominant sponge morphologies were related to seasonal changes (mostly turbidity and temperature); encrusting sponges were more abundant in winter (was explained by competition with algae in summer), abundance of erect-branching sponges was consistent, apart from a peak in October (explained by reproduction); overall predominance of erect and fistular sponges across seasons suggested high sedimentation at site. Seasonal differences were most apparent through encrusting, erect-branching and tubular sponges	Berman et al., 2013
	At a highly turbid, high-sedimentation site with fine sediments and strong tidal currents wide cups were rare (5% of all sponge individuals scored*). The few wide cups that occurred often displayed necrotic or dead parts or had parts missing that presumably had previously died*. Barrels were also uncommon, but conspicuous (6%*). They usually had coarse sediments in their apical, concave part (Fig. 8), with fine sediments having been washed out by the exhalant stream*. While Abdul Wahab et al. (2017b) stated encrusting and massive sponges to be predominant, the other two sources found the sponge community was dominated by erect forms (ca. 50%*) and endopsammic, fistular forms (22%*). Massives together contributed only 30%*. Data in Abdul Wahab (2017a) suggest that scoring may have been incorrectly applied.	Fromont et al., 2013*; Schönberg pers. obs. 2013*; Abdul Wahab et al., 2017b
	In a before-after sediment-impact study by capital dredging at a turbid site with fine sediments, fistular, erect-branching forms and barrels increased in abundance after the impact, which are all morphologies with strategies to deal with sedimentation.	Abdul Wahab et al., 2017b
	Many bioeroding sponges can tolerate high levels of turbidity and moderately high sedimentation. However, endolithic-bioeroding sponges can be smothered by fine sediments and do not well in muddy environments.	Schönberg et al., 2017; Schönberg pers. obs. 2013; Abdul Wahab pers. comm.

Environmental condition	Sponge morphologies	Reference
Ctd.: Turbid water	At the study's clear-water site cups were 1.5 x as abundant than at the turbid site. Erect forms were 13 x as abundant at the turbid site. No differences were found for crusts and massives.	Abdul Wahab et al. 2018
	Despite shown sediment-clearing abilities, *Crella incrustans* developed fistule-like appendages in an experiment applying high suspended sediment concentration to resemble fistular sponges	Cummings et al., 2020
High sedimentation rate	When *Hymeniacidon perlevis* occurred in areas with high sedimentation and became covered in mud, it displayed fistular projections, raising the oscules above the sediments.	Stone, 1970
	In a reef environment, at a sheltered site below 6 m depth and with high rates of sedimentation, only few sponge species were found. These were "tall or massive" and half-buried in sediment (fistular). Encrusting sponges occurred on vertical surfaces where they had enough flow, but were at the same time at safe distance from the sediment and avoided sediment deposition.	Rützler, 1972
	Based on approximated calculations, Jackson (1979) ranked expected success of sessile marine invertebrates in high sedimentation as erect-branching > tabular, massive (here including cup-like forms), vines (= rope sponges that Jackson described as creeping) > encrusting, creeping.	Jackson, 1979
	The amphora- or tube-shaped *Varongia aerophoba* grew faster when sedimentation was excluded with a transparent roof.	Wilkinson and Vacelet, 1979
	The ball-shaped *Cinachyrella* (as *Cinachyra*) *apion* survived > 15 days of burial in ventilated reef sediment.	Rice, 1984
	The erect-reticulate *Echinodictyum pulchrum* (as *E. cancellatum*) occurs on "shallow coastal and shallow offshore rock reefs, in mud or areas with high sedimentation". Erect-branching *Raspailia* spp. can tolerate extremely high sedimentation levels.	Hooper, 1991; Bell and Barnes, 2000b, 2000c
	The freshwater *Spongilla lacustris* developed erect parts to avoid burial.	Manconi and Pronzato, 1991
	The encrusting sponges *Crambe crambe*, *Scopalina lophyropoda* and some *Hymedesmia* spp. were less common or excluded from sites with high levels of siltation and rather occurred on vertical surfaces, under overhangs or on the underside of stones. Simple-massive *Sarcotragus* spp. were excluded from high sedimentation sites.	Carballo et al., 1996
	At depth crusts were more common on vertical surfaces (presumably avoiding sedimentation and moving into levels with higher flow than in the boundary layer). Predominance of cups at about -520 m (here: astrophorids) was interpreted as an adaptation to maximize feeding and sediment avoidance. No stalked sponges were seen, but the morphology was interpreted as adaptations to soft abyssal bottoms.	Maldonado and Young, 1996
	Tabular Hexactinellida are very sensitive to sedimentation and will perish under such conditions.	Leinfelder, 1996
	Moderate sedimentation selects for tubular sponge morphologies, as these create bundled exhalant jets suited to prevent sediment entering or collecting in the concave parts of the body.	Krautter, 1998
	In comparison to other local *Spongia* species, *S. (S.) agaricina* was most tolerant to high levels of sedimentation, and its peak in occurrence matched the sedimentation. While it most commonly had an incomplete or complete cup-like morphology with clear separation of in- and exhalants, the local sediments were mostly coarse, and the sponge incorporated sediments into its fibres.	Pronzato et al., 1998
	In contrast to other local *Spongia* species, *S. (S.) virgultosa* only occurred in sheltered, shallow waters of 3-10 m, where it formed crusts with small fistules. The abundance of this species was similar to sedimentation levels. This species did not incorporate sediment grains in its fibres and needed the erect structures to deal with potential sediment deposition and with observed overgrowth by epibiotic organisms.	
	The thickly encrusting or low-relief massive sponge *Cliona (Spheciospongia?* – published as *Anthosigmella) varians* produces erect branching structures at sites with higher sedimentation, becoming more fistular.	Hill, 1999

Environmental condition	Sponge morphologies	Reference
Ctd.: High sedimentation rate	With reduced flow and higher rates of sediment settlement erect-branching forms, morphologies with short stalks, and cryptic-massive forms with fistules emerging from the sediment increased in frequency (e.g., *Polymastia* spp.); encrusting forms were lacking or grow on vertical surfaces. The simple-massive sponge *Cliona* cf. *celata* occurred at high sedimentation sites, growing on inclined (fewer, larger specimens) and on vertical surfaces (more, smaller specimens).	Bell and Barnes, 2000a, 2000b, 2000c
	Ball-shaped, globular sponges have often been found in turbid waters with high sedimentation rates, e.g. *Tethya aurantium* and the Tetillidae in general.	Bell and Barnes, 2000b; van Soest and Rützler, 2002
	With increased water depth and sedimentation and decreased flow branching complexity was reduced in three-dimensionally erect-branching sponges.	Bell et al., 2002a
	Encrusting and endolithic growth forms of *Cliona* cf. *celata* were more common at sites with reduced flow and higher sedimentation, as well as developing fistules, except for one site they had also more oscules per unit surface area.	Bell et al., 2002b
	The ball-shaped *Cinachyrella australiensis* was adapted to high sedimentation levels and occurs in high turbidity and strong flushing. The sponge formed thicker spicules in environments with the coarser sediment, and a flattened growth form with finer sediments.	McDonald et al., 2002
	The ball-shaped *Cinachyra barbata* occurred on "sediment-rich bottoms".	Van Soest and Rützler, 2002
	Haliclona (Haliclona) urceolus is a tubular sponge with an apical water jet protecting the oscular opening; it was common in sedimented habitats.	Bell, 2004
	Seasonal sediment deposition events reduced the diversity of the coastal sponge community by smothering larger sponges (massive and branching), but endolithic-bioeroding, encrusting clionaids and *Clathria (Microciona)* sp. survived. It was not explained whether the encrusting species were located on horizontal surfaces and how they survived being covered, but they have a micro-hispid ectosome that may help in keeping their surfaces clean (Schönberg, 2015). Overall, the habitat was described as high-energy, with turbulent flow.	Carballo, 2006
	Sedimentation can select for some clionaid, endolithic-bioeroding sponges.	Carballo et al., 2006
	Experiments creating elevated levels of suspended sediments proved lethal for cup-shaped *Callyspongia confoederata* and caused necrosis in other sponges with much horizontal surface area (massives, encrusting sponges, wide cups).	Pineda et al., 2006
	The wide cup-shaped and photosymbiotic sponge *Cymbastela concentrica* did not tolerate sedimentation or shading very well.	Roberts et al., 2006b
	The barrel-shaped *Speciospongia vesparium* and the composite-massive to fistular, sediment-incorporating *Tectitethya crypta* are tolerant to sedimentation.	Alcolado, 2007
	The ball-shaped *Paratetilla corrugata* (as *P. bacca*) was adapted to perturbed sites and high sedimentation levels, and displayed a bristly surface that caught sediments and kept pores free.	De Voogd and Cleary, 2007
	Dysidea avara became increasingly less compact and more erect and branching with water depth and increased sedimentation. At the deepest site, where the sponge was covered with a film of sediments, the apical oscules were smaller than at intermediate depth, where intermittent flow occurred.	Mendola et al., 2008
	Highly turbid and sedimented reef areas in Singapore were dominated by globular, fistular, fan-shaped and creeping sponges. Cup-shaped and photosymbiotic sponges were absent.	De Voogd and Cleary, 2009
	The ball-shaped *Paratetilla* sp. is a heterotrophic globular sponge with a natural crust of sediments and algae, and it occurred in very shallow depths on sandflats. In an 8 d flow-through tank experiment sponges were subjected to daily application of a handful of mud or sand onto the sponges. In *Paratetilla* sp. mud and sand treatments had no visible effect at all. Most sediment slid off and what remained on top of the sponge did not cause any change. The control sponges did not show any signs of tank effects.	Büttner and Siebler 2013 (incl. Schönberg pers. obs. 2013)

Environmental condition	Sponge morphologies	Reference
Ctd.: High sedimentation rate	At a highly turbid, high-sedimentation site with fine sediments and strong tidal currents wide cups were rare (5% of all sponge individuals scored*). The few wide cups that occurred often displayed necrotic or dead parts or had parts missing that presumably had previously died*. Barrels were also uncommon, but conspicuous (6%*). They usually had coarse sediments in their apical, concave part, with fine sediments having been washed out by the exhalant stream*. While Abdul Wahab et al. (2017b) stated encrusting and massive sponges to be predominant, the other two sources found the sponge community was dominated by erect forms (ca. 50%*) and endopsammic, fistular forms (22%*). Massives together contributed 30%*. Data in Abdul Wahab (2017a) suggest that scoring may have been incorrectly applied.	Fromont et al., 2013*; Schönberg pers. obs. 2013*; Abdul Wahab et al., 2017b
	In a before-after sediment-impact study by capital dredging at a turbid site with fine sediments, fistular, erect-branching forms and barrels increased in abundance after the impact. During the construction work the proportion of finer sediments increased at the site.	Abdul Wahab et al., 2017b
	Biemna fortis developed a fistular or cryptic-massive morphology at a site with higher levels of suspended particles (and presumably high rates of sedimentation), whereas at a site with les suspended material, the sponge had a simple-massive growth form	Dahihande and Thakur, 2017
	Many endolithic-bioeroding sponges can tolerate high levels of turbidity and moderately high sedimentation. However, they can be smothered by fine sediments and do not well in muddy environments.	Schönberg et al., 2017; Schönberg pers. obs. 2013; Abdul Wahab pers. comm.
Other parameters		
Bathymetry	[Apart from rare exceptions, keratose sponges] are never found at greater depths than [ca. 180 m], and seldom go down so far as that even". On the other hand, the "Hexactinellida, typical deep-sea animals, are but rarely found at depths less than [ca. 180 m]".	Burton, 1928
	In the deep sea, morphology per species becomes more uniform, and forms become more symmetrical.	Burton, 1928
	At greater depth [= with finer sediments and reduced flow], sponges develop special morphological structures such as spicule tufts for anchoring in mud and stalks to be distanced from the substrate. While such stalks appear of similar length between younger and older sponges, the body size increases with age.	Burton, 1928
	Clustering of Antarctic sponge associations related to substrate properties and sedimentation, not depth.	Barthel and Gutt, 1992
	The erect, carnivorous sponge *Cladorhiza gelida* was found on rock and muddy bottom in 780-2800 m depth.	Barthel and Tendal, 1993
	Low-profile forms such as encrusting, massive and creeping dominated in shallower water, erect and fistular forms increased in frequency at deeper sites. This was mainly discussed in the context of flow.	Bell and Barnes, 2000a
	Comparing intertidal and subtidal sites, tubular and branching forms were missing at the former site (but site-relevant covariables possibly affecting result were not discussed; branching sponges were observed in the intertidal in NW Australia, Schönberg pers. obs.).	Barnes and Bell, 2002
	Demospongiae and Homoscleromorpha remained largely confined to shelf habitats between 0 and 200 m with dSI concentrations of <150 µM. Hexactinellida mostly required high-silica conditions >100 µM and extended down to 6000 m, and the Calcarea had another peak between 1500 and 3000 m. However, the paper did not investigate and differentiate growth forms.	Alvarez et al., 2017
Light/shade	Calcified sclerosponges that function as encrusting sponges often prefer shaded environments.	Hartman and Goreau, 1970
	Based on approximated shape parameter calculations, Jackson (1979) ranked expected success under an abundance of food and light as encrusting, massive (including cup-like forms) ≥ vines (= creeping rope sponges) ≥ tabular, erect-branching > creeping. Under food/light limitation this ranking changed to: erect-branching, tabular > massive, vines (creeping rope sponges) > encrusting > creeping.	Jackson, 1979
	With distance into caves, flow reduction and darkness resulted in food limitation. Here, thin crusts "with a more efficient filtration surface ratio" dominated.	Bibiloni et al., 1989
	The encrusting *Crambe crambe* had an irregular outline in light (shallow) and a more directional growth at sciaphilous locations. This was thought to be more likely due to lack of space competition at the shallow sites, rather than a light effect.	Becerro et al., 1994

Environmental condition	Sponge morphologies	Reference
Ctd.: Light/shade	When the photosymbiotic massive sponge *Ircinia felix* was transplanted from 4 m depth to 100, 200 and 300 m, it lost its cyanobacteria and developed fistule-like processes in 200 m. None survived in 300 m. The tubular *Aplysina fistularis* only survived in 100 m, did not lose the photosymbionts and did not develop fistules.	Maldonado and Young, 1998
	Exposure to strong light was interpreted as stressful for sponges, and those exposed to light were observed to have a cortex or had lacunae to trap water when exposed, or they were partially buried. Encrusting and tabular forms were found more commonly in shaded environments. The authors' views on light effects may perhaps be too simplified, ignoring other factors that may have had a stronger influence on the morphology.	Barnes, 1999
	Endolithic-bioeroding and endopsammic-fistular bioeroding sponges such as *Siphonodictyon* spp. and some *Spheciospongia* spp. are relatively resistant to exposure to air, and some species occur in the upper intertidal, where they would also be exposed to high UV irradiation during low tide.	Rützler, 1971; Schönberg, 2000, 2001; Schönberg and Tapanila, 2006; Schönberg pers. obs. 1996-2013
	The wide cup-shaped and photosymbiotic sponge *Cymbastela concentrica* did not tolerate sedimentation or shading very well.	Roberts et al., 2006b
	Frequency of photosymbiotic sponges decreased with water depth, but this was not related to morphology.	Bell, 2007a
Exposure to air	The encrusting *Hymeniacidon perlevis* (as *H. sanguinea*) can survive exposure to air in the upper intertidal, but exposure often results in partial tissue death and fragmentation of the specimens, leading to smaller individuals.	Burton, 1928
	Endolithic-bioeroding and endopsammic-fistular bioeroding sponges such as *Siphonodictyon* spp. and some *Spheciospongia* spp. are relatively resistant to exposure to air, and some species occur in the upper intertidal, where they would also be exposed to high UV irradiation during low tide.	Rützler, 1971; Schönberg, 2000, 2001; Schönberg and Tapanila, 2006; Schönberg pers. obs. 1996-2013
	The intertidal site of this study lacked tubular and branching sponges. Supposedly, these were at larger risk of desiccation due to the comparatively large surface area and the proportionally longer exposure being erect.	Barnes and Bell, 2002
Climate, temperature, heat events	Keratose sponges are excluded from cold waters. […] "formation of spongin can usually only take place in moderate temperatures[, and keratose sponges] are confined, for the most part, to the seas between 45° of latitude north and south of the Equator and are pre-eminently abundant in the warm shallow waters of the Mediterranean and Gulf of Mexico. Outside this area their occurrence is extremely rare."	Burton, 1928
	Photosymbiotic sponges often have a wide cup-shaped growth form that provide the sponge with more horizontal surface area for light harvest, erect-branching sponges are not as likely to be photosymbiotic. E.g. encrusting, low-profile sponges near the substrate surface with reduced flow are more likely to bleach and to die than erect sponges that reach into layers with stronger currents, or larger sponges with large canal system and oscules that can produce a cooling effect with the pumping currents they produce.	Bell, 2007a
	The subtropics and tropics have a more morphologically and taxonomically diverse sponge fauna than temperate waters. The authors found more erect-branching and palmate sponges at their tropical sites than at their subtropical sites (but site-relevant covariables affecting result were not discussed).	Barnes and Bell, 2002
	Morphological and species richness were correlated, but unlike for bottom characteristics, the correlation slopes of taxonomic diversity versus morphological diversity did not differ with climate.	Bell and Barnes, 2002
	The encrusting sponge *Hemimycale columella* tended to fission in the colder season.	Garate et al., 2017
	Endolithic-bioeroding sponges appear to be more heat tolerant than many other benthic organisms	Schönberg et al., 2017
Anoxia	The ball-shaped *Cinachyrella* (as *Cinachyra*) *apion* survived > 15 days of burial in ventilated reef sediment.	Rice, 1984

Environmental condition	Sponge morphologies	Reference
Nutrients	Individuals of *Grantia compressa* were larger in estuarine environments rich in detritus than in other marine environments.	Burton, 1928
	Erect forms of sessile marine invertebrates have an advantage against low-relief forms in terms of resource and nutrient access in higher layers of the water column. Their disadvantage is a small basal attachment area. Vines (= creeping forms) can bridge between low-relief encrusting and erect-branching forms by often forming erect branches. Based on his approximated shape parameter calculations, Jackson (1979) ranked expected success under an abundance of food and light as encrusting, massive (including cup-like forms) ≥ vines (= creeping rope sponges) ≥ tabular, erect-branching > creeping. Under food/light limitation this ranking changed to: erect-branching, tabular > massive (incl. some cup-likes), vines (creeping rope sponges) > encrusting > creeping.	Jackson, 1979
	Encrusting sponges have openings at an angle to prevailing flow that may induce passive flow through the sponge (Vogel, 1974, 1977), while this is not the case in erect sponges. The latter employ a different strategy, i.e. they extent into the water column, moving away from the nutrient-depleted boundary layer.	Trammer, 1979
	During aquarium experiments the form-variable sponges *Haliclona (Halichoclona) fistulosa*, *H. (Reniera) cinerea* (as *H. elegans*), *H. (Gellius) rava*, *H. (Rhizoniera) rosea*, *Amphilectus fucorum* and *Halichondria (Halichondria) bowerbanki* reacted to starvation with process formation. The author interpreted this observation as an attempt to increase feeding efficiency by increasing the surface : volume ratio and as a means to spread out into other microhabitats. All these sponges range in nature from encrusting to fistular and erect-branchingß.	Jones, 1994
	Hydrodynamic conditions have an impact on the growth form of sessile animals such as sponge and corals. Fractal modelling showed that this process is strongly linked to the nutrient distribution. "[…] sensitivity to the amount of contact with the environment, for example by a relatively low contribution of translocation of nutrients from the place of absorption to more remote sites, could play a role in the formation of branches." A more open branching pattern assures a better nutrient distribution to all branches. Branching asymmetry suggests that arriving nutrients are depleted when passing through the branch structure. Highest nutrient access is upstream and near the tips, where the most intensive growth proceeds.	Kaandorp and Sloot, 2001
	Experimentally changed nutrient conditions did not seem to have a significant effect on the cup-shaped and photosymbiotic sponge *Cymbastela concentrica*.	Roberts et al., 2006b
	Near human settlement, the abundance of globular, fistular and fan-shaped sponges increased.	De Voogd and Cleary, 2007
	Bioeroding sponge abundances increase with eutrophication (evidence mostly for endolithic-encrusting sponges, but likely also valid for fistular forms). Although, this is probably also true for a vast range of different sponges with different morphologies.	Schönberg, 2008; Schönberg et al., 2017
Silica	Sponge distributions could not conclusively be correlated to certain silica concentrations, except that the Hexactinellida largely required high-silica conditions >100 µM and extended down to 6000 m, and the Calcarea had another peak between 1500 and 3000 m. The Demospongiae and Homoscleromorpha remained mostly confined to shelf habitats between 0 and 200 m with dSI concentrations of <150 µM. The paper did not investigate and differentiate growth forms.	Alvarez et al., 2017
Salinity	Individuals of the amphora-like *Grantia compressa* were larger in estuarine than in marine environments.	Burton, 1928
	The wide cup-shaped sponge *Cymbastela concentrica* did not tolerate lowered salinity.	Roberts et al., 2006b
Heavy metals	The encrusting *Crambe crambe* developed increased shape irregularity and fission at a contaminated site and accumulated lead, copper and vanadium, and survival, growth rates and fecundity were reduced. The polluted site had also finer sediments.	Cebrian et al., 2003
Ocean acidification	In areas of low pH only encrusting sponges were found.	Goodwin et al., 2013
	At a CO_2 seep site, the sample location with the lowest pH had a x40 increase in ambient abundance of the fistular *Coelocarteria singaporense* and the ball-shaped *Cinachyra* sp. The composite-massive *Stylissa massa* was less common near the high-CO_2 site.	Morrow et al., 2015
	Sponge cover in general was reduced with decreasing distance to a vent site and a lowered pH in the field.	Fabricius et al., 2011

Environmental condition	Sponge morphologies	Reference
Predation, spongivory	Predation is thought to act more general, unlikely to affect different morphologies to different levels, apart from targeting more conspicuous forms more strongly. Jackson (1979) listed reactions of sessile marine invertebrates to predation to include distribution and abundance patterns, and structural, chemical or behavioural mechanisms. However, survival, recovery and regrowth may differ between different growth forms. He ranked expected success with high predator abundance as creeping, encrusting, vines (= creeping rope sponges potentially with erect elements) > massive (including cup-like forms) > tabular, erect-branching.	Jackson, 1979
	The branching (fistular?) morph of the thickly encrusting *Cliona varians (Spheciospongia?* – published as *Anthosigmella)* developed a higher spicule content and became encrusting when subjected to real or simulated spongivory, but the encrusting morph did not develop branches when fish was excluded.	Hill and Hill, 2002
	Grazers that can ingest sponge tissue appear to suppress bioeroding sponges (here largely endolithic-bioeroding forms).	Carreiro-Silva and McClanahan 2012; Schönberg et al., 2017
Space competition	Due to the way they occupy available space and substrate, encrusting sessile marine invertebrates are superior space competitors. The author hypothesised that creeping forms may be "escapists incapable of confrontation" and that they would exhibit greater growth rates than other morphologies, possibly at the expense of sexual reproductive output (but cited evidence pointing in the opposite direction). This competition strategy would strongly separate creeping from more typically encrusting forms that are otherwise morphologically similar. For epibiosis he ranked forms creeping (his runners and vines) > encrusting > massive (including some cups), tabular, erect-branching.	Jackson, 1979
	The encrusting *Crambe crambe* had an irregular outline in light (shallow) and a more directional growth at sciaphilous locations. This was thought to be more likely due to lack of space competition at the shallow sites, rather than a light effect. The sponges were more toxic at depth.	Becerro et al., 1994, 1995
	In field surveys encrusting and massive sponges were better competitors against corals than erect morphologies (more contact area).	Aerts and van Soest, 1997
	Under intense space competition, there is selection for erect and tubular morphologies as they require less area to attach to and can make use of small patches of substratum.	Krautter, 1998
	"Sponges which exhibited thick (>2 mm) crusts were, in the majority of interactions, superior competitors compared to the thin (<1 mm) crusts."	Bell and Barnes, 2003
	At coral reef sites with a mix of live and dead coral and sponges, latter had predominantly growth forms that required little attachment space, such as cups, fans and columnar (= 1D-erect) sponges. A similar situation emerged on dead coral in competition with turf algae, however, here thick crusts or fast-growing creeping sponges emerged. Balls were also observed.	Hadi et al., 2015
Disease	2006a: In a long-term study sponge community changes were observed that differed by growth form. "No erect-branching species were lost, 40% of encrusting species were lost, and 80% of massive species were lost." Changes were discussed as natural fluctuations or being due to disease. 2006b: During a more targeted investigation massive (mound-shaped) sponges suffered higher losses from mortality due to disease than branching sponge. Latter had a higher incidence of disease but were more likely to recover. Branching sponges were rope sponges with fast growth rates and tendency to have creeping parts. (Note: Wulff's 2006a, 2006b definitions differed from the present one, as both erect and massive forms included cup-like morphologies. See Suppl. 1 for a comparison of approaches to the uses of sponge morphologies.)	Wulff, 2006a, 2006b
	Comparing resistance/recovery properties of two haliclonid species, the more tubular ("massive") one was more fragile, and unattached fragments would likely perish, but remaining sponges healed fast. The cushion-shaped species with raised papillae to produce a fistular appearance ("submassive") and resisted physical damage, but was more vulnerable to necrosis.	Abdo et al., 2008

Environmental condition	Sponge morphologies	Reference
Physical damage due to e.g. dredging, fishing, storms	Encrusting and creeping sessile marine invertebrates were modelled to exhibit a low feeding and reproductive potential compared to other morphologies. Especially mound-shaped (simple-massive) forms can increase these potentials with size. In contrast, in erect forms attachment area decreases with size and makes them more vulnerable to physical damage. After disturbance, Jackson (1979) expected a succession from creeping, encrusting to massive (incl. cups) – when food supply is high, or to erect forms – when food supply is low.	Jackson, 1979
	Erect-branching rope sponges with tendencies to have creeping parts such as *Amphimedon* spp. and *Aplysina cauliformis* and *Aplysina fulva* have a very high growth rates and can quickly recover to original or even increased abundance after physical damage. However, *Aplysina* spp. are also flexible and resist drag forces and may not suffer much damage.	Wulff, 1994, 2005; Alcolado, 2007; Biggs, 2013
	Sponges with a higher spongin content are more resistant to physical damage such as during storms.	E.g., Wulff, 1995
	Scallop dredging reduced the overall sponge biodiversity and may select for certain morphologies. Massive and erect forms were more affected by dredging than creeping forms. Endolithic-bioeroding sponges were removed together with the substrate. Encrusting and cushion-shaped (simple-massive) sponges were turned over with their substrate and died. The abundance of the morphologically variable *Suberites massa* increased after dredging.	Kefalas et al., 2003
	After experimental damage tubular sponges healed faster than vasiform, cup-shaped sponge.	Walters and Pawlik, 2005; Wulff, 2006c
	Comparing resistance/recovery properties of two haliclonid species, the more tubular (“massive”) one was more fragile, and unattached fragments would likely perish, but remaining sponges healed fast. The cushion-shaped species with raised papillae to produce a fistular appearance (“submassive”) and resisted physical damage, but was more vulnerable to necrosis.	Abdo et al., 2008
	Sponge recovery potential may vary with morphology. The creeping sponge *Neopetrosia* (as *Xestospongia*) *subtriangularis* increased after a storm. Balls were not affected by the observed disturbances. Simple-massive, barrel-shaped and tubular species mostly recovered after a bloom-induced mortality event, but some at a slower rate, or they deteriorated or vanished due to further disturbance.	Stevely et al., 2010
	Sponges washed up on the beach by waves were mostly branching, massive and cushion-shaped. Encrusting species were never found washed up. While sponges with high spongin content occurred in the area, they were not found washed up.	Ávila et al., 2011
	Storm surges removed almost 40% of the erect sponges, followed by an almost 25% increase of encrusting sponges.	Gochfeld et al., 2020

Supplement 3. List of species names used in the publication and its supplements, together with taxonomic affiliations, taxon authors and predominantly seen (but occasionally variable) growth forms. The latest formats and taxonomic agreements were checked in the World Register of Marine Species (WoRMS, 2020), where original descriptions are also deposited. Figure references are for images displayed in the main publication.

Class	Subclass	Order	Family	Genus	Species	Taxon author	Morphologies
Calcarea	Calcaronea	Leucosolenida	Grantiidae	*Grantia*	compressa	(Fabricius, 1780)	amphora or tube clusters
Calcarea	Calcaronea	Leucosolenida	Sycettidae	*Sycon*	-	Risso, 1827	amphora
Calcarea	Calcaronea	Leucosolenida	Sycettidae	*Sycon*	*abyssale*	Borojevic and Graat-Kleeton, 1965	tubular, with short stalk
Demospongiae	Heteroscleromorpha	Agelasida	Agelasidae	*Agelas*	*conifera*	(Schmidt, 1870)	creeping
Demospongiae	Heteroscleromorpha	Agelasida	Agelasidae	*Agelas*	*dispar*	Duchassaing and Michelotti, 1864	composite-massive
Demospongiae	Heteroscleromorpha	Agelasida	Agelasidae	*Agelas*	*sceptrum*	(De Lamarck, 1815)	erect-branching in three dimensions
Demospongiae	Heteroscleromorpha	Agelasida	Agelasidae	*Agelas*	*tubulata*	Lehnert and van Soest, 1996	tube
Demospongiae	Heteroscleromorpha	Axinellida	Axinellidae	*Axinella*	-	Schmidt, 1862	variable, mostly erect (e.g. Fig. 4J)
Demospongiae	Heteroscleromorpha	Axinellida	Axinellidae	*Axinella*	*aruensis*	(Hentschel, 1912)	variable, mostly erect
Demospongiae	Heteroscleromorpha	Axinellida	Axinellidae	*Axinella*	*australiensis*	Bergquist, 1970	erect-reticulate
Demospongiae	Heteroscleromorpha	Axinellida	Axinellidae	*Axinella*	*damicornis*	(Esper, 1794)	composite-massive
Demospongiae	Heteroscleromorpha	Axinellida	Axinellidae	*Axinella*	*infundibuliformis*	(Linnaeus, 1759)	wide cup
Demospongiae	Heteroscleromorpha	Axinellida	Axinellidae	*Cymbastela*	-	Hooper and Bergquist, 1992	tabular to wide cups
Demospongiae	Heteroscleromorpha	Axinellida	Axinellidae	*Cymbastela*	*concentrica*	(Von Lendenfeld, 1887)	cup
Demospongiae	Heteroscleromorpha	Axinellida	Axinellidae	*Cymbastela*	*coralliophilia*	Hooper and Bergquist, 1992	cup or tabular
Demospongiae	Heteroscleromorpha	Axinellida	Axinellidae	*Cymbastela*	*marshae*	Hooper and Bergquist, 1992	cup
Demospongiae	Heteroscleromorpha	Axinellida	Axinellidae	*Cymbastela*	*stipitata*	(Bergquist and Tizard, 1967)	cup
Demospongiae	Heteroscleromorpha	Axinellida	Axinellidae	*Dragmacidon*	*reticulatum*	(Ridley and Dendy, 1886)	composite-massive
Demospongiae	Heteroscleromorpha	Axinellida	Axinellidae	*Pararhaphoxya*	*sinclairi*	(Gray, 1843)	erect-branching in three dimensions
Demospongiae	Heteroscleromorpha	Axinellida	Axinellidae	*Phakellia*	-	Bowerbank, 1862	variable, flabellate to cups
Demospongiae	Heteroscleromorpha	Axinellida	Axinellidae	*Phakellia*	*ventilabrum*	(Linnaeus, 1767)	incomplete cups to erect-laminar fans
Demospongiae	Heteroscleromorpha	Axinellida	Axinellidae	*Pipestela*	*candelabra*	Alvarez et al., 2008	tube cluster
Demospongiae	Heteroscleromorpha	Axinellida	Axinellidae	*Reniochalina*	*stalagmitis*	Von Lendenfeld, 1888	erect-palmate
Demospongiae	Heteroscleromorpha	Axinellida	Raspailiidae (Echinodictyinae)	*Echinodictyum*	*clathrioides*	Hentschel, 1911	cup
Demospongiae	Heteroscleromorpha	Axinellida	Raspailiidae (Echinodictyinae)	*Echinodictyum*	*mesenterinum*	(De Lamarck, 1814)	cup
Demospongiae	Heteroscleromorpha	Axinellida	Raspailiidae (Echinodictyinae)	*Echinodictyum*	*pulchrum*	Brøndsted, 1934	erect-reticulate
Demospongiae	Heteroscleromorpha	Axinellida	Raspailiidae (Raspailiinae)	*Ectyoplasia*	*frondosa*	(Von Lendenfeld, 1887)	fan to cup
Demospongiae	Heteroscleromorpha	Axinellida	Raspailiidae (Raspailiinae)	*Ectyoplasia*	*tabula*	(De Lamarck, 1814)	palmate
Demospongiae	Heteroscleromorpha	Axinellida	Raspailiidae (Raspailiinae)	*Raspailia (Raspaxilla)*	*topsenti*	Dendy, 1924	erect-branching in three dimensions
Demospongiae	Heteroscleromorpha	Axinellida	Stelligeridae	*Acanthoclada*	*prostrata*	Bergquist, 1970	thick crust
Demospongiae	Heteroscleromorpha	Axinellida	Stelligeridae	*Halicnemia*	*patera*	Bowerbank, 1864	thin crust
Demospongiae	Heteroscleromorpha	Biemnida	Biemnidae	*Biemna*	*fortis*	(Topsent, 1897)	fistular to massive, endopsammic
Demospongiae	Heteroscleromorpha	Bubarida	Dictyonellidae	*Acanthella*	-	Schmidt, 1862	variable, often composite-massive
Demospongiae	Heteroscleromorpha	Bubarida	Dictyonellidae	*Acanthella*	*pulcherrima*	Ridley and Dendy, 1886	composite-massive
Demospongiae	Heteroscleromorpha	Bubarida	Dictyonellidae	*Tethyspira*	*spinosa*	(Bowerbank, 1874)	encrusting to simple-massive
Demospongiae	Heteroscleromorpha	Clionaida	Clionaidae	*Cliona*	-	Grant, 1926	endolithic-bioeroding
Demospongiae	Heteroscleromorpha	Clionaida	Clionaidae	*Cliona*	*caribbaea*	Carter, 1882	endolithic-bioeroding (Fig. 4C)
Demospongiae	Heteroscleromorpha	Clionaida	Clionaidae	*Cliona*	*celata*	Grant, 1926	variable, can be endolithic-bioeroding or simple-massive or fistular (but is published as a species complex, so different morphologies can refer to different species)
Demospongiae	Heteroscleromorpha	Clionaida	Clionaidae	*Cliona*	*orientalis*	Thiele, 1900	endolithic-bioeroding
Demospongiae	Heteroscleromorpha	Clionaida	Clionaidae	*Cliona*	*patera*	(Hardwicke, 1820)	stalked or cup
Demospongiae	Heteroscleromorpha	Clionaida	Clionaidae	*Cliona*	*varians*[1]	(Duchassaing and Michelotti, 1864)	thickly encrusting, can have erect portions, basally eroding
Demospongiae	Heteroscleromorpha	Clionaida	Clionaidae	*Cliona*	*viridis*	(Schmidt, 1862)	variable, can be endolithic-bioeroding or fistular (but is published as a species complex, so different morphologies can refer to different species)
Demospongiae	Heteroscleromorpha	Clionaida	Clionaidae	*Cliothosa*	-	Topsent, 1905	endolithic-bioeroding
Demospongiae	Heteroscleromorpha	Clionaida	Clionaidae	*Cliothosa*	*delitrix*	(Pang, 19730	endolithic-bioeroding (Fig. 5E)
Demospongiae	Heteroscleromorpha	Clionaida	Clionaidae	*Pione*	-	Gray, 1867	endolithic-bioeroding
Demospongiae	Heteroscleromorpha	Clionaida	Clionaidae	*Pione*	*vastifica*	(Hancock, 1849)	endolithic-bioeroding
Demospongiae	Heteroscleromorpha	Clionaida	Clionaidae	*Spheciospongia*	-	Marshall, 1892	often fistular, but can be simple-massive or barrels (Fig. 4F)
Demospongiae	Heteroscleromorpha	Clionaida	Clionaidae	*Spheciospongia*	*florida*[2]	(Von Lendenfeld, 1897)	fistular

[1] This sponge is more likely a *Spheciospongia* species (C. Schönberg unpubl. data).
[2] This species strongly resembles *Spheciospongia inconstans* and is part of the *Spheciospongia vagabunda* species complex (C. Schönberg unpubl. data).

Class	Subclass	Order	Family	Genus	Species	Taxon author	Morphologies
Demospongiae	Heteroscleromorpha	Clionaida	Clionaidae	*Spheciospongia*	*inconstans*	(Dendy, 1887)	mostly fistulate (Fig. 1C), occas. simple-massive
Demospongiae	Heteroscleromorpha	Clionaida	Clionaidae	*Spheciospongia*	*solida*	(Ridley and Dendy, 1886)	fistular
Demospongiae	Heteroscleromorpha	Clionaida	Clionaidae	*Spheciospongia*	*vagabunda*	(Ridley, 1884)	fistular
Demospongiae	Heteroscleromorpha	Clionaida	Clionaidae	*Spheciospongia*	*vesparium*	(De Lamarck, 1815)	barrel
Demospongiae	Heteroscleromorpha	Clionaida	Placospongiidae	*Placospherastra*	*micraster*[3]	(Lehnert and Heimler, 2001)	thick crust (Fig. 7A)
Demospongiae	Heteroscleromorpha	Clionaida	Placospongiidae	*Placospongia*	-	Gray, 1867	thick crust
Demospongiae	Heteroscleromorpha	Clionaida	Placospongiidae	*Placospongia*	*melobesioides*	Gray, 1867	thick crust
Demospongiae	Heteroscleromorpha	Clionaida	Spirastrellidae	*Spirastrella*	-	Schmidt, 1868	thin crust
Demospongiae	Heteroscleromorpha	Haplosclerida	Callyspongiidae	*Callyspongia*	-	Duchassaing and Michelotti, 1864	variable, often creeping
Demospongiae	Heteroscleromorpha	Haplosclerida	Callyspongiidae	*Callyspongia*	*confoederata*[4]	(*sensu* Ridley, 1884)	cup
Demospongiae	Heteroscleromorpha	Haplosclerida	Callyspongiidae	*Callyspongia (Callyspongia)*	*fallax*	Duchassaing and Michelotti, 1864	creeping
Demospongiae	Heteroscleromorpha	Haplosclerida	Callyspongiidae	*Callyspongia (Cladochalina)*	*aculeata*	(Linnaeus, 1759)	tube
Demospongiae	Heteroscleromorpha	Haplosclerida	Callyspongiidae	*Callyspongia (Cladochalina)*	*tenerrima*	Duchassaing and Michelotti, 1864	creeping
Demospongiae	Heteroscleromorpha	Haplosclerida	Callyspongiidae	*Callyspongia (Euplacella)*	*biru*	De Voogd, 2004	erect-branching in three dimensions, but can also be creeping
Demospongiae	Heteroscleromorpha	Haplosclerida	Chalinidae	*Haliclona*	-	Grant, 1841	variable, can be creeping or low-relief
Demospongiae	Heteroscleromorpha	Haplosclerida	Chalinidae	*Haliclona*	*koremella*	De Laubenfels, 1954	erect-branching in three dimensions, but can also be simple-erect and tends to creeping
Demospongiae	Heteroscleromorpha	Haplosclerida	Chalinidae	*Haliclona (Gellius)*	*cymaeformis*	(Esper, 1806)	creeping
Demospongiae	Heteroscleromorpha	Haplosclerida	Chalinidae	*Haliclona (Gellius)*	*rava*	(Stephens, 1912)	thick crust
Demospongiae	Heteroscleromorpha	Haplosclerida	Chalinidae	*Haliclona (Halichoclona)*	*fistulosa*	(Bowerbank, 1866)	thick crust to low cushion, with fistular tendencies (= for large, slightly tubular oscules or slim, erect-branching processes)
Demospongiae	Heteroscleromorpha	Haplosclerida	Chalinidae	*Haliclona (Haliclona)*	*oculata*	(Linnaeus, 1759)	mostly erect-palmate, but can be erect branching in three dimensions
Demospongiae	Heteroscleromorpha	Haplosclerida	Chalinidae	*Haliclona (Haliclona)*	*urceolus*	(Rathke and Vahl, 1806)	tubular
Demospongiae	Heteroscleromorpha	Haplosclerida	Chalinidae	*Haliclona (Reniera)*	*cinerea*	(Grant, 1826)	thick crust to low cushion, with fistular tendencies (= for large, tubular oscules or sometimes for slim, erect-branching processes)
Demospongiae	Heteroscleromorpha	Haplosclerida	Chalinidae	*Haliclona (Reniera)*	*fascigera*	(Hentschel, 1912)	mostly tubular, but can vary into erect-branching and cup-shaped
Demospongiae	Heteroscleromorpha	Haplosclerida	Chalinidae	*Haliclona (Rhizoniera)*	*rosea*	(Bowerbank, 1866)	thick crust, can have pronounced to elevated oscules
Demospongiae	Heteroscleromorpha	Haplosclerida	Chalinidae	*Haliclona (Soestella)*	*caerulea*	(Hechtel, 1965)	variable, mostly thickly encrusting with almost fistule like, raised oscules
Demospongiae	Heteroscleromorpha	Haplosclerida	Niphatidae	*Amphimedon*	-	Duchassaing and Michelotti, 1864	can be creeping
Demospongiae	Heteroscleromorpha	Haplosclerida	Niphatidae	*Amphimedon*	*paraviridis*	Fromont, 1993	creping to erect-branching
Demospongiae	Heteroscleromorpha	Haplosclerida	Niphatidae	*Cribrochalina*	*vasculum*	(De Lamarck, 1814)	cup (Fig. 7K)
Demospongiae	Heteroscleromorpha	Haplosclerida	Niphatidae	*Gelliodes*	*fibulata*	(Carter, 1881)	creeping
Demospongiae	Heteroscleromorpha	Haplosclerida	Niphatidae	*Niphates*	*erecta*	Duchassaing and Michelotti, 1864	creeping
Demospongiae	Heteroscleromorpha	Haplosclerida	Niphatidae	*Niphates*	*digitalis*	(De Lamarck, 1814)	cup
Demospongiae	Heteroscleromorpha	Haplosclerida	Niphatidae	*Niphates*	*olemda*	(De Laubenfels, 1954)	tubular
Demospongiae	Heteroscleromorpha	Haplosclerida	Petrosidae	*Xestospongia*	-	De Laubenfels, 1932	genus contains e.g. barrels and thickly encrusting or massive species
Demospongiae	Heteroscleromorpha	Haplosclerida	Petrosidae	*Xestospongia*	*mamillata*	Pulitzer-Finali, 1982	? taxon author described a flat fragment
Demospongiae	Heteroscleromorpha	Haplosclerida	Petrosidae	*Xestospongia*	*testudinaria*	(De Lamarck, 1815)	barrel (Fig. 2B, 5F-G, 8)
Demospongiae	Heteroscleromorpha	Haplosclerida	Petrosidae	*Neopetrosia*	*chaliniformis*	(Thiele, 1899)	variable, can be creeping, thickly encrusting to erect-branching
Demospongiae	Heteroscleromorpha	Haplosclerida	Petrosiidae	*Neopetrosia*	*subtriangularis*	(Duchassaing, 1850)	variable, can be creeping or low-relief (Fig. 7E)
Demospongiae	Heteroscleromorpha	Haplosclerida	Petrosiidae	*Petrosia (Petrosia)*	*ficiformis*	(Poiret, 1789)	creeping
Demospongiae	Heteroscleromorpha	Haplosclerida	Phloeodictyidae	*Oceanapia*	-	Norman, 1869	fistular (Fig. 10E)
Demospongiae	Heteroscleromorpha	Haplosclerida	Phloeodictyidae	*Oceanapia*	*amboinensis*	Topsent, 1897	fistular
Demospongiae	Heteroscleromorpha	Haplosclerida	Phloeodictyidae	*Oceanapia*	*sagittaria*	(Sollas, 1902)	fistular
Demospongiae	Heteroscleromorpha	Haplosclerida	Phloeodictyidae	*Siphonodictyon*	-	Bergquist, 1965	smaller species and individuals: endolithic-bioeroding, larger species and individuals: fistular
Demospongiae	Heteroscleromorpha	Haplosclerida	Phloeodictyidae	*Siphonodictyon*	*coralliphagum*	Rützler, 1971	mostly fistular (Fig. 7G), or when smaller: endolithic-bioeroding, occasionally thickly encrusting
Demospongiae	Heteroscleromorpha	Haplosclerida	Phloeodictyidae	*Siphonodictyon*	*mucosum*	Bergquist, 1965	fistular
Demospongiae	Heteroscleromorpha	Poecilosclerida	Acarnidae	*Iophon*	*minor*	(Brøndsted, 1924)	erect-reticulate
Demospongiae	Heteroscleromorpha	Poecilosclerida	Chondropsidae	*Chondropsis*	-	Carter, 1886	variable (Fig. 4A)
Demospongiae	Heteroscleromorpha	Poecilosclerida	Cladorhizidae	*Abyssocladia*	-	Lévi, 1964	carnivorous
Demospongiae	Heteroscleromorpha	Poecilosclerida	Cladorhizidae	*Chondrocladia (Chondrocladia)*	*grandis*	(Verrill, 1879)	carnivorous (Fig. 3E)
Demospongiae	Heteroscleromorpha	Poecilosclerida	Cladorhizidae	*Chondrocladia (Symmetrocladia)*	*lyra*	Lee et al., 2012	carnivorous (Fig. 3D)
Demospongiae	Heteroscleromorpha	Poecilosclerida	Cladorhizidae	*Cladorhiza*	-	Sars, 1872	carnivorous

[3] The genus change from *Timea* to *Placospherastra* is presently not implemented in van Soest et al. (2020), but is explained in the Sponge Guide (Zea et al., 2014)
[4] See taxonomic remarks in van Soest et al. (2020).

Class	Subclass	Order	Family	Genus	Species	Taxon author	Morphologies
Demospongiae	Heteroscleromorpha	Poecilosclerida	Cladorhizidae	*Cladorhiza*	*gelida*	Lundbeck, 1905	carnivorous
Demospongiae	Heteroscleromorpha	Poecilosclerida	Coelosphaeridae	*Forcepia (Forcepia)*	*topsenti*	Lundbeck, 1905	endopsammic, likely fistular
Demospongiae	Heteroscleromorpha	Poecilosclerida	Coelosphaeridae	*Lissodendoryx (Acanthodoryx)*	*fibrosa*	(Lévi, 1961)	erect-laminar
Demospongiae	Heteroscleromorpha	Poecilosclerida	Crambeidae	*Crambe*	*crambe*	(Schmidt, 1862)	thick crust
Demospongiae	Heteroscleromorpha	Poecilosclerida	Crellidae	*Crella*	*incrustans*	(Carter, 1885)	variable, often encrusting, but can develop fistules
Demospongiae	Heteroscleromorpha	Poecilosclerida	Desmacididade	*Desmacidon*	-	Bowerbank, 1861	variable
Demospongiae	Heteroscleromorpha	Poecilosclerida	Esperiopsidae	*Amphilectus*	*fucorum*	(Esper, 1794)	thickly encrusting to erect-branching, can have fistular tendencies
Demospongiae	Heteroscleromorpha	Poecilosclerida	Hymedesmiidae	*Hemimycale*	*columella*	(Bowerbank, 1874)	encrusting
Demospongiae	Heteroscleromorpha	Poecilosclerida	Hymedesmiidae	*Hymedesmia*	-	Bowerbank, 1864	often encrusting
Demospongiae	Heteroscleromorpha	Poecilosclerida	Hymedesmiidae	*Hymedesmia (Hymedesmia)*	*stylata*	Lundbeck, 1905	thin crust, creeping over particles, but functionally fistular
Demospongiae	Heteroscleromorpha	Poecilosclerida	Hymedesmiidae	*Hymedesmia (Stylopus)*	*coriacea*	(Fristedt, 1885)	thin crust
Demospongiae	Heteroscleromorpha	Poecilosclerida	Hymedesmiidae	*Phorbas*	-	Duchassaing and Michelotti, 1864	variable, often thickly encrusting
Demospongiae	Heteroscleromorpha	Poecilosclerida	Hymedesmiidae	*Phorbas*	*fictitius*	Bowerbank, 1866	thick crust
Demospongiae	Heteroscleromorpha	Poecilosclerida	Isodictyidae	*Coelocarteria*	-	Burton, 1934	fistular
Demospongiae	Heteroscleromorpha	Poecilosclerida	Isodictyidae	*Coelocarteria*	*singaporensis*	(Carter, 1883)	fistular
Demospongiae	Heteroscleromorpha	Poecilosclerida	Iotrochotidae	*Iotrochota*	*baculifera*	Ridley, 1884	thickly encrusting
Demospongiae	Heteroscleromorpha	Poecilosclerida	Microcionidae (Microcioninae)	*Clathria*	-	Schmidt, 1862	variable, can be composite-massive
Demospongiae	Heteroscleromorpha	Poecilosclerida	Microcionidae (Microcioninae)	*Clathria (Clathria)*	-	Schmidt, 1862	variable
Demospongiae	Heteroscleromorpha	Poecilosclerida	Microcionidae (Microcioninae)	*Clathria (Clathria)*	*hjorti*	(Arnesen, 1920)	erect-reticulate
Demospongiae	Heteroscleromorpha	Poecilosclerida	Microcionidae (Microcioninae)	*Clathria (Microciona)*	-	Bowerbank, 1862	variable
Demospongiae	Heteroscleromorpha	Poecilosclerida	Microcionidae (Microcioninae)	*Clathria (Microciona)*	*aceratoobtusa*	(Carter, 1887)	thin crust
Demospongiae	Heteroscleromorpha	Poecilosclerida	Microcionidae (Microcioninae)	*Clathria (Thalysias)*	*coppingeri*	Ridley, 1884	erect-reticulate (Fig. 10C)
Demospongiae	Heteroscleromorpha	Poecilosclerida	Microcionidae (Microcioninae)	*Clathria (Thalysias)*	*costifera*	Hallmann, 1912	erect-laminar
Demospongiae	Heteroscleromorpha	Poecilosclerida	Microcionidae (Microcioninae)	*Clathria (Thalysias)*	*fusterna*	Hooper, 1996	erect-stalked
Demospongiae	Heteroscleromorpha	Poecilosclerida	Microcionidae (Microcioninae)	*Clathria (Thalysias)*	*lendenfeldi*	Ridley and Dendy, 1886	usually erect-laminar
Demospongiae	Heteroscleromorpha	Poecilosclerida	Microcionidae (Microcioninae)	*Clathria (Thalysias)*	*major*	Hentschel, 1912	erect-palmate
Demospongiae	Heteroscleromorpha	Poecilosclerida	Microcionidae (Microcioninae)	*Clathria (Thalysias)*	*placenta*	(De Lamarck, 1814)	erect-laminar
Demospongiae	Heteroscleromorpha	Poecilosclerida	Microcionidae (Microcioninae)	*Clathria (Thalysias)*	*procera*	(Ridley, 1884)	erect-branching in three dimensions, but can also be simple-erect and tends to creeping
Demospongiae	Heteroscleromorpha	Poecilosclerida	Microcionidae (Microcioninae)	*Clathria (Thalysias)*	*spinifera*	(Lindgren, 1897)	erect-palmate
Demospongiae	Heteroscleromorpha	Poecilosclerida	Microcionidae (Microcioninae)	*Clathria (Thalysias)*	*virgultosa*	(Esper, 1806)	creeping, rope sponge that can also be erect-branching in three dimensions (Fig. 7D)
Demospongiae	Heteroscleromorpha	Poecilosclerida	Microcionidae (Microcioninae)	*Clathria (Wilsonella)*	*mixta*	Hentschel, 1912	erect
Demospongiae	Heteroscleromorpha	Poecilosclerida	Microcionidae (Microcioninae)	*Echinochalina (Protophlitaspongia)*	*isaaci*	Hooper, 1996	tube cluster
Demospongiae	Heteroscleromorpha	Poecilosclerida	Microcionidae (Ophlitaspongiinae)	*Ophlitaspongia*	*papilla*	Bowerbank, 1866	encrusting
Demospongiae	Heteroscleromorpha	Poecilosclerida	Mycalidae	*Mycale (Aegogropila)*	-	Gray, 1867	often creeping or thickly encrusting
Demospongiae	Heteroscleromorpha	Poecilosclerida	Mycalidae	*Mycale (Arenochalina)*	*laxissima*	(Duchassaing and Michelotti, 1864)	amphora
Demospongiae	Heteroscleromorpha	Poecilosclerida	Mycalidae	*Mycale (Mycale)*	*laevis*	(Carter, 1882)	thick crust (insinuating) or creeping
Demospongiae	Heteroscleromorpha	Poecilosclerida	Mycalidae	*Mycale (Oxymycale)*	*acerata*	Kirkpatrick, 1907	tube cluster
Demospongiae	Heteroscleromorpha	Poecilosclerida	Myxillidae	*Myxilla (Myxilla)*	*rosacea*	(Lieberkühn, 1859)	encrusting to simple-massive
Demospongiae	Heteroscleromorpha	Poecilosclerida	Podospongiidae	*Diacarnus*	*megaspinorhabdosa*	Kelly-Borges and Vacelet, 1995	ball
Demospongiae	Heteroscleromorpha	Poecilosclerida	Podospongiidae	*Podospongia*	*virga*	Sim-Smith and Kelly, 2011	erect-stalked
Demospongiae	Heteroscleromorpha	Poecilosclerida	Raspailiidae (Cyamoninae)	*Trikentrion*	*flabelliforme*	Hentschel, 1912	erect-palmate
Demospongiae	Heteroscleromorpha	Poecilosclerida	Raspailiidae (Echinodictyinae))	*Echinodictyum*	*pulchrum*	Brøndsted, 1934	erect-reticulate
Demospongiae	Heteroscleromorpha	Poecilosclerida	Raspailiidae (Raspailiinae)	*Ectyoplasia*	*tabula*	(De Lamarck, 1814)	erect-palmate
Demospongiae	Heteroscleromorpha	Poecilosclerida	Raspailiidae (Raspailiinae)	*Raspailia (Raspaxilla)*	-	Topsent, 1913	usually erect, often branching
Demospongiae	Heteroscleromorpha	Poecilosclerida	Tedaniidae	*Tedania (Tedania)*	*ignis*	(Duchassaing and Michelotti, 1864)	can be fistular
Demospongiae	Heteroscleromorpha	Polymastiida	Polymastiidae	*Polymastia*	-	Bowerbank, 1862	fistular
Demospongiae	Heteroscleromorpha	Polymastiida	Polymastiidae	*Polymastia*	*grimaldii*	(Topsent, 1913)	fistular
Demospongiae	Heteroscleromorpha	Polymastiida	Polymastiidae	*Polymastia*	*hemisphaerica*	(Sars, 1872)	fistular
Demospongiae	Heteroscleromorpha	Polymastiida	Polymastiidae	*Polymastia*	*invaginata*	Kirkpatrick, 1907	fistular
Demospongiae	Heteroscleromorpha	Polymastiida	Polymastiidae	*Polymastia*	*mamillaris*	Bowerbank, 1862	fistular
Demospongiae	Heteroscleromorpha	Polymastiida	Polymastiidae	*Radiella*	*sol*	(Schmidt, 1870)	ball
Demospongiae	Heteroscleromorpha	Polymastiida	Polymastiidae	*Tentorium*	*papillatum*	(Kirkpatrick, 1908)	fistular
Demospongiae	Heteroscleromorpha	Polymastiida	Polymastiidae	*Tentorium*	*semisuberites*	(Schmidt, 1870)	fistular
Demospongiae	Heteroscleromorpha	Scoplainida	Scopalinidae	*Scopalina*	*lophyropoda*	Schmidt, 1862	encrusting

Class	Subclass	Order	Family	Genus	Species	Taxon author	Morphologies
Demospongiae	Heteroscleromorpha	Scoplainida	Scopalinidae	*Stylissa*	*flabelliformis*	(Hentschel, 1912)	erect-laminar
Demospongiae	Heteroscleromorpha	Scoplainida	Scopalinidae	*Stylissa*	*massa*	(Carter, 1887)	variable, often composite-massive
Demospongiae	Heteroscleromorpha	Spongillida	Spongillidae	*Spongilla*	*lacustris*	(Linnaeus, 1759)	thickly encrusting to erect-branching
Demospongiae	Heteroscleromorpha	Suberitida	Halichondriidae	*Ciocalypta*	-	Bowerbank, 1862	fistular
Demospongiae	Heteroscleromorpha	Suberitida	Halichondriidae	*Ciocalypta*	*penicillus*	Bowerbank, 1862	fistular
Demospongiae	Heteroscleromorpha	Suberitida	Halichondriidae	*Halichondria (Halichondria)*	*bowerbanki*	Burton, 1930	thin to thick crust that can develop pronounced, fistule-like oscules and fine erect-branching processes
Demospongiae	Heteroscleromorpha	Suberitida	Halichondriidae	*Halichondria (Halichondria)*	*melanadocia*	De Laubenfels, 1936	variable, can be encrusting, simple-massive to branching or even fistular, or can function as creeping
Demospongiae	Heteroscleromorpha	Suberitida	Halichondriidae	*Halichondria (Halichondria)*	*panicea*	(Pallas, 1766)	variable, can be encrusting, simple-massive to branching or even fistular, or can function as creeping
Demospongiae	Heteroscleromorpha	Suberitida	Halichondriidae	*Hymeniacidon*	*perlevis*	(Montagu, 1814)	variable, encrusting, can develop fistules
Demospongiae	Heteroscleromorpha	Suberitida	Stylocordylidae	*Stylocordyla*	*chupachups*	Uriz et al., 2011	erect-stalked
Demospongiae	Heteroscleromorpha	Suberitida	Suberitidae	*Caulospongia*	-	Kent, 1871	erect, ranging in function from simple-erect to three-dimensionally branching to stalked (Fig. 4G)
Demospongiae	Heteroscleromorpha	Suberitida	Suberitidae	*Rhizaxinella*	-	Keller, 1880	erect-stalked
Demospongiae	Heteroscleromorpha	Suberitida	Suberitidae	*Suberites*	-	Nardo, 1833	variable, small species can behave as balls
Demospongiae	Heteroscleromorpha	Suberitida	Suberitidae	*Suberites*	*carnosus*	(Johnston, 1842)	ball
Demospongiae	Heteroscleromorpha	Suberitida	Suberitidae	*Suberites*	*ficus*	(Johnston, 1842)	variable, can be simple-massive, or thickly encrusting or ball-shaped
Demospongiae	Heteroscleromorpha	Suberitida	Suberitidae	*Suberites*	*massa*	Nardo, 1847	variable, can be thickly encrusting to composite-massive to fistular
Demospongiae	Heteroscleromorpha	Suberitida	Suberitidae	*Terpios*	-	Duchassaing and Michelotti, 1864	thin crust
Demospongiae	Heteroscleromorpha	Tethyida	Hemiasterellidae	*Adreus*	*axiferum*	(Hentschel, 1912)	palmate or 3D erect-branching
Demospongiae	Heteroscleromorpha	Tethyida	Hemiasterellidae	*Axos*	-	Gray, 1867	can be erect-palmate (Fig. 14A)
Demospongiae	Heteroscleromorpha	Tethyida	Hemiasterellidae	*Axos*	*cliftoni*	Gray, 1867	erect-palmate
Demospongiae	Heteroscleromorpha	Tethyida	Hemiasterellidae	*Axos*	*flabelliformis*	Carter, 1879	erect-palmate (cliftoni, flabelliformis)
Demospongiae	Heteroscleromorpha	Tethyida	Hemiasterellidae	*Liosina*	*granularis*	Kelly-Borges and Bergquist, 1988	tubular
Demospongiae	Heteroscleromorpha	Tethyida	Hemiasterellidae	*Liosina*	*paradoxa*	Thile, 1899	tubular
Demospongiae	Heteroscleromorpha	Tethyida	Tethyidae	*Tectitethya*	*crypta*	(De Laubenfels, 1949)	
Demospongiae	Heteroscleromorpha	Tethyida	Tethyidae	*Tethya*	-	De Lamarck, 1815	ball (Fig. 1C)
Demospongiae	Heteroscleromorpha	Tethyida	Tethyidae	*Tethya*	*aurantium*	(Pallas, 1766)	ball
Demospongiae	Heteroscleromorpha	Tethyida	Tethyidae	*Tethycometes*	*radicosa*	Lim and Tan, 2008	erect-stalked
Demospongiae	Heteroscleromorpha	Tethyida	Tethyidae	*Xenospongia*	*patelliformis*	Gray, 1858	is an unattached disc, but is adapted to sandy habitats similar as fistular sponges (Fig. 6)
Demospongiae	Heteroscleromorpha	Tethyida	Timeidae	*Timea*	*unistellata*	(Topsent, 1892)	thin crust
Demospongiae	Heteroscleromorpha	Tetractinellida (Astrophorina)	Ancorinidae	*Asteropus*	*niger*	Hajdu and van Soest, 1992	simple-massive (Fig. 7F)
Demospongiae	Heteroscleromorpha	Tetractinellida (Astrophorina)	Ancorinidae	*Stelletta*	*clavosa*	Ridley, 1884	ball
Demospongiae	Heteroscleromorpha	Tetractinellida (Astrophorina)	Geodiidea (Erylinae)	*Melophlus*	*sarassinorum*	Thiele, 1899	ball, but on "feet", short stalks that slightly elevate it
Demospongiae	Heteroscleromorpha	Tetractinellida (Astrophorina)	Geodiidea (Erylinae)	*Pachymatisma*	*johnstonia*	(Bowerbank in Johnston, 1842)	encrusting to simple-massive
Demospongiae	Heteroscleromorpha	Tetractinellida (Astrophorina)	Geodiidea (Geodiinae)	*Geodia*	*neptuni*	(Sollas, 1886)	barrel
Demospongiae	Heteroscleromorpha	Tetractinellida (Astrophorina)	Theneidae	*Thenea*	-	Gray, 1867	often fistular, but can be balls or barrels in function
Demospongiae	Heteroscleromorpha	Tetractinellida (Astrophorina)	Theonellidae	*Theonella*	*swinhoei*	Gray, 1868	amphora
Demospongiae	Heteroscleromorpha	Tetractinellida (Spirophorina)	Tetillidae	*Cinachyra*	-	Sollas, 1886	ball
Demospongiae	Heteroscleromorpha	Tetractinellida (Spirophorina)	Tetillidae	*Cinachyra*	*barbata*	Sollas, 1886	ball
Demospongiae	Heteroscleromorpha	Tetractinellida (Spirophorina)	Tetillidae	*Cinachyrella*	-	Wilson, 1925	ball
Demospongiae	Heteroscleromorpha	Tetractinellida (Spirophorina)	Tetillidae	*Cinachyrella*	*apion*	(Uliczka, 1929)	ball
Demospongiae	Heteroscleromorpha	Tetractinellida (Spirophorina)	Tetillidae	*Cinachyrella*	*arabica*	(Carter, 1869)	ball
Demospongiae	Heteroscleromorpha	Tetractinellida (Spirophorina)	Tetillidae	*Cinachyrella*	*australiensis*	(Carter, 1886)	ball
Demospongiae	Heteroscleromorpha	Tetractinellida (Spirophorina)	Tetillidae	*Cinachyrella*	*kuekenthali*	(Uliczka, 1929)	ball (Fig. 7H)
Demospongiae	Heteroscleromorpha	Tetractinellida (Spirophorina)	Tetillidae	*Paratetilla*	-	Dendy, 1905	balls
Demospongiae	Heteroscleromorpha	Tetractinellida (Spirophorina)	Tetillidae	*Paratetilla*	*bacca*	(Selenka, 1867)	ball
Demospongiae	Heteroscleromorpha	Tetractinellida (Spirophorina)	Tetillidae	*Paratetilla*	*corrugata*	Dendy, 1922	ball
Demospongiae	Homoscleromorpha	Homosclerophorida	Plakinidae	*Plakortis*	-	Schulze, 1880	variable, OTU species in paper was basically ball-shaped (Fig. 4D)
Demospongiae	Homoscleromorpha	Homosclerophorida	Plakinidae	*Plakortis*	*simplex*	Schulze, 1880	thin crust
Demospongiae	Keratosa	Dendroceratida	Darwinellidae	*Aplysilla*	*rosea*	(Barrois, 1876)	composite-massive
Demospongiae	Keratosa	Dendroceratida	Darwinellidae	*Darwinella*	*australiensis*	Carter, 1885	thin crust (Fig. 4B)
Demospongiae	Keratosa	Dictyoceratida	Dysideidae	*Dysidea*	-	Johnston, 1842	variable
Demospongiae	Keratosa	Dictyoceratida	Dysideidae	*Dysidea*	*avara*	(Schmidt, 1862)	variable, can be simple-massive to more tubular or erect-branching

Class	Subclass	Order	Family	Genus	Species	Taxon author	Morphologies
Demospongiae	Keratosa	Dictyoceratida	Dysideidae	*Lamellodysidea*	*herbacea*	(Keller, 1889)	variable, creeping, but can have a significant erect portion of finger-like or little flabellate projections
Demospongiae	Keratosa	Dictyoceratida	Irciniidae	*Ircinia*	*campana*	(De Lamarck, 1814)	cup (Fig. 7J)
Demospongiae	Keratosa	Dictyoceratida	Irciniidae	*Ircinia*	*felix*	(Duchassaing and Michelotti, 1864)	composite-massive
Demospongiae	Keratosa	Dictyoceratida	Irciniidae	*Ircinia*	*strobilina*	(De Lamarck, 1816)	barrel
Demospongiae	Keratosa	Dictyoceratida	Irciniidae	*Psammocinia*	*bulbosa*	Bergquist, 1995	fistular, endopsammic
Demospongiae	Keratosa	Dictyoceratida	Irciniidae	*Sarcotragus*	-	Schmidt, 1862	often simple-massive
Demospongiae	Keratosa	Dictyoceratida	Spongiidae	*Coscinoderma*	*matthewsi*	Von Lendenfeld, 1886	simple-massive
Demospongiae	Keratosa	Dictyoceratida	Spongiidae	*Rhopaloeides*	*odorabile*	Thompson et al., 1987	variable, commonly simple-massive
Demospongiae	Keratosa	Dictyoceratida	Spongiidae	*Spongia (Spongia)*	-	Linnaeus, 1759	variable, commonly simple-massive
Demospongiae	Keratosa	Dictyoceratida	Spongiidae	*Spongia (Spongia)*	*agaricina*	Pallas, 1766	variable, can be cup-like to erect-laminar
Demospongiae	Keratosa	Dictyoceratida	Spongiidae	*Spongia (Spongia)*	*officinalis*	Linnaeus, 1759	simple-massive (Fig. 1B, 5A-D), can function as creeping
Demospongiae	Keratosa	Dictyoceratida	Spongiidae	*Spongia (Spongia)*	*virgultosa*	(Schmidt, 1868)	crusts with small fistules
Demospongiae	Keratosa	Dictyoceratida	Thorectidae (Phyllospongiinae)	*Carteriospongia*	*foliascens*	(Pallas, 1766)	cups, incomplete cups to erect-laminar fans (Fig. 9)
Demospongiae	Keratosa	Dictyoceratida	Thorectidae (Thorectinae)	*Aplysinopsis*	-	(Von Lendenfeld, 1888)	variable, mostly simple-massive or low-relief
Demospongiae	Keratosa	Dictyoceratida	Thorectidae (Thorectinae)	*Cacospongia*	-	Schmidt, 1862	mostly simple-massive
Demospongiae	Keratosa	Dictyoceratida	Thorectidae (Thorectinae)	*Fascaplysinopsis*	*reticulata*	(Hentschel, 1912)	simple-massive
Demospongiae	Keratosa	Dictyoceratida	Thorectidae (Thorectinae)	*Hyrtios*	*cavernosus*	Vacelet et al., 1976	simple-massive (Fig. 7B)
Demospongiae	Keratosa	Dictyoceratida	Thorectidae (Thorectinae)	*Hyrtios*	*erectus*	(Keller, 1889)	creeping
Demospongiae	Verongimorpha	Verongiida	Chondrillidae	*Thymosia*	*guernei*	Topsent, 1895	encrusting to simple-massive
Demospongiae	Verongimorpha	Verongiida	Aplysinidae	*Aplysina*	-	Nardo, 1834	creeping
Demospongiae	Verongimorpha	Verongiida	Aplysinidae	*Aplysina*	*aerophoba*	(Nardo, 1833)	tube
Demospongiae	Verongimorpha	Verongiida	Aplysinidae	*Aplysina*	*archeri*	(Higgin, 1875)	variable, e.g. erect-branching (Fig. 7C)
Demospongiae	Verongimorpha	Verongiida	Aplysinidae	*Aplysina*	*cauliformis*	(Carter, 1882)	tube (Fig. 7L)
Demospongiae	Verongimorpha	Verongiida	Aplysinidae	*Aplysina*	*fistularis*	(Pallas, 1766)	tube
Demospongiae	Verongimorpha	Verongiida	Aplysinidae	*Aplysina*	*fulva*	(Pallas, 1766)	erect-branching in three dimensions, but can also be simple-etect and tends to creeping
Demospongiae	Verongimorpha	Verongiida	Aplysinidae	*Verongula*	*reiswigi*	Alcolado, 1984	barrel or cup (Fig. 7I), or even tube
Demospongiae	Verongimorpha	Verongiida	Ernstilligae	*Ernstilla*	*lacunosa*	(Hentschel, 1912)	erect-palmate (Fig. 10B)
Demospongiae	Verongimorpha	Verongiida	Ianthellidae	*Ianthella*	-	Gray, 1869	mostly erect-laminar, but can form functionally intermediate forms towards cup-like morphologies
Demospongiae	Verongimorpha	Verongiida	Ianthellidae	*Ianthella*	*basta*	(Pallas, 1766)	often tubular (Fig. 2B, 4H-I), small specimens can be erect-laminar
Demospongiae	Verongimorpha	Verongiida	Ianthellidae	*Ianthella*	*flabelliformis*	(Linnaeus, 1759)	erect-laminar (Fig. 10A)
Demospongiae	Verongimorpha	Verongiida	Pseudoceratinidae	*Pseudoceratina*	*purpurea*	(Carter, 1880)	creeping
Demospongiae	Verongimorpha	Verongiida	Pseudoceratinidae	*Pseudoceratina*	*verrucosa*	Bergquist, 1995	creeping
Hexactinellida	Amphidiscophora	Amphidiscosida	Hyalonematidae	*Hyalonema*	-	Gray, 1832	erect-stalked
Hexactinellida	Hexasterophora	Lyssacinosida	Euplectellidae (Bolosominae)	*Bolosoma*	-	Ijima, 1904	erect-stalked
Hexactinellida	Hexasterophora	Lyssacinosida	Euplectellidae (Euplectellinae)	*Docosaccus*	-	Topsent, 1910	tabular
Hexactinellida	Hexasterophora	Lyssacinosida	Euplectellidae (Euplectellinae)	*Euplectella*	-	Owen, 1841	tube to amphora
Hexactinellida	Hexasterophora	Lyssacinosida	Euplectellidae (Euplectellinae)	*Euplectella*	*aspergillum*	Owen, 1841	tube to amphora
Hexactinellida	Hexasterophora	Lyssacinosida	Rossellidae (Lanuginellidae)	*Caulophacus*	-	Schulze, 1886	erect-stalked
Hexactinellida	Hexasterophora	Lyssacinosida	Rossellidae (Lanuginellidae)	*Caulophacus (Caulophacus)*	*arcticus*	(Hansen, 1885)	erect-stalked
Hexactinellida	Hexasterophora	Lyssacinosida	Rossellidae (Rossellinae)	*Anoxycalyx (Scolymastra)*	*joubini*	(Topsent, 1916)	amphora
Hexactinellida	Hexasterophora	Lyssacinosida	Rossellidae (Rossellinae)	*Bathydorus*	-	Schulze, 1886	tabular
Hexactinellida	Hexasterophora	Lyssacinosida	Rossellidae (Rossellinae)	*Rossella*	-	Carer, 1872	amphora
Hexactinellida	Hexasterophora	Sceptrulophora	Aphrocallistidae	*Aphrocallistes*	*vastus*	Schulze, 1886	amphora
Hexactinellida	Hexasterophora	Sceptrulophora	Euretidae (Chonalesmatinae)	*Chonelasma*	-	Schulze, 1886	erect-stalked to erect-palmate
Ascidiacea	-	Stolidobranchia	Pyuridae	*Pyura*	*spinifera*	(Quoi and Gaimard, 1834)	stalked (but not a sponge)
Anthozoa	Hexacorallia	Scleractinia	Dendrophylliidae	*Turbinaria*	-	Oken, 1815	shallow complete cup to tabular (but not a sponge)
Hydrozoa	Hydroidolina	Anthoathecata (Capitata)	Milleporidae	*Millepora*	*complanata*	De Lamarck, 1816	3D or 2D branching to composite-massive (but not a sponge)

Supplement 4. Cheat sheet. Print, trim off white frame, laminate, bring for fieldwork or as reference

1-2 FUNCTIONAL CRUST (EN)

1 – Crust (EN-lat) *sensu lato*

- **1.1 – true crust (EN-cr)**, thin (few mm; **thn**, showing substrate contours) and thick crusts (few cm; **thc**); none or low surface relief
- **1.2 - endolithic, bioeroding (EN-be)**, tissue dots or as crust, difficult to recognise as non-expert, but very similar to above

2 - creeping, repent (EN-rep), branches follow ground, can have erect parts, multiple attachm., easy to detach

Body width significantly greater than height, extending across substrate surface. Typical for high-velocity, turbulent flow. Partly vulnerable against sedimentation.

3-6 MASSIVE IN FUNCTION (M)

- **3 - simple-massive (M-s)**, about as wide as high, inhalants and exhalants scattered across same surface
- **4 - balls (M-bl)**, small body, more or less globular, in- and exhalants mixed or separate
- **5 - composite-massive (M-c)**, overall body shape and function massive, but body composed of densely merged or meshed subunits
- **6 - fistular-massive (M-f)**, more or less embedded in the sediment, usually with elevated fistules, often with (hidden) anchoring structures

Body width and height roughly similar, various forms. Usually mixed in- and exhalants. Fistular-massive forms and many balls sediment specialists.

7-9 CUP-LIKE FUNCTION (C)

7 – Wide cups (C-w) apical diameter > body dioameter

- **7.1 – tables, or very shallow cups (C-tab)**, can easily be covered by sediments
- **7.2 - incomplete cup (C-inc)**, intermediate form to erect-laminar, but body curled to funnel
- **7.3 – complete cup (C-cmp)**, concave, catch sediment that is more difficult to be washed out

8 – Narrow cups (C-nr)

- **8.1 – tube or chimney (C-t)**, apical diameter = body diameter
- **8.1 – amphora or sack (C-a)**, apical diameter < body diameter

9 – barrels or "massive" cups (C-b), lateral inhalants, central-apical exhalant or exhalant cluster, usually with barrel, high mound or cone shape

Apically concave or hollow forms, in- and exhalants usually spatially separated. Sediment-vulnerable unless with bundled exhalant jet. Many photosynthetic species.

10-14 ERECT IN FUNCTION (E)

10 – 1D-erect, simple-erect (E-1D), columns, rods, whips, usually in- & exhalants, +/- round in cross section

11 – 2D-erect (E-2D)

- **11.1 - erect-laminar, spatulas, fans (E-lam)**, flabellate, flat-upright, can have a short stalk or stem
- **11.2 - erect-palmate, hand-shaped, flat bush (E-pal)**, small base or stalk, with round or flat branches fanning out in 1 plane
- **11.3 - erect-reticulate (E-r)**, upright meshes and lattices, often with short stalk or stem

12 – 3D-erect, erect-branching (E-3D), arborescent, bush or otherwise irregularly branching, in different planes

13 – stalked (E-st), elevated body mass of misc. shape, no pores the stalk, in- & exhalants usually separated

14 – carnivorous (E-c), usually delicate, usually stalked or branching from central axis

Body and branches longer than wide, solid in cross section. 1D and 2D typical for strong, laminar flow. Sediment-tolerant and implying nutrient limitation.

Australian Government

Australian Institute of Marine Science

The University of Western Australia

CHEAT SHEET v. 2020-04

Sponge functional growth forms (*sensu* Schönberg 2020)

Can be used for classification without taxonomy and to generate (limited) information about environmental conditions. Four main functional categories are further subdivided – for environmental surrogacy, distinguish morphologies at integer level. All morphologies are steps in a continuum, and intermediate forms occur. Always decide by function in preference to shape.

Examples. Photographs from the central Pacific (NOAA; https://oceanexplorer.noaa.gov/), SE Australia (JT, https://www.flickr.com/photos/johnwturnbull/), NW Australia and the central Great Barrier Reef (CS, EB, FS; AIMS). © AIMS, NOAA or photographer: CS – Christine Schönberg, EB – Evy Büttner, FS – Flora Siebler, JT – John Turnbull, with friendly permission. CAAB = CSIRO Codes for Australian Aquatic Biota. More: Suppl. 3.

Supplement 5.1. Example images of sponge morphologies by functional growth form, *in situ* and as sample specimens.

1.1.1. Thin crusts
CAAB 10 000923

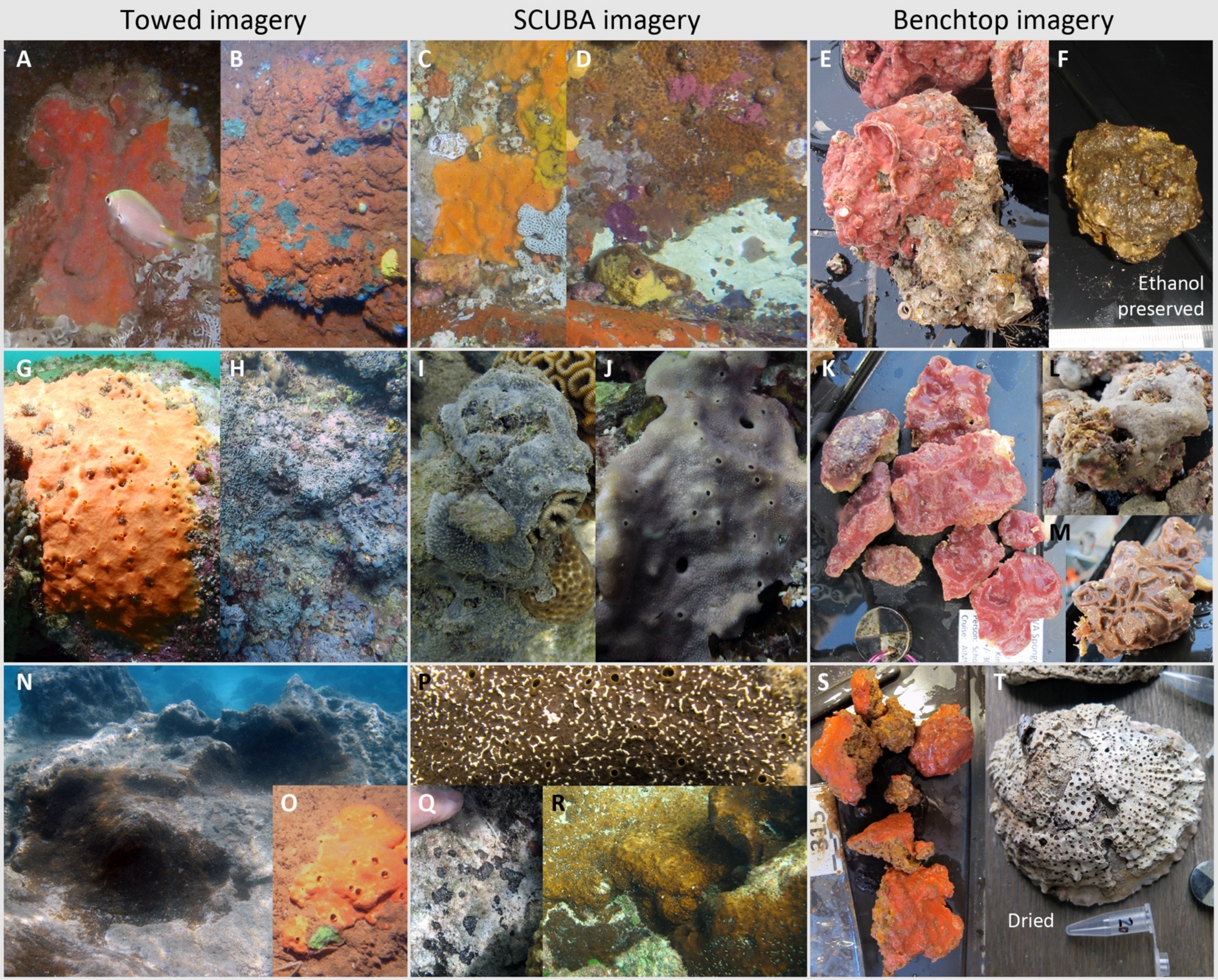
- Minimum relief
- Minimum flow resistance
- Maximum horizontal surface area
- Maximum attachment area

1.1.2. Thick crusts
CAAB 10 000924

- Very low relief
- Very low flow resistance
- Maximum horizontal surface area
- Maximum attachment area

1.2. Endolithic-bioeroding
CAAB 10 000921

- Minimum relief
- Minimum flow resistance
- Very large horizontal surface area
- Maximum attachment area



Supplement 5.2. Example images of sponge morphologies by functional growth form, *in situ* and as sample specimens.

2. Creeping
CAAB 10 000917

- Low relief
- Low flow resistance
- Variable horizontal surface area
- Variable attachment area

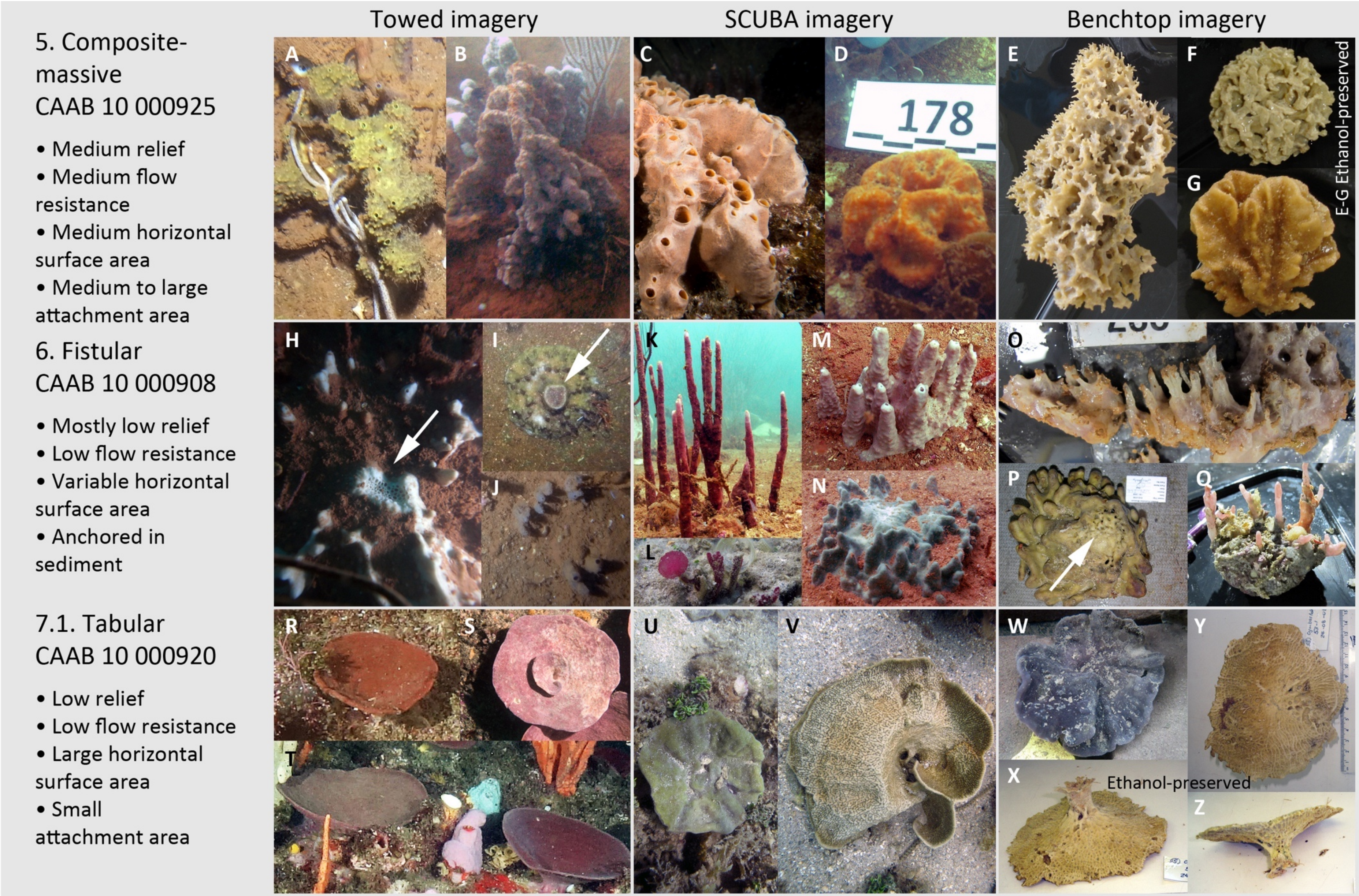
3. Simple-massive
CAAB 10 000904

- Low to high relief
- High flow resistance
- Medium horizontal surface area
- Medium to high attachment area

4. Balls
CAAB 10 000905

- Medium relief
- Low flow resistance
- Medium horizontal surface area
- Medium to high attachment support

Supplement 5.3. Example images of sponge morphologies by functional growth form, *in situ* and as sample specimens. Arrows: oscule plates.



Supplement 5.4. Example images of sponge morphologies by functional growth form, *in situ* and as sample specimens.

7.2. Incomplete cups
CAAB 10 000918

- Medium relief
- Medium flow resistance
- Large horizontal surface area
- Small attachment area

7.3. Complete cups
CAAB 10 000919

- Medium relief
- Medium flow resistance
- Large horizontal surface area
- Small attachment area

8.1. Tubes
CAAB 10 000911

- High relief
- Medium flow resistance
- Minimum hori-zontal surface area
- Small attachment area

Supplement 5.5. Example images of sponge morphologies by functional growth form, *in situ* and as sample specimens.

Supplement 5.6. Example images of sponge morphologies by functional growth form, *in situ* and as sample specimens.

Towed imagery | SCUBA imagery | Benchtop imagery

11.1. 2D laminar
CAAB 10 000913

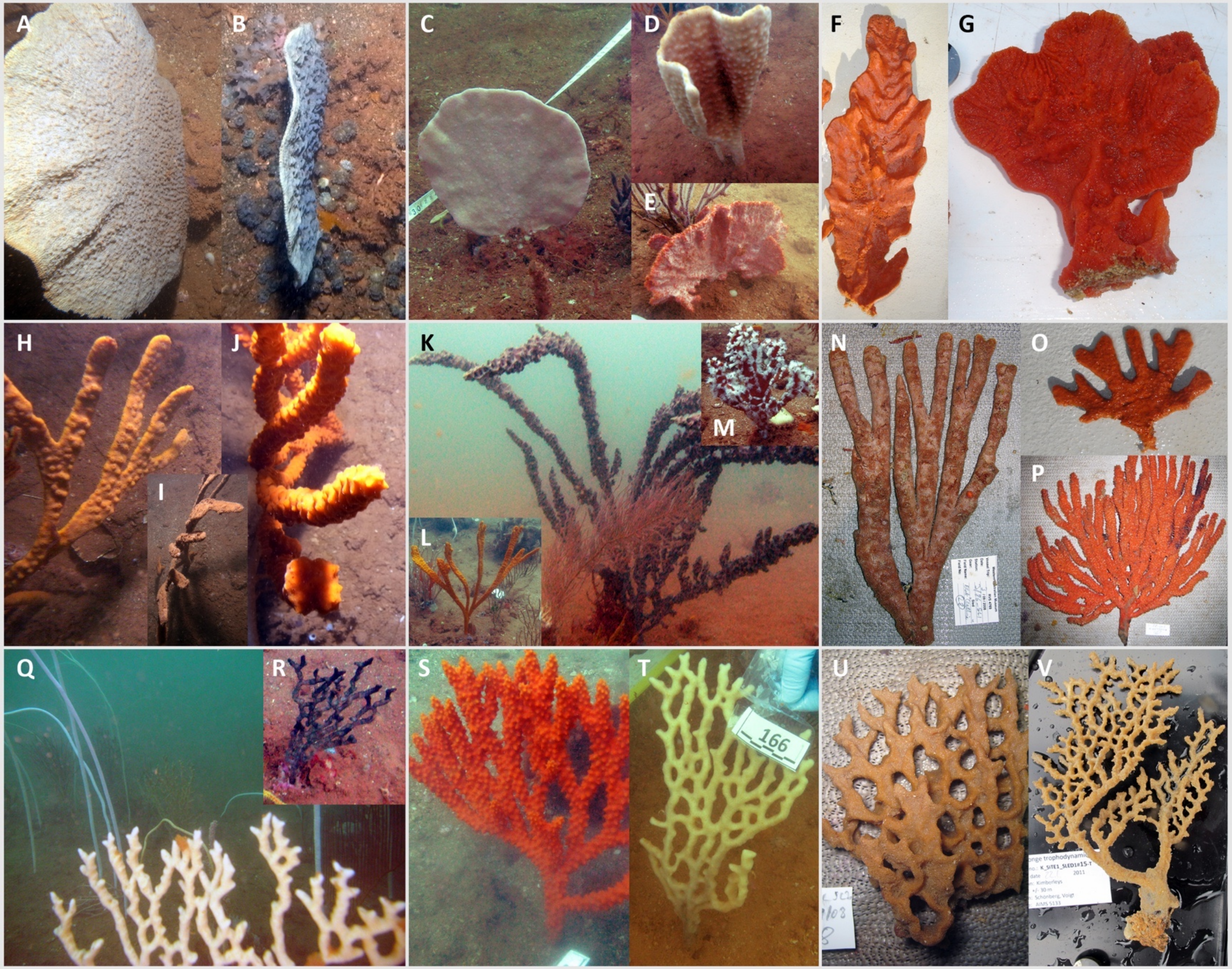
- High relief
- High flow resistance (but often >spongin)
- Minimum horizontal surface area
- Small attachment area

11.2. 2D palmate
CAAB 10 000914

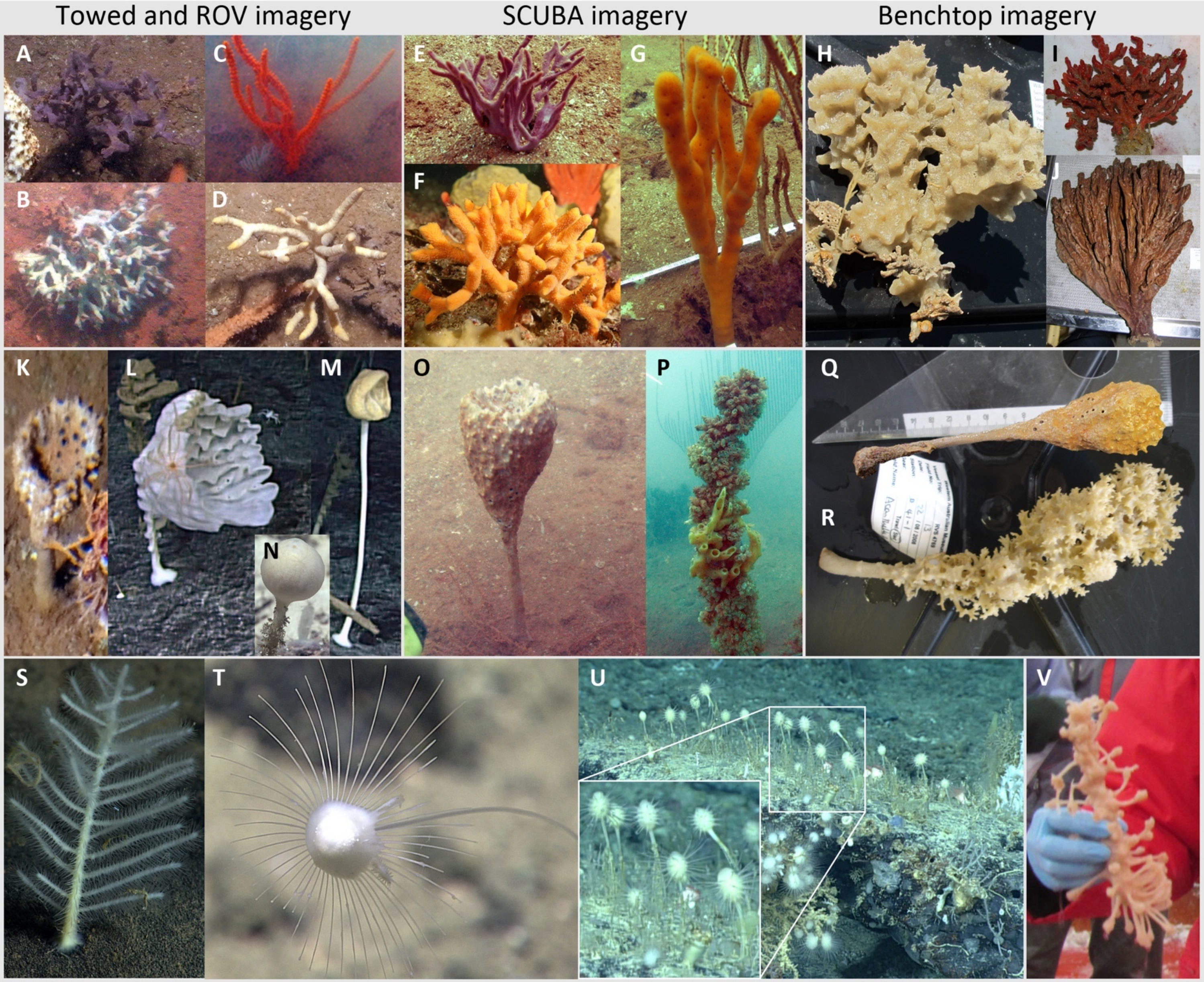
- High relief
- Some flow resistance (but often >spongin)
- Minimum horizontal surface area
- Small attachment area

11.3. 2D reticulate
CAAB 10 000929

- High relief
- Some flow resistance (but often >spongin)
- Minimum horizontal surface area
- Small attachment area



Supplement 5.7. Example images of sponge morphologies by functional growth form, *in situ* and as sample specimens.



12. 3D branching
CAAB 10 000915

- High relief
- Medium resistance (but often >spongin)
- Minimum horizontal surface area
- Small attachment area

13. Stalked
CAAB 10 000906

- High relief
- Medium flow resistance
- Medium horizontal surface area
- Small attachment area

14. Carnivorous
CAAB 10 000930

- High relief
- High flow resistance (but >spicule content)
- Minimum horizontal surface area
- Small attachment area

Sources for Images in Supplement 5

The above images come from different sources. Except for the carnivorous sponges all depict Australian sponges. Towed imagery was collected during surveys that were funded by the Western Australian Marine Science Institution (WAMSI) as part of the WAMSI Dredging Science Node Theme 6.3 (https://www.wamsi.org.au/dredging-science-node), a project made possible through investment from Chevron Australia, Woodside Energy Limited, BHP Billiton as environmental offsets and by co-investment from the WAMSI Joint Venture partners. Other significant sources of above images were the "Surrogates for Biodiversity" project of the Commonwealth Environmental Research Facilities (CERF) Marine Biodiversity Hub in partnership between Geoscience Australia and the Australian Institute of Marine Science (https://www.nespmarine.edu.au/project/improvement-existing-and-development-new-surrogacy-relationships-between-physical-variables), various AIMS research projects led by Christine Schönberg and from specimens in her reference collection, and from publicly accessible Flickr albums collated by John Turnbull (https://www.flickr.com/photos/johnwturnbull/albums/72157672870310525). These and other sources are listed below as per-image information. Collection abbreviations: AIMS – Australian Institute of Marine Science, CERF – Commonwealth Environmental Research Facilities (samples stored at WAM), KIM – Kimberely collection (samples stored at WAM), WAM – Western Australian Museum, ZMB – Berlin Museum of Natural History. When identifications are unsure, the qualifiers "cf." and "aff." are used in the sense of "looks like, could be" and "looks similar, but unlikely to be", respectively.

Supplement 5.1: Thin and thick crusts, and endolithic-bioeroding sponges

A Red encrusting sponge, shelf habitat at Carnarvon Shelf, NW Australia. Photograph AIMS.

B Blue-grey encrusting sponge in -8 to -15 m, Onslow, NW Australia. Photograph AIMS, WAMSI Dredging Science Node.

C-D Patches of encrusting sponges, North Bondi, Sydney, SE Australia. From https://www.flickr.com/photos/johnwturnbull/albums/72157672870310525, accessed March 28, 2020. Photographs John Turnbull, with friendly permission.

E Unidentified thin crust from -21 m, S Montgomery Reef, N Australia. Sample KIM_1_1_49. Photograph Christine Schönberg.

F *Clathria (Microciona)* sp. from -45 m, Mandu, Carnarvon Shelf, NW Australia. Sample CERF 1_009_1_14. Photograph Christine Schönberg, CERF project (Schönberg et al., 2006).

G Thickly encrusting sponge at Bare Island, Botany Bay, Sydney, SE Australia. From https://www.flickr.com/photos/johnwturnbull/albums/72157672870310525, accessed March 28, 2020. Photograph John Turnbull, with friendly permission.

H Thickly encrusting blue-grey sponge in -4 m, Sandy Bay, Carnarvon Shelf, NW Australia. Photograph Christine Schönberg.

I Thickly encrusting grey sponge in the intertidal, Montgomery Reef, N Australia. Photograph Janett Voigt.

J Thickly encrusting purplish grey sponge in -4 to -5 m, Sandy Bay, Carnarvon Shelf, NW Australia. Photograph Christine Schönberg.

K-M Thickly encrusting sponges from -26 m, NE Montgomery Reef, N Australia. Photographs Christine Schönberg. K – *Xestospongia* sp., sample KIM_2_1_6. L – Unidentified grey sponge, sample KIM_2_1_13. M – *Placospongia* sp., sample KIM_2_1_12.

N *Cliona orientalis* in -4 m, Orpheus Island, central Great Barrier Reef. Photograph Christine Schönberg.

O *Cliona* sp. in -8 to -15 m, Onslow, NW Australia. Photograph AIMS, WAMSI Dredging Science Node.

P *Cliona* aff. *viridis* at Rhodes Island in shallow water. Photograph Max Wisshak, Senckenberg, with friendly permission.

Q *Cliona* cf. *orientalis* in -1 m, One Tree Island S Great Barrier Reef. Photograph Christine Schönberg.

R *Cliona orientalis* in -6 m, Orpheus Island, central Great Barrier Reef. Photograph Christine Schönberg.

S Cliona sp. from -12 m, Onslow, NW Australia. Sample WAMSI_315 = WAM Z65318. Photograph Flora Siebler, WAMSI Dredging Science Node.

T *Cliona* cf. *celata* from Sylt Island, E North Sea. Sample ZMB1518. Photograph Christine Schönberg.

Supplement 5.2: Thin and thick creeping, simple-massive and ball-shaped sponges

A-C Repent sponges in -8 to -15 m, Onslow, NW Australia. Photographs AIMS, WAMSI Dredging Science Node.

D Cf. *Lamellodysidea herbacea* in the intertidal, Montgomery Reef, N Australia. Photograph Christine Schönberg.

E Cf. *Amphimedon paraviridis* in -10 to -15 m, Onslow, NW Australia. Photograph Christine Schönberg, WAMSI Dredging Science Node.

F Unidentified red sponge from -3 m, Orpheus Island, central Great Barrier Reef. Photograph Christine Schönberg.

G Unidentified orange sponge from -23 m, S Montgomery Reef, N Australia, sample KIM_1_2_1. Photograph Christine Schönberg.

H *Amphimedon* cf. *paraviridis* from -11 m, Onslow, NW Australia. Sample WAMSI_133 = WAM Z65173. Photograph Flora Siebler, WAMSI Dredging Science Node.

I Shelf habitat at Gnaraloo, Carnarvon Shelf, NW Australia. Photograph AIMS.

J Unidentified red sponge in -10 to -15 m, Onslow, NW Australia. Photograph AIMS, WAMSI Dredging Science Node.

K Aff. *Pseudoceratina verrucosa* in -12 m, Onslow, NW Australia. Photograph Christine Schönberg, WAMSI Dredging Science Node.

L-M Unidentified massive sponges in -13 m, Gnaraloo, Carnarvon Shelf, NW Australia. Photographs Jamie Colquhoun, AIMS.

N *Pseudoceratina* cf. *verrucosa* from -12 m, Onslow, NW Australia. Sample WAMSI_328 = WAM Z65328. Photograph Flora Siebler, WAMSI Dredging Science Node.

O *Mycale (Aegogropila)* sp. from -14 m, Onslow, NW Australia. Sample WAMSI_111 = WAM Z53919. Photographs Flora Siebler, WAMSI Dredging Science Node.

P Unidentified tetractinellid sponges in -95 m, Point Cloates, Carnarvon Shelf, NW Australia. Photograph AIMS (Brooke et al., 2008).

Q-R Spirophorine sponges in -8 to -15 m, Onslow, NW Australia. Photographs AIMS, WAMSI Dredging Science Node. Q – *Cinachyra* sp. R – Unidentified.

S Unidentified spirophorine sponge in the intertidal, Montgomery Reef, N Australia. Photograph Christine Schönberg.

T Unidentified spirophorine sponge in -12 m, Ashburton Island, NW Australia. Photograph Christine Schönberg, WAMSI Dredging Science Node.

U Unidentified spirophorine sponge in -11 m, Onslow, NW Australia. Photograph Evy Büttner, WAMSI Dredging Science Node.

V *Cinachyra* sp. from -11 m, Ashburton Island, NW Australia. Sample WAMSI_289 = WAM Z65296. Photograph Flora Siebler, WAMSI Dredging Science Node. The sponge ruptured after sampling and was globular *in situ*.

W *Cinachyrella* cf. *australiensis* from -12 m, Onslow, NW Australia. Sample WAMSI_156 = WAM Z53985. Photograph Flora Siebler, WAMSI Dredging Science Node.

X *Cinachyrella* sp. from -21 m, S Montgomery Reef, N Australia. Sample KIM_1_1_24. Photograph Christine Schönberg.

Supplement 5.3: Composite-massive, fistular and table-shaped sponges

A Cf. *Pseudoceratina verrucosa* in -8 to -15 m, Onslow, NW Australia. Photograph AIMS, WAMSI Dredging Science Node.

B Unidentified sponge in -11 m, Onslow, NW Australia. Photograph Christine Schönberg, WAMSI Dredging Science Node.

C Lobed sponge at Middle Head, Sydney Harbour, SE Australia. From https://www.flickr.com/photos/johnwturnbull/albums/72157672870310525, accessed March 28, 2020. Photograph John Turnbull, with friendly permission.

D *Stylissa* cf. *flabelliformis* in -11 m, Onslow, NW Australia. Sample WAMSI_178 = WAM Z65220. Photograph Evy Büttner, WAMSI Dredging Science Node.

E *Clathria* (cf. *Clathria*) sp. from -30 m, Point Cloates, Carnarvon Shelf, NW Australia, sample CERF 2_047_1_27A. Photograph Christine Schönberg, CERF project (Schönberg et al., 2006).

F *Dysidea* sp. from -72 m, Point Cloates, Carnarvon Shelf, NW Australia, sample CERF 2_031_1_04. Photograph Christine Schönberg, CERF project (Schönberg et al., 2006).

G *Raspailia (Raspaxilla)* sp. from -60 m, Point Cloates, Carnarvon Shelf, NW Australia, sample CERF 2_049_1_13. Photograph Christine Schönberg, CERF project (Schönberg et al., 2006).

H-J Fistular sponges in 8-15 m, Onslow, NW Australia. Photograph Australian Institute of Marine Science, WAMSI Dredging Science Node. Please note oscule plates in H and I (arrow).

K *Oceanapia* sp. in -11 m, Onslow, NW Australia. Photograph Evy Büttner, WAMSI Dredging Science Node.

L *Oceanapia sagittaria* in -2 m, Orpheus Island, central Great Barrier Reef. Photograph Flora Siebler.

M-N Fistular sponges at Ashburton Island, NW Australia. Photographs Christine Schönberg, WAMSI Dredging Science Node. M – *Psammocinia* cf. *bulbosa* in -11m. N – *Spheciospongia* sp. in -12 m.

O *Xestospongia* sp. from -12 m, Onslow, NW Australia. Sample WAMSI_097 = WAM Z65140. Photographs Flora Siebler, WAMSI Dredging Science Node.

P *Spheciospongia* sp. from -41 m, Gnaraloo, Carnarvon Shelf, NW Australia, sample CERF 3_086_2_33. Photograph Christine Schönberg, CERF project. Please note oscule plate (arrow).

Q *Oceanapia* sp. from -28 m, Montgomery Reef, N Australia, sample KIM_2_3_36 = WAM Z29296. Photograph Christine Schönberg.

R-T Tabular sponges in SE Australia. From https://www.flickr.com/photos/johnwturnbull/albums/72157672870310525, accessed March 28, 2020. Photograph John Turnbull, with friendly permission. R, T: Dee Why Wide, Curl Curl Beach, N Sydney. S: -18 m, Henry Head, Botany Bay, Sydney.

U-V Tabular sponges in -1 m, Fantome Island, central Great Barrier Reef. Photograph Flora Siebler. U – *Cymbastela coralliophila*. V – *Carteriospongia foliascens*.

W *Cymbastela coralliophila* from -1 m, Fantome Island, central Great Barrier Reef. Photograph Evy Büttner.

X-Z *Phakellia* sp. from -36 m, Point Cloates, Carnarvon Shelf, NW Australia. Sample CERF_2_53_1_15. Photographs Christine Schönberg, X – bottom, Y – top, and Z – side views, CERF project (Schönberg et al., 2006).

Supplement 5.4: Incomplete and complete wide cups and tubular sponges

A Yellow incomplete cup sponge in -95 m, Point Cloates, Carnarvon Shelf, NW Australia. Image AIMS.

B Cf. *Stylissa flabelliformis* in -8 to -15 m, Onslow, NW Australia. Photograph AIMS, WAMSI Dredging Science Node.

C Incomplete cup sponge at North Head, Sydney Harbour, SE Australia. From https://www.flickr.com/photos/johnwturnbull/albums/72157672870310525, accessed March 28, 2020. Photograph John Turnbull, with friendly permission.

D *Ectyoplasia frondosa* in -12 m, Ashburton Island, NW Australia. Sample WAMSI_327 = WAM Z65327. Photograph Christine Schönberg, WAMSI Dredging Science Node.

E *Cymbastela stipitata* from -11 m, Onslow, NW Australia. Sample WAMSI_208 = WAM Z65188. Photograph Flora Siebler, WAMSI Dredging Science Node.

F Macerated spongin skeleton of a keratose sponge, beach find, Ashburton Island, NW Australia. Photograph Christine Schönberg,

G *Clathria (Thalysias)* cf. *lendenfeldi* from -11 m, Onslow, NW Australia. Sample WAMSI_333 = WAM Z65297. Photograph Flora Siebler, WAMSI Dredging Science Node. This sponge can be either interpreted as a fan or due to the slight rounding as a cup-like form.

H-K Different cup-shaped sponges in -8 to -15 m, Onslow, NW Australia. Photographs AIMS, WAMSI Dredging Science Node.

L *Ectyoplasia frondosa* in -12 m, Onslow, NW Australia. Sample WAMSI_123 = WAM Z65146 (same as P). Photograph Evy Büttner, WAMSI Dredging Science Node.

M Cf. *Cymbastela stipitata* in -12 m, Ashburton Island, NW Australia. Photograph Christine Schönberg, WAMSI Dredging Science Node.

N *Carteriospongia foliascens* in -1 m, Fantome Island, central Great Barrier Reef. Photograph Flora Siebler.

O-P Cup-like sponges from -12 m, Onslow, NW Australia. Photographs Flora Siebler, WAMSI Dredging Science Node. O – *Echinodictyum clathrioides*. Sample WAMSI_155 = WAM Z53966. P – *Ectyoplasia frondosa*. Sample WAMSI _123 = WAM Z65146 (same as L).

Q-S Tubular sponges in -8 to -15 m, Onslow, NW Australia. Photographs AIMS, WAMSI Dredging Science Node. Q-R – Unidentified sponges, their habit and location in fine sediments possibly suggesting that they are fistular, rather than tubes. The scoring context sometimes needs to be decided from what is known about the sample area. S – *Iantella basta*.

T Sponge tube cluster at Port Stephens, New South Wales, SE Australia. From https://www.flickr.com/photos/johnwturnbull/albums/72157672870310525, accessed March 28, 2020. Photograph John Turnbull, with friendly permission.

U Unidentified sponge in -12 m, Ashburton Island, NW Australia. Photograph Christine Schönberg, WAMSI Dredging Science Node.

V Sponge tube cluster at Kurnell, Whale Watch Platform, Botany Bay, Sydney, SE Australia. From https://www.flickr.com/photos/johnwturnbull/albums/72157672870310525, accessed March 28, 2020. Photograph John Turnbull, with friendly permission.

W Macerated spongin skeleton of a tubular sponge, beach find, Fowlers Bay, S Australia. Photograph Christine Schönberg.

X Dried tubular sponge, beach find, Ashburton Island, NW Australia. Photograph Christine Schönberg.

Supplement 5.5: Amphoras, barrels and 1D-erect sponges

A *Euplectella* sp. in -810 to -830 m, Ocean Explorer dive 05-2019, Stetson Mound Field, waters off E Florida, USA. From https://oceanexplorer.noaa.gov/okeanos/explorations/ex1907/logs/photolog/welcome.html#, accessed April 25, 2020. Photograph US National Oceanic and Atmospheric Administration, creative commons.

B Hexactinellid sponge in -750 to -830 m, Ocean Explorer dive 02-2019, Stetson Mesa, waters off E Florida, USA. From https://oceanexplorer.noaa.gov/okeanos/explorations/ex1907/logs/photolog/welcome.html#, accessed April 25, 2020. Photograph US National Oceanic and Atmospheric Administration, creative commons.

C Amphora-like cluster of a sponge in -10 to -15 m, Onslow, NW Australia. Photograph AIMS, WAMSI Dredging Science Node.

D Sponge amphora cluster at Bare Island, Botany Bay, Sydney, SE Australia. From https://www.flickr.com/photos/johnwturnbull/albums/72157672870310525, accessed March 28, 2020. Photograph John Turnbull, with friendly permission. Due to the density of this cluster, this could possibly alternatively be interpreted as a composite-massive sponge.

E Macerated spongin skeleton of an amphora-shaped sponge, beach find, Rossiter Bay, Cape Le Grand, SW Australia. Photograph Christine Schönberg.

F Barrel-shaped sponge in -8 to -15 m, Onslow, NW Australia. Photograph Australian Institute of Marine Science, WAMSI Dredging Science Node.

G Barrel- or cup-like white sponge in an outer-shelf seabed habitat at the Muiron Islands, NW Australia. Photograph AIMS (Brooke et al., 2008).

H Barrel-like sponge in -8 to -15 m, Onslow, NW Australia. Photograph AIMS, WAMSI Dredging Science Node.

I Aff. *Pseudoceratina verrucosa* in -11 m, Onslow, NW Australia. Photograph Evy Büttner, WAMSI Dredging Science Node.

J-K Barrel sponges at Onslow, NW Australia. Photographs Christine Schönberg, WAMSI Dredging Science Node. J – Cf. *Sarcotragus* sp. in -14 m. K – *Xestospongia testudinaria* in -12 m.

L *Spheciospongia vesparium* from the W Atlantic. Sample ZMB1518. Photograph Christine Schönberg.

M *Spheciospongia* sp. of unknown origin. Sample ZMB0037. Photograph Christine Schönberg.

N Geodiid sponge from -108 m, Mandu, Carnarvon Shelf, NW Australia. Photograph Matthew McArthur, CERF project. Geoscience Australia, with friendly permission.

O-P One-dimensionally erect sponges in a shelf habitat at the Muiron Islands, NW Australia. Photographs AIMS.

Q Mostly one-dimensionally erect sponge in -10 to -15 m, Onslow, NW Australia. Photograph AIMS, WAMSI Dredging Science Node.

R One-dimensionally erect branch of an orange sponge at Bare Island, Botany Bay, Sydney, SE Australia. https://www.flickr.com/photos/johnwturnbull/albums/72157672870310525, accessed March 28, 2020. Photograph John Turnbull, with friendly permission.

S-T One-dimensionally-erect sponges in -12 m, Onslow, NW Australia. Photographs Christine Schönberg, WAMSI Dredging Science Node. S – *Reniochalina* cf. *stalagmitis*. Sample WAMSI_239 = WAM Z65235. T – *Ernstilla lacunosa*.

U-W One-dimensionally-erect sponges from -21 m, Montgomery Reef, N Australia. Photographs Christine Schönberg. U – *Trikentrion flabelliforme*, sample KIM_1_1_89 = WAM Z29040 (with zoanthids). V – Unidentified sponge, sample KIM_1_1_93. W – Unidentified poecilosclerid sponge, sample KIM_1_1_74.

Supplement 5.6: 2D-erect sponges – laminar, palmate and reticulate erect sponges.

A-B *Ianthella* sp. -8 to -15 m, Onslow, NW Australia. Photographs AIMS, WAMSI Dredging Science Node.

C *Trikentrion flabelliforme* in -11 m, Onslow, NW Australia. Sample WAMSI_303 = WAM Z65303. Photograph Evy Büttner, WAMSI Dredging Science Node.

D-E Erect-laminar sponges in -11 m, Onslow, NW Australia. Photographs Christine Schönberg, WAMSI Dredging Science Node. D – Cf. *Axinella aruensis*. E – *Clathria (Thalysias) major*, sample WAMSI_201 = WAM Z65164.

F-G Erect-laminar sponges from -35 m, Red Bluff, Carnarvon Shelf, NW Australia. Photographs Christine Schönberg.

H-J Erect-palmate sponges in -8 to -15 m, Onslow, NW Australia. Photographs AIMS, WAMSI Dredging Science Node.

K *Ernstilla lacunosa* in -12 m, Onslow, NW Australia. Photograph Evy Büttner, WAMSI Dredging Science Node.

L-M Erect-palmate sponges in -12 m, Ashburton Island, NW Australia. Photographs Christine Schönberg, WAMSI Dredging Science Node. L – *Ectyoplasia tabula*. M – *Trikentrion flabelliforme* with white zoanthids, sample WAMSI_317 = WAM Z65319.

N *Ectyoplasia tabula* from -41 m, Gnaraloo, Carnarvon Shelf, NW Australia, sample CERF 3_086_1_28. Photograph Andrew Heyward, CERF project (Schönberg et al., 2006).

O *Phorbas* sp. from -35 m, Red Bluff, Carnarvon Shelf, NW Australia. Photograph Christine Schönberg.

P *Desmacidon* sp. from -45 m, Gnaraloo, Carnarvon Shelf, NW Australia, sample CERF 3_088_2_15. Photograph Andrew Heyward, CERF project.

Q Erect-reticulate sponge in -10 to -15 m, Onslow, NW Australia. Photograph AIMS, WAMSI Dredging Science Node.

R Cf. *Echinodictyum pulchrum* in -12 m, Onslow, NW Australia. Sample WAM Z65183. Photograph Christine Schönberg, WAMSI Dredging Science Node. The discolouration suggests that the sponge was diseased, compare to T.

S *Axos flabelliformis* in -11 m, Onslow, NW Australia. Sample WAMSI_253 = WAM Z65218. Photograph Christine Schönberg, WAMSI Dredging Science Node.

T *Echinodictyum pulchrum* in -11 m, Onslow, NW Australia. Sample WAMSI_166 = WAM Z65183. Photograph Evy Büttner, WAMSI Dredging Science Node.

U Unidentified sponge from -39 m, Gnaraloo, Carnarvon Shelf, NW Australia, sample CERF 3_101_2_P8. Photograph Andrew Heyward, CERF project.

V *Clathria (Thalysias) coppingeri* from -21 m, Montgomery Reef, N Australia. Photographs Christine Schönberg.

Supplement 5.7: 3D-erect branching, stalked and carnivorous sponges.

A-B Three-dimensionally erect-branching sponges in 10-15 m, Onslow, NW Australia. Photographs AIMS, WAMSI Dredging Science Node. A – Cf. *Cacospongia* sp. B – Unidentified.

C Cf. *Axos cliftoni* in -11 m, Onslow, NW Australia. Photograph Christine Schönberg, WAMSI Dredging Science Node.

D Cf. *Adreus axiferum* in -8 to -15 m, Onslow, NW Australia. Photograph AIMS, WAMSI Dredging Science Node.

E Cf. *Cacospongia* sp. in -11 m, Onslow, NW Australia. Photograph Christine Schönberg, WAMSI Dredging Science Node.

F Three-dimensionally erect-branching sponge at North Head, Sydney Harbour, SE Australia. From https://www.flickr.com/photos/johnwturnbull/albums/72157672870310525, accessed March 28, 2020. Photograph John Turnbull, with friendly permission.

G *Axinella aruensis* in -11 m, Onslow, NW Australia. Sample WAMSI_277 = WAM Z65289. Photograph Christine Schönberg, WAMSI Dredging Science Node.

H *Callyspongia* sp. from -21 m, S Montgomery Reef, N Australia. Photographs Christine Schönberg.

I Undetermined three-dimensionally erect-branching sponge from -37 m, Gnaraloo, Carnarvon Shelf, NW Australia, sample CERF 3_089_1_7. Photograph Andrew Heyward, CERF project (Schönberg et al., 2006).

J *Haliclona* sp. from -41 m, Gnaraloo, Carnarvon Shelf, NW Australia, sample CERF 3_086_1_20. Photograph Andrew Heyward, CERF project (Schönberg et al., 2006).

K Cf. *Aplysinopsis* sp. in -8- to 15 m, Onslow, NW Australia. Photograph AIMS, WAMSI Dredging Science Node.

L-M Stalked glass sponges in 2360 m, Ocean Explorer dive 11-2017, Laulima O Ka Moana, Johnston Atoll. From https://oceanexplorer.noaa.gov/okeanos/explorations/ex1706/dailyupdates/dailyupdates.html#cbpi=july25.html, accessed April 25, 2020. Images US National Oceanic and Atmospheric Administration, creative commons.

N Stalked lollipop sponge in -810 to -830 m, Ocean Explorer dive 05-2019, Stetson Mound Field, waters off E Florida, USA. From https://oceanexplorer.noaa.gov/okeanos/explorations/ex1907/logs/photolog/welcome.html#, accessed April 25, 2020. Image US National Oceanic and Atmospheric Administration, creative commons.

O-P Stalked sponges, Onslow, NW Australia. Photographs Christine Schönberg, WAMSI Dredging Science Node. O – *Aplysinopsis* sp. in -12 m, sample WAMSI_118 = WAM Z53977 (same as in Q). P – Cf. *Haliclona* sp. in -14 m.

Q *Aplysinopsis* sp. from -12 m, Onslow, NW Australia. Sample WAMSI_118 = WAM Z53977 (same as in Q). Photograph Flora Siebler, WAMSI Dredging Science Node.

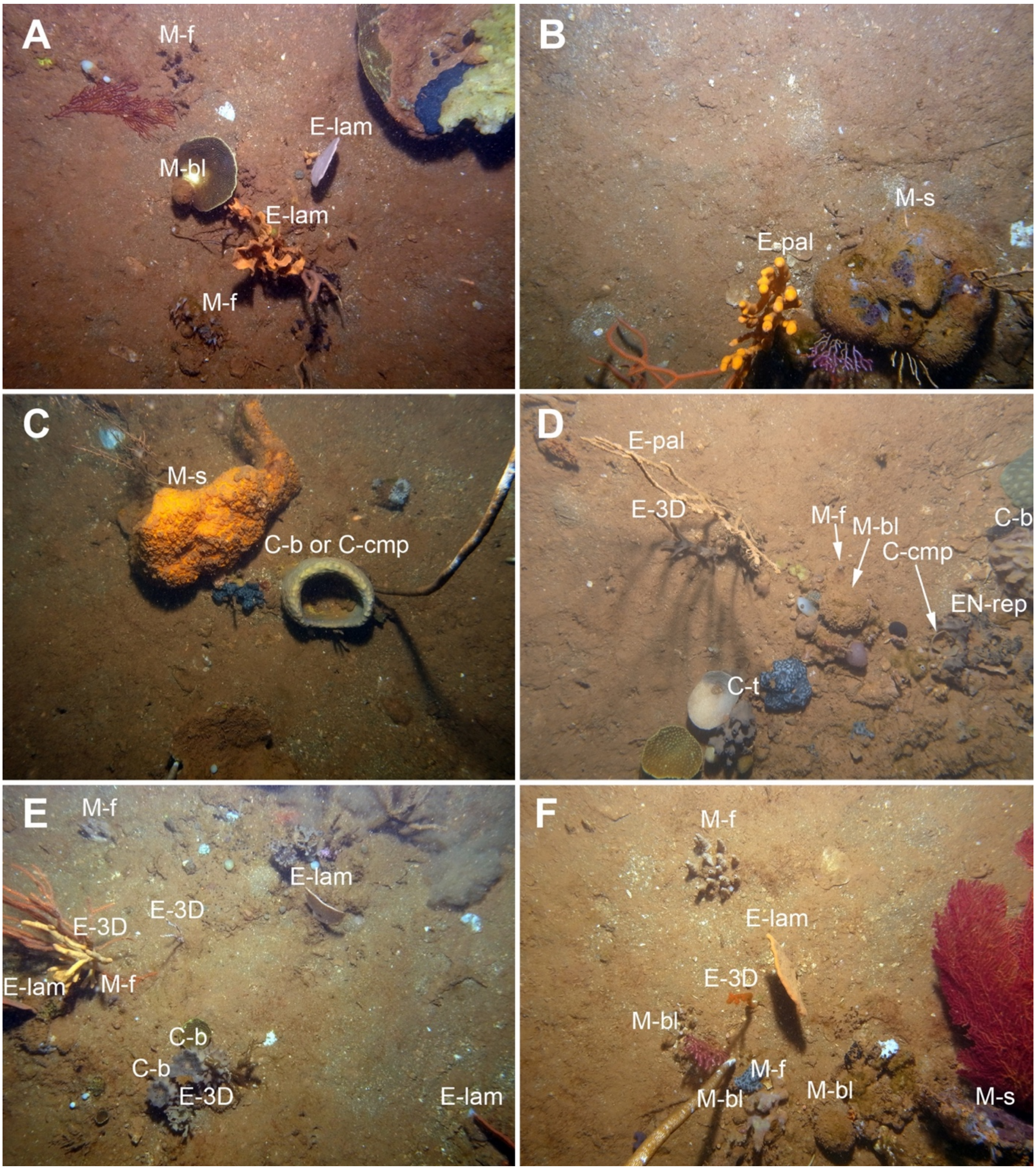
R *Acanthella* sp. from -91 m, Point Cloates, Carnarvon Shelf, NW Australia, sample CERF 2_041_1_1. Photograph Christine Schönberg, CERF project (Schönberg et al., 2006).

S Carnivorous sponge in -4640 m, Ocean Explorer dive 10-2014, unnamed seamount, NW Atlantic. From https://oceanexplorer.noaa.gov/okeanos/explorations/ex1404/dailyupdates/dailyupdates.html#cbpi=sept30.html, accessed April 25, 2020. Image US National Oceanic and Atmospheric Administration, creative commons.

T Carnivorous sponge, Ocean Explorer dive in 2016, Hadal Wall at the Mariana Trench. From https://oceanexplorer.noaa.gov/okeanos/explorations/ex1605/logs/photolog/welcome.html#cbpi=/okeanos/explorations/ex1605/logs/may12/media/video/mn-habs.html, accessed May 1, 2020. Image US National Oceanic and Atmospheric Administration, creative commons.

U Carnivorous sponges in -510 to -560 m, Ocean Explorer dive 08-2019, Miami Terrace off SE Florida, USA. From https://oceanexplorer.noaa.gov/okeanos/explorations/ex1907/logs/photolog/welcome.html#, accessed April 25, 2020. Image US National Oceanic and Atmospheric Administration, creative commons.

V *Chondrocladia (Chondrocladia) grandis* from the Gulf of Maine, Canada (Northern Neighbours Cruise). From https://oceanexplorer.noaa.gov/explorations/17gulfofmaine/logs/june15/june15.html, accessed April 25, 2020. Photograph US National Oceanic and Atmospheric Administration/Arctic Net, creative commons.



Supplement 6. Scoring examples for towed imagery captured with a stills camera pointing downwards, in -8 to -15 m at Onslow, NW Australia. Images were contrast-enhanced, but not otherwise changed. When zooming into images, corallite structure in most shallow cups confirmed that they were *Turbinaria* corals (in A, D – here one was bleached or dead, E). Mottled appearance of dark blue structures and translucent appearance of grey globular structures was suggestive of ascidians. Some sponges were recognised by finding pores on their surfaces (e.g. for E-pal in D). *C-b* – barrel, *C-cmp* – complete cup, *E-lam* – erect-laminar, fan, *E-pal* -palmate, *E-3D* – three-dimensionally erect-branching, *EN-rep* –here functioning as creeping, repent (dark grey patch, may become a barrel when growing up, may consist of two different sponges), *M-bl* – ball, *M-f* – fistular and endopsammic sponge, *M-s* – simple massive sponge.

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