ONLINE SUPPLEMENTARY MATERIAL

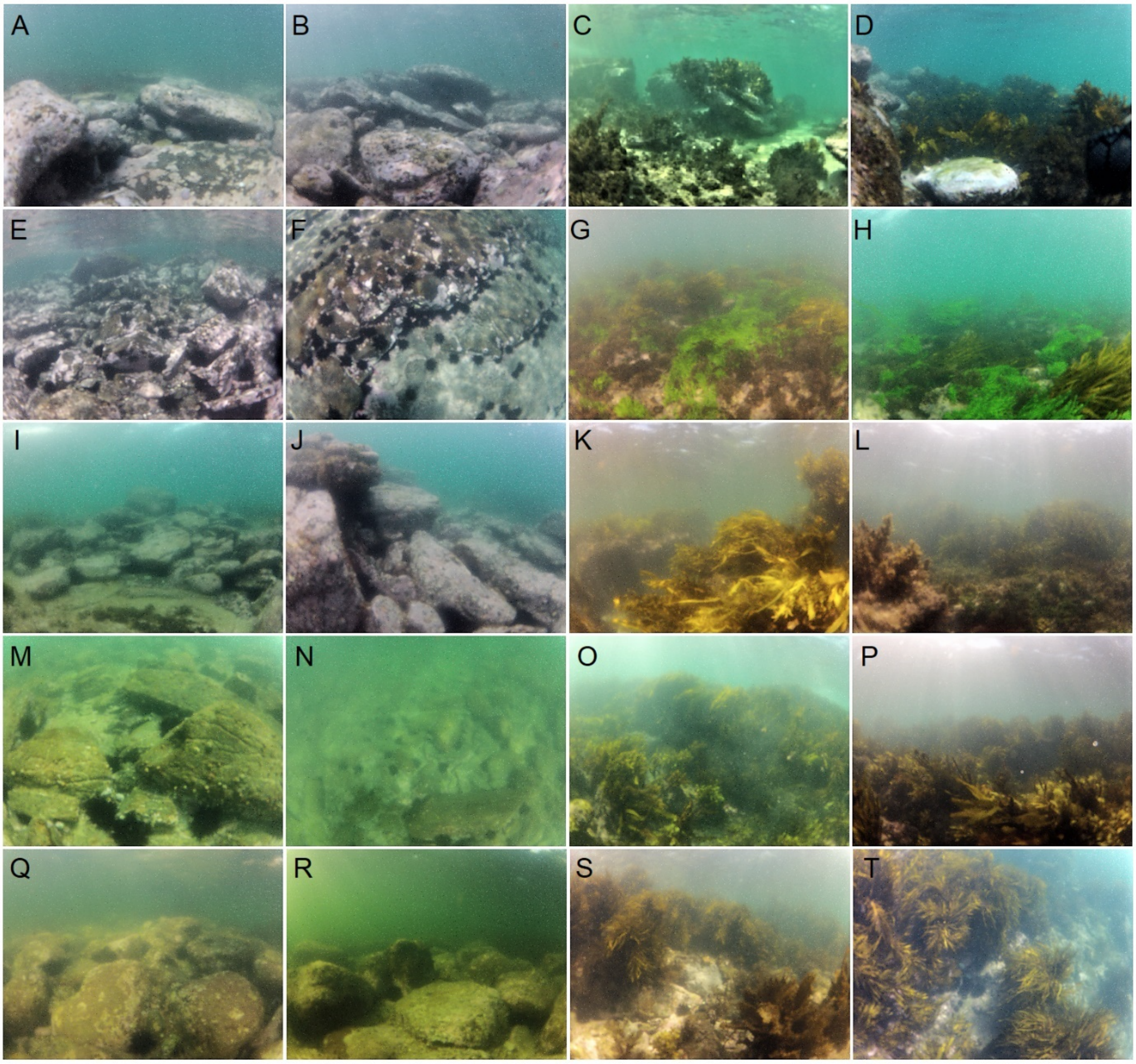

Fig S1. Photographs of habitats where urchins were collected. Each row represents a location, with barrens sites shown in the first two columns and macroalgae sites in the last two columns. Top row, Sydney: Malabar (barren site) and Little Bay (macroalgae site); second row, Wollongong: Bass Point (barren site) and Sandon Point (macroalgae site); Middle row, Bendalong: Bendalong Point (barren site) and Washerwomans Beach (macroalgae site); fourth row, Bermagui: Horseshoe Bay (barren site), and Yallumgo Cove (macroalgae site); bottom row, Eden: Russ Bay (barren site) and Aslings Beach (macroalgae site).

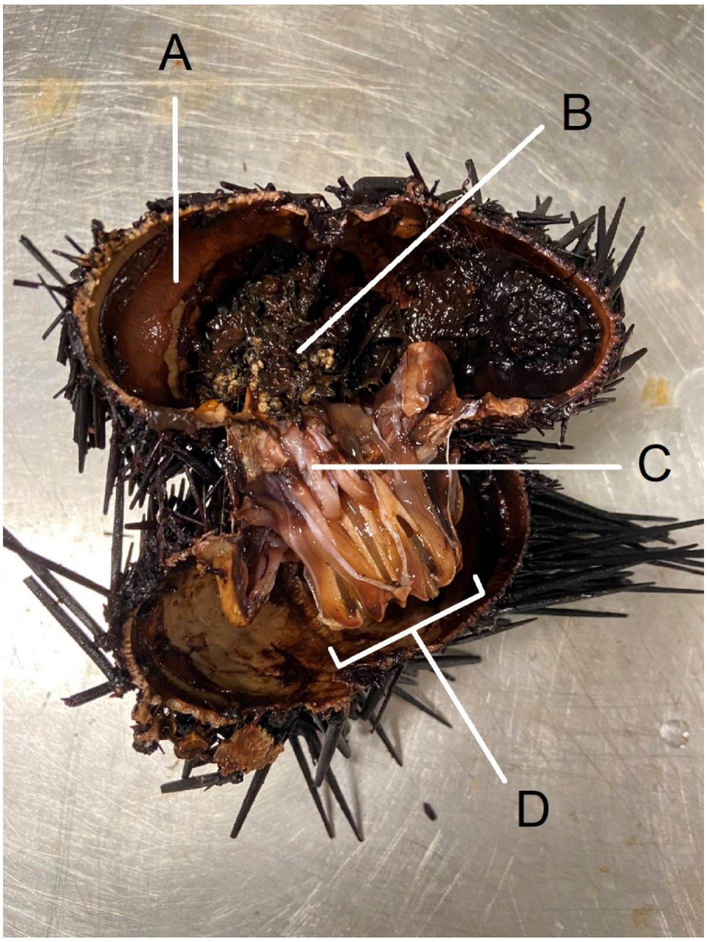

Fig. S2. Dissected urchin showing (A) an undamaged ray of roe material, (B) stomach contents and membranes, (C) white muscle tissue surrounding (D) the aristotle's lantern (feeding appendage).

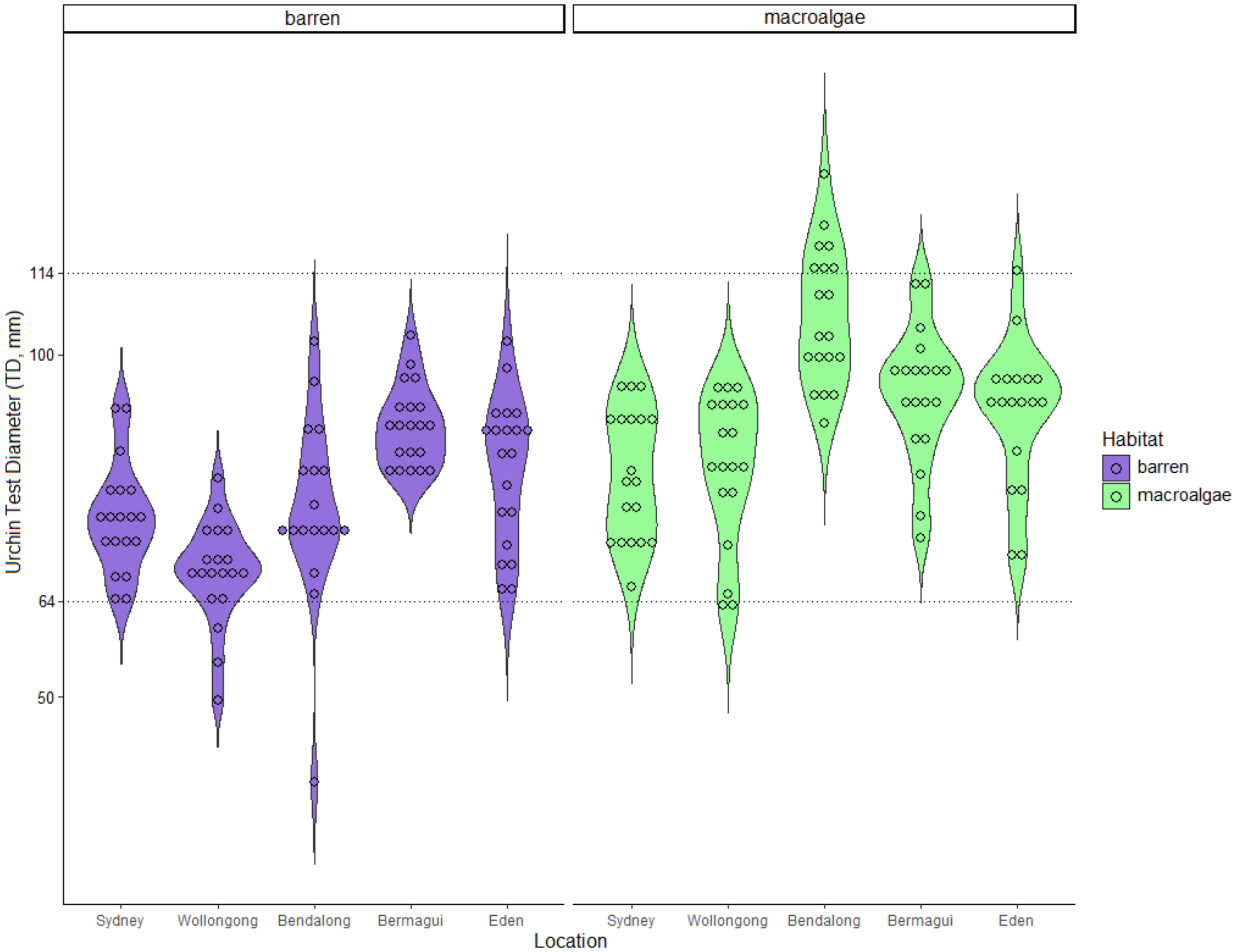

Fig. S3. Violin plot showing urchin sizes by location and habitat type. This plot shows the full size range of 190 *Centrostephanus rodgersii* (long-spined urchin) specimens collected, ranging from 37.5 mm – 126.5 mm Test Diameter (TD). Inflexion points for the urchin size range of 64-114 mm TD are shown by horizontal dotted lines and urchins falling within this size range were used for analysis, exclusively.

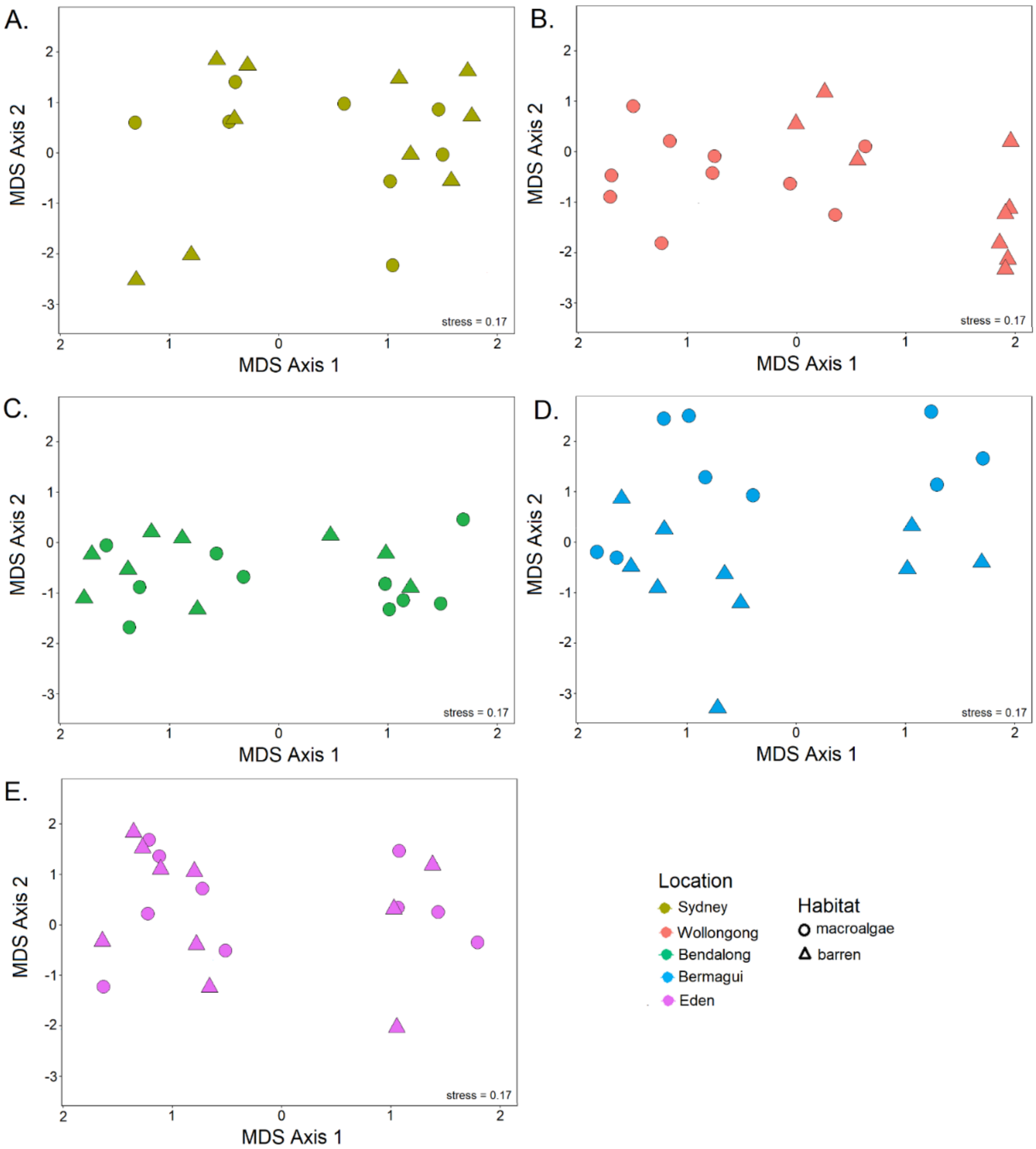

Fig. S4. Multi-Dimensional Scaling (MDS) plots representing gut contents composition (presence/absence) for urchins collected from macroalgae and barrens areas across south eastern Australia. Locations are shown separately for A. Sydney, B. Wollongong, C. Bendalong, D. Bermagui, and E. Eden with habitats shown by symbols (macroalgae = circles, barrens = triangles). Twenty individual urchins were dissected per location (n=10 per habitat, 100 urchins overall).

Table S1. Taxonomic classification scheme for (a) soft and (b) hard parts based on morphometrics taken from the literature (Endean 1955, Lawry 1967, Novikoff and Holsman 1970, Melack 1985, Rowan 1989, Mann and Jahns 1996, Zrzavý and Štys 1997, Tsakiris et al. 2004, Penney et al. 2007, Clements et al. 2008, Haug et al. 2012, Kupriyanova et al. 2016, Seesao et al. 2017, Williams 2017, Ab Lah et al. 2019, Boagle et al. 2020, Day et al. 2021). All observations were made using a dissecting microscope and items were identified to species level where possible.

	Character 1	Character 2	Character 3	Character 4	Species ID
(a) Soft parts					
Fleshy Green algae	Green colour	Fleshy	Translucent	NA	*Ulva australis*
Fleshy Brown algae	Brown colour	Fleshy	Opaque	NA	*Phyllospora comosa, Ecklonia radiata*
			Translucent	NA	*Padina* sp.
Fleshy Red algae	Red colour	Fleshy	In pieces	NA	*Asparagopsis taxiformis,* *Plocamium* sp. *Acrosorium* sp.
Filamentous Green algae	Green colour	Filamentous	Flocculated	NA	*Codium* sp.
Filamentous Brown algae	Brown colour	Filamentous	Flocculated	NA	NA
Filamentous Red algae	Red colour	Filamentous	Flocculated	NA	NA
Crustose coralline algae	$CaCO^3$ structures	Segmented	Red, pink, white	NA	*Amphiroa anceps,* *Corallina officinalis*
Seagrass		Rhizomes	Green, brown	NA	*Zostera spp.*

	Plant cell wall		Elongated		*Posidonia spp.*
Animal tissue		Animal cell wall	Organelles	Fleshy and soft	NA
Sponge			No organelles	Fleshy and rigid	NA
	Body pores	Spicules			
Nematode			Chitinous cuticle	Flexible cuticle	NA
	Body pores	Non-segmented			
Amphipod				NA	NA
	Body pores		Segmented		
Cunjevoi		Articulated		Bumpy membranes	*Pyura praeputialis*
	CaCO3 parts		Opaque		
		Brown			
	Fleshy		Translucent		
(b) Hard parts					
Polychaete	$CaCO^3$ tube	Chaetae	Cirri	Segmented	*Galeolaria caespitosa,* *Ficopomatus enigmaticus*
Decapod	$CaCO^3$ parts	Articulated	Segmented	Opaque	NA
Barnacle	$CaCO^3$ parts	No nacre	Few whorls	Interlocking plates	*Tetraclitella purpurascens,* *Amphibalanus variegatus*
Chiton	$CaCO^3$ parts	Little nacre	Few whorls	Interlocking plates	*Ischnochiton* spp.
Gastropod	$CaCO^3$ parts	Much nacre	Many whorls	No hairy filaments	*Lunella undulata*

			Few whorls		*Lunella torquata*
Mussel bivalve	$CaCO^3$ parts	Much nacre		Dark colour	*Mytilus edulis* or *M. galloprovencialis*
			Low profile		*Cellana* sp.
Limpet	$CaCO^3$ parts	Little nacre	Spine shape	Light colour	*Centrostephanus rodgersii*
Urchin	$CaCO^3$ parts	Spine hue		Presence of dye	*Heliocidaris erythrogramma*

Table S2. Tukey's pairwise comparisons as post-hoc testing for relationships between gonad amount (Gonad Index, 'GI') and gut fullness (Gut Fullness Index, 'GFI') shown via Likelihoods Ratio Testing (LRT) within a Generalized Linear Model (GLM). Significant values are shown in ($p < 0.05$) bold and marked with an asterisk (*)

Response	Predictor	comparison	model estimate	SE	df	t-ratio	*P*-value
GI	Bendalong	barren-macroalgae	-0.13	0.27	88	-0.49	0.62
GI	Bermagui	barren-macroalgae	-0.12	0.24	88	-0.50	0.62
GI	Eden	barren-macroalgae	0.19	0.24	88	0.82	0.42
GI	Sydney	barren-macroalgae	-0.37	0.24	88	-1.56	0.12
GI	Wollongong	barren-macroalgae	-1.14	0.26	88	-4.44	**<0.01***
GFI	Bendalong	barren-macroalgae	0.47	0.25	88	1.87	0.06
GFI	Bermagui	barren-macroalgae	-0.76	0.25	88	-3.1	**0.03***
GFI	Eden	barren-macroalgae	-0.13	0.2	88	-0.66	0.51
GFI	Sydney	barren-macroalgae	-0.13	0.23	88	-0.54	0.59
GFI	Wollongong	barren-macroalgae	-1.08	0.22	88	-4.83	**<0.01***

LITERATURE CITED: urchin gut contents taxonomy

Ab Lah R, Bucher D, Savins D, Dowell A, Benkendorff K (2019) Temporal variation in condition index and meat quality of *Lunella undulata* (Turbinidae), in relation to the reproductive cycle. Mollusc Res*,* 39:122–139

Bogale M, Baniya A, DiGennaro P (2020) Nematode identification techniques and recent advances. Plants, 9:1260. doi:10.3390/plants9101260

Clements R, Liew TS, Vermeulen JJ, Schilthuizen M (2008) Further twists in gastropod shell evolution. Biol Lett 4:179–182 doi:10.1098/rsbl.2007.0602

Day JK, Knott NA, Swadling DS Ayre DJ (2021) Dietary analysis and mesocosm feeding trials confirm the eastern rock lobster (*Sagmariasus verreauxi*) as a generalist predator that can avoid ingesting urchin spines during feeding. Mar Freshw Res 72:1220-1232

Endean R (1955) Studies of the blood and tests of some Australian ascidians. II. The test of *Pyura stolonifera* (Heller). Mar Fresh Res 6:139-156

Haug JT, Maas A, Haug C, Waloszek D (2012) Evolution of crustacean appendages. In: Watling L, Thiel M (eds) 'The Natural History of the Crustacea'. pp. 34–73 (Oxford University Press, New York, NY, USA.)

Kupriyanova E, Hutchings P, Wong E (2016) A fully illustrated web-based guide to distinguish native and introduced polychaetes of Australia. Manag Biol Invasions, 7:305-312

Lawry JV (1967) Structure and function of the parapodial cirri of the polynoid polychaete, Harmothoë. Zeitschrift für Zellforschung und Mikroskopische Anatomie*,* 82:345–361

Mann DG, Jahns HM (1995) 'Algae: an Introduction to Phycology', 1st edition. (Cambridge University Press: New York, NY, USA.)

Melack JM (1985) Interactions of detrital particulates and plankton. In: Davies BR, Walmsley RD (eds) 'Perspectives in Southern Hemisphere Limnology'. pp. 209–220 (Springer: Dordrecht, Netherlands.)

Novikoff AB, Holtzman E (1970) Cell organelles. In: 'Cells and Organelles', 2nd edition. pp.105–106 (Holt, Rinehart and Winston: New York, NY, USA.)

Penney RW, Hart MJ, Templeman ND (2007) Shell strength and appearance in cultured blue mussels *Mytilus edulis*, *M. trossulus*, and *M. edulis* × *M. trossulus* hybrids. Nor Amer Journ Aqua*,* 69:281–295

Rowan KS (1989) Photosynthetic Pigments of Algae. (Cambridge University Press: Cambridge, UK)

Seesao Y, Gay M, Merlin S, Viscogliosi E, Aliouat-Denis CM, Audebert C (2017) A review of methods for nematode identification. Journ Microbial Methods**,** 138:37-49

Tsakiris DP, Menciassi A, Sfakiotakis M, La Spina G, Dario P (2004) Undulatory locomotion of polychaete annelids: mechanics, neural control and robotic prototypes. In: 'Annual Computational Neuroscience Meeting', 18–22 July 2004, Baltimore, MD, USA. pp. 1–3. (Foundation for Research and Technology.)

Williams ST (2017). Molluscan shell colour. Biol Rev Cambr Philosl Soc 92:1039–1058

Zrzavý J, Štys (1997). The basic body plan of arthropods: insights from evolutionary morphology and developmental biology. Journl Evol Biol 10:353–367