Evolutionary loss of Shell Pigmentation, Pattern, and Eye Structure in Deep-Sea Snails in the Dysphotic Zone

ONLINE SUPPORTING INFORMATION

Suzanne T. Williams[1*], Emily S. Noone[1,2], Lisa Marie Smith[1,3] and Lauren Sumner-Rooney[4]

[1] *Department of Life Sciences, Natural History Museum, Cromwell Rd, SW7 5BD, United Kingdom*

[2] *Imperial College, Department of Life Sciences, Buckhurst Road, Ascot, Berks, SL5 7PY*

[3] *Current Address: National Institute of Water and Atmospheric Research, 301 Evans Bay Parade, Hataitai, Wellington 6021, New Zealand*

[4] *Leibniz Institute for Biodiversity and Evolution, Museum für Naturkunde, Invalidenstrasse 43, 10115 Berlin, Germany.*

*Corresponding author: Suzanne T. Williams; email: s.williams@nhm.ac.uk; ORCID-ID: **0000-0003-2995-5823**

Co-author emails: Emily Noone: emilynoone@talktalk.net; Lisa Smith: lisa.smith@niwa.co.nz; Lauren Sumner-Rooney: Lauren.Sumner-Rooney@mfn.berlin

Table S1 Table listing species, sampling details and GenBank Accession Numbers for all specimens included in Figure 2. Specimens with new sequence data are in bold (OK392049– OK392072; OK393746–OK393767; OK393769– OK393793; OK393794–OK393817).

Table S2. Morphological trait data. Species with new eye data are in bold font; where different, name used in Williams et al. (2013), Sumner-Rooney et al. (2016) or Williams et al. (2020) is given in parentheses. Pigmentation and pattern data are new to this study. Notes on depth indicate whether data came from molecular specimens only, with the reason in parentheses (species ID: only known from molecular samples; species delimitation: molecular results indicate that there is some confusion about species boundaries), or literature reports (references given).

Table S3. List of species examined under UV light.

Table S4 (in separate file). Fasta file of four gene alignment. Note that alignment excludes bases removed by Gblocks.

Table S5. Mean rate of change and 95% highest posterior density intervals (HPD) between character states for shell pigmentation, shell pattern and 'vision' in solariellid snails using an asymmetric, non-BSSVS substitution model, as implemented in BEAST and read in TRACER.

Table S6. Testing for correlation between morphological traits (pigmentation, pattern, 'vision') and depth. Depth bin and Log Marginal Likelihood (average of three runs) and Bayes Factor for each trait testing 500 Beast trees.

Figure S1. Local Moran's *I* (I_i) values for log transformed depth data, random data and Brownian model plotted onto the phylogenetic tree from Figure 2.

Table S1. Table listing species, sampling details and GenBank Accession Numbers for all specimens included in Figure 2. Specimens with new sequence data are in bold (OK392049– OK392072; OK393746–OK393767; OK393769– OK393793; OK393794–OK393817).

Species	Expedition	Station	Sample locality	Country	Latitude	Longitude	Depth (m)	Registration Number	28S	COI	16S	12S
Archiminolia sp 1	SALOMON2	DW2301	S Gatukai I.	Solomon Islands	9° 06.9' S	158° 20.6' E	267–329	MNHN IM-2007-18540	HF586167	HF586310	HF586019	HF585858
Archiminolia sp 2	EBISCO	DW2532	N Banc Nova	New Caledonia	22° 15' S	159° 27' E	350	MNHN IM-2007-34079	HF586174	HF586317	HF586026	HF585866
Archiminolia sp 3	PAPUA NIUGUINI	CP4016	E Umboi I., Dampier Strait	Papua New Guinea	05° 40'S	148° 14'E	208–285	MNHN IM-2013-19974	LT575949	LT575868	LT575903	LT575922
***Archiminolia* sp 4**	**NANHAI 2014**	**CP4115**	**Continental slope**	**China Seas**	**20° 03'N**	**114° 11'E**	**265–300**	**MNHN IM-2013-44414**	**OK393794**	**OK392049**	**OK393746**	**OK393769**
Arxellia boucheti Vilvens et al. 2014	NORFOLK2	DW2057	Norfolk Ridge	New Caledonia	24° 40' S	168° 39' E	555–565	MNHN IM-2009-17850	HF586161	HF586304	HF586014	HF585850
Arxellia helicoides Vilvens et al. 2014	BIOPAPUA	DW3687	Seamount S of Manus I.	Papua New Guinea	3° 04' S	147° 32' E	305–579	MNHN IM-2009-15189	HF586159	HF586302	HF586011	HF585848
Arxellia tenorioi (Poppe, Tagaro & Dekker, 2006)	PANGLAO2005	CP2394	Off Balicasag I.	Philippines	9° 28.6' N	123° 40.0' E	470–566	MNHN IM-2007-18424	HF586163	HF586306	HF586016	HF585854
***Arxellia thaumasta* Vilvens et al. 2014**	**ZHONGSHA 2015**	**DW4143**	**Seamount, W. off Macclesfield**	**China Seas**	**16° 02'N**	**113° 54'E**	**360–403**	**MNHN IM-2013-61841**	**OK393795**	**OK392050**	**OK393747**	**OK393770**
Arxellia tracheia Vilvens et al. 2014	BIOPAPUA	CP3721	Vitiaz Straight	Papua New Guinea	6° 03' S	147° 37' E	542–554	MNHN IM-2009-15183	HF586156	–	HF586008	HF585780
Arxellia tracheia Vilvens et al. 2014	PAPUA NIUGUINI	DW4005	SE Tuam I.	Papua New Guinea	06° 04'S	148° 08'E	440–480	MNHN IM-2013-19901	–	LT596070	–	–
Arxellia trochos Vilvens et al. 2014	EXBODI	DW3862	Banc de L'Orne/Walpole	New Caledonia	22° 20'S	169° 01'E	400–520	MNHN IM-2009-23092	LT596066	LT596073	LT596063	LT596059
***Bathymophila bairdi* (Dall, 1889)**	**KARUBENTHOS 2015**	**DW4630**	**W Marie-Galante**	**Guadeloupe**	**15° 48'N**	**61° 28'W**	**379–428**	**MNHN IM-2013-61300**	**OK393796**	**OK392051**	**OK393748**	**OK393771**
***Bathymophila* sp 6**	**EXBODI**	**DW3938**	**Récif Pétrie**	**New Caledonia**	**18° 36'S**	**164° 24'E**	**505–761**	**MNHN IM-2009-23090**	**OK393797**	**OK392052**	**OK393749**	**OK393772**
Bathymophila sp 7	EXBODI	DW3879	Ile Matthew-Volcan	New Caledonia	22° 19'S	171° 20'E	925	MNHN IM-2009-23095	LT575952	OK501982	LT575907	LT575927
Bathymophila sp 9	CONCALIS	DW3023	Grand Passage	New Caledonia	19° 00' S	163° 26' E	285–300	MNHN IM-2007-35590	HF586100	HF586241	HF585949	HF585779
Bathymophila sp 10	BIOPAPUA	CP3724	Vitiaz Straight	Papua New Guinea	05° 59' S	147° 39' E	860–880	MNHN IM-2009-15182	OK491642	HF586242	HF585950	HF585781
Bathymophila sp 11	TARASOL	DW3369	Niau	Tuamotu Archipelago	16° 08' S	146° 24' W	412–520	MNHN IM-2009-15175	HF586102	HF586243	HF585951	HF585787
Bathymophila sp 15	T/V Nagasaki-maru, N226	dredge A	SW of Nagasaki, Kyushu I.	Japan	32° 10' N	129° 30' E	470–487	YK1383	HF586103	HF586244	HF585952	HF585782
Bathymophila sp 16	BOA1	CP2473	Between Ambrim and Malekula	Vanuatu	16° 19' S	167° 47' E	657–685	YK1385	HF586104	–	HF585953	HF585783
Bathymophila sp 19	EXBODI	DW3877	N Ile Matthew-Volcan	New Caledonia	22° 17'S	171° 18'E	785	MNHN IM-2009-23081	LT575960	–	LT575914	LT575935
Bathymophila sp 20	EXBODI	DW3879	Ile Matthew-Volcan	New Caledonia	22° 19'S	171° 20'E	925	MNHN IM-2009-23102	OK491643	LT575882	LT575913	LT575934
***Bathymophila* sp 27**	**KAVIENG 2014**	**DW4495**	**New Ireland**	**Papua New Guinea**	**02° 24'S**	**149° 55'E**	**272–274**	**MNHN IM-2013-59008**	**OK393798**	**–**	**–**	**OK393773**

Bathymophila' sp 18	EXBODI	DW3879	Ile Matthew-Volcan	New Caledonia	22° 19'S	171° 20'E	925	MNHN IM-2009-23080	LT575953	LT575877	LT575908	LT575929
***Bathymophila*-Like sp 23**	**EXBODI**	**DW3785**	**Canal de l' Havannah**	**New Caledonia**	**22° 15'S**	**167° 10'E**	**386–387**	**MNHN IM-2009-23105**	**OK393799**	**OK392053**	**OK393750**	**OK393774**
***Bathymophila*-Like sp 26**	**EXBODI**	**DW3886**	**Volcan-Mont Vauban**	**New Caledonia**	**22° 22'S**	**171° 42'E**	**249–269**	**MNHN IM-2009-23084**	**OK393800**	**OK392054**	**–**	**OK393775**
***Bathymophila*-Like sp 28**	**KAVIENG 2014**	**DW4484**	**New Ireland**	**Papua New Guinea**	**02° 26'S**	**149° 55'E**	**229**	**MNHN IM-2013-58876**	**OK393801**	**OK392055**	**–**	**OK393776**
Chonospeira nuda (Dall, 1896)	MAINBAZA	CP3140	Maputo transect	Mozambique Channel	23° 33' S	36° 02' E	886–898	MNHN IM-2009-8739	HE800720	HE800621	HE800760	HE800671
Clade D '*Suavotrochus*' sp 1	T/V Nagasaki-maru, N295	R-2(3)	W of Amami I.	Japan	28° 36' N	127° 04' E	704–730	YK1382	HF586198	HF586343	HF586049	HF585897
Clade D '*Machaeroplax*' *delicatus* (Dall 1919)	R/V Tansei-maru, KT-11-12	T10-2	Off Cape Toi, Miyazaki, Kyushu I.	Japan	31° 07' N	131° 39' E	1063–1082	YK1484	HF586197	HF586342	HF586048	HF585896
Elaphriella cantharos Vilvens & Williams, 2016	SALOMON2	CP2243	W Vella, Lavella I.	Solomon Islands	7° 42.9' S	156° 27.3' E	518–527	MNHN IM-2009-43073	HF586063	HF586208	HF585913	HF585736
Elaphriella helios Vilvens & Williams, 2016	PANGLAO2005	CP2398	Bohol Sea, off Balicasag I.	Philippines	9° 32.6' N	123° 40.5' E	713–731	MNHN IM-2007-18426	HF586060	HF586206	HF585910	HF585732
Elaphriella leia Vilvens & Williams, 2016	SALOMON2	DW2259	Kolombangara I., Vella Gulf	Solomon Islands	8° 03.7' S	156° 55.0' E	396–423	MNHN IM-2007-18539	HF586061	HF586207	HF585911	HF585733
***Elaphriella paulinae* Vilvens & Williams, 2016**	**EXBODI**	**CP3871**	**Banc Ellet**	**New Caledonia**	**22° 53'S**	**169° 25'E**	**580–780**	**MNHN IM-2009-23096**	**OK393802**	**OK392056**	**OK393751**	**OK393777**
Elaphriella wareni Vilvens & Williams, 2016	SALOMON2	CP2249	NW Vella, Lavella I.	Solomon Islands	7° 31' S	156° 18' E	782–884	MNHN IM-2009-13008	HF586059	–	HF585909	HF585730
Elaphriella sp 7	T/V Nagasaki-maru, N226	dredge A	SW of Nagasaki, Kyushu I.	Japan	32° 10' N	129° 30' E	470–487	YK1384	HF586069	HF586210	HF585919	HF585743
Elaphriella sp 9	PAPUA NIUGUINI	DW4004	SE Tuam I., Papua New Guinea	Papua New Guinea	06° 03'S	148° 08'E	440	MNHN IM-2013-19896	LT575961	LT575884	LT575915	LT575938
Ilanga biradiatula (E. von Martens, 1902)	MAINBAZA	CP3135	Maputo transect	Mozambique Channel	25° 13' S	35° 18' E	480–503	MNHN IM-2009-8740	HE800723	HE800624	HE800763	HE800674
Ilanga boreia Vilvens & Williams, 2020	EBISCO	CP2571	N Bellona	New Caledonia	20° 25' S	158° 45' E	298–309	MNHN IM-2007-34080	HF586141	HF586282	HF585991	HF585826
Ilanga comes Vilvens & Williams, 2020	PANGLAO2004	T27	Between Panglao I. and Pamilacan I.	Philippines	9° 33.4' N	123° 51.0' E	106–137	MNHN IM-2009-13003	HF586126	HF586267	HF585977	HF585810
***Ilanga corrineae* Vilvens & Williams, 2020**	**KAVIENG 2014**	**DW4473**	**New Ireland**	**Papua New Guinea**	**02° 43'S**	**150° 36'E**	**93–149**	**MNHN IM-2013-58754**	**OK393803**	MK393384	**OK393752**	**OK393778**
Ilanga discus Herbert, 1987	MIRIKY	CP3188	Between Nosy-bé and Banc du Leven	Madagascar	12° 31' S	48° 22' E	298–301	MNHN IM-2009-8760	HF586110	HF586249	HF585960	HF585792

***Ilanga dongshaensis* Vilvens & Williams, 2020**	**ZHONGSHA 2015**	**DW4158**	**N. off DongSha**	**China Seas**	**21° 05'N**	**116° 44'E**	**310–325**	**MNHN IM-2013-59760**	**OK393804**	MK393376	**OK393753**	**OK393779**
Ilanga eurystoma Vilvens & Williams, 2020	BIOPAPUA	DW3745	Seamount off Bougainville	Papua New Guinea	5° 33' S	154° 00' E	369–377	MNHN IM-2009-15190	HF586107	HF586246	HF585957	HF585789
Ilanga fulgens (Dall, 1907)	PANGLAO2005	CP2344	Bohol Sea, off Pamilacan I.	Philippines	9° 28.4' N	123° 50.1' E	128–142	MNHN IM-2007-18421	HF586120	HF586259	HF585970	HF585802
Ilanga harrytaylori Vilvens & Williams, 2020	CONCALIS	CP3010	Grand Passage	New Caledonia	18° 46' S	163° 19' E	603	MNHN IM-2007-35581	HF586132	HF586273	HF585983	HF585817
Ilanga helicoides Vilvens & Williams, 2020	SALOMON2	CP2287	E Rendova I.	Solomon Islands	8° 40.8' S	157° 24.6' E	253–255	MNHN IM-2009-13307	–	–	HF585955	HF585883
Ilanga herberti Vilvens & Williams, 2020	MAINBAZA	CP3143	Maputo transect	Mozambique Channel	23° 32' S	35° 46' E	264–277	MNHN IM-2009-15174	HF586106	–	HF585956	HF585890
Ilanga laevissima (E. von Martens, 1881)	NMDP (Africana)	St A 18994 D	Plettenberg Bay, S Cape	South Africa	34° 19.5' S	23° 30' E	104	NMSA V4397	HF586151	HF586293	HF586003	HF585788
Ilanga mesembrine Vilvens & Williams, 2020	TERRASSES	CP3087	SE Terrasses	New Caledonia	22° 11' S	167° 12' E	380–400	MNHN IM-2009-8808	HF586148	HF586289	HF585998	HF585835
Ilanga navakaensis (Ladd, 1982)	SANTO2006	no data	no data	Vanuatu	no data	no data	no data	MNHN IM-2007-18447	HF586128	HF586269	HF585979	HF585813
Ilanga oxeia Vilvens & Williams, 2020	BOA1	CP2413	Malo I.	Vanuatu	15° 42' S	167° 02' E	268–445	MNHN IM-2007-18301	HF586114	OK501978	HF585964	HF585796
Ilanga stephanophora Vilvens & Williams, 2020	CONCALIS	CP2961	Grand Passage	New Caledonia	19° 04' S	163° 11' E	220–390	MNHN IM-2007-35578	HF586123	HF586264	HF585974	HF585807
***Ilanga undata sphinx* Herbert, 1987**	**Dredged M. Els, 11/11/2013**	**–**	**East London, 20 km off harbour, East Cape**	**South Africa**	**33° 10'S**	**28° 02'E**	**90**	**NMSA W9630**	**–**	**OK392057**	**OK393754**	**–**
***Ilanga whitechurchi* (W. H. Turton, 1932)**	**Dredged M. Els, 11/11/2013**	**–**	**East London, 20 km off harbour, East Cape**	**South Africa**	**33° 10'S**	**28° 02'E**	**90**	**NMSA W9631**	**–**	**–**	**OK393755**	**–**
Ilanga sp 18	NMDP (Africana)	St A 18178 D	S of Tsitsikamma, W Cape	South Africa	34° 25' S	24° 00' E	115	NMSA V3139	–	–	HF586002	–
***Lamellitrochus tubula* (Dall, 1927)**	**KARUBENTHOS 2015**	**DW4630**	**W Marie-Galante**	**Guadeloupe**	**15° 48'N**	**61° 28'W**	**379–428**	**MNHN IM-2013-61302**	**OK393805**	**OK392058**	**OK393756**	**OK393780**
Lamellitrochus* sp 1 *cf lamellosus	**KARUBENTHOS 2015**	**DW4641**	**S Marie-Galante**	**Guadeloupe**	**15° 45'N**	**61° 10'W**	**621–626**	**MNHN IM-2013-61478**	**OK393806**	**OK392059**	**OK393757**	**OK393781**
***Lamellitrochus* sp 3**	**KARUBENTHOS 2015**	**DW4637**	**S Marie-Galante**	**Guadeloupe**	**15° 52'N**	**61° 20'W**	**217–225**	**MNHN IM-2013-61432**	**OK393807**	**OK392060**	**OK393758**	**OK393782**
***Lamellitrochus* sp 5**	**KARUBENTHOS 2015**	**DW4630**	**W Marie-Galante**	**Guadeloupe**	**15° 48'N**	**61° 28'W**	**379–428**	**MNHN IM-2013-61307**	**OK393808**	**OK392061**	**OK393759**	**OK393783**
***Lamellitrochus* sp 6**	**KARUBENTHOS 2015**	**DW4553**	**E La Désirade**	**Guadeloupe**	**16° 21'N**	**60° 54'W**	**111–162**	**MNHN IM-2013-60491**	**OK393809**	**OK392062**	**OK393760**	**OK393784**
Lamellitrochus* sp 7 *cf quadricinta	**KARUBENTHOS 2015**	**DW4590**	**W Marie-Galante**	**Guadeloupe**	**15° 57'N**	**61° 27'W**	**83–135**	**MNHN IM-2013-60946**	**OK393810**	**OK392063**	**OK393761**	**OK393785**

Lamellitrochus* sp 8 *cf lacunella	**KARUBENTHOS 2015**	**DW4575**	**E La Désirade**	**Guadeloupe**	**16° 21'N**	**60° 53'W**	**79–165**	**MNHN IM-2013-60801**	**OK393811**	**OK392064**	**OK393762**	**OK393786**
Microgaza rotella (Dall, 1881)	KARUBENTHOS 2012	GN22	Guadeloupe	Guadeloupe	16° 25'N	61° 33'W	120	MNHN IM-2013-31167	LT575967	LT575901	LT575919	LT575944
***Microgaza* sp 1**	**KARUBENTHOS 2015**	**DW4637**	**S Marie-Galante**	**Guadeloupe**	**15° 52'N**	**61° 20'W**	**217–225**	**MNHN IM-2013-61433**	**OK393812**	**OK392065**	**OK393763**	**OK393787**
Minolia nyssonus (Dall, 1919)	T/V Seisui-maru, 96-05	D-4	E of Daiozaki, Mie, Honshu I.	Japan	34° 17' N	137° 10' E	263	YK1355	HF586152	HF586294	HF586004	HF585838
Minolia punctata A. Adams, 1860	–	Misaki Marine Biological Station	Off Misaki, Kanagawa, Honshu I.	Japan	35° 09' N	139° 35' E	80	YK1379	HF586155	HF586297	HF586007	HF585841
Minolia watanabei (Shikama, 1962)	R/V Wakataka-maru, Leg. 3	EF350	Off Kinkazan, Miyagi, Honshu I.	Japan	37° 59' N	141° 59' E	350	YK1464	HF586105	HF586245	HF585954	HF585784
Minolia sp 1	–	Misaki Marine Biological Station	Off Misaki, Kanagawa, Honshu I.	Japan	35° 09' N	139° 35' E	80	YK0205	HF586154	AB365226	HF586006	HF585840
***Phragmomphalina alabida* (B. A. Marshall, 1979)**	**RV Karehoa**	**2000044**	**S Kermadec Ridge, Rumble III volcano**	**New Zealand**	**35° 43.42' S**	**178° 29.28' E**	**523**	**NMNZ M.299686**	**–**	**OK392066**	**–**	**HF585776**
Phragmomphalina diadema (B. A. Marshall, 1999)	TERRASSES	DW3040	Mont J	Loyalty Ridge	23° 58' S	169° 43' E	750–780	MNHN IM-2009-8802	HF586083	HF586225	HF585933	HF585760
Phragmomphalina vilvensi Herbert & Williams, 2020	MIRIKY	CP3221	Between Nosy-bé and Banc du Leven	Madagascar	12° 47' S	48° 08' E	782	MNHN IM-2009-8762	HF586089	HF586230	HF585939	HF585765
Phragmomphalina sp 1	CONCALIS	DW2993	Grand Passage	New Caledonia	18° 00' S	163° 02' E	700–730	MNHN IM-2007-35577	HF586077	HF586218	HF585927	HF585751
Phragmomphalina sp 2	BORDAU1	DW1432	–	Fiji	17° 20' S	178° 44' W	477–493	MNHN NR	–	–	–	HF585777
Phragmomphalina sp 3	BIOPAPUA	CP3747	Seamounts near Bougainville	Papua New Guinea	05° 33’S	153° 59’E	458	MNHN IM-2009-15206	–	OK501981	–	–
Solariella amabilis (Jeffreys, 1865) (*affinis* form)	R/V 'Harry Borthen'	–	Møre og Romsdal county, Vanylven, Rovdefjorden, NE of Kropperevet	Norway	62° 11.45' N	5° 34' E	150–200	NHMUK 20120233	–	HF586321	HF586029	HF585872
Solariella chodon Vilvens, 2009	PANGLAO2004	T26	Boholi I., Cortes	Philippines	9° 43.3' N	123° 48.8' E	123–135	MNHN IM-2007-18348	HF586180	HF586325	HF586033	–
Solariella segersi (Poppe, Tagaro & Dekker, 2006)	PANGLAO2005	CP2344	Bohol Sea, off Balicasag I.	Philippines	9° 28.4' N	123° 50.1' E	128–142	MNHN IM-2007-18422	HF586177	HF586322	HF586030	HF585875
Solariella sp 6	SALOMON2	DW2169 [?]	Russel I., W Bay	Solomon Islands	9° 01.1' S	159° 05.7' E	100–200	MNHN IM-2007-18537	–	HF586338	–	HF585891
***Solariella* sp 9**	**EXBODI**	**DW3888**	**Mont Vauban Partie Sud-Est**	**New Caledonia**	**22° 24'S**	**171° 38'E**	**300**	**MNHN IM-2009-23086**	**OK393813**	**OK392067**	**–**	**OK393788**
***Solariella' carvalhoi* Lopes & Cardoso, 1958**	**KARUBENTHOS 2015**	**DW4630**	**W Marie-Galante**	**Guadeloupe**	**15° 48'N**	**61° 28'W**	**379–428**	**MNHN IM-2013-61297**	**OK393814**	**OK392068**	**OK393764**	**OK393789**

Solariella' varicosa (Mighels & C. B. Adams, 1842)	R/V 'Asterias'	–	Finnmark county, Varangerfjorden, SW of Vestre Jakobselv	Norway	70° 4' N	29° 12' E	10–174	NHMUK 20120235	–	–	–	HF585720
Spectamen bellulum (Angas, 1869)	–	–	N Moreton I., Moreton Bay, Queensland	Australia	26° 56.60' S	153° 24.25' E	31	NHMUK 20110452	HE800726	HF586320	HF586028	HF585870
Spectamen laevior (Schepman, 1908)	PANGLAO2005	CP2344	Bohol Sea, off Balicasag I.	Philippines	9° 28.4' N	123° 50.1' E	128–142	MNHN IM-2007-18428	HF586187	HF586332	HF586039	HF585882
Spectamen mutabile (Schepman, 1908)	T/V Nagasaki-maru	N319, st. G3	W of Kusagaki Is, Kyushu	Japan	30° 39' N	127° 54' E	298–299	YK1462	HF586190	HF586336	HF586041	HF585886
Spectamen sp 1	PANGLAO2004	T39	W Pamilacan I., Cervera Shoal	Philippines	9° 30.1' N	123° 50.4' E	100–138	MNHN IM-2007-18351	HF586186	HF586331	HF586038	HF585881
Spectamen sp 4	CSIRO RV 'Southern Surveyor'	SS1005/042	Off Bald I., Western Australia	Australia	35° 16.11' S	118° 43.12' E	973–999	WAM S25789	OK491649	HF586319	HF586027	HF585869
***Spectamen* sp 7**	**ZHONGSHA 2015**	**CP4149**	**N. Macclesfield bank**	**China Seas**	**16° 07'N**	**114° 23'E**	**162–165**	**MNHN IM-2013-59758**	**OK393815**	**OK392069**	**OK393765**	**OK393790**
***Suavotrochus lubricus* (Dall, 1881)**	**KARUBENTHOS 2015**	**DW4630**	**W Marie-Galante**	**Guadeloupe**	**15° 48'N**	**61° 28'W**	**379–428**	**MNHN IM-2013-61322**	**OK393816**	**OK392070**	**OK393766**	**OK393791**
***Suavotrochus* sp 1**	**KARUBENTHOS 2015**	**CP4643**	**S Marie-Galante**	**Guadeloupe**	**15° 45'N**	**61° 09'W**	**609–611**	**MNHN IM-2013-61520**	**OK393817**	**OK392071**	**OK393767**	**OK393792**
***Zetela kopua* B. A. Marshall, 1999**	**RV Tangaroa**	**2003209**	**Seamount WNW of Three Kings Is**	**New Zealand**	**34° 02.88' S**	**171° 08.18' E**	**1145–1185**	**NMNZ M.160804**	**OK491650**	**OK392072**	**–**	**OK393793**
Zetela sp 1	MAINBAZA	CP3138	Maputo transect	Mozambique Channel	25° 13' S	35° 21' E	700–707	MNHN IM-2009-8748	HF586195	HF586341	OK534151	HF585895
Zetela sp 2	ANDEEP III	PS67/074-6-E	Eastern Weddell Sea	Antarctica	71° 18.35' S	13° 57.71' W	1030	NHMUK 20120236	HF586050	HF586199	HF585898	HF585714
Zetela sp 3	LAMPOS ANDEEP	150-1	Burdwood Bank	Antarctica	54° 30.22' S	56° 8.20' W	286–290	NHMUK 20120238	HF586051	HF586200	OK534152	HF585715

Table S2. Morphological trait data. Species with new eye data are in bold font; where different, name used in Williams et al. (2013), Sumner-Rooney et al. (2016) or Williams et al. (2020) is given in parentheses. Pigmentation and pattern data are new to this study. Notes on depth indicate whether data came from molecular specimens only, with the reason in parentheses (species ID: only known from molecular samples; species delimitation: molecular results indicate that there is some confusion about species boundaries), or literature reports (references given).

Species	**Minimum Depth (m)[a]**	**Pigmentation**	**Pattern**	**'Vision'**	**Notes on Depth**
Archiminolia sp 1	267	1	0	1	molecular data only (species ID)
Archiminolia sp 2	318	1	1	1	molecular data only (species ID)
Archiminolia sp 3	208	1	1	1	molecular data only (species ID)
***Archiminolia* sp 4**	298	1	1	1	molecular data only (species ID)
***Arxellia boucheti* Vilvens et al. 2014 (Clade A sp 4)**	402	1	0	1	Vilvens et al. 2014
Arxellia helicoides Vilvens et al. 2014 (Clade A sp 1)	402	1	0	1	Vilvens et al. 2014
Arxellia tenorioi (Poppe, Tagaro & Dekker, 2006)	242	0	0	1	Vilvens et al. 2014; Poppe et al. 2006
***Arxellia thaumasta* Vilvens et al. 2014 (Clade A sp 6)**	479	0	0	1	Vilvens et al. 2014; new molecular data
Arxellia tracheia Vilvens et al. 2014 (Clade A sp 3)	440	1	0	1	Vilvens et al. 2014; new molecular data
Arxellia trochos Vilvens et al. 2014	471	0	0	1	Vilvens et al. 2014
***Bathymophila bairdi* (Dall, 1889)**	366	0	0	0	Quinn, 1979
Bathymophila sp 6	650	0	0	0	molecular data only (species ID)
Bathymophila sp 7	925	0	0	0	molecular data only (species ID)
Bathymophila sp 9	285	0	0	0	molecular data only (species ID)
Bathymophila sp 10	860	0	0	0	molecular data only (species ID)
Bathymophila sp 11	412	0	0	0	molecular data only (species ID)
Bathymophila sp 15	470	0	0	0	molecular data only (species ID)
Bathymophila sp 16	657[b]	1	0	0	molecular data only (species ID)
Bathymophila sp 19	785	0	0	0	molecular data only (species ID)
Bathymophila sp 20	925	0	0	0	molecular data only (species ID)
***Bathymophila* sp 27**	272	0	0	0	molecular data only (species ID)
Bathymophila' sp 18	925	0	0	0	molecular data only (species ID)
***Bathymophila*-Like sp 23**	350	0	0	1	molecular data only (species ID)
***Bathymophila*-Like sp 26**	249	1	1	1	molecular data only (species ID)
***Bathymophila*-Like sp 28**	229	1	1	1	molecular data only (species ID)
Chonospeira nuda (Dall, 1896) (Clade B sp 2)	545	0	0	1	Dall (1896); molecular data
Clade D '*Suavotrochus*' sp 1	704	0	0	0	molecular data only (species ID)
Clade D '*Machaeroplax*' *delicatus* (Dall 1919)	500	0	0	0	Okutani, 2000; Hasegawa, 2009
Elaphriella cantharos Vilvens & Williams, 2016 (*E. khantaros* Clade C sp 5)	328	1	1	0	Vilvens & Williams, 2016; molecular data

Elaphriella helios Vilvens & Williams, 2016 (Clade C sp 3)	713	0	0	1	Vilvens & Williams, 2016
***Elaphriella leia* Vilvens & Williams, 2016 (Clade C sp 4)**	423	1	1	1	Vilvens & Williams, 2016; molecular data
Elaphriella paulinae Vilvens & Williams, 2016 (Clade C sp 8)	692	1	1	0	Vilvens & Williams, 2016
Elaphriella wareni Vilvens & Williams, 2016 (Clade C sp 2)	800	0	0	0	Vilvens & Williams, 2016; molecular data
Elaphriella sp 7 (*Elaphriella* n. s. 1)	470	1	0	1	molecular data only (species ID)
Elaphriella sp 9 (*Elaphriella* n. s. 2)	440	1	0	1	molecular data only (species ID)
Ilanga biradiatula (E. von Martens, 1902)	90	1	1	1	Vilvens & Williams, 2020; Herbert, 1987; Marshall, 1999; molecular data
Ilanga boreia Vilvens & Williams, 2020 (*Ilanga* 9)	304	1	1	1	Vilvens & Williams, 2020
Ilanga comes Vilvens & Williams, 2020 (*Ilanga* 12)	106	1	1	1	Vilvens & Williams, 2020; molecular data
Ilanga corrineae Vilvens & Williams, 2020 (*Ilanga* 21)	101	1	1	1	Vilvens & Williams, 2020
Ilanga discus Herbert, 1987	165	1	1	1	Vilvens & Williams, 2020; Herbert, 1987
***Ilanga dongshaensis* Vilvens & Williams, 2020**	309	1	1	1	Vilvens & Williams, 2020
Ilanga eurystoma Vilvens & Williams, 2020 (*Ilanga* 1)	377	1	1	1	Vilvens & Williams, 2020
Ilanga fulgens (Dall, 1907) (*Ilanga* 4 & 17)	50	1	1	1	Vilvens & Williams, 2020; Poppet al. 2006; Okutani, 2000
Ilanga harrytaylori Vilvens & Williams, 2020 (*Ilanga* cf. *norfolkensis*)	437	1	1	1	Vilvens & Williams, 2020
***Ilanga helicoides* Vilvens & Williams, 2020 (*Ilanga* 20)**	255	1	1	1	Vilvens & Williams, 2020
Ilanga herberti Vilvens & Williams, 2020 (*Ilanga* 11)	264	1	1	1	Vilvens & Williams, 2020
Ilanga laevissima (E. von Martens, 1881)	50	1	1	1	Vilvens & Williams, 2020; Herbert, 1987
Ilanga mesembrine Vilvens & Williams, 2020 (*Ilanga* 10)	290	1	1	1	Vilvens & Williams, 2020
Ilanga navakaensis (Ladd, 1982) (*Ilanga* 6)	10	1	1	1	Vilvens & Williams, 2020; molecular data
Ilanga oxeia Vilvens & Williams, 2020 (*Ilanga* 3 & 15)	268	1	1	1	Vilvens & Williams, 2020
Ilanga stephanophora Vilvens & Williams, 2020 (*Ilanga* 5 & 16)	82	1	1	1	Vilvens & Williams, 2020
***Ilanga undata sphinx* Herbert, 1987**	90	1	1	1	Herbert, 1987
***Ilanga whitechurchi* (W. H. Turton, 1932)**	60	1	1	1	Herbert, 1987
***Ilanga* sp 18**	115	1	1	1	molecular data only (species ID)
***Lamellitrochus tubula* (Dall, 1927)**	353	1	0	1	Quinn, 1979
Lamellitrochus* sp 1 *cf lamellosus	621	0	0	1	molecular data only (species ID)
***Lamellitrochus* sp 3**	217	1	1	1	molecular data only (species ID)
***Lamellitrochus* sp 5**	379	0	0	1	molecular data only (species ID)
***Lamellitrochus* sp 6**	111	1	1	1	molecular data only (species ID)
Lamellitrochus* sp 7 *cf quadricinta	83	1	1	1	molecular data only (species ID)
Lamellitrochus* sp 8 *cf lacunella	165	1	1	1	molecular data only (species ID)
Microgaza rotella (Dall, 1881)	1	1	1	1	molecular data only (species delimitation)
***Microgaza* sp 1**	217	1	1	1	molecular data only (species delimitation)
Minolia nyssonus (Dall, 1919)	50	0	0	1	Okutani, 2000

Minolia punctata A. Adams, 1860	50	1	1	1	Okutani, 2000
Minolia watanabei (Shikama, 1962)	350	1	0	1	molecular data only (species delimitation)
Minolia sp 1	80	1	1	1	molecular data only (species ID)
Phragmomphalina alabida (B. A. Marshall, 1979)	523	1	1	0	Marshall, 1979, 1999; molecular data
Phragmomphalina diadema (B. A. Marshall, 1999)	430	1	1	0	Marshall, 1999; molecular data
Phragmomphalina vilvensi Herbert & Williams, 2020 (*Bathymophila* sp. 4)	580	1	1	0	Willliams et al. 2020; molecular data
Phragmomphalina sp 1 (*Bathymophila* sp. 2)	300	1	1	0	molecular data only (species ID)
Phragmomphalina sp 2 (*Bathymophila* sp. 14)	477	1	1	0	molecular data only (species ID)
Phragmomphalina sp 3 (*Bathymophila* sp. 21)	458	1	1	1	molecular data only (species ID)
Solariella amabilis (Jeffreys, 1865) (*affinis* form)	150	0	0	1	Warén, 1993
Solariella chodon Vilvens, 2009	123	1	1	1	molecular data only (Vivlens, 2009 - dead spec only)
Solariella segersi (Poppe, Tagaro & Dekker, 2006)	50	1	1	1	Poppe et al. 2006
Solariella sp 6	100	1	1	1	molecular data only (species ID)
***Solariella* sp 9**	300	1	1	1	molecular data only (species ID)
***'Solariella' carvalhoi* Lopes & Cardoso, 1958**	0	1	1	1	Cavallari et al., 2016; molecular data
Solariella' varicosa (Mighels & C. B. Adams, 1842)	5	0	0	1	Warén, 1993
Spectamen bellulum (Angas, 1869) (*Spectamen philippensis)*	31	1	1	1	molecular data only (species delimitation)
Spectamen laevior (Schepman, 1908)	128	0	0	1	molecular data only (species delimitation)
Spectamen mutabile (Schepman, 1908)	295	1	1	1	molecular data only (species delimitation)
Spectamen sp 1	100	1	1	1	molecular data only (species ID)
Spectamen sp 4	973	1	1	1	molecular data only (species ID)
***Spectamen* sp 7**	162	0	0	1	molecular data only (species ID)
***Suavotrochus lubricus* (Dall, 1881)**	379	0	0	1	molecular data only (species delimitation)
***Suavotrochus* sp 1**	609	0	0	0	molecular data only (species ID)
***Zetela kopua* B. A. Marshall, 1999**	1185	0	0	1	Marshall, 1999; molecular data
Zetela sp 1	700	0	0	0	molecular data only (species ID)
Zetela sp 2	1030	0	0	1	molecular data only (species ID)
Zetela sp 3	272	0	0	1	molecular data only (species ID)

[a] Molecular specimens were primarily collected in trawls, which may range over hundreds of metres in depth. For these specimens we therefore conservatively follow Bouchet et al. (2008) in taking the "inner values of the deepest and shallowest stations" where specimens were collected from multiple stations. "For instance, if a species has been collected at six stations at depths of, for example, 611–636 m, 582–594 m, 693–811 m, 749–799 m, 283–405 m, and 350–800 m, the combined confirmed bathymetric range is 405–749 m" (Bouchet et al. 2008, p. 15).

[b] Assignment of shell pigmentation was straightforward for all but *Bathymophila* sp 16, which had a yellowish iridescent shell. Comparison with *Bathymophila* sp 15, which also had a yellow nacreous shell layer and a partially corroded white chalky shell layer on top, suggests that the yellow shell in *Bathymophila* sp 16 may also be nacreous shell layer exposed by complete corrosion of the overlying layer of shell, but in the absence of that layer, the yellow colouration was conservatively scored as pigmentation occurring in the outer shell layer.

Table S3. List of species examined under UV light.

Lamellitrochus cf quadricinta MNHN IM-2013-60946, 83–135 m;
Spectamen bellulum, NHMUK 20110452, 31 m;
Spectamen sp. 4 WAM S25789, 973–999 m;
Microgaza rotella MNHN IM-2013-20336, 1 m;
Archiminolia sp 4 MNHN IM-2013-44414, 265–300 m;
Elaphriella khantaros MNHN IM-2009-43073, 518–527 m;
Ilanga mesembrine MNHN IM-2009-8797, 360–380 m;
Solariella sp. 7 MNHN NR A_MIN_SP, 250–270 m;
Phragmomphalina sp. 3 MNHN IM-2009-15206, 458 m;
Arxellia tracheia MNHN IM-2013-19898, 440 m;
Bathymophila-Like sp. 28 MNHNIM-2013-58876, 229 m;
Minolia punctata NHMUK 1878.10.16.6, 90 m.

Table S4. Fasta file of four gene alignment. Note that alignment excludes bases removed by Gblocks.

— **(in separate file) —**

Table S5. Mean rate of change and 95% highest posterior density intervals (HPD) between character states for shell pigmentation, shell pattern and 'vision' in solariellid snails using an asymmetric, non-BSSVS substitution model, as implemented in BEAST and read in TRACER.

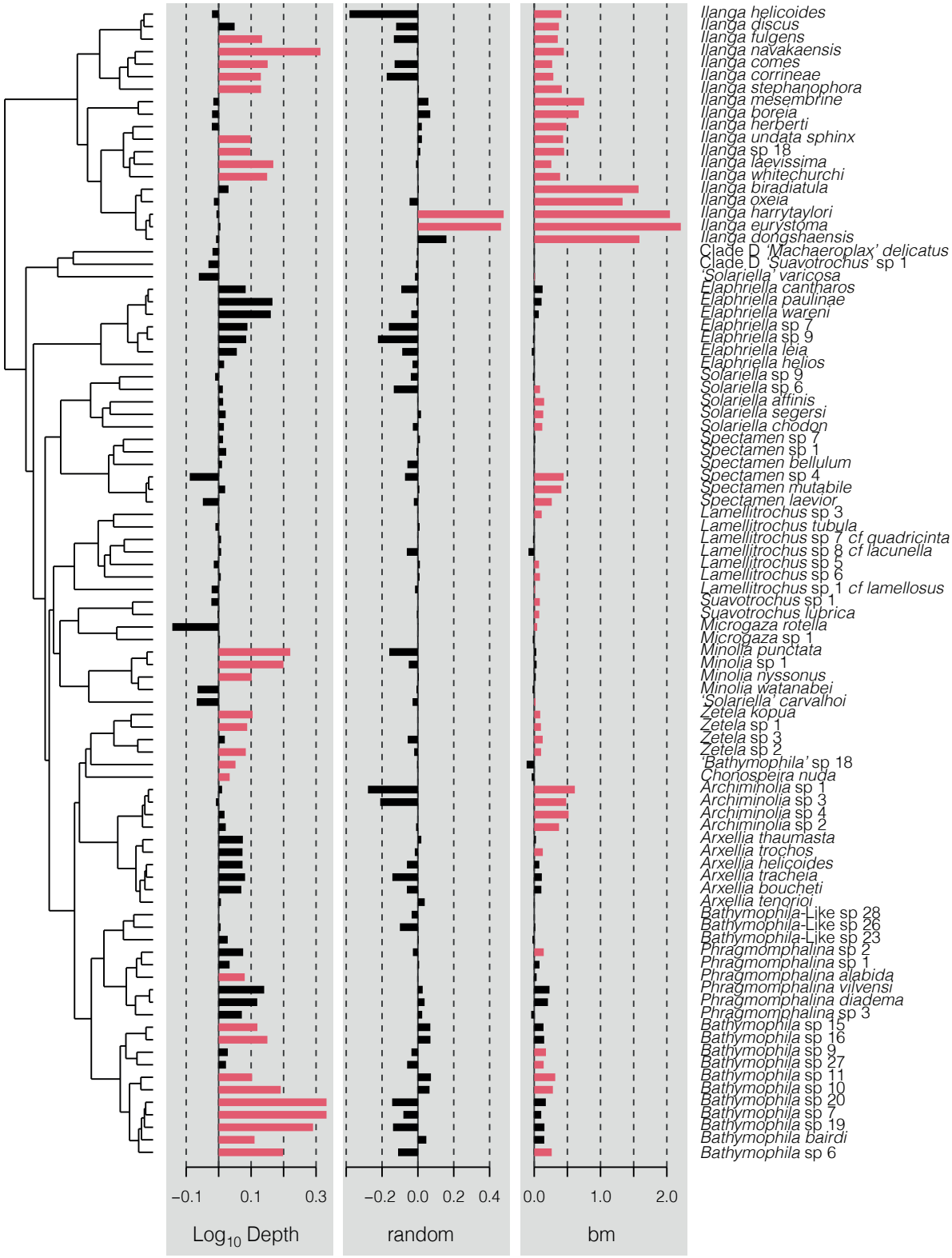
Character State Change	**Mean Rate**	**95% HPD**
Loss of pigmentation	1.522	$7.9797 \times 10^{-3} – 9.6944$
Gain of pigmentation	0.439	$5.5651 \times 10^{-5} – 4.8039$
Loss of pattern	1.679	$5.5043 \times 10^{-3} – 4.1202$
Gain of pattern	0.270	$4.8515 \times 10^{-6} – 1.0068$
Loss of 'vision'	1.479	0.0221 – 3.7127
Gain of 'vision'	0.479	$2.5736 \times 10^{-6} – 1.5552$

Table S6. Testing for correlation between morphological traits (pigmentation, pattern, 'vision') and depth allowing for phylogenetic uncertainty. Depth bin and Log Marginal Likelihood (average of three runs) and Bayes Factor for each trait testing 500 BEAST trees.

Depth Bin	Model	PIGMENT: Log Marginal Likelihood	PIGMENT: Log Bayes Factor[a]	PATTERN: Log Marginal Likelihood	PATTERN: Log Bayes Factor[a]	'VISION': Log Marginal Likelihood	'VISION': Log Bayes Factor[a]
200 m	Dependent	-117.65	-7.09**§	-117.32	-3.51*§	-98.50	-5.43**§
	Independent	-114.10		-115.56		-95.78	
300 m	Dependent	-123.01	0.28	-117.27	-5.14**§	-105.61	-1.99§
	Independent	-123.15		-114.70		-104.61	
400 m	Dependent	-119.34	3.70*	-118.80	6.99**	-102.75	-0.03§
	Independent	-121.19		-122.29		-102.73	
500 m	Dependent	-119.33	4.20*	-118.80	6.68**	-102.68	0.08
	Independent	-121.44		-122.14		-102.72	
600 m	Dependent	-98.98	13.55***	-104.01	4.86*	-87.70	-1.63§
	Independent	-105.76		-106.44		-86.89	
700 m	Dependent	-91.52	11.55***	-97.74	0.24	-83.62	-9.60§**
	Independent	-97.29		-97.86		-78.83	
800 m	Dependent	-87.42	3.73*	-92.47	-4.50*§	-77.64	-14.42§***
	Independent	-89.28		-90.22		-70.43	
900 m	Dependent	-84.41	0.19	-88.76	-7.16**§	-74.20	-17.28§***
	Independent	-84.51		-85.18		-65.56	

[a] Bayes Factor (BF) are interpreted following Rafferty in (p163–188, Gilks, 1996). BF<0: supports alternate model (i.e. depth and trait are not correlated: §); 0–2: weak evidence; >2: positive evidence (*); 5–10: strong evidence (**); >10: very strong evidence (***).

Figure S1. Local Moran's *I* (I_i) values for log transformed depth data, random data and Brownian model plotted onto the phylogenetic tree from Figure 2.



REFERENCES

Bouchet, P., Héros, V., Lozouet, P., & Maestrati, P. (2008). A quarter-century of deep-sea malacological exploration in the South and West Pacific: Where do we stand? How far to go. *Tropical deep-sea Benthos, 25*, 9-40.

Cavallari, D. C., Salvador, R. B., & Simone, L. R. (2016). *Solariella quadricincta* Quinn, 1992 and *S. staminea* Quinn, 1992 are synonyms of *S. carvalhoi* Lopes & Cardoso, 1958 from the SW Atlantic (Gastropoda: Solariellidae). *Zootaxa, 4109*(1), 96-100. doi:10.11646/zootaxa.4109.1.9

Dall, W. H. (1896). Diagnoses of new species of mollusks from the west coast of America. *Proceedings of the United States National Museum*.

Gilks, W. R. (1996). Introducing markov chain monte carlo. *Markov chain Monte Carlo in practice.*

Hasegawa, K. (2009). *Upper bathyal gastropods of the Pacific coast of Northern Honshu, Japan, chiefly collected by R/V Wakataka-maru* (T. Fujita Ed. Vol. 39).

Herbert, D. G. (1987). Revision of the Solariellinae (Mollusca: Prosobranchia: Trochidae) in southern Africa. *Annals of the Natal Museum, 28*(2), 283-382.

Marshall, B. A. (1979). The Trochidae and Turbinidae of the Kermadec Ridge (Mollusca: Gastropoda). *New Zealand Journal of Zoology, 6*(4), 521-552. doi:10.1080/03014223.1979.10428396

Marshall, B. A. (1999). A revision of the Recent Solariellinae (Gastropoda : Trochoidea) of the New Zealand region *Nautilus, 113*(1), 4-42.

Okutani, T. (2000). *Marine mollusks in Japan*: Tokai University Press.

Poppe, G. T., Tagaro, S. P., & Dekker, H. (2006). The Seguenziidae, Chilodontidae, Trochidae, Calliostomatidae and Solariellidae of the Philippine Islands. *Visaya Supplement, 2*, 1-228.

Quinn, J. F., Jr. (1979). Biological results of the University of Miami deep-sea expeditions. 130. The systematics and zoogeography of the gastropod family Trochidae collected in the Straits of Florida and its approaches. *Malacologia, 19*(1), 1-62.

Quinn, J. F., Jr. (1991). *Lamellitrochus*, a new genus of Solariellinae (Gastropoda: Trochidae), with descriptions of six new species from the Western Atlantic Ocean. *Nautilus, 105*(3), 81-91.

Rosenberg, G., Moretzsohn, F., & Garcia, E. F. (2009). Gastropoda (Mollusca) of the Gulf of Mexico. In D. L. Felder & D. K. Camp (Eds.), *Gulf of Mexico: Origins, Waters, and Biota. Volume 1: Biodiversity* (pp. 579-699). College Station: Texas A & M University Press.

Sumner-Rooney, L., J. D. Sigwart, J. McAfee, L. Smith, and S. T. Williams. 2016. Repeated eye reduction events reveal multiple pathways to degeneration in a family of marine snails. *Evolution* 70:2268-2295.

Vilvens, C. (2009). New species and new records of Solariellidae (Gastropoda: Trochoidea) from Indonesia and Taiwan. *Novapex, 10*, 69-96.

Vilvens, C., & Williams, S. T. (2016). New genus and new species of Solariellidae (Gastropoda: Trochoidea) from New Caledonia, Fiji, Vanuatu, Solomon Islands, Philippines, Papua New Guinea and French Polynesia. In V. Héros, E. Strong, & P. Bouchet (Eds.), *Tropical Deep Sea Benthos* (Vol. 29, pp. 267-289).

Williams, S. T., Y. Kano, A. Warén, and D. G. Herbert. 2020. Marrying molecules and morphology: first steps towards a reevaluation of solariellid genera (Gastropoda: Trochoidea) in the light of molecular phylogenetic studies. *Journal of Molluscan Studies* 86:1-26.

Williams, S. T., L. M. Smith, D. G. Herbert, B. A. Marshall, A. Warén, S. Kiel, P. Dyal, K. Linse, C. Vilvens, and Y. Kano. 2013. Cenozoic climate change and diversification on the continental shelf and slope: evolution of gastropod diversity in the family Solariellidae (Trochoidea). *Ecol Evol* 3:887-917.