

Table S1. Specimen list with GenBank Accession numbers and data on their sampling, storage and sequences

Species	ID on tree		Repository	Specimen ID	Area	Latitude	Longitude	Depth, m	GenBank Acc. Number		COI Primers	16S Primers	Sequence length, bp	
									COI	16S			COI	16S
<i>Elpidia kurilensis</i>	<i>Elpidia kurilensis</i>	IORAS ECH01814	KB2_987_1	northwest Pacific	45.65	152.95	7154	MZ563466	MZ563445	LCOech1aF1 ^a , HCO2198 ^b	16sfHolo ^g , 16srHolo ^h	658	327	
<i>Peniagone azorica</i>	<i>Peniagone azorica</i> F62	NOCS	ECOMAR_F62	North Atlantic	54.00	-34.18	2500	-	MZ563455	-	16sfHolo ^g , 16srHolo ^h	-	326	
<i>Peniagone azorica</i>	<i>Peniagone azorica</i> F63	NOCS	ECOMAR_F63	North Atlantic	54.00	-34.18	2500	-	MZ563458	-	16sfHolo ^g , 16srHolo ^h	-	326	
<i>Peniagone azorica</i>	<i>Peniagone azorica</i> F64	NOCS	ECOMAR_F64	North Atlantic	54.00	-34.18	2500	-	MZ563449	-	16sfHolo ^g , 16srHolo ^h	-	303	
<i>Peniagone azorica</i>	<i>Peniagone azorica</i> F66	NOCS	ECOMAR_F66	North Atlantic	54.00	-34.18	2500	-	MZ563451	-	16sfHolo ^g , 16srHolo ^h	-	326	
<i>Peniagone coccinea</i>	<i>Peniagone coccinea</i> B30	NOCS	ECOMAR_B30	North Atlantic	48.97	-27.85	2600	MZ563467	MZ563446	COIf ^c , COIr ^d	16sfHolo ^g , 16srHolo ^h	654	365	
<i>Peniagone coccinea</i>	<i>Peniagone coccinea</i> D42	NOCS	ECOMAR_D42	North Atlantic	48.97	-27.85	2600	MZ563477	MZ563461	COIf ^c , COIr ^d	16sfHolo ^g , 16srHolo ^h	654	365	
<i>Peniagone islandica</i>	<i>Peniagone islandica</i> B4	NOCS	ECOMAR_B4	North Atlantic	48.97	-27.85	2600	-	MZ563456	-	16sfHolo ^g , 16srHolo ^h	-	326	
<i>Peniagone islandica</i>	<i>Peniagone islandica</i>	NOCS	ECOMAR_B12	North Atlantic	48.97	-27.85	2600	-	MZ56346	-	16sfHolo ^g , 16srHolo ^h	-	326	

	B12							0					
<i>Peniagone islandica</i>	<i>Peniagone islandica</i> H30	NOCS	ECOMAR_H30	North Atlantic	48.97	-27.85	2600	-	MZ5 6345 4	-	16sfHolog, 16srHolog ^h	-	293
<i>Peniagone islandica</i>	<i>Peniagone islandica</i> H33	NOCS	ECOMAR_H33	North Atlantic	48.97	-27.85	2600	MZ5 6347 0	-	COIf ^c , COIr ^d	-	654	-
<i>Peniagone islandica</i>	<i>Peniagone islandica</i> H50	NOCS	ECOMAR_H50	North Atlantic	48.97	-27.85	2600	MZ5 6346 5 4	MZ5 6344	COIf ^c , COIr ^d	16sfHolog, 16srHolog ^h	654	321
<i>Peniagone mus</i>	<i>Peniagone mus</i> ECH02148	IORAS ECH02148	KB2_744 _1	northwest Pacific	45.94	152.8 8	6185	MZ5 6347 5	MZ5 6345 9	LCOech1aF1 ^a , HCO2198 ^b	16sfHolog, 16srHolog ^h	658	326
<i>Peniagone mus</i>	<i>Peniagone mus</i> ECH01808	IORAS ECH01808	KB2_744 _2	northwest Pacific	45.94	152.8 8	6185	MZ5 6346 8	MZ5 6344 7	LCOech1aF1 ^a , HCO2198 ^b	16sfHolog, 16srHolog ^h	658	326
<i>Peniagone mus</i>	<i>Peniagone mus</i> ECH01812	IORAS ECH01812	KB2_745 _1	northwest Pacific	45.94	152.8 8	6185	MZ5 6347 3	MZ5 6345 3	LCOech1aF1 ^a , HCO2198 ^b ; COIeFe, COIeR ⁱ	16sfHolog, 16srHolog ^h	841	326
<i>Peniagone mus</i>	<i>Peniagone mus</i> ECH01813	IORAS ECH01813	Pen_L_1 0_7_2	northwest Pacific	46.10	152.2 4	4769	MZ5 6347 6	-	LCOech1aF1 ^a , HCO2198 ^b	-	658	-
<i>Peniagone</i> <i>cf. purpurea</i>	<i>Peniagone</i> <i>cf. purpurea</i> ECH01810	IORAS ECH01810	SO223-1- 13_H3	northwest Pacific	43.97	157.2 6	5427	MZ5 6347 4	MZ5 6345 7	LCOech1aF1 ^a , HCO2198 ^b	16sfHolog, 16srHolog ^h	658	329
<i>Peniagone</i> <i>cf. purpurea</i>	<i>Peniagone</i> <i>cf. purpurea</i> ECH01811	IORAS ECH01811	KB_113_ 1	northwest Pacific	43.97	157.3 2	5422	MZ5 6346 9	MZ5 6344 8	LCOech1aF1 ^a , HCO2198 ^b ; COIeFe, COIeR ⁱ	16sfHolog, 16srHolog ^h	841	329
<i>Peniagone saveljevae</i>	<i>Peniagone saveljevae</i> ECH02151	IORAS ECH02151	PenL1- 11	Okhotsk Sea, northwest Pacific	46.15	146.0 1	3305	-	MZ5 6344 2	-	16sfHolog, 16srHolog ^h	-	326
<i>Peniagone</i>	<i>Peniagone</i>	IORAS	KB_2077	northwest	42.49	154.0	5293	MZ5	MZ5	LCOech1aF1 ^a ,	16sfHolog,	841	326

sp. "miniatura "	sp. "miniatur a"	ECH01809	_1	Pacific		0		6346 4	6344 3	HCO2198 ^b ; COIeF ^e , COIeR ^f	16srHolo ^h		
<i>Peniagone</i> sp.	<i>Peniagone</i> sp. ECH00852	IORAS ECH00852	ECH008 52	Antarctic	-64.02	-39.15	4780	MZ5 6347 1	MZ5 6345 0	COIeF ^c , COIeR ^f	16sfHolo ^g , 16srHolo ^h	652	327
<i>Peniagone</i> sp.	<i>Peniagone</i> sp. ZMBN 140277	ZMBN 140277	ZMBN_ PE30	Antarctic	-68.46	11.52	1730	MZ5 6344 0	MZ5 6343 7	LCOech1aF1 ^a , HCO2198 ^b	16sfHolo ^g , 16sbrH ⁱ	658	413
<i>Peniagone</i> sp.	<i>Peniagone</i> sp. ZMBN 140278	ZMBN 140278	ZMBN_ PE31	Antarctic	-68.46	11.52	1730	MZ5 6344 1	MZ5 6343 8	LCOech1aF1 ^a , HCO2198 ^b	16sfHolo ^g , 16sbrH	658	413
<i>Peniagone</i> sp.	<i>Peniagone</i> sp. ZMBN 140279	ZMBN 140279	ZMBN_ PE32	Antarctic	-68.87	11.85	1090	- 6343 9	MZ5 6343 9	-	16sfHolo ^g , 16sbrH	-	358
<i>Scotoplanes</i> <i>hanseni</i>	<i>Scotoplane</i> <i>s hanseni</i>	IORAS ECH01815	KB2_637 _1	northwest Pacific	45.95	152.8 8	6183	MZ5 6347 2	MZ5 6345 2	LCOech1aF1 ^a , HCO2199 ^b	16sfHolo ^g , 16srHolo ^h	658	323

^a LCOech1aF1 [28] 5'-TTTTTCTACTAAACACAAGGATATTGG-3'; ^b HCO2198 [26] 5'-TAAACTTCAGGGTGACCAAAAAATCA-3'; ^c COIeF [27] 5'-ACTGCCCACGCCCTAGCAATGATATTTTTTATGGTNATGC-3'; ^d COIeR [27] 5'-TCGTGTGTCTACGTCCATTCTACTCTRAACATRTG-3'; ^e COIeF [25] 5'-ATAATGATAGGAGGRTTGG-3'; ^f COIeR [25] 5'-GCTCGTGTRTCTACRTCCAT-3'; ^g 16sfHolo (designed in this study by C.A.) 5'-TGACCGTGCAAAGGTAGC-3'; ^h 16srHolo (designed in this study by C.A.) 5'-GAGGTCGCAAACCCTTCT-3'; ⁱ 16sbrH [29] 5'-CCGGTCTGAACTCAGATCACGT-3'.

Table S2. List of sequences obtained from GenBank and BOLD

Species	ID on phylogenetic trees	GenBank accession number/BOLD process ID	
		COI	16S
<i>Amperima robusta</i>	<i>Amperima robusta</i>	KX874381	KX856728
<i>Elpidia glacialis</i>	<i>Elpidia glacialis</i>	HM196429	-
<i>Peniagone diaphana</i>	<i>Peniagone diaphana</i>	KX874384	KX856725
<i>Peniagone incerta</i>	<i>Peniagone incerta</i> MOLN114	HM196398	-
<i>Peniagone incerta</i>	<i>Peniagone incerta</i> MOLN115	HM196399	-
<i>Peniagone incerta</i>	<i>Peniagone incerta</i> MOLAF720	HM196400	-
<i>Peniagone incerta</i>	<i>Peniagone incerta</i> MOLAF764	HM196401	-
<i>Peniagone incerta</i>	<i>Peniagone incerta</i> MOLAF761	HM196402	-
<i>Peniagone leander</i>	<i>Peniagone leander</i>	-	MN567717
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> MOLAF748	HM196381	-
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> MOLAF721	HM196382	-
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> MOLG073	HM196383	-
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> MOLN098	HM196384	-
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> MOLG074	HM196385	-
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> MOLAF755	HM196386	-
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> MOLAF724	HM196387	-
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> MOLAF725	HM196388	-
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> MOLAF763	HM196389	-
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> MOLAF744	HM196390	-
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> MOLAF749	HM196391	-
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> MOLG075	HM196392	-
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> MOLN096	HM196393	-
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> MOLAF727	HM196394	-
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> MOLAF738	HM196395	-
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> MOLN099	HM196396	-
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> MOLN097	HM196397	-
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> NZEC252-08	NZEC252-08	-

<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> NZEC254-08	NZEC254-08	-
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> NZEC255-08	NZEC255-08	-
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> NZEC251-08	NZEC251-08	-
<i>Peniagone vignoni</i>	<i>Peniagone vignoni</i> NZEC253-08	NZEC253-08	-
<i>Peniagone</i> sp.	<i>Peniagone</i> sp. YYH-2013	KF915304	KF915304
<i>Peniagone</i> sp.	<i>Peniagone</i> sp. SIO-BIC E5608	KX874385	KX856726
<i>Peniagone</i> sp.	<i>Peniagone</i> sp. NZEC232-08	NZEC232-08	
<i>Peniagone</i> sp.	<i>Peniagone</i> sp. NZEC235-08	NZEC235-08	-
<i>Peniagone</i> sp.	<i>Peniagone</i> sp. NZEC236-08	NZEC236-08	-
<i>Protelpidia murrayi</i>	<i>Protelpidia murrayi</i> Echinoderm1B1_St42	KF713386	KF713450
<i>Protelpidia murrayi</i>	<i>Protelpidia murrayi</i> SIO-BIC E5110	-	KX856727
<i>Scotoplanes</i> sp.	<i>Scotoplanes</i> sp.	LC416624	LC416624