

Supplementary Information for the following manuscript:

Molecular and structural divergence of c-opsin-based phototransduction in the radiolar eyes of Sabellid fan worms

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Table S1. Summary of *de novo* assembly of *Pseudopotamilla ocellata* and *Bispira guinensis* radiolar eye transcriptome.

Sequencing statistics	Count	
	<i>Pseudopotamilla ocellata</i>	<i>Bispira guinensis</i>
Raw reads (paired-end)	12,706,367	11,433,861
Clean reads (paired-end)	12,704,125	11,432,038
Q20 (%)	97.6%	97.8%
Q30 (%)	92.6%	93.3%
GC content (%)	39%	44%
Assembly statistics		
Total assembled bases	68,825,399	132,657,336
Total number of transcripts	136,290	287,018
Total number of unigenes	104,753	247,755
Median contig length (bp)	443	336
Average length of unigenes (bp)	657.03	434.67
GC content (%)	34.17%	38.67%
Raw reads mapped to contigs (%)	94.97%	86.72%
N50 (bp)	1,037	469
BUSCO completeness (%)	83.7%	56.6%

Table S2: Summary of the opsin and G protein alpha subunit gene contigs identified from the transcriptome of the *P. ocellata* and *B. guinensis* radiolar eye by PIA3

Gene	Contig	Length (AA)	Expression level (TPM)
<i>Pseudopotamilla ocellata</i> (compound-single eye)			
Opsin			
Invertebrate C-opsin	TRINITY_DN2164_c0_g1_i1	360	22.44
G protein alpha subunit			
G protein alpha O subunit (GNAO)	TRINTIY_DN507_c0_g1_i2	355	2.41
G protein alpha S subunit (GNAS)	TRINITY_DN77838_c0_g1_i1	382	2.46
G protein alpha I subunit (GNAI)	TRINITY_DN14483_c0_g2_i7	355	2.68
G protein alpha Q subunit (GNAQ)	TRINITY_DN21067_C0_g3_i3	358	4.84
<i>Bispira guinensis</i> (compound-paired eye)			
Opsin			
Invertebrate C-opsin	TRINITY_DN4388_c0_g2_i1	341	2.88
Peropsin	TRINITY_DN52778_c0_g1_i1	337	3.71
G protein alpha subunit			
G protein alpha O subunit (GNAO)	TRINITY_DN209176_c0_g1_i1	242	1.01
G protein alpha Q subunit (GNAQ)	TRINITY_DN15766_c0_g1_i2	285	1.45

Table S3. Datasets used for phylogenetic comparisons of the opsin sequences found in the radiolar eyes transcriptome of *Bispira guinensis* and *Pseudopotamilla ocellata* (refer to Fig.5A). Putative opsin transcripts identified in this study are bolded and highlighted.

Class	Sub-group	Clade	Accession no. / ref
Outgroup	Thyrotropin receptor	OG TSHR	[1]
	Placopsin	Placopsin Trichoplax adhaerens 429092 Placozoa Placopsin Trichoplax adhaerens 430364 Placozoa Placopsin Trichoplax adhaerens 429091 Placozoa	[2]
	Pseudopsin	Pseudopsin Linenus longissimus Nemertea Pseudopsin Owenia fusiformis Annelida Pseudopsin Elysia chlorotica Mollusca Pseudopsin Architeuthis dux Mollusca	[3]
Teraopsin	Go-opsin	Go Branchiostoma belcheri Chordata Go Branchiostoma lanceolatum Chordata Go Argopecten irradians 2 Mollusca Go Brachiostoma floridae Chordata Go Lottia gigantea 1 Mollusca Go Lottia gigantea 2 Mollusca Go Lottia gigantea 3 Mollusca Go Lottia gigantea 4Mollusca Go_Platynereis_dumerilii_1_Annelida Go_Platynereis_dumerilii_2_Annelida	A0A455ZAM3 A0A2Z4C054 A0A1J0CN96 C3Y4A0 XP_009053517.1 XP_009049184.1 XP_009045392.1 XP_009058695.1 A0A0K0YBE3 A0A0K0YBE9
	Neuropsin	Neuropsin Apostichopus japonicus Echinoderms Neuropsin Strongylocentrotus purpuratus Echinoderms Neuropsin Paramacrobrotus richtersi Tardigrada Neuropsin Hypsibius dujardini Tardigrada Neuropsin Argopecten irradians Mollusca Neuropsin Platynereis dumerilii Annelida Neuropsin Branchiostoma floridae Chordata	PIK35078.1 XP_001199309.1 QYF06549.1 A0A097GXY4 A0A1J0CN87 A0A097ETF5 A0A2H4KKR6

	Neuropsin <i>Danio rerio</i> Chordata	Q5RIV6
	Neuropsin <i>Homo sapiens</i> Chordata	Q6U736
	Neuropsin <i>Cricetulus barabensis</i> Chordata	A0A1W6KZ83
	Neuropsin <i>Mus musculus</i> Chordata	Q6VZZ7
Peropsin	Peropsin <i>Parasteatoda tepidariorum</i> Arthropoda	A0A0G3Y5J3
	Peropsin <i>Hasarius adansoni</i> Arthropoda	E1CFG1
	Peropsin <i>Cupiennius salei</i> Arthropoda	T2I4T4
	Peropsin <i>Euphausia superba</i> Arthropoda	A0A142BLT2
	Peropsin <i>Brachionus plicatilis</i> Rotifera	A0A3M7R2C9
	Peropsin <i>Brachionus koreanus</i> Rotifera	A0A0A7DNF4
	Peropsin <i>Spadella cephaloptera</i> Chaetognatha	A0A7G9IS11
	Peropsin <i>Stichopus japonicus</i> Echinodermata	A0A2G8LPG3
	Peropsin <i>Holothuria leucospilota</i> Echinodermata	A0A9Q0YNS8
	Peropsin <i>Mus musculus</i> Chordata	O35214
	Peropsin <i>Homo sapiens</i> Chordata	O14718
	Peropsin <i>Gallus gallus</i> Chordata	Q69FK3
	Peropsin <i>Anguilla japonica</i> Chordata	A0A3T1E2B0
	Peropsin <i>Trichiurus lepturus</i> Chordata	A0A1S7J214
	Peropsin <i>Acanthopleura granulate</i> Mollusca	A0A8H2S108
	Peropsin <i>Chiton marmoratus</i> Mollusca	A0A8H2S110
	Peropsin <i>Platynereis dumerilii</i> Annelida	W5XRX9
	Peropsin <i>Schistosoma haematobium</i> Platyhelminthes	A0A094ZWX2
	Bispira guinensis DN52778 Peropsin	PX778786
RPE-retinal G protein-coupled receptor	RGR <i>Acanthaster planci</i> Echinodermata	A0A8B7Y2P0
	RGR <i>Lytechinus pictus</i> Echinodermata	XP_054773189.2
	RGR <i>Strongylocentrotus purpuratus</i> Echinodermata	XP_030835583.1
	RGR <i>Danio rerio</i> Chordata	Q6DH22
	RGR <i>Lynx pardinus</i> Chordata	A0A485MX82
	RGR <i>Mus musculus</i> Chordata	Q9Z2B3
	RGR <i>Homo sapiens</i> Chordata	P47804
Retinochrome	Retinochrome <i>Leptochiton asellus</i> Mollusca	A0A8D7ZEZ5

		Retinochrome <i>Todarodes pacificus</i> Mollusca	P23820
		Retinochrome <i>Clonorchis sinensis</i> Platyhelminthes	G7YJG0
		Retinochrome <i>Paragonimus heterotremus</i> Platyhelminthes	A0A8J4SS14
R-opsin	Melanopsin	Melanopsin <i>Schistosoma haematobium</i> Platyhelminthes	A0A6A5DBJ8
		Melanopsin <i>Schistosoma japonicum</i> Platyhelminthes	C1LEE2
		Melanopsin <i>Danio Rerio</i> Chordata	Q1JPS6
		Melanopsin <i>Rattus norvegicus</i> Chordata	Q8R456
		Melanopsin <i>Homo sapiens</i> Chordata	Q9UHM6
	Mollusca/ Annelida/ Platyhelminthes R-opsins	Ropsin <i>Schistosoma mansoni</i> Rhodopsin Platyhelminthes	A0A3Q0KTX7
		Ropsin <i>Platynereis dumerilii</i> Annelida	AJ316544.1
		Ropsin <i>Mystilus galloprovincialis</i> Mollusca	A0A8B6D6A1
		Ropsin <i>Biomphalaria glabrata</i> Rhodopsin Mollusca	KAK7004571.1
		Ropsin <i>Loligo forbesii</i> Rhodopsin Mollusca	P24603
		Ropsin <i>Xipholeptos notoides</i> Mollusca	PP836149.1
		Ropsin <i>Todarodes pacificus</i> Rhodopsin Mollusca	P31356.2
	Tardigrada R-opsins	Ropsin <i>Hypsibius dujardini</i> Tardigrada	A0A097GXM4
	Arthropoda UV/SW opsins	Ropsin <i>Procambarus clarkii</i> SWS Arthropoda	XP_045596873.1
		Ropsin <i>Photuris frontalis</i> UV Arthropoda	A0A0M3PZ72
		Ropsin <i>Photinus marginellus</i> UV Arthropoda	A0A0M5IAE5
		Ropsin <i>Macroglossum stellatarum</i> UV Arthropoda	V5L921
		Ropsin <i>Apis mellifera</i> UV Arthropoda	O61303
		Ropsin <i>Drosophila melanogaster</i> Rh4 Arthropoda	P08255
		Ropsin <i>Drosophila melanogaster</i> Rh3 Arthropoda	P04950
	Arthropoda LW opsins	Ropsin <i>Neogonodactylus oerstedii</i> LW	AUC64079.1
		Ropsin <i>Hemimysis anomala</i> LW Arthropoda	B0LKYY3
		Ropsin <i>Mysis segerstralei</i> LW Arthropoda	B0LKYY2
		Ropsin <i>Caspiomysis knipowitschi</i> LW Arthropoda	B0LKYY5
		Ropsin <i>Paramysis loxolepis</i> LW Arthropoda	B0LKXX3
		Ropsin <i>Katamysis warpachowskyi</i> LW Arthropoda	B0LKY0

	Ropsin Schistomysis assimilis LW Arthropoda	ABY81041.1
	Ropsin Drosophila melanogaster Rh6 Arthropoda	O01668
	Ropsin Drosophila melanogaster Rh1 Arthropoda	P06002
	Ropsin Drosophila melanogaster Rh2 Arthropoda	P08099
	Ropsin Diaphorina citri LW Arthropoda	A0A859N6R0
	Ropsin Daktulosphaira vitifoliae LW Arthropoda	Q8MPN0
	Ropsin Meoura viciae LW Arthropoda	AF189714.1
	Ropsin Lachnus roboris LW Arthropoda	Q8MPM2
	Ropsin Ceratovacuna nekoashi LW Arthropoda	A0A0K0K3U4
	Ropsin Thoracaphis quercifoliae LW Arthropoda	A0A0K0K3E5
	Ropsin Spodoptera litura LW Arthropoda	V5L9H5
	Ropsin Celastrina ladon LW Arthropoda	A0A7T3PKC1
	Ropsin Tetramorium tosii LW Arthropoda	A0A0H4JFF7
	Ropsin Pheidole longispinosa LW Arthropoda	A0A0H4JEY8
	Ropsin Mystrum rogeri LW Arthropoda	A0A0H4JBA3
	Ropsin Cerapachy sp LW Arthropoda	A0A0H4JB89
	Ropsin Gryllus bimaculatus LW Arthropoda	I6LX01
	Ropsin Svercacheta siamensis LW Arthropoda	A0A060N2S8
	Ropsin Luciola cruciata LW Arthropoda	AB300328
	Ropsin Photuris sp LW Arthropoda	KR150962.1
	Ropsin Bicellonycha wichershamorum LW Arthropoda	KR150955.1
	Ropsin Pyractomena dispersa LW Arthropoda	KR150963.1
Arthropoda MW opsins	Ropsin Neogonodactylus oerstedii MWS Arthropoda	QIW86031.1
	Ropsin Drosophila melanogaster Rh5 Arthropoda	P91657
	Ropsin Bicyclus anynana BlueRh Arthropoda	Q05EC7
	Ropsin Limenitis arthemis Astyanax BlueRh Arthropoda	Q05EC4
	Ropsin Heliconius pacheus BlueRh Arthropoda	ADN96755.1
	Ropsin Heliconius erato BlueRh Arthropoda	AY918906.1
Onychopsions	Onychopsin Eoperipatus sp Onychophora	JQ780372.1
	Onychopsin Eppiperipatus cf isthmicola Onychophora	JN661373.1
	Onychopsin Phallocephale tallagandensis Onychophora	JQ780371.1
	Onychopsin Ooperipatus hispidus Onychophora	JQ780373.1

Onychopsin Euperipatoides rowelli Onychophora JN661372.1

Xenopsin	Xenopsins	Xenopsin Prostheceraeus vittatus Platyhelminthes	[4]
		Xenopsin Malacoceros fuliginosus Annelida	
		Xenopsin Argopecten irradians Mollusca	
		Xenopsin Stylochus ellipticus Platyhelminthes	
		Xenopsin Ambigolimax valentianus Mollusca	
	Cnidops	Cnidops Tripedalia cystophora op2 Cnidaria	AGB67503.1
		Cnidops Tripedalia Cystophora op6 Cnidaria	AGB67499.1
		Cnidops Tripedalia cystophora op12 Cnidaria	AGB67493.1
		Cnidops Cladonema radiatum CropD Cnidaria	A9CR34
		Cnidops Cladonema radiatum CropJ Cnidaria	A9CR54
		Cnidops Hydra vulgaris MWS like Cnidaria	XP_002163358.2
	Invertebrate C-opsins	InvC Cupiennius salei Arthropoda	CCP46950.1
		InvC Limulus polyphemus 1 Arthropoda	ANF89425.1
		InvC Limulus polyphemus 2 Arthropoda	ANF89426.1
		InvC Hyalella azteca Arthropoda	XP_047740305.1
		InvC Euperipatoides kanangrensis Onychophora	CCP46947.1
		InvC Euperipatoides rowell Onychophora	AIT40614.1
		InvC Tribolium castaneum Arthropoda	NP_001138950.1
		InvC Platynereis dumerilii Annelida	ASM47595.1
		Bispira guinensis DN4388 InvC	PX778785
		Pseudopotamilla ocellata DN2164 InvC	PX778780
		InvC Acromegalomma interruptum Annelida	[5]
	Panarthropod pteropsin	Pteropsin Apis mellifera Arthropoda	NP_001035057.1
		Pteropsin Ischnura asiatica Arthropoda	BAQ54906.1
		Pteropsin Epiophlebia superstes Arthropoda	BAQ54881.1
		Pteropsin Manduca sexta Arthropoda	QDR51017.1
		Pteropsin Danaus plexippus Arthropoda	OWR46498.1
		Pteropsin Heliconius Melpomene Arthropoda	QDR50943.1

Encephalopsin	ENCEPH4 braFlo Chordata	[1]
	ENCEPH Paralichthys olivaceus Chordata	A0A4P2TKN5
	ENCEPH Homo sapiens Chordata	NP_055137.2
Teleost multiple tissue	TMT Takifugu rubripes Chordata	NP_001027778.1
	TMT Danio rerio Chordata	R9R6H5
	TMT Gallus gallus Chordata	A0A1J1DZN4
	TMT Monodelphis domestica Chordata	R9R6C8
	TMT Xenopus tropicalis Chordata	A0A0P0YQA4
Parietopsin	PARIE Betta splendens Chordata	XP_029008486.1
	PARIE xenTro Chordata	[1]
	PARIE gasAcu Chordata	
Vertebrate ancient opsin	VAOP Oryzias latipes Chordata	NP_001129987.1
	VAOP danRer Chordata	[1]
	VAOP galGal Chordata	
Parapinopsin	PPIN ictPun Chordata	
	PPIN letJap Chordata	
	PPIN xenTro Chordata	
Pinopsin	PIN utaSta Chordata	
	PIN galGal Chordata	
Long-wavelength sensitive opsin	LWS homSap Chordata	
	LWS ornAna Chordata	
	LWS xenTro Chordata	
	LWS takRub Chordata	
Medium-wavelength sensitive opsin	MWS Ratnor Chordata	
	MWS Ambtig Chordata	
	MWS Caraur Chordata	
	MWS Lucgoo Chordata	

Short-wavelength	SWS1 Pomacentrus coelestis Chordata	A0A191W0A7
sensitive opsin 1	SWS1 Dimcom Chordata	[1]
	SWS1 Isoobe Chordata	
	SWS1 Alopal Chordata	
Short-wavelength	SWS2 Punnye Chordata	
sensitive opsin 2	SWS2 takRub Chordata	
	SWS2 Colliv Chordata	
	SWS2 neoFor Chordata	
Rhodopsin 1	RHO1 letJap Chordata	
	RHO1 geoAus Chordata	
	RHO1 angAng Chordata	
	Rh1 Gadmor Chordata	
	Rh1 Chedad Chordata	
	RH1 Odoros Chordata	
	RHO1 homSap Chordata	
	RH1 Ursmar Chordata	
	RHO1 bosTau Chordata	
Rhodopsin 2	RHO2 galGal Chordata	
	RH2 Caraur Chordata	
	RH2 Dismaw Chordata	
	RH2 Plealt Chordata	

Table S4. Datasets used for phylogenetic comparisons of the G protein alpha subunit sequences identified from the transcriptome of the radiolar eyes of *Bispira guinensis* and *Pseudopotamilla ocellata* (refer to Fig.5B). Putative GPCR transcripts identified in this study are bolded and highlighted.

Class	Clade	Accession no. / ref
Outgroup	Concertina isoform A <i>Drosophila melanogaster</i> Arthropoda	NP_001036421.1
GNA12/13	GNA12 <i>Branchiostoma floridae</i> Chordata	A0A9J7M5J4
	GNA12 <i>Mus musculus</i> Chordata	P27600
	GNA12 <i>Homo sapiens</i> Chordata	Q03113
	GNA13 <i>Branchiostoma lanceolatum</i> Chordata	A0A8K0EY94
	GNA13 <i>Branchiostoma belcheri</i> Chordata	A0A6P5A048
	GNA13 <i>Phallusia mammillata</i> Chordata	A0A6F9DED6
	GNA13 <i>Mus musculus</i> Chordata	P27601
	GNA13 <i>Rattus norvegicus</i> Chordata	Q6Q7Y5
GNAQ	GNAQ <i>Mytilus coruscus</i> Mollusca	A0A6J8DJ39
	GNAQ <i>Ephydatia fluviatilis</i> Porifera	Q9Y203
	GNAQ <i>Geodia barretti</i> Porifera	A0AA35RW37
	GNAQ <i>Geodia cydonium</i> Porifera	Q9XZV4
	GNAQ <i>Schistosoma rodhaini</i> Platyhelminthes	A0AA85F2T7
	GNAQ <i>Paragonimus skrjabini miyazakii</i> Platyhelminthes	A0A8S9Z0T0
	GNAQ <i>Drosophila melanogaster</i> Arthropoda	P23625
	GNAQ <i>Procambarus clarkii</i> Arthropoda	MF279133.1
	GNAQ <i>Homarus americanus</i> Arthropoda	P91950
	GNAQ <i>Lytechinus variegatus</i> Echinodermata	AAS38584.1
	GNAQ <i>Acanthaster planci</i> Echinodermata	XP_022082144.1
	GNAQ <i>Patiria pectinifera</i> Echinodermata	U3U8X2
	GNAQ <i>Trichinella spiralis</i> Nematoda	KAL1238571.1
	GNAQ <i>Loa Loa</i> Nematoda	XP_020305425.1
	GNAQ <i>Toxocara canis</i> Nematoda	A0A0B2V558
	GNAQ <i>Anisakis simplex</i> Nematoda	A0A158PPH7
	GNAQ <i>Loligo forbesii</i> Mollusca	P38412

GNAQ Hydra vulgaris Cnidaria	T2MFU3
GNAQ Actinia tenebrosa Cnidaria	A0A6P8H5S7
GNAQ Stylophora pistillata Cnidaria	A0A2B4S0N9
GNAQ Acropora cervicornis Cnidaria	A0AAD9QMR3
GNAQ Callorhinchus milii Chordata	A0A4W3IP32
GNAQ Nothobranchius rachovii Chordata	A0A1A8NQ29
GNAQ Anolis carolinensis Chordata	G1KEY8
GNAQ Pipra filicauda Chordata	A0A6J2G2R1
GNAQ Homo sapiens Chordata	P50148
GNAQ Delphinapterus leucas Chordata	A0A2Y9NIQ8
GNAQ Sus scrofa Chordata	Q2PKF4
GNAQ Alpine marmot Chordata	A0A8C5ZHX7
GNAQ Heterocephalus glaber Chordata	A0A0P6K1M4
GNAQ Mus musculus Chordata	P21279
GNAQ Bugula neritina Bryozoa	A0A7J7K8U3
GNAQ Lymnaea stagnalis Mollusca	P38411
GNAQ Terebratalia transversa Brachiopoda	M9UTN9
GNAQ Echinostoma caproni Platyhelminthes	A0A183B172
GNAQ Schistosoma japonicum Platyhelminthes	Q5DDL4
GNAQ Lineus longissimus Annelida	XP_064645439.1
GNAQ Capitella teleta Annelida	X7YV83
GNAQ Lamellibrachia satsuma Annelida	KAI0211148.1
GNAQ Ridgeia piscesae Annelida	A0AAD9NM32
GNAQ Dipolydora quadrilobate Annelida	B0LJE3
GNAQ Pseudopotamilla ocellata DN21067	PX778784
GNAQ Bispira guinensis DN15766	PX778788
GNAQ Platynereis dumerilii Annelida	L7S051
GNAQ Perinereis aibuhitensis Annelida	M9P1E6
GNAQ Mizuhopecten yessoensis Mollusca	O15975
GNAQ Chiton tuberculatus Mollusca	QKY89054.1
GNAQ Macrostomum lignano Platyhelminthes	A0A1I8FAL6

GNAS

GNAS Terebratalia transversa 1 Brachiopoda	M9UW32
GNAS Terebratalia transversa 2 Brachiopoda	M9UWA1

GNAS_Clonorchis sinensis Platyhelminthes	G7YKV0
GNAS Schistosoma mansoni Platyhelminthes	P30669
GNAS Schistosoma japonicum Platyhelminthes	A0A4Z2DJP1
GNAS Mnemiopsis leidyi Ctenophora	L0I774
GNAS Toxocara canis Nematoda	A0A0B2V936
GNAS Chionoecetes opilio Arthropoda	A0A8J4XXK6
GNAS Homarus americanus Arthropoda	O16118
GNAS Araneus ventricosus Arthropoda	A0A4Y2FR49
GNAS Spodoptera litura 1 Arthropoda	A0A9J7DTR0
GNAS Spodoptera litura 2 Arthropoda	A0A9J7DZ18
GNAS Anopheles gambia Arthropoda	Q7PD79
GNAS Drosophila yakuba Arthropoda	A0A0R1DX90
GNAS Drosophila erecta Arthropoda	A0A0Q5VQ94
GNAS Drosophila melanogaster Arthropoda	P20354
GNAS Lymnaea stagnalis Mollusca	P30684
GNAS Pseudopotamilla ocellata DN77838	PX778782
GNAS Schistocephalus solidus Platyhelminthes	A0A0X3NXXE9
GNAS Patiria pectinifera Echinodermata	U3U8P2
GNAS Hydra vulgaris Cnidaria	T2NC71
GNAS Nematostella vectensis Cnidaria	A7RHA6
GNAS Pelodiscus sinensis Chordata	K7FA67
GNAS Xenopus laevis Chordata	P24799
GNAS Bos taurus Chordata	P04896
GNAS Mus musculus Chordata	P63094
GNAS Homo sapiens Chordata	P63092
GNAS Canis familiaris Chordata	P63091

GNAO	GNAO Salpingoeca rosetta Choanoflagellata	F2UH11
	GNAO Monosiga brevicollis Choanoflagellata	A9V4X4
	GNAO Amphimedon queenslandica Porifera	A0A1X7VFK4
	GNAO Geodia cydonium Porifera	Q9XZV3
	GNAO Holothuria leucospilota Echinodermata	A0A9Q1C4V1
	GNAO Oncorhynchus mykiss Chordata	A0A8C7TJ20
	GNAO Dicentrarchus labrax Chordata	A0A8C4H9W5

GNAO <i>Neogobius melanostomus</i> Chordata	A0A8C6TAT2
GNAO <i>Bispira guinensis</i> DN209176	PX778787
GNAO <i>Callosobruchus maculatus</i> Arthropoda	A0A653CBW3
GNAO <i>Timema monikensis</i> Arthropoda	A0A7R9HQM7
GNAO <i>Bugula neritina</i> Bryozoa	A0A7J7J0I2
GNAO <i>Lottia gigantea</i> Mollusca	V4BDV4
GNAO <i>Octopus glabrata</i> Mollusca	A0A9W2ZT16
GNAO <i>Octopus bimaculoides</i> Mollusca	A0AL8H4X6
GNAO <i>Octopus vulgaris</i> Mollusca	A0A6P7TQL2
GNAO <i>Geodia barretti</i> Porifera	A0AA35RG40
GNAO <i>Strongylocentrotus purpuratus</i> Echinodermata	A0A7M7LSI8
GNAO <i>Acanthaster planci</i> Echinodermata	A0A8B7ZVA2
GNAO <i>Patiria miniata</i> Echinodermata	A0A914B1L8
GNAO <i>Trichoplax</i> sp Placozoa	A0A369SJ11
GNAO <i>Paramuricea clavata</i> Cnidaria	A0A6S7G0T6
GNAO <i>Stylophora pistillata</i> Cnidaria	A0A2B4T2E0
GNAO <i>Pocillopora damicornis</i> Cnidaria	A0A3M6UZX6
GNAO <i>Nematostella vectensis</i> Cnidaria	A7SUS4
GNAO <i>Actinia tenebrosa</i> Cnidaria	A0A6P8IBV3
GNAO <i>Exaiptasia diaphana</i> Cnidaria	A0A913WS41
GNAO <i>Xenopus laevis</i> Chordata	P10825
GNAO <i>Bos taurus</i> Chordata	P08239
GNAO <i>Homo sapiens</i> Chordata	P09471
GNAO <i>Mus musculus</i> Chordata	P18872
GNAO <i>Rattus norvegicus</i> Chordata	P59215
GNAO <i>Poeciliopsis prolifica</i> Chordata	A0A0S7MDP5
GNAO <i>Callorhinchus milii</i> Chordata	V9KGJ4
GNAO <i>Chiloscyllium punctatum</i> Chordata	A0A401S7T5
GNAO <i>Etmopterus spinax</i> Chordata	A0A6B9CM83
GNAO <i>Brachionus plicatilis</i> Rotifera	A0A3M7Q0P2
GNAO <i>Brachionus calyciflorus</i> Rotifera	A0A814BVR7
GNAO <i>Trichinella spiralis</i> Nematoda	E5SUB9
GNAO <i>Brugia malayi</i> Nematoda	A0A4E9FNQ2
GNAO <i>Loa Loa</i> Nematoda	A0A1S0UE82

GNAO <i>Ascaris lumbricoides</i> Nematoda	A0A9J2PMY7
GNAO <i>Caenorhabditis elegans</i> Nematoda	P51875
GNAO <i>Manduca sexta</i> Arthropoda	P53359
GNAO <i>Drosophila melanogaster</i> Arthropoda	P16378
GNAO <i>Bombus impatiens</i> Arthropoda	A0A6P3E0B6
GNAO <i>Photinus pyralis</i> Arthropoda	A0A1Y1JSB5
GNAO <i>Locusta migratoria</i> Arthropoda	P38404
GNAO <i>Macrostomum lignano</i> Platyhelminthes	A0A1I8GGD7
GNAO <i>Schistosoma japonicum</i> Platyhelminthes	A0A4Z2CXC9
GNAO <i>Mesocostoides corti</i> Platyhelminthes	A0A5K3EI71
GNAO <i>Schistocephalus solidus</i> Platyhelminthes	A0A0X3PCL2
GNAO <i>Mizuhopecten yessoensis</i> Mollusca	O15976
GNAO <i>Aplysia californica</i> Mollusca	Q0ZA01
GNAO <i>Lymnaea stagnalis</i> Mollusca	P30683
GNAO <i>Planorbella trivolvis</i> Mollusca	P51877
GNAO <i>Owenia fusiformis</i> Annelida	A0A8S4NGT9
GNAO <i>Terebratalia transversa</i> Brachiopoda	M9UZR9
GNAO <i>Pseudopotamilla ocellata</i> DN507	PX778781
GNAO <i>Acromegalomma interruptum</i> Annelida	Bok <i>et al</i>
GNAO <i>Paralvinella palmiformis</i> Annelida	A0AAD9IX84
GNAO <i>Helobdella robusta</i> Annelida	T1FZ51
GNAO <i>Ridgeia piscesae</i> Annelida	A0AAD9P6E7
GNAO <i>Capitella teleta</i> Annelida	R7TUE2

GNAI/T

GNAI <i>Aceria tosichella</i> Arthropoda	A0A6G1S786
GNAI <i>Schistosoma japonicum</i> Platyhelminthes	Q5DBN1
GNAI <i>Schistocephalus solidus</i> Platyhelminthes	A0A0X3PGI8
GNAI <i>Clonorchis sinensis</i> Platyhelminthes	G7YH32
GNAI <i>Macrostomum lignano</i> Platyhelminthes	A0A1I8GE31
GNAI <i>Terebratalia transversa</i> Brachiopoda	M9V131
GNAI <i>Mytilus edulis</i> Mollusca	A0A8S3RSG3
GNAI <i>Mytilus coruscus</i> Mollusca	A0A6J8BWW2
GNAI <i>Lymnaea stagnalis</i> Mollusca	P30682
GNAI <i>Planorbella trivolvis</i> Mollusca	P51876

GNAI Platynereis dumerilii Annelida	A0A2H5BFB0
GNAI Pseudopotamilla ocellata DN14483	PX778783
GNAI Acromegalomma interruptum Annelida	Bok <i>et al</i>
GNAI Patiria pectinifera Echinodermata	P30676
GNAI Homarus americanus Arthropoda	P41776
GNAI Chionoecetes opilio Arthropoda	A0A8J4YKH0
GNAI Procambarus clarkii Arthropoda	A0A6C0T8G7
GNAI Drosophila willistoni Arthropoda	B4MKT5
GNAI Drosophila melanogaster Arthropoda	P20353
GNAI Drosophila ananassae Arthropoda	B3M9F2
GNAI Gallus gallus Chordata	P50147
GNAI Homo sapiens i Chordata	P08754
GNAI Mus musculus i Chordata	Q9DC51
GNAI Bos taurus i Chordata	P63097
GNAI Xenopus laevis i Chordata	P27044
GNAI Scophthalmus maximus Chordata	A0A8K1PTD8
GNAI Oryzias latipes Chordata	P87383
GNAI Mnemiopsis leidyi 1 Ctenophora	K9LM62
GNAI Mnemiopsis leidyi 2 Ctenophora	L0I990
GNAT Rattus norvegicus Chordata	P29348
GNAI Bos taurus t Chordata	P0C7Q4
GNAT Homo sapiens t Chordata	P19087
GNAT Dromas ardeola Chordata	NWU55202.1
GNAT Alligator mississippiensis Chordata	NC_081837.1
GNAI Mus musculus t Chordata	P20612
GNAT Acipenser oxyrinchus Chordata	A0AAD8FZ35
GNAI Xenopus laevis t Chordata	P38407



Fig S1. *Pseudopotamiila ocellata* habitated in the subtidal area. (A-B) Radiolar crowns periodically expose out of the sea level which may cause stronger photo-bleaching and UV damage to the photoreceptor cells during low tide. (C) A closer look of a colony of *P. ocellata* with hundreds of individuals clustered together.

Table S5. Primer sequences used for cDNA amplification in *P. ocellata*

Target Gene	Forward Primer (5'-3')	Reverse Primer (5'-3')	Product Size (bp)
InvC	AACTAGACTTGGCAAGCAACG	ATTGGCATTCTGGCTAATGG	736
GNAO	GCTGAGGATAGGTTGGCGAT	AGTAGCACATGTCTGATGGCA	963
GNAS	TGGGCATCTGTTGAATATCG	TGCCAGAAGGCTTAGATTGC	988
GNAI	GCATAGCCTTCATTCTGTTGG	AGTCCCCACTCACAATCTGC	931
GNAQ	GCTTTGGACTCTTCCATTCG	AATCCCTTCTGGCTTAATCG	846

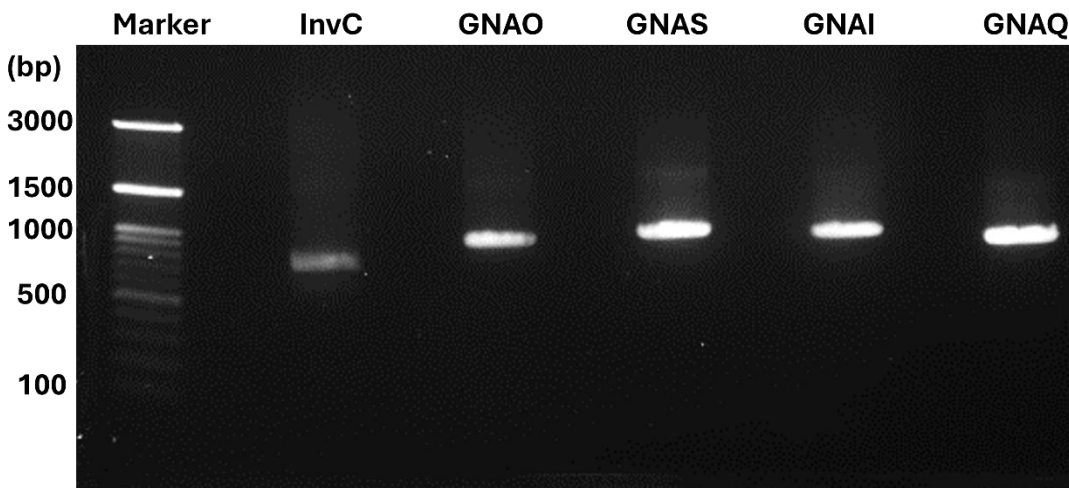


Fig S3. PCR amplification of c-opsin and G protein alpha subunits from *Pseudopotamilla ocellata* radiolar eyes. Gel electrophoresis shows the successful amplification of cDNA fragments for invertebrate c-opsin (InvC), GNAO, GNAS, GNAI and GNAQ. ExcelBand DM2300 DNA ladder was loaded on the left. All bands corresponded to the expected molecular weights, confirming the expression of these components within the radiolar ocular tissue.

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