

GEPHE SUMMARY

opsin - (SWS2) (https://www.gephebase.org/search-criteria/?and+Gene Gephebase=%opsin-(SWS2)^#gephebase-summary-title)	Gephebase Gene	GP00001679	GepheID
	Entry Status	Prigent	Main curator
Published			

PHENOTYPIC CHANGE

Trait Category			
Physiology (https://www.gephebase.org/search-criteria/?and+Trait+Category=%Physiology^#gephebase-summary-title)	Trait		
Color vision (blue- and red-shifts) (https://www.gephebase.org/search-criteria/?and+Trait=%Color+vision+(blue-+and+red-shifts)^#gephebase-summary-title)	Trait State in Taxon A		
Photoreception adapted to clearwater lakes	Trait State in Taxon B		
Photoreception adapted to blackwater lakes	Ancestral State		
Unknown	Taxonomic Status		
Intraspecific (https://www.gephebase.org/search-criteria/?and+Taxonomic+Status=%Intraspecific^#gephebase-summary-title)			
Taxon A	Latin Name	Taxon B	Latin Name
Gasterosteus aculeatus (https://www.gephebase.org/search-criteria/?and+Taxon+and+Synonyms=%Gasterosteus+aculeatus^#gephebase-summary-title)		Gasterosteus aculeatus (https://www.gephebase.org/search-criteria/?and+Taxon+and+Synonyms=%Gasterosteus+aculeatus^#gephebase-summary-title)	
three-spined stickleback	Common Name	three-spined stickleback	Common Name
three-spined stickleback; three spined stickleback; Gasterosteus aculeatus Linnaeus, 1758	Synonyms	three-spined stickleback; three spined stickleback; Gasterosteus aculeatus Linnaeus, 1758	Synonyms
species	Rank	species	Rank
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Deuterostomia; Chordata; Craniata; Vertebrata; Gnathostomata; Teleostomi; Euteleostomi; Actinopterygii; Actinopteri; Neopterygii; Teleostei; Osteoglossocephalai; Clupeocephala; Euteleosteomorpha; Neoteleostei; Eurypterygia; Ctenosquamata; Acanthomorphata; Euacanthomorphacea; Percomorphacea; Euperaria; Perciformes; Cottioidei; Gasterosteales; Gasterosteidae; Gasterosteus	Lineage	cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Deuterostomia; Chordata; Craniata; Vertebrata; Gnathostomata; Teleostomi; Euteleostomi; Actinopterygii; Actinopteri; Neopterygii; Teleostei; Osteoglossocephalai; Clupeocephala; Euteleosteomorpha; Neoteleostei; Eurypterygia; Ctenosquamata; Acanthomorphata; Euacanthomorphacea; Percomorphacea; Euperaria; Perciformes; Cottioidei; Gasterosteales; Gasterosteidae; Gasterosteus	Lineage
Gasterosteus () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 69292)	Parent	Gasterosteus () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 69292)	Parent
69293 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 69293)	NCBI Taxonomy ID	69293 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 69293)	NCBI Taxonomy ID
Yes	is Taxon A an Infraspecies?	Yes	is Taxon B an Infraspecies?
threespine stickleback from clearwater or from blackwater lake transplanted in clearwater pond (resampled after 19 years)	Taxon A Description	threespine sticklebacks from blackwater lakes	Taxon B Description

GENOTYPIC CHANGE

Generic Gene Name			
opn1sw2	Synonyms	Q9W6A8 (http://www.uniprot.org/uniprot/Q9W6A8)	UniProtKB Danio rerio
SWS2; bluops; zflblue; Sl;zK13A21.5; opn1sw1; sws2	String	0	GenebankID or UniProtKB
7955.ENSDARP00000019477 (http://string-db.org/newstring_cgi/show_network_section.pl?identifier=7955.ENSDARP00000019477)	Sequence Similarities		
Belongs to the G-protein coupled receptor 1 family. Opsin subfamily.	GO - Molecular Function		
GO:0009882 : blue light photoreceptor activity (https://www.ebi.ac.uk/QuickGO/term/GO:0009882)			

GO:0008020 : G protein-coupled photoreceptor activity
(<https://www.ebi.ac.uk/QuickGO/term/GO:0008020>)

GO - Biological Process

GO:0007186 : G protein-coupled receptor signaling pathway
(<https://www.ebi.ac.uk/QuickGO/term/GO:0007186>)

GO:0018298 : protein-chromophore linkage
(<https://www.ebi.ac.uk/QuickGO/term/GO:0018298>)

GO:0007601 : visual perception (<https://www.ebi.ac.uk/QuickGO/term/GO:0007601>)

GO:0071482 : cellular response to light stimulus
(<https://www.ebi.ac.uk/QuickGO/term/GO:0071482>)

GO:0007602 : phototransduction (<https://www.ebi.ac.uk/QuickGO/term/GO:0007602>)

GO - Cellular Component

GO:0005887 : integral component of plasma membrane

(<https://www.ebi.ac.uk/QuickGO/term/GO:0005887>)

GO:0001750 : photoreceptor outer segment

(<https://www.ebi.ac.uk/QuickGO/term/GO:0001750>)

Mutation #1

Presumptive Null

No (<https://www.gephebase.org/search-criteria?/and+Presumptive+Null=^No^#gephebase-summary-title>)

Molecular Type

Coding (<https://www.gephebase.org/search-criteria?/and+Molecular+Type=^Coding^#gephebase-summary-title>)

Aberration Type

SNP (<https://www.gephebase.org/search-criteria?/and+Aberration+Type=^SNP^#gephebase-summary-title>)

SNP Coding Change

Nonsynonymous

Molecular Details of the Mutation

7 aa changes including 2 changes (C97S & G109A) known to cause a red-shift in light absorption favored in blackwater lakes but disfavored in the clearwater habitat

Experimental Evidence

Candidate Gene (<https://www.gephebase.org/search-criteria?/and+Experimental+Evidence=^Candidate+Gene^#gephebase-summary-title>)

	Taxon A	Taxon B	Position
Codon	-	-	-
Amino-acid	Cys	Ser	97

Main Reference

Convergent evolution of SWS2 opsin facilitates adaptive radiation of threespine stickleback into different light environments. (2017) (<https://pubmed.ncbi.nlm.nih.gov/28399148/>)

Authors

Marques DA; Taylor JS; Jones FC; Di Palma F; Kingsley DM; Reimchen TE

Abstract

Repeated adaptation to a new environment often leads to convergent phenotypic changes whose underlying genetic mechanisms are rarely known. Here, we study adaptation of color vision in threespine stickleback during the repeated postglacial colonization of clearwater and blackwater lakes in the Haida Gwaii archipelago. We use whole genomes from 16 clearwater and 12 blackwater populations, and a selection experiment, in which stickleback were transplanted from a blackwater lake into an uninhabited clearwater pond and resampled after 19 y to test for selection on cone opsin genes. Patterns of haplotype homozygosity, genetic diversity, site frequency spectra, and allele-frequency change support a selective sweep centered on the adjacent blue- and red-light sensitive opsins SWS2 and LWS. The haplotype under selection carries seven amino acid changes in SWS2, including two changes known to cause a red-shift in light absorption, and is favored in blackwater lakes but disfavored in the clearwater habitat of the transplant population. Remarkably, the same red-shifting amino acid changes occurred after the duplication of SWS2 198 million years ago, in the ancestor of most spiny-rayed fish. Two distantly related fish species, bluefin killifish and black bream, express these old paralogs divergently in black- and clearwater habitats, while sticklebacks lost one paralog. Our study thus shows that convergent adaptation to the same environment can involve the same genetic changes on very different evolutionary time scales by reevolving lost mutations and reusing them repeatedly from standing genetic variation.

Additional References

Mutation #2

Presumptive Null

No (<https://www.gephebase.org/search-criteria?/and+Presumptive+Null=^No^#gephebase-summary-title>)

Molecular Type

Coding (<https://www.gephebase.org/search-criteria?/and+Molecular+Type=^Coding^#gephebase-summary-title>)

Aberration Type

SNP (<https://www.gephebase.org/search-criteria?/and+Aberration+Type=^SNP^#gephebase-summary-title>)

SNP Coding Change

Nonsynonymous

Molecular Details of the Mutation

7 aa changes including 2 changes (C97S & G109A) known to cause a red-shift in light absorption favored in blackwater lakes but disfavored in the clearwater habitat

Experimental Evidence

Candidate Gene (<https://www.gephebase.org/search-criteria?/and+Experimental+Evidence=^Candidate+Gene^#gephebase-summary-title>)

	Taxon A	Taxon B	Position
Codon	-	-	-
Amino-acid	Gly	Ala	109

Marques DA; Taylor JS; Jones FC; Di Palma F; Kingsley DM; Reimchen TE

Abstract

Repeated adaptation to a new environment often leads to convergent phenotypic changes whose underlying genetic mechanisms are rarely known. Here, we study adaptation of color vision in threespine stickleback during the repeated postglacial colonization of clearwater and blackwater lakes in the Haida Gwaii archipelago. We use whole genomes from 16 clearwater and 12 blackwater populations, and a selection experiment, in which stickleback were transplanted from a blackwater lake into an uninhabited clearwater pond and resampled after 19 y to test for selection on cone opsin genes. Patterns of haplotype homozygosity, genetic diversity, site frequency spectra, and allele-frequency change support a selective sweep centered on the adjacent blue- and red-light sensitive opsins SWS2 and LWS. The haplotype under selection carries seven amino acid changes in SWS2, including two changes known to cause a red-shift in light absorption, and is favored in blackwater lakes but disfavored in the clearwater habitat of the transplant population. Remarkably, the same red-shifting amino acid changes occurred after the duplication of SWS2 198 million years ago, in the ancestor of most spiny-rayed fish. Two distantly related fish species, bluefin killifish and black bream, express these old paralogs divergently in black- and clearwater habitats, while sticklebacks lost one paralog. Our study thus shows that convergent adaptation to the same environment can involve the same genetic changes on very different evolutionary time scales by reevolving lost mutations and reusing them repeatedly from standing genetic variation.

Additional References

RELATED GEPHE

Related Genes

No matches found.

Related Haplotypes

No matches found.

EXTERNAL LINKS

COMMENTS

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