GEPHE SUMMARY

Gephebase Gene
opsin - (SWS2) (https://www.gephebase.org/search-criteria?/and+Gene Gephebase=^opsin - (SWS2)^#gephebase-summary-title)

GepheID
GP00001679

Entry Status
Published

Main curator
Prigent

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
Gasterosteus aculeatus (https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=^Gasterosteus aculeatus^#gephebase-summary-title)

Common Name
three-spined stickleback

Synonyms
three-spined stickleback; three spined stickleback; Gasterosteus aculeatus Linnaeus, 1758

Rank
species

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; Percomorphaceae; Eupercaria; Perciformes; Cottioidei; Gasterosteales; Gasterosteidae; Gasterosteus

Parent
Gasterosteus () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 69292)

NCBI Taxonomy ID
69293 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 69293)

is Taxon A an Infraspecies?
Yes

Taxon A Description
threespine stickleback from clearwater or from blackwater lake transplanted in clearwater pond (resampled after 19 years)

Taxon B

Latin Name
Gasterosteus aculeatus (https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=^Gasterosteus aculeatus^#gephebase-summary-title)

Common Name
three-spined stickleback

Synonyms
three-spined stickleback; three spined stickleback; Gasterosteus aculeatus Linnaeus, 1758

Rank
species

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; Percomorphaceae; Eupercaria; Perciformes; Cottioidei; Gasterosteales; Gasterosteidae; Gasterosteus

Parent
Gasterosteus () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 69292)

NCBI Taxonomy ID
69293 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 69293)

is Taxon B an Infraspecies?
Yes

Taxon B Description
threespine sticklebacks from blackwater lakes

GENOTYPIC CHANGE

Generic Gene Name
opn1sw2

Synonyms
SWS2; bluops; zfblue; Sl:zK13A21.5; opn1sw1; sws2

String
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)

UniProtKB Danio rerio
Q9W6A8 (http://www.uniprot.org/uniprot/Q9W6A8)

GenebankID or UniProtKB
()

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

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

RELATED GEPHE

Related Genes

No matches found.

Related Haplotypes

No matches found.

EXTERNAL LINKS

COMMENTS

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