GEPHE SUMMARY

Gephebase Gene
opsin - rhodopsin (UVRh2) (https://www.gephebase.org/search-criteria?/and+Gene Gephebase=^opsin - rhodopsin (UVRh2)^#gephebase-summary-title)

GepheID
GP00000779

Entry Status
Published

Main curator
Courtier

PHENOTYPIC CHANGE

Trait Category
Physiology (https://www.gephebase.org/search-criteria?/and+Trait Category=^Physiology^#gephebase-summary-title)

Trait
Color vision (UV-shift) (https://www.gephebase.org/search-criteria?/and+Trait=^Color vision (UV-shift)^#gephebase-summary-title)

Trait State in Taxon A
Other butterflies

Trait State in Taxon B
Heliconius spp.

Ancestral State
Data not curated

Taxonomic Status
Intergeneric or Higher (https://www.gephebase.org/search-criteria?/and+Taxonomic Status=^Intergeneric or Higher^#gephebase-summary-title)

Taxon A

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

Common Name
brushfoots

Synonyms
brushfoots; brush-footed butterflies

Rank
family

Lineage
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Holometabola; Amphiesmenoptera; Lepidoptera; Glossata; Neolepidoptera; Heteroneura; Ditrysia; Obtectomera; Papilionoidea

Parent
Papilionoidea (butterflies) - (Rank: superfamily) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 37572)

NCBI Taxonomy ID
33415 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 33415)

is Taxon A an Infraspecies?
No

Taxon B #1

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

Common Name
-

Synonyms
Heliconius cydno pachinus; Heliconius pachinus Salvin, 1871

Rank
species

Lineage
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Holometabola; Amphiesmenoptera; Lepidoptera; Glossata; Neolepidoptera; Heteroneura; Ditrysia; Obtectomera; Papilionoidea; Nymphalidae; Heliconiinae; Heliconiini; Heliconius

Parent
Heliconius () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 33416)

NCBI Taxonomy ID
33428 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 33428)

is Taxon B an Infraspecies?
No

Taxon B #2

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

Common Name
crimson-patched longwing

Synonyms
crimson-patched longwing; Heliconius erato (Linnaeus, 1764)

Rank
species

Lineage
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Holometabola; Amphiesmenoptera; Lepidoptera; Glossata; Neolepidoptera; Heteroneura; Ditrysia; Obtectomera; Papilionoidea; Nymphalidae; Heliconiinae; Heliconiini; Heliconius

Parent
Heliconius () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 33416)

NCBI Taxonomy ID

33431
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 33431)

is Taxon B an Infraspecies?

No

Taxon B #3

Latin Name

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

Common Name

-

Synonyms

-

Rank

species

Lineage

cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Holometabola; Amphiesmenoptera; Lepidoptera; Glossata; Neolepidoptera; Heteroneura; Ditrysia; Obtectomera; Papilionoidea; Nymphalidae; Heliconiinae; Heliconiini; Heliconius

Parent

Heliconius () - (Rank: genus)
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 33416)

NCBI Taxonomy ID

196493
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 196493)

is Taxon B an Infraspecies?

No

Taxon B #4

Latin Name

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

Common Name

-

Synonyms

Heliconius sapho (Drury, 1782)

Rank

species

Lineage

cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Holometabola; Amphiesmenoptera; Lepidoptera; Glossata; Neolepidoptera; Heteroneura; Ditrysia; Obtectomera; Papilionoidea; Nymphalidae; Heliconiinae; Heliconiini; Heliconius

Parent

Heliconius () - (Rank: genus)
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 33416)

NCBI Taxonomy ID

33433
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 33433)

is Taxon B an Infraspecies?

No

Taxon B #5

Latin Name

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

Common Name

zebra longwing

Synonyms

Heliconius charitonius; zebra longwing; zebra butterfly; Heliconius charithonia (Linnaeus, 1767)

Rank

species

Lineage

cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Holometabola; Amphiesmenoptera; Lepidoptera; Glossata; Neolepidoptera; Heteroneura; Ditrysia;

Obtectomera; Papilionoidea; Nymphalidae; Heliconiinae; Heliconiini; Heliconius

Parent

Heliconius () - (Rank: genus)
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 33416)

NCBI Taxonomy ID

33434
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 33434)

is Taxon B an Infraspecies?

No

Taxon B #6

Latin Name

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

Common Name

postman butterfly

Synonyms

postman butterfly; common postman; Heliconius melpomene (Linnaeus, 1758)

Rank

species

Lineage

cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Holometabola; Amphiesmenoptera; Lepidoptera; Glossata; Neolepidoptera; Heteroneura; Ditrysia; Obtectomera; Papilionoidea; Nymphalidae; Heliconiinae; Heliconiini; Heliconius

Parent

Heliconius () - (Rank: genus)
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 33416)

NCBI Taxonomy ID

34740
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 34740)

is Taxon B an Infraspecies?

No

Taxon B #7

Latin Name

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

Common Name

-

Synonyms

Heliconius elevatus Noldner, 1901

Rank

species

Lineage

cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Holometabola; Amphiesmenoptera; Lepidoptera; Glossata; Neolepidoptera; Heteroneura; Ditrysia; Obtectomera; Papilionoidea; Nymphalidae; Heliconiinae; Heliconiini; Heliconius

Parent

Heliconius () - (Rank: genus)
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 33416)

NCBI Taxonomy ID

33444
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 33444)

is Taxon B an Infraspecies?

No

Taxon B #8

Latin Name

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

Common Name

-

Synonyms

Heliconius cydno Doubleday, 1847

Rank

species

Lineage

cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Holometabola; Amphiesmenoptera; Lepidoptera; Glossata; Neolepidoptera; Heteroneura; Ditrysia; Obtectomera; Papilionoidea; Nymphalidae; Heliconiinae; Heliconiini; Heliconius

Parent

Heliconius () - (Rank: genus)
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 33416)

NCBI Taxonomy ID

33424
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 33424)

is Taxon B an Infraspecies?

No

GENOTYPIC CHANGE

Generic Gene Name

UVRh2

Synonyms

-

String

-

Sequence Similarities

Belongs to the G-protein coupled receptor 1 family.

GO - Molecular Function

GO:0004930 : G protein-coupled receptor activity
(https://www.ebi.ac.uk/QuickGO/term/GO:0004930)

GO - Biological Process

GO:0007601 : visual perception (https://www.ebi.ac.uk/QuickGO/term/GO:0007601)
GO:0007602 : phototransduction (https://www.ebi.ac.uk/QuickGO/term/GO:0007602)

GO - Cellular Component

GO:0016021 : integral component of membrane
(https://www.ebi.ac.uk/QuickGO/term/GO:0016021)

UniProtKB Heliconius melpomene

E2DZL8 (http://www.uniprot.org/uniprot/E2DZL8)

GenebankID or UniProtKB

()

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

T180A; Y277F (human LWS/MWS numbering system) - Homology modeling of the UVRh rhodopsins of H. erato indicates sites 179 and 289 correspond to experimentally determined spectral tuning sites 180 and 277 in the human red cone pigment numbering system. The two Heliconius visual pigments differ in having amino acid changes A180T and F277Y at these sites. In site-directed mutagenesis experiments amino acid changes A180S and F277Y increased lambda-max values of human green pigment by â^¼47 and 10 nm, respectively, and the effects of these amino acid substitutions on lambda-max were approximately additive

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	Thr	Ala	180

Main Reference

Positive selection of a duplicated UV-sensitive visual pigment coincides with wing pigment evolution in Heliconius butterflies. (2010) (https://pubmed.ncbi.nlm.nih.gov/20133601)

Authors

Briscoe AD; Bybee SM; Bernard GD; Yuan F; Sison-Mangus MP; Reed RD; Warren AD; Llorente-Bousquets J; Chiao CC

Abstract

The butterfly Heliconius erato can see from the UV to the red part of the light spectrum with color vision proven from 440 to 640 nm. Its eye is known to contain three visual pigments, rhodopsins, produced by an 11-cis-3-hydroxyretinal chromophore together with long wavelength (LWRh), blue (BRh) and UV (UVRh1) opsins. We now find that H. erato has a second UV opsin mRNA (UVRh2)-a previously undescribed duplication of this gene among Lepidoptera. To investigate its evolutionary origin, we screened eye cDNAs from 14 butterfly species in the subfamily Heliconiinae and found both copies only among Heliconius. Phylogeny-based tests of selection indicate positive selection of UVRh2 following duplication, and some of the positively selected sites correspond to vertebrate visual pigment spectral tuning residues. Epi-microspectrophotometry reveals two UV-absorbing rhodopsins in the H. erato eye with lambda(max) = 355 nm and 398 nm. Along with the additional UV opsin, Heliconius have also evolved 3-hydroxy-DL-kynurenine (3-OHK)-based yellow wing pigments not found in close relatives. Visual models of how butterflies perceive wing color variation indicate this has resulted in an expansion of the number of distinguishable yellow colors on Heliconius wings. Functional diversification of the UV-sensitive visual pigments may help explain why the yellow wing pigments of Heliconius are so colorful in the UV range compared to the yellow pigments of close relatives lacking the UV opsin duplicate.

Additional References

Contrasting modes of evolution of the visual pigments in Heliconius butterflies. (2010) (https://pubmed.ncbi.nlm.nih.gov/20478921)

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

T180A; Y277F (human LWS/MWS numbering system) - Homology modeling of the UVRh rhodopsins of H. erato indicates sites 179 and 289 correspond to experimentally determined spectral tuning sites 180 and 277 in the human red cone pigment numbering system. The two Heliconius visual pigments differ in having amino acid changes A180T and F277Y at these sites. In site-directed mutagenesis experiments amino acid changes A180S and F277Y increased lambda-max values of human green pigment by â^¼47 and 10 nm, respectively, and the effects of these amino acid substitutions on lambda-max were approximately additive

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	Tyr	Phe	277

Main Reference

Positive selection of a duplicated UV-sensitive visual pigment coincides with wing pigment evolution in Heliconius butterflies. (2010) (https://pubmed.ncbi.nlm.nih.gov/20133601)

Authors

Briscoe AD; Bybee SM; Bernard GD; Yuan F; Sison-Mangus MP; Reed RD; Warren AD; Llorente-Bousquets J; Chiao CC

Abstract

The butterfly Heliconius erato can see from the UV to the red part of the light spectrum with color vision proven from 440 to 640 nm. Its eye is known to contain three visual pigments, rhodopsins, produced by an 11-cis-3-hydroxyretinal chromophore together with long wavelength (LWRh), blue (BRh) and UV (UVRh1) opsins. We now find that H. erato has a second UV opsin mRNA (UVRh2)-a previously undescribed duplication of this gene among Lepidoptera. To investigate its evolutionary origin, we screened eye cDNAs from 14 butterfly species in the subfamily Heliconiinae and found both copies only among Heliconius. Phylogeny-based tests of selection indicate positive selection of UVRh2 following duplication, and some of the positively selected sites correspond to vertebrate visual pigment spectral tuning residues. Epi-microspectrophotometry reveals two UV-absorbing rhodopsins in the H. erato eye with lambda(max) = 355 nm and 398 nm. Along with the additional UV opsin, Heliconius have also evolved 3-hydroxy-DL-kynurenine (3-OHK)-based yellow wing pigments not found in close relatives. Visual models of how butterflies perceive wing color variation indicate this has resulted in an expansion of the number of distinguishable yellow colors on Heliconius wings. Functional diversification of the UV-sensitive visual pigments may help explain why the yellow wing pigments of Heliconius are so colorful in the UV range compared to the yellow pigments of close relatives lacking the UV opsin duplicate.

Additional References

Contrasting modes of evolution of the visual pigments in Heliconius butterflies. (2010) (https://pubmed.ncbi.nlm.nih.gov/20478921)

RELATED GEPHE

Related Genes

1 (opsin - rhodopsin (LWRh)) (https://www.gephebase.org/search-criteria?/or+Taxon ID=^33415^/and+Trait=Color vision/or+Taxon ID=^33428^/and+Trait=Color vision/or+Taxon ID=^33431^/and+Trait=Color vision/or+Taxon ID=^196493^/and+Trait=Color vision/or+Taxon ID=^33433^/and+Trait=Color vision/or+Taxon ID=^33434^/and+Trait=Color vision/or+Taxon ID=^34740^/and+Trait=Color vision/or+Taxon ID=^33444^/and+Trait=Color vision/or+Taxon ID=^33424^/and+Trait=Color vision/and+groupHaplotypes=true#gephebase-summary-title)

Related Haplotypes

No matches found.

EXTERNAL LINKS

COMMENTS

@SeveralMutationsWithEffect