

GEPHE SUMMARY

	Gephebase Gene	GepheID
opsin - rhodopsin (UVRh2) (https://www.gephebase.org/search-criteria?/and+Gene Gephebase=^opsin - rhodopsin (UVRh2)^#gephebase-summary-title)	GP00000779	
	Entry Status	Main curator
Published	Courier	

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	Latin Name
Nymphalidae (https://www.gephebase.org/search-criteria?/and+Taxon+and+Synonyms=^Nymphalidae^#gephebase-summary-title)		
	Common Name	Common Name
brushfoots		
brushfoots; brush-footed butterflies	Synonyms	Synonyms
	Rank	Rank
family		
	Lineage	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	Parent
Papilionoidea (butterflies) - (Rank: superfamily) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 37572)		
	NCBI Taxonomy ID	NCBI Taxonomy ID
33415 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 33415)		
	is Taxon A an Infraspecies?	is Taxon B an Infraspecies?
No		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
-	
Heliconius cydno pachinus; Heliconius pachinus Salvin, 1871	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; Helconiinae; 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
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; Helconiinae; Heliconiini; Heliconius	
	Parent
Heliconius () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 33416)	
	NCBI Taxonomy ID
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
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; Helconiinae; Heliconiini; Heliconius	
	Parent
Heliconius () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 33416)	
	NCBI Taxonomy ID
No	

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 Common Name
(<https://www.gephbase.org/search-criteria?/and+Taxon+and+Synonyms=%^Heliconius+hortense%#gephbase-summary-title>)
- 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; Papilioidea; 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 Common Name
(<https://www.gephbase.org/search-criteria?/and+Taxon+and+Synonyms=%^Heliconius+sapho%#gephbase-summary-title>)
- 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; Papilioidea; 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 Common Name
(<https://www.gephbase.org/search-criteria?/and+Taxon+and+Synonyms=%^Heliconius+charithonia%#gephbase-summary-title>)
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; Papilioidea; 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.gephbase.org/search-criteria?/and+Taxon+and+Synonyms=%7Heliconius+melpomene%23gephbase-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; Papilioidea; 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.gephbase.org/search-criteria?/and+Taxon+and+Synonyms=%7Heliconius+elevatus%23gephbase-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; Papilioidea; 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.gephbase.org/search-criteria?/and+Taxon+and+Synonyms=%7Heliconius+cydno%23gephbase-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; Dicondyla; Pterygota; Neoptera; Holometabola;
 Amphiesmenoptera; Lepidoptera; Glossata; Neolepidoptera; Heteroneura; Ditrysia;
 Obtectomera; Papilioidea; 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

UVRh2	Generic Gene Name	E2DZL8 (http://www.uniprot.org/uniprot/E2DZL8)	UniProtKB Heliconius melpomene
-	Synonyms		GenebankID or UniProtKB
-	String	0	
-	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)			

Mutation #1	Presumptive Null
No (https://www.gephbase.org/search-criteria?/and+Presumptive Null=^No^#gephbase-summary-title)	Molecular Type
Coding (https://www.gephbase.org/search-criteria?/and+Molecular Type=^Coding^#gephbase-summary-title)	Aberration Type
SNP (https://www.gephbase.org/search-criteria?/and+Aberration Type=^SNP^#gephbase-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 <i>H. erato</i> 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 <i>Heliconius</i> 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 \approx 147 and 10 nm, respectively, and the effects of these amino acid substitutions on lambda-max were approximately additive	Experimental Evidence
Candidate Gene (https://www.gephbase.org/search-criteria?/and+Experimental Evidence=^Candidate Gene^#gephbase-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. Epifluorescence reveals two UV-absorbing rhodopsins in the *H. erato* eye with λ_{max} = 355 nm and 398 nm. Along with the additional UV opsin, *Heliconius* have also evolved 3-hydroxy-DL-kynurenone (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

No (https://www.gephebase.org/search-criteria/?and+Presumptive+Null=%No%#gephebase-summary-title)	Presumptive Null
Coding (https://www.gephebase.org/search-criteria/?and+Molecular+Type=%Coding%#gephebase-summary-title)	Molecular Type
SNP (https://www.gephebase.org/search-criteria/?and+Aberration+Type=%SNP%#gephebase-summary-title)	Aberration Type
Nonsynonymous	SNP Coding Change
T180A; Y277F (human LWS/MWS numbering system) - Homology modeling of the UVRh rhodopsins of <i>H. erato</i> 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 <i>Heliconius</i> 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 $\Delta\lambda = 47$ and 10 nm, respectively, and the effects of these amino acid substitutions on lambda-max were approximately additive	Molecular Details of the Mutation
Candidate Gene (https://www.gephebase.org/search-criteria/?and+Experimental+Evidence=%Candidate+Gene%#gephebase-summary-title)	Experimental Evidence

	Taxon A	Taxon B	Position
Codon	-	-	-
Amino-acid	Tyr	Phe	277

Positive selection of a duplicated UV-sensitive visual pigment coincides with wing pigment evolution in <i>Heliconius</i> butterflies. (2010) (https://pubmed.ncbi.nlm.nih.gov/20133601)	Main Reference
Briscoe AD; Bybee SM; Bernard GD; Yuan F; Sison-Mangus MP; Reed RD; Warren AD; Llorente-Bousquets J; Chiao CC	Authors
The butterfly <i>Heliconius erato</i> 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 <i>H. erato</i> 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 <i>Heliconius</i> . 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 <i>H. erato</i> eye with $\lambda_{max} = 355$ nm and 398 nm. Along with the additional UV opsin, <i>Heliconius</i> have also evolved 3-hydroxy-DL-kynurenone (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 <i>Heliconius</i> wings. Functional diversification of the UV-sensitive visual pigments may help explain why the yellow wing pigments of <i>Heliconius</i> are so colorful in the UV range compared to the yellow pigments of close relatives lacking the UV opsin duplicate.	Abstract
Contrasting modes of evolution of the visual pigments in <i>Heliconius</i> butterflies. (2010) (https://pubmed.ncbi.nlm.nih.gov/20478921)	Additional References

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

