

GEPHE SUMMARY

|                                                                                                                                                                                                                   |  |              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--------------|
| Gephebase Gene                                                                                                                                                                                                    |  | GepheID      |
| opsin - rhodopsin (LWRh) ( <a href="https://www.gephebase.org/search-criteria?/and+Gene">https://www.gephebase.org/search-criteria?/and+Gene</a><br>Gephebase="opsin - rhodopsin (LWRh)"#gephebase-summary-title) |  | GP00000769   |
| Entry Status                                                                                                                                                                                                      |  | Martin       |
| Published                                                                                                                                                                                                         |  | Main curator |

PHENOTYPIC CHANGE

|                                                                                                                                                                                                                                                                                                                                                                                             |  |                                                                                                                                                                                                                                                                                                                                                                                             |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| Trait Category                                                                                                                                                                                                                                                                                                                                                                              |  |                                                                                                                                                                                                                                                                                                                                                                                             |  |
| Physiology ( <a href="https://www.gephebase.org/search-criteria?/and+Trait">https://www.gephebase.org/search-criteria?/and+Trait</a><br>Category="Physiology"#gephebase-summary-title)                                                                                                                                                                                                      |  | Trait                                                                                                                                                                                                                                                                                                                                                                                       |  |
| Color vision (blue shift) ( <a href="https://www.gephebase.org/search-criteria?/and+Trait">https://www.gephebase.org/search-criteria?/and+Trait</a><br>vision (blue shift)"#gephebase-summary-title)                                                                                                                                                                                        |  | Trait State in Taxon A                                                                                                                                                                                                                                                                                                                                                                      |  |
| Limenitis astyanax; other butterflies                                                                                                                                                                                                                                                                                                                                                       |  | Trait State in Taxon B                                                                                                                                                                                                                                                                                                                                                                      |  |
| Limenitis weidemeyerii; L. archippus; L. lorquini                                                                                                                                                                                                                                                                                                                                           |  | Ancestral State                                                                                                                                                                                                                                                                                                                                                                             |  |
| Data not curated                                                                                                                                                                                                                                                                                                                                                                            |  | Taxonomic Status                                                                                                                                                                                                                                                                                                                                                                            |  |
| Intergeneric or Higher ( <a href="https://www.gephebase.org/search-criteria?/and+Taxonomic">https://www.gephebase.org/search-criteria?/and+Taxonomic</a><br>Status="Intergeneric or Higher"#gephebase-summary-title)                                                                                                                                                                        |  |                                                                                                                                                                                                                                                                                                                                                                                             |  |
| Taxon A                                                                                                                                                                                                                                                                                                                                                                                     |  | Taxon B                                                                                                                                                                                                                                                                                                                                                                                     |  |
| Limenitis arthemis                                                                                                                                                                                                                                                                                                                                                                          |  | Limenitis archippus                                                                                                                                                                                                                                                                                                                                                                         |  |
| ( <a href="https://www.gephebase.org/search-criteria?/and+Taxon">https://www.gephebase.org/search-criteria?/and+Taxon</a> and Synonyms="Limenitis arthemis"#gephebase-summary-title)                                                                                                                                                                                                        |  | ( <a href="https://www.gephebase.org/search-criteria?/and+Taxon">https://www.gephebase.org/search-criteria?/and+Taxon</a> and Synonyms="Limenitis archippus"#gephebase-summary-title)                                                                                                                                                                                                       |  |
| Common Name                                                                                                                                                                                                                                                                                                                                                                                 |  | Common Name                                                                                                                                                                                                                                                                                                                                                                                 |  |
| white admiral                                                                                                                                                                                                                                                                                                                                                                               |  | viceroy                                                                                                                                                                                                                                                                                                                                                                                     |  |
| Synonyms                                                                                                                                                                                                                                                                                                                                                                                    |  | Synonyms                                                                                                                                                                                                                                                                                                                                                                                    |  |
| Basilarchia arthemis; white admiral; Basilarchia arthemis (Drury, 1773)                                                                                                                                                                                                                                                                                                                     |  | Basilarchia archippus; Papilio archippus; viceroy; Limenitis archippus (Cramer, 1775)                                                                                                                                                                                                                                                                                                       |  |
| Rank                                                                                                                                                                                                                                                                                                                                                                                        |  | Rank                                                                                                                                                                                                                                                                                                                                                                                        |  |
| species                                                                                                                                                                                                                                                                                                                                                                                     |  | species                                                                                                                                                                                                                                                                                                                                                                                     |  |
| 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; Nymphalidae; Limenitidinae; Limenitidini; Limenitis |  | 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; Limenitidinae; Limenitidini; Limenitis |  |
| Parent                                                                                                                                                                                                                                                                                                                                                                                      |  | Parent                                                                                                                                                                                                                                                                                                                                                                                      |  |
| Limenitis (admirals) - (Rank: genus)                                                                                                                                                                                                                                                                                                                                                        |  | Limenitis (admirals) - (Rank: genus)                                                                                                                                                                                                                                                                                                                                                        |  |
| ( <a href="https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=124410">https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=124410</a> )                                                                                                                                                                                                                                     |  | ( <a href="https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=124410">https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=124410</a> )                                                                                                                                                                                                                                     |  |
| NCBI Taxonomy ID                                                                                                                                                                                                                                                                                                                                                                            |  | NCBI Taxonomy ID                                                                                                                                                                                                                                                                                                                                                                            |  |
| 124411                                                                                                                                                                                                                                                                                                                                                                                      |  | 42270                                                                                                                                                                                                                                                                                                                                                                                       |  |
| ( <a href="https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=124411">https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=124411</a> )                                                                                                                                                                                                                                     |  | ( <a href="https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=42270">https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=42270</a> )                                                                                                                                                                                                                                       |  |
| is Taxon A an Intraspecies?                                                                                                                                                                                                                                                                                                                                                                 |  | is Taxon B an Intraspecies?                                                                                                                                                                                                                                                                                                                                                                 |  |
| No                                                                                                                                                                                                                                                                                                                                                                                          |  | No                                                                                                                                                                                                                                                                                                                                                                                          |  |

GENOTYPIC CHANGE

|                                                                                                                                                   |  |                                                                                                                      |
|---------------------------------------------------------------------------------------------------------------------------------------------------|--|----------------------------------------------------------------------------------------------------------------------|
| Generic Gene Name                                                                                                                                 |  | UniProtKB Heliconius melpomene                                                                                       |
| LWRh                                                                                                                                              |  | E2DZP1 ( <a href="http://www.uniprot.org/uniprot/E2DZP1">http://www.uniprot.org/uniprot/E2DZP1</a> )                 |
| Synonyms                                                                                                                                          |  | GenebankID or UniProtKB                                                                                              |
| -                                                                                                                                                 |  | AF385332 ( <a href="https://www.ncbi.nlm.nih.gov/nucore/AF385332">https://www.ncbi.nlm.nih.gov/nucore/AF385332</a> ) |
| String                                                                                                                                            |  |                                                                                                                      |
| -                                                                                                                                                 |  |                                                                                                                      |
| Sequence Similarities                                                                                                                             |  |                                                                                                                      |
| Belongs to the G-protein coupled receptor 1 family. Opsin subfamily.                                                                              |  |                                                                                                                      |
| GO - Molecular Function                                                                                                                           |  |                                                                                                                      |
| GO:0004930 : G protein-coupled receptor activity                                                                                                  |  |                                                                                                                      |
| ( <a href="https://www.ebi.ac.uk/QuickGO/term/GO:0004930">https://www.ebi.ac.uk/QuickGO/term/GO:0004930</a> )                                     |  |                                                                                                                      |
| GO:0009881 : photoreceptor activity ( <a href="https://www.ebi.ac.uk/QuickGO/term/GO:0009881">https://www.ebi.ac.uk/QuickGO/term/GO:0009881</a> ) |  |                                                                                                                      |
| GO - Biological Process                                                                                                                           |  |                                                                                                                      |
| GO:0018298 : protein-chromophore linkage                                                                                                          |  |                                                                                                                      |
| ( <a href="https://www.ebi.ac.uk/QuickGO/term/GO:0018298">https://www.ebi.ac.uk/QuickGO/term/GO:0018298</a> )                                     |  |                                                                                                                      |
| GO:0007601 : visual perception ( <a href="https://www.ebi.ac.uk/QuickGO/term/GO:0007601">https://www.ebi.ac.uk/QuickGO/term/GO:0007601</a> )      |  |                                                                                                                      |
| GO:0007602 : phototransduction ( <a href="https://www.ebi.ac.uk/QuickGO/term/GO:0007602">https://www.ebi.ac.uk/QuickGO/term/GO:0007602</a> )      |  |                                                                                                                      |

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

## 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

I17M; S137A=S180A in human LWS/MWS numbering system

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 | Ile     | Met     | 17       |

Main Reference

Adaptive evolution of color vision as seen through the eyes of butterflies. (2007) (<https://pubmed.ncbi.nlm.nih.gov/17494749>)

Authors

Frentiu FD; Bernard GD; Cuevas CI; Sison-Mangus MP; Prudic KL; Briscoe AD

Abstract

Butterflies and primates are interesting for comparative color vision studies, because both have evolved middle- (M) and long-wavelength- (L) sensitive photopigments with overlapping absorbance spectrum maxima (lambda(max) values). Although positive selection is important for the maintenance of spectral variation within the primate pigments, it remains an open question whether it contributes similarly to the diversification of butterfly pigments. To examine this issue, we performed epimicrospectrophotometry on the eyes of five *Limnitis* butterfly species and found a 31-nm range of variation in the lambda(max) values of the L-sensitive photopigments (514-545 nm). We cloned partial *Limnitis* L opsin gene sequences and found a significant excess of replacement substitutions relative to polymorphisms among species. Mapping of these L photopigment lambda(max) values onto a phylogeny revealed two instances within Lepidoptera of convergently evolved L photopigment lineages whose lambda(max) values were blue-shifted. A codon-based maximum-likelihood analysis indicated that, associated with the two blue spectral shifts, four amino acid sites (Ile17Met, Ala64Ser, Asn70Ser, and Ser137Ala) have evolved substitutions in parallel and exhibit significant d(N)/d(S) >1. Homology modeling of the full-length *Limnitis arthemis astyanax* L opsin placed all four substitutions within the chromophore-binding pocket. Strikingly, the Ser137Ala substitution is in the same position as a site that in primates is responsible for a 5- to 7-nm blue spectral shift. Our data show that some of the same amino acid sites are under positive selection in the photopigments of both butterflies and primates, spanning an evolutionary distance >500 million years.

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

I17M; S137A=S180A in human LWS/MWS numbering system

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 | Ser     | Ala     | 180      |

Main Reference

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and exhibit significant  $d(N)/d(S) > 1$ . Homology modeling of the full-length *Limnitis arthemis astyanax* L opsin placed all four substitutions within the chromophore-binding pocket. Strikingly, the Ser137Ala substitution is in the same position as a site that in primates is responsible for a 5- to 7-nm blue spectral shift. Our data show that some of the same amino acid sites are under positive selection in the photopigments of both butterflies and primates, spanning an evolutionary distance >500 million years.

Additional References

RELATED GEPHE

No matches found.

Related Genes

No matches found.

Related Haplotypes

EXTERNAL LINKS

COMMENTS

@SeveralMutationsWithEffect