GEPHE SUMMARY

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

GepheID
GP00002667

Entry Status
Published

Main curator
Courtier

PHENOTYPIC CHANGE

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

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

Trait State in Taxon A
Bombyx mori - wild-type allele - black eyes and dark eggs

Trait State in Taxon B
Bombyx mori - pink-eyed white egg (pe) allele - red eyes and white or pale pink eggs

Ancestral State
Taxon A

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

Taxon A

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

Common Name
domestic silkworm

Synonyms
domestic silkworm; silk moth; silkworm; Bombyx mori 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; Bombycoidea; Bombycidae; Bombycinae; Bombyx

Parent
Bombyx () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 7090)

NCBI Taxonomy ID
7091 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 7091)

is Taxon A an Infraspecies?
No

Taxon B

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

Common Name
domestic silkworm

Synonyms
domestic silkworm; silk moth; silkworm; Bombyx mori 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; Bombycoidea; Bombycidae; Bombycinae; Bombyx

Parent
Bombyx () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 7090)

NCBI Taxonomy ID
7091 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 7091)

is Taxon B an Infraspecies?
No

GENOTYPIC CHANGE

Generic Gene Name
cd

Synonyms
CG6969; Dmel\CG6969; HPX6; PHS; Dmel_CG6969

String
7227.FBpp0083696 (http://string-db.org/newstring_cgi/show_network_section.pl?identifier= 7227.FBpp0083696)

Sequence Similarities
-

GO - Molecular Function
GO:0020037 : heme binding (https://www.ebi.ac.uk/QuickGO/term/GO:0020037)
GO:0004601 : peroxidase activity (https://www.ebi.ac.uk/QuickGO/term/GO:0004601)
GO:0140825 : lactoperoxidase activity (https://www.ebi.ac.uk/QuickGO/term/GO:0140825)

GO - Biological Process
GO:1901216 : positive regulation of neuron death

UniProtKB Drosophila melanogaster
Q9VCW2 (http://www.uniprot.org/uniprot/Q9VCW2)

GenebankID or UniProtKB
()

(https://www.ebi.ac.uk/QuickGO/term/GO:1901216)
GO:0006979 : response to oxidative stress
(https://www.ebi.ac.uk/QuickGO/term/GO:0006979)
GO:0070189 : kynurenine metabolic process
(https://www.ebi.ac.uk/QuickGO/term/GO:0070189)
GO:1900369 : negative regulation of post-transcriptional gene silencing by RNA
(https://www.ebi.ac.uk/QuickGO/term/GO:1900369)
GO:0006727 : ommochrome biosynthetic process
(https://www.ebi.ac.uk/QuickGO/term/GO:0006727)

GO - Cellular Component

GO:0016020 : membrane (https://www.ebi.ac.uk/QuickGO/term/GO:0016020)
GO:0005764 : lysosome (https://www.ebi.ac.uk/QuickGO/term/GO:0005764)

Presumptive Null

Yes (https://www.gephebase.org/search-criteria?/and+Presumptive Null=^Yes^#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

-

Molecular Details of the Mutation

Missense mutation in a conserved motif in exon 9. The tryptophan residue which is converted to arginine in the two pe strains is widely conserved in holometabolous insects.

Experimental Evidence

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

	Taxon A	Taxon B	Position
Codon	TGG	CGG	-
Amino-acid	Trp	Arg	-

Main Reference

Positional cloning of a Bombyx pink-eyed white egg locus reveals the major role of cardinal in ommochrome synthesis. (2016) (https://pubmed.ncbi.nlm.nih.gov/26328757)

Authors

Osanai-Futahashi M; Tatematsu KI; Futahashi R; Narukawa J; Takasu Y; Kayukawa T; Shinoda T; Ishige T; Yajima S; Tamura T; Yamamoto K; Sezutsu H

Abstract

Ommochromes are major insect pigments involved in coloration of compound eyes, eggs, epidermis and wings. In the silkworm Bombyx mori, adult compound eyes and eggs contain a mixture of the ommochrome pigments such as ommin and xanthommatin. Here, we identified the gene involved in ommochrome biosynthesis by positional cloning of B. mori egg and eye color mutant pink-eyed white egg (pe). The recessive homozygote of pe has bright red eyes and white or pale pink eggs instead of a normal dark coloration due to the decrease of dark ommochrome pigments. By genetic linkage analysis, we narrowed down the pe-linked region to ~258â€‰kb, containing 17 predicted genes. RNA sequencing analyses showed that the expression of one candidate gene, the ortholog of Drosophila haem peroxidase cardinal, coincided with egg pigmentation timing, similar to other ommochrome-related genes such as Bm-scarlet and Bm-re. In two pe strains, a common missense mutation was found within a conserved motif of B. mori cardinal homolog (Bm-cardinal). RNA interference-mediated knockdown and transcription activator-like effector nuclease (TALEN)-mediated knockout of the Bm-cardinal gene produced the same phenotype as pe in terms of egg, adult eye and larval epidermis coloration. A complementation test of the pe mutant with the TALEN-mediated Bm-cardinal-deficient strain showed that the mutant phenotype could not be rescued, indicating that Bm-cardinal is responsible for pe. Moreover, knockdown of the cardinal homolog in Tribolium castaneum also induced red compound eyes. Our results indicate that cardinal plays a major role in ommochrome synthesis of holometabolous insects.

Additional References

RELATED GEPHE

Related Genes

9 (apontic-like, Bm-iAANAT, cortex, SCARB1, SCRB15, Wnt1, Carotenoid-binding protein (CBP), Tyrosine hydroxylase, UGT86 (Bm-UGT10286))
(https://www.gephebase.org/search-criteria?/or+Taxon ID=^7091^/and+Trait=Coloration/and+groupHaplotypes=true#gephebase-summary-title)

Related Haplotypes

No matches found.

EXTERNAL LINKS

COMMENTS

The enzyme cardinal appears to catalyze the last step of ommin formation by using either 3-hydroxykynurenine or xanthommatin as substrates. Spontaneous mutation.