

GEPHE SUMMARY

	Gephebase Gene		GepheID
BCO2 = beta-carotene oxygenase 2 (https://www.gephebase.org/search-criteria?/and+Gene+Gephebase+BCO2+beta-carotene+oxygenase+2+Gephebase-summary-title)		GP00002387	
Published	Entry Status	Santos	Main curator

PHENOTYPIC CHANGE

	Trait Category	
Morphology (https://www.gephebase.org/search-criteria?/and+Trait+Category+Morphology+Gephebase-summary-title)		
	Trait	
Coloration (feather) (https://www.gephebase.org/search-criteria?/and+Trait+Coloration+feather+Gephebase-summary-title)		
	Trait State in Taxon A	
less extensive carotenoid pigmentation		
	Trait State in Taxon B	
more extensive carotenoid pigmentation		
	Ancestral State	
Taxon A		
	Taxonomic Status	
Interspecific (https://www.gephebase.org/search-criteria?/and+Taxonomic+Status+Interspecific+Gephebase-summary-title)		

Taxon A	Latin Name	Taxon B	Latin Name
Setophaga pensylvanica (https://www.gephebase.org/search-criteria?/and+Taxon+and+Synonyms+Setophaga+pensylvanica+Gephebase-summary-title)		Setophaga petechia (https://www.gephebase.org/search-criteria?/and+Taxon+and+Synonyms+Setophaga+petechia+Gephebase-summary-title)	
	Common Name		Common Name
Chestnut-sided warbler		yellow warbler	
	Synonyms		Synonyms
Dendroica pensylvanica; Chestnut-sided warbler; Setophaga pensylvanica (Linnaeus, 1766)		Dendroica petechia; yellow warbler; Setophaga petechia (Linnaeus, 1766)	
	Rank		Rank
species		species	
	Lineage		Lineage
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Deuterostomia; Chordata; Craniata; Vertebrata; Gnathostomata; Teleostomi; Euteleostomi; Sarcopterygii; Dipnotetrapodomorpha; Tetrapoda; Amniota; Sauropsida; Sauria; Archelosauria; Archosauria; Dinosauria; Saurischia; Theropoda; Coelurosauria; Aves; Neognathae; Passeriformes; Passeroidea; Parulidae; Setophaga		cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Deuterostomia; Chordata; Craniata; Vertebrata; Gnathostomata; Teleostomi; Euteleostomi; Sarcopterygii; Dipnotetrapodomorpha; Tetrapoda; Amniota; Sauropsida; Sauria; Archelosauria; Archosauria; Dinosauria; Saurischia; Theropoda; Coelurosauria; Aves; Neognathae; Passeriformes; Passeroidea; Parulidae; Setophaga	
	Parent		Parent
Setophaga () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=182948)		Setophaga () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=182948)	
	NCBI Taxonomy ID		NCBI Taxonomy ID
92122 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=92122)		123631 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=123631)	
	is Taxon A an Intraspecies?		is Taxon B an Intraspecies?
No		No	

GENOTYPIC CHANGE

	Generic Gene Name		UniProtKB Homo sapiens
BCO2		Q9BYV7 (http://www.uniprot.org/uniprot/Q9BYV7)	
	Synonyms		GenebankID or UniProtKB
BCDO2; B-DIOX-II		()	
	String		
9606.ENSP00000350314 (http://string-db.org/newstring.cgi/show_network_section.pl?identifier=9606.ENSP00000350314)			
	Sequence Similarities		
Belongs to the carotenoid oxygenase family.			
	GO - Molecular Function		
GO:0046872 : metal ion binding (https://www.ebi.ac.uk/QuickGO/term/GO:0046872)			
GO:0003834 : beta-carotene 15,15'-monooxygenase activity (https://www.ebi.ac.uk/QuickGO/term/GO:0003834)			
GO:0010436 : carotenoid dioxygenase activity (https://www.ebi.ac.uk/QuickGO/term/GO:0010436)			
GO:0004744 : retinal isomerase activity			

(<https://www.ebi.ac.uk/QuickGO/term/GO:0004744>)
GO:0102076 : beta,beta-carotene-9',10'-cleaving oxygenase activity
(<https://www.ebi.ac.uk/QuickGO/term/GO:0102076>)
GO:0016702 : oxidoreductase activity, acting on single donors with incorporation of molecular oxygen, incorporation of two atoms of oxygen
(<https://www.ebi.ac.uk/QuickGO/term/GO:0016702>)

GO - Biological Process

GO:0055114 : oxidation-reduction process
(<https://www.ebi.ac.uk/QuickGO/term/GO:0055114>)
GO:0001523 : retinoid metabolic process
(<https://www.ebi.ac.uk/QuickGO/term/GO:0001523>)
GO:0016121 : carotene catabolic process
(<https://www.ebi.ac.uk/QuickGO/term/GO:0016121>)
GO:0042574 : retinal metabolic process
(<https://www.ebi.ac.uk/QuickGO/term/GO:0042574>)
GO:0016119 : carotene metabolic process
(<https://www.ebi.ac.uk/QuickGO/term/GO:0016119>)
GO:0016116 : carotenoid metabolic process
(<https://www.ebi.ac.uk/QuickGO/term/GO:0016116>)
GO:0051881 : regulation of mitochondrial membrane potential
(<https://www.ebi.ac.uk/QuickGO/term/GO:0051881>)
GO:2000377 : regulation of reactive oxygen species metabolic process
(<https://www.ebi.ac.uk/QuickGO/term/GO:2000377>)
GO:0042573 : retinoic acid metabolic process
(<https://www.ebi.ac.uk/QuickGO/term/GO:0042573>)
GO:0016122 : xanthophyll metabolic process
(<https://www.ebi.ac.uk/QuickGO/term/GO:0016122>)

GO - Cellular Component

GO:0005739 : mitochondrion (<https://www.ebi.ac.uk/QuickGO/term/GO:0005739>)
GO:0005622 : intracellular (<https://www.ebi.ac.uk/QuickGO/term/GO:0005622>)
GO:0005759 : mitochondrial matrix (<https://www.ebi.ac.uk/QuickGO/term/GO:0005759>)

Unknown (<https://www.gephebase.org/search-criteria?/and+Presumptive Null=^Unknown^#gephebase-summary-title>)

Presumptive Null

Unknown (<https://www.gephebase.org/search-criteria?/and+Molecular Type=^Unknown^#gephebase-summary-title>)

Molecular Type

Unknown (<https://www.gephebase.org/search-criteria?/and+Aberration Type=^Unknown^#gephebase-summary-title>)

Aberration Type

Molecular Details of the Mutation

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Experimental Evidence

Association Mapping (<https://www.gephebase.org/search-criteria?/and+Experimental Evidence=^Association Mapping^#gephebase-summary-title>)

Main Reference

Pigmentation Genes Show Evidence of Repeated Divergence and Multiple Bouts of Introgression in Setophaga Warblers. (2021) (<https://pubmed.ncbi.nlm.nih.gov/33259789>)

Authors

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Abstract

Species radiations have long served as model systems in evolutionary biology. However, it has only recently become possible to study the genetic bases of the traits responsible for diversification and only in a small number of model systems. Here, we use genomes of 36 species of North, Central, and South American warblers to highlight the role of pigmentation genes involved in melanin and carotenoid processing in the diversification of this group. We show that agouti signaling protein (ASIP) and beta-carotene oxygenase 2 (BCO2) are predictably divergent between species that differ in the distribution of melanin and carotenoid in their plumages, respectively. Among species, sequence variation at ASIP broadly mirrors the species' phylogenetic history, consistent with repeated, independent mutations generating melanin-based variation. In contrast, BCO2 variation is highly discordant from the species tree, with evidence of cross-lineage introgression among species like the yellow warbler (*Setophaga petechia*) and magnolia warbler (*S. magnolia*) with extensive carotenoid-based coloration. We also detect introgression of a small part of the BCO2 coding region (<3 kb) in *S. discolor* and *S. vitellina*, including an amino acid substitution that is unique to warblers but otherwise highly conserved across birds. Lateral transfer of carotenoid-processing genes has been documented in arthropods, but introgression of BCO2 as demonstrated here—presumably adaptive—represents the first example of carotenoid gene transfer among vertebrates. These contrasting genomic patterns show that both independent evolution in a common set of genes and past hybridization have fueled plumage diversification in this colorful avian radiation.

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Additional References

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