

GEPHE SUMMARY

cytochrome b (https://www.gephebase.org/search-criteria?/and+Gene Gephebase= [^] cytochrome b [^] #gephebase-summary-title)	Gephebase Gene	GP00002599	GepheID
Published	Entry Status	Courtier	Main curator

PHENOTYPIC CHANGE

Physiology (https://www.gephebase.org/search-criteria?/and+Trait Category= [^] Physiology [^] #gephebase-summary-title)	Trait Category		
Xenobiotic resistance (insecticide ; bifenazate) (<a href="https://www.gephebase.org/search-criteria?/and+Trait=<sup>^</sup>Xenobiotic resistance (insecticide ; bifenazate)<sup>^</sup>#gephebase-summary-title">https://www.gephebase.org/search-criteria?/and+Trait=[^]Xenobiotic resistance (insecticide ; bifenazate)[^]#gephebase-summary-title)	Trait		
Tetranychus urticae - sensitive	Trait State in Taxon A		
Tetranychus urticae - resistant to bifenazate	Trait State in Taxon B		
Taxon A	Ancestral State		
Interspecific (https://www.gephebase.org/search-criteria?/and+Taxonomic Status= [^] Interspecific [^] #gephebase-summary-title)	Taxonomic Status		
	Taxon A	Taxon B	
	Latin Name	Latin Name	
Tetranychus urticae (<a href="https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=<sup>^</sup>Tetranychus urticae<sup>^</sup>#gephebase-summary-title">https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=[^]Tetranychus urticae[^]#gephebase-summary-title)	Tetranychus urticae (<a href="https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=<sup>^</sup>Tetranychus urticae<sup>^</sup>#gephebase-summary-title">https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=[^]Tetranychus urticae[^]#gephebase-summary-title)	Tetranychus urticae (<a href="https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=<sup>^</sup>Tetranychus urticae<sup>^</sup>#gephebase-summary-title">https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=[^]Tetranychus urticae[^]#gephebase-summary-title)	
	Common Name	Common Name	
two-spotted spider mite	two-spotted spider mite	two-spotted spider mite	
	Synonyms	Synonyms	
two-spotted spider mite; red spider mite; twospotted mite; Tetranychus urticae Koch, 1836	two-spotted spider mite; red spider mite; twospotted mite; Tetranychus urticae Koch, 1836	two-spotted spider mite; red spider mite; twospotted mite; Tetranychus urticae Koch, 1836	
	Rank	Rank	
species	species	species	
	Lineage	Lineage	
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Chelicerata; Arachnida; Acari; Acariformes; Trombidiformes; Prostigmata; Eleutherengona; Raphignathae; Tetranychoidae; Tetranychidae; Tetranychus	cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Chelicerata; Arachnida; Acari; Acariformes; Trombidiformes; Prostigmata; Eleutherengona; Raphignathae; Tetranychoidae; Tetranychidae; Tetranychus	cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Chelicerata; Arachnida; Acari; Acariformes; Trombidiformes; Prostigmata; Eleutherengona; Raphignathae; Tetranychoidae; Tetranychidae; Tetranychus	
	Parent	Parent	
Tetranychus () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 32263)	Tetranychus () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 32263)	Tetranychus () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 32263)	
	NCBI Taxonomy ID	NCBI Taxonomy ID	
32264 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 32264)	32264 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 32264)	32264 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 32264)	
	is Taxon A an Intraspecies?	is Taxon B an Intraspecies?	
No	No	No	

GENOTYPIC CHANGE

UQCRFS1	Generic Gene Name	P47985 (http://www.uniprot.org/uniprot/P47985)	UniProtKB Homo sapiens
RIP1; RIS1; RISP; UQCR5	Synonyms	()	GenebankID or UniProtKB
9606.ENSP00000306397 (http://string-db.org/newstring_cgi/show_network_section.pl?identifier=9606.ENSP00000306397)	String		
-	Sequence Similarities		
	GO - Molecular Function		
GO:0046872 : metal ion binding (https://www.ebi.ac.uk/QuickGO/term/GO:0046872)			
GO:0051537 : 2 iron, 2 sulfur cluster binding (https://www.ebi.ac.uk/QuickGO/term/GO:0051537)			
GO:0008121 : ubiquinol-cytochrome-c reductase activity (https://www.ebi.ac.uk/QuickGO/term/GO:0008121)			
	GO - Biological Process		

GO:0006122 : mitochondrial electron transport, ubiquinol to cytochrome c

(<https://www.ebi.ac.uk/QuickGO/term/GO:0006122>)

GO - Cellular Component

GO:0016021 : integral component of membrane

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

GO:0005739 : mitochondrion (<https://www.ebi.ac.uk/QuickGO/term/GO:0005739>)

GO:0005743 : mitochondrial inner membrane

(<https://www.ebi.ac.uk/QuickGO/term/GO:0005743>)

GO:0005751 : mitochondrial respiratory chain complex IV

(<https://www.ebi.ac.uk/QuickGO/term/GO:0005751>)

GO:0005750 : mitochondrial respiratory chain complex III

(<https://www.ebi.ac.uk/QuickGO/term/GO:0005750>)

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

G126S and I136T mutation both located in the cd1 helix of the Qo pocket. Combination of these mutations gave extreme resistance to bifenthrin.

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	Gly	Ser	126

Main Reference

Mitochondrial heteroplasmy and the evolution of insecticide resistance: non-Mendelian inheritance in action. (2008) (<https://pubmed.ncbi.nlm.nih.gov/18408150>)

Authors

Van Leeuwen T; Vanholme B; Van Pottelberge S; Van Nieuwenhuysse P; Nauen R; Tirry L; Denholm I

Abstract

Genes encoded by mitochondrial DNA (mtDNA) exist in large numbers per cell but can be selected very rapidly as a result of unequal partitioning of mtDNA between germ cells during embryogenesis. However, empirical studies of this "bottlenecking" effect are rare because of the apparent scarcity of heteroplasmic individuals possessing more than one mtDNA haplotype. Here, we report an example of insecticide resistance in an arthropod pest (*Tetranychus urticae*) being controlled by mtDNA and on its inheritance in a heteroplasmic mite strain. Resistance to the insecticide bifenthrin is highly correlated with remarkable mutations in cytochrome b, a mitochondrially encoded protein in the respiratory pathway. Four sites in the Q(o) site that are absolutely conserved across fungi, protozoa, plants, and animals are mutated in resistant mite strains. Despite the unusual nature of these mutations, resistant mites showed no fitness costs in the absence of insecticide. Partially resistant strains, consisting of heteroplasmic individuals, transmit their resistant and susceptible haplotypes to progeny in highly variable ratios consistent with a sampling bottleneck of approximately 180 copies. Insecticide selection on heteroplasmic individuals favors those carrying resistant haplotypes at a frequency of 60% or more. This combination of factors enables very rapid evolution and accounts for mutations being fixed in most field-collected resistant strains. The results provide a rare insight into non-Mendelian mechanisms of mitochondrial inheritance and evolution, relevant to anticipating and understanding the development of other mitochondrially encoded adaptations in arthropods. They also provide strong evidence of cytochrome b being the target site for bifenthrin in spider mites.

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

G126S and I136T mutation both located in the cd1 helix of the Qo pocket. Combination of these mutations gave extreme resistance to bifenthrin.

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	Thr	136

Main Reference

Mitochondrial heteroplasmy and the evolution of insecticide resistance: non-Mendelian inheritance in action. (2008) (<https://pubmed.ncbi.nlm.nih.gov/18408150>)

Authors

Genes encoded by mitochondrial DNA (mtDNA) exist in large numbers per cell but can be selected very rapidly as a result of unequal partitioning of mtDNA between germ cells during embryogenesis. However, empirical studies of this "bottlenecking" effect are rare because of the apparent scarcity of heteroplasmic individuals possessing more than one mtDNA haplotype. Here, we report an example of insecticide resistance in an arthropod pest (*Tetranychus urticae*) being controlled by mtDNA and on its inheritance in a heteroplasmic mite strain. Resistance to the insecticide bifenthrin is highly correlated with remarkable mutations in cytochrome b, a mitochondrially encoded protein in the respiratory pathway. Four sites in the Q(o) site that are absolutely conserved across fungi, protozoa, plants, and animals are mutated in resistant mite strains. Despite the unusual nature of these mutations, resistant mites showed no fitness costs in the absence of insecticide. Partially resistant strains, consisting of heteroplasmic individuals, transmit their resistant and susceptible haplotypes to progeny in highly variable ratios consistent with a sampling bottleneck of approximately 180 copies. Insecticide selection on heteroplasmic individuals favors those carrying resistant haplotypes at a frequency of 60% or more. This combination of factors enables very rapid evolution and accounts for mutations being fixed in most field-collected resistant strains. The results provide a rare insight into non-Mendelian mechanisms of mitochondrial inheritance and evolution, relevant to anticipating and understanding the development of other mitochondrially encoded adaptations in arthropods. They also provide strong evidence of cytochrome b being the target site for bifenthrin in spider mites.

Additional References

RELATED GEPHE

8 (Acetylcholinesterase (Ace-1), Chitin synthase 1 (CHS1), CPR, CYP392A16, CYP392E8, glutamate-gated chloride channel (GluCl), para (kdr), PSST)
(<https://www.gephebase.org/search-criteria?/or+Taxon ID=^32264^/and+Trait=Xenobiotic resistance/and+groupHaplotypes=true#gephebase-summary-title>)

Related Genes

No matches found.

Related Haplotypes

EXTERNAL LINKS

COMMENTS

@MitochondrialGene