

CYP6ER1 (https://www.gephebase.org/search-criteria?/and+GeneGephebase=~CYP6ER1~#gephebase-summary-title)	Gephebase Gene	GP00002473	GepheID
Published	Entry Status	Courtier	Main curator

Trait Category		Trait	
Physiology (#https://www.gephebase.org/search-criteria?/and+Trait+Category=~Physiology)			
Xenobiotic resistance (insecticide; imidacloprid) (https://www.gephebase.org/search-criteria?/and+Trait=~Xenobiotic resistance (insecticide; imidacloprid))			
Nilaparvata lugens - sensitive	Trait State in Taxon A		
Nilaparvata lugens - resistant (CYP6ER1vB allele)	Trait State in Taxon B		
	Ancestral State		
Taxon A			
Intraspecific (#https://www.gephebase.org/search-criteria?/and+Taxonomic+Status=~Intraspecific)	Taxonomic Status		
Taxon A	Latin Name	Taxon B	Latin Name
Nilaparvata lugens (#https://www.gephebase.org/search-criteria?/and+Taxon+and+Synonyms=~Nilaparvata lugens)		Nilaparvata lugens (#https://www.gephebase.org/search-criteria?/and+Taxon+and+Synonyms=~Nilaparvata lugens)	
brown planthopper	Common Name	brown planthopper	Common Name
brown planthopper; Nilaparvata lugens (Stal, 1854); Nalaparvata lugens	Synonyms	brown planthopper; Nilaparvata lugens (Stal, 1854); Nalaparvata lugens	Synonyms
species	Rank	species	Rank
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Paraneoptera; Hemiptera; Auchenorrhyncha; Fulgoromorpha; Fulgoroidea; Delphacidae; Delphacinae; Nilaparvata	Lineage	cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Paraneoptera; Hemiptera; Auchenorrhyncha; Fulgoromorpha; Fulgoroidea; Delphacidae; Delphacinae; Nilaparvata	Lineage
Nilaparvata () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=108930)	Parent	Nilaparvata () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=108930)	Parent
108931 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=108931)	NCBI Taxonomy ID	108931 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=108931)	NCBI Taxonomy ID
is Taxon A an Intraspecies?		is Taxon B an Intraspecies?	
No		No	

cyp6er1	Generic Gene Name	UniProtKB Nilaparvata lugens
-	Synonyms	A0A2l8B6P1 (http://www.uniprot.org/uniprot/A0A2l8B6P1) GenebankID or UniProtKB Nilaparvata lugens
-	String	A0A2l8B6P1 (https://www.ncbi.nlm.nih.gov/nuccore/A0A2l8B6P1)
Sequence Similarities		
Belongs to the cytochrome P450 family.		
GO - Molecular Function		
GO:0020037 : heme binding (https://www.ebi.ac.uk/QuickGO/term/GO:0020037)		
GO:0005506 : iron ion binding (https://www.ebi.ac.uk/QuickGO/term/GO:0005506)		
GO:0004497 : monooxygenase activity (https://www.ebi.ac.uk/QuickGO/term/GO:0004497)		
GO:0016705 : oxidoreductase activity, acting on paired donors, with incorporation or reduction of molecular oxygen (https://www.ebi.ac.uk/QuickGO/term/GO:0016705)		
GO - Biological Process		
-		

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

No (<https://www.gephebase.org/search-criteria?/and+Presumptive Null=~No~#gephebase-summary-title>)

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

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

1-9 bp

Deletion of Pro377. This provides a more moderate but significant 4.5-fold increase in resistance.

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

Neofunctionalization of Duplicated P450 Genes Drives the Evolution of Insecticide Resistance in the Brown Planthopper. (2018) (<https://pubmed.ncbi.nlm.nih.gov/29337073>)

Zimmer CT; Garrood WT; Singh KS; Randall E; Lueke B; Gutbrod O; Matthiesen S; Kohler M; Nauen R; Davies TGE; Bass C

Gene duplication is a major source of genetic variation that has been shown to underpin the evolution of a wide range of adaptive traits [1, 2]. For example, duplication or amplification of genes encoding detoxification enzymes has been shown to play an important role in the evolution of insecticide resistance [3-5]. In this context, gene duplication performs an adaptive function as a result of its effects on gene dosage and not as a source of functional novelty [3, 6-8]. Here, we show that duplication and neofunctionalization of a cytochrome P450, CYP6ER1, led to the evolution of insecticide resistance in the brown planthopper. Considerable genetic variation was observed in the coding sequence of CYP6ER1 in populations of brown planthopper collected from across Asia, but just two sequence variants are highly overexpressed in resistant strains and metabolize imidacloprid. Both variants are characterized by profound amino-acid alterations in substrate recognition sites, and the introduction of these mutations into a susceptible P450 sequence is sufficient to confer resistance. CYP6ER1 is duplicated in resistant strains with individuals carrying paralogs with and without the gain-of-function mutations. Despite numerical parity in the genome, the susceptible and mutant copies exhibit marked asymmetry in their expression with the resistant paralogs overexpressed. In the primary resistance-conferring CYP6ER1 variant, this results from an extended region of novel sequence upstream of the gene that provides enhanced expression. Our findings illustrate the versatility of gene duplication in providing opportunities for functional and regulatory innovation during the evolution of an adaptive trait.

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RELATED GEPHE

4 (Acetylcholinesterase (Ace-1), CYP6AY1, esterase NI-EST1, GST) (<https://www.gephebase.org/search-criteria?/or+Taxon ID=~108931~/and+Trait=Xenobiotic resistance/and+groupHaplotypes=true#gephebase-summary-title>)

3 (<https://www.gephebase.org/search-criteria?/or+Gene Gephebase=~CYP6ER1~/and+Taxon ID=~108931~/or+Gene Gephebase=~CYP6ER1~/and+Taxon ID=~108931~#gephebase-summary-title>)

EXTERNAL LINKS

COMMENTS

@Epistasis. When T318S is combined with P377del (as seen in CYP6ER1vB); an epistatic interaction is observed with the resistance conferred by the double mutation (20-fold) less than the sums of the effects of the component single mutations. In contrast; an additive interaction is observed when T318S is combined with A375del+A376P (as observed in CYP6ER1vA); with this combination exhibiting the highest resistance of all mutant lines (35-fold).