GEPHE SUMMARY

Gephebase Gene
CYP6CY3

GephelD
GP00001474

Entry Status
Published

Main curator
Prigent

PHENOTYPIC CHANGE

Trait Category
Physiology

Trait
Xenobiotic resistance (nicotine and nicotinoid insecticides) and host plant

Trait State in Taxon A
Peach-potato aphid 4106A does not survive for 144h on a diet containing 30ppm nicotine ; tobacco aphid JR with 100% mortality at 144h on a diet containing 320ppm nicotine

Trait State in Taxon B
tobacco aphid 5410R with 7% mortality at 144h on a diet containing 320ppm nicotine ; tobacco aphid 5191A survive for 144h on a diet containing 30ppm nicotine

Ancestral State
Taxon A

Taxonomic Status
Intraspecific

Taxon A

Latin Name
Myzus persicae

Common Name
green peach aphid

Synonyms
Myzus (Nectarosiphon) persicae; green peach aphid; peach-potato aphid; Myzus persicae (Sulzer, 1776); Myzus persiceae

Rank
species

Lineage
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Paraneoptera; Hemiptera; Sternorrhyncha; Aphidomorpha; Aphidoidea; Aphididae; Aphidinae; Macrosiphini; Myzus

Parent
Myzus () - (Rank: genus)

NCBI Taxonomy ID
13164

is Taxon A an Infraspecies?
Yes

Taxon A Description
Peach-potato aphid 4106A does not survive for 144h on a diet containing 30ppm nicotine ; tobacco aphid JR with 100% mortality at 144h on a diet containing 320ppm nicotine

Taxon B

Latin Name
Myzus persicae

Common Name
green peach aphid

Synonyms
Myzus (Nectarosiphon) persicae; green peach aphid; peach-potato aphid; Myzus persicae (Sulzer, 1776); Myzus persiceae

Rank
species

Lineage
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Paraneoptera; Hemiptera; Sternorrhyncha; Aphidomorpha; Aphidoidea; Aphididae; Aphidinae; Macrosiphini; Myzus

Parent
Myzus () - (Rank: genus)

NCBI Taxonomy ID
13164

is Taxon B an Infraspecies?
Yes

Taxon B Description
tobacco aphid 5410R with 7% mortality at 144h on a diet containing 320ppm nicotine ; tobacco aphid 5191A survive for 144h on a diet containing 30ppm nicotine

GENOTYPIC CHANGE

Generic Gene Name
CYP6CY3

Synonyms
-

String
-

Sequence Similarities
Belongs to the cytochrome P450 family.

GO - Molecular Function
GO:0020037 : heme binding
GO:0005506 : iron ion binding

UniProtKB Myzus persicae
V5SQ25

GenebankID or UniProtKB

GO:0004497 : monooxygenase activity
GO:0016705 : oxidoreductase activity, acting on paired donors, with incorporation or reduction of molecular oxygen

GO - Biological Process
-

GO - Cellular Component
GO:0016021 : integral component of membrane

Presumptive Null
No

Molecular Type
Cis-regulatory

Aberration Type
Insertion

Insertion Size
10-99 bp

Molecular Details of the Mutation
Expansion of a AC dinucleotide microsatellite (from 15 to 48 repeat units) in the promoter 198 bp upstream of the start codon that enhances gene expression

Experimental Evidence
Candidate Gene

Main Reference
Gene amplification and microsatellite polymorphism underlie a recent insect host shift. (2013)

Authors
Bass C; Zimmer CT; Riveron JM; Wilding CS; Wondji CS; Kaussmann M; Field LM; Williamson MS; Nauen R

Abstract
Host plant shifts of herbivorous insects may be a first step toward sympatric speciation and can create new pests of agriculturally important crops; however, the molecular mechanisms that mediate this process are poorly understood. Certain races of the polyphagous aphid Myzus persicae have recently adapted to feed on tobacco (Myzus persicae nicotianae) and show a reduced sensitivity to the plant alkaloid nicotine and cross-resistance to neonicotinoids a class of synthetic insecticides widely used for control. Here we show constitutive overexpression of a cytochrome P450 (CYP6CY3) allows tobacco-adapted races of M. persicae to efficiently detoxify nicotine and has preadapted them to resist neonicotinoid insecticides. CYP6CY3, is highly overexpressed in M. persicae nicotianae clones from three continents compared with M. persicae s.s. and expression level is significantly correlated with tolerance to nicotine. CYP6CY3 is highly efficient (compared with the primary human nicotine-metabolizing P450) at metabolizing nicotine and neonicotinoids to less toxic metabolites in vitro and generation of transgenic Drosophila expressing CYP6CY3 demonstrate that it confers resistance to both compounds in vivo. Overexpression of CYP6CY3 results from the expansion of a dinucleotide microsatellite in the promoter region and a recent gene amplification, with some aphid clones carrying up to 100 copies. We conclude that the mutations leading to overexpression of CYP6CY3 were a prerequisite for the host shift of M. persicae to tobacco and that gene amplification and microsatellite polymorphism are evolutionary drivers in insect host adaptation.

Additional References

RELATED GEPHE

Related Genes
No matches found.
Related Haplotypes
1

COMMENTS

For four of the M. persicae nicotianae clones all amplified copies of CYP6CY3 appear to share the microsatellite expansion suggests that this mutation predates the gene amplification event ; an other A>G SNP 138 bp upstream of the start codon is also observed but it is experimentally shown to not be involved