GEPHE SUMMARY

Gephebase Gene
CYP9M6 (https://www.gephebase.org/search-criteria?/and+Gene Gephebase=^CYP9M6^#gephebase-summary-title)

GepheID
GP00002448

Entry Status
Published

Main curator
Courtier

PHENOTYPIC CHANGE

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

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

Trait State in Taxon A
Aedes aegypti

Trait State in Taxon B
Aedes aegypti - resistant selected strain

Ancestral State
Taxon A

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

Taxon A

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

Common Name
yellow fever mosquito

Synonyms
Stegomyia aegypti; yellow fever mosquito; Aedes aegypti (Linnaeus, 1762)

Rank
species

Lineage
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Holometabola; Diptera; Nematocera; Culicomorpha; Culicoidea; Culicidae; Culicinae; Aedini; Aedes; Stegomyia

Parent
Stegomyia () - (Rank: subgenus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 53541)

NCBI Taxonomy ID
7159 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 7159)

is Taxon A an Infraspecies?
No

Taxon B

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

Common Name
yellow fever mosquito

Synonyms
Stegomyia aegypti; yellow fever mosquito; Aedes aegypti (Linnaeus, 1762)

Rank
species

Lineage
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Holometabola; Diptera; Nematocera; Culicomorpha; Culicoidea; Culicidae; Culicinae; Aedini; Aedes; Stegomyia

Parent
Stegomyia () - (Rank: subgenus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 53541)

NCBI Taxonomy ID
7159 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 7159)

is Taxon B an Infraspecies?
No

GENOTYPIC CHANGE

Generic Gene Name
CYP9M6

Synonyms
CYP9M6; CYP9M6v1; CYP9M6v2; CYP9M6v3; CYP9M6v4; CYP9M6v5; AAEL001312

String
-

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 - Cellular Component

UniProtKB Aedes aegypti
X5ICI6 (http://www.uniprot.org/uniprot/X5ICI6)

GenebankID or UniProtKB Aedes aegypti
X5ICI6 (https://www.ncbi.nlm.nih.gov/nuccore/X5ICI6)

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

Presumptive Null

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

Molecular Type

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

Aberration Type

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

Insertion Size

unknown

Molecular Details of the Mutation

CYP9M6 has the capability to metabolize permethrin and is over expressed in the resistant strain partially due to gene amplification. The average copy number of the CYP9M9 gene is 4.6-fold more than the standard strain based on qPCR.

Experimental Evidence

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

Main Reference

Mechanisms of pyrethroid resistance in the dengue mosquito vector, Aedes aegypti: target site insensitivity, penetration, and metabolism. (2014) (https://pubmed.ncbi.nlm.nih.gov/24945250)

Authors

Kasai S; Komagata O; Itokawa K; Shono T; Ng LC; Kobayashi M; Tomita T

Abstract

Aedes aegypti is the major vector of yellow and dengue fevers. After 10 generations of adult selection, an A. aegypti strain (SP) developed 1650-fold resistance to permethrin, which is one of the most widely used pyrethroid insecticides for mosquito control. SP larvae also developed 8790-fold resistance following selection of the adults. Prior to the selections, the frequencies of V1016G and F1534C mutations in domains II and III, respectively, of voltage-sensitive sodium channel (Vssc, the target site of pyrethroid insecticide) were 0.44 and 0.56, respectively. In contrast, only G1016 alleles were present after two permethrin selections, indicating that G1016 can more contribute to the insensitivity of Vssc than C1534. In vivo metabolism studies showed that the SP strain excreted permethrin metabolites more rapidly than a susceptible SMK strain. Pretreatment with piperonyl butoxide caused strong inhibition of excretion of permethrin metabolites, suggesting that cytochrome P450 monooxygenases (P450s) play an important role in resistance development. In vitro metabolism studies also indicated an association of P450s with resistance. Microarray analysis showed that multiple P450 genes were over expressed during the larval and adult stages in the SP strain. Following quantitative real time PCR, we focused on two P450 isoforms, CYP9M6 and CYP6BB2. Transcription levels of these P450s were well correlated with the rate of permethrin excretion and they were certainly capable of detoxifying permethrin to 4′-HO-permethrin. Over expression of CYP9M6 was partially due to gene amplification. There was no significant difference in the rate of permethrin reduction from cuticle between SP and SMK strains.

Additional References

Pyrethroid resistance in Aedes aegypti and Aedes albopictus: Important mosquito vectors of human diseases. (2016) (https://pubmed.ncbi.nlm.nih.gov/27742355)

RELATED GEPHE

Related Genes

4 (ABCB4, CYP9J26, para (kdr), resistance to dieldrin) (https://www.gephebase.org/search-criteria?/or+Taxon ID=^7159^/and+Trait=Xenobiotic resistance/and+groupHaplotypes=true#gephebase-summary-title)

Related Haplotypes

No matches found.

EXTERNAL LINKS

COMMENTS

After 10 generations of adult selection this A. aegypti strain noted SP developed 1650-fold resistance to permethrin. The gene was identified based on transcriptome comparison with a non selected strain.