GEPHE SUMMARY

Gephebase Gene
Acetylcholinesterase (Ace-1)

GephelD
GP00001372

Entry Status
Published

Main curator
Prigent

PHENOTYPIC CHANGE

Trait Category
Physiology

Trait
Xenobiotic resistance (insecticide)

Trait State in Taxon A
Anopheles gambiae Mosquitoes- KisumuP- susceptible to OP and CX insecticides ; wild type for viability and fertility

Trait State in Taxon B
Anopheles gambiae Mosquitoes- Acerduplikis ; resistant to OP and CX insecticides ; slightly lower viability than wildtype

Ancestral State
Taxon A

Taxonomic Status
Intraspecific

Taxon A

Latin Name
Anopheles gambiae

Common Name
African malaria mosquito

Synonyms
Anopheles gambiae S; African malaria mosquito; Anopheles gambiae Giles, 1902; Anopheles gambia

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; Anophelinae; Anopheles; Cellia; Pyretophorus; gambiae species complex

Parent
gambiae species complex () - (Rank: no rank)

NCBI Taxonomy ID
7165

is Taxon A an Infraspecies?
Yes

Taxon A Description
Anopheles gambiae Mosquitoes- KisumuP- susceptible to OP and CX insecticides ; wild type for viability and fertility

Taxon B

Latin Name
Anopheles gambiae

Common Name
African malaria mosquito

Synonyms
Anopheles gambiae S; African malaria mosquito; Anopheles gambiae Giles, 1902; Anopheles gambia

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; Anophelinae; Anopheles; Cellia; Pyretophorus; gambiae species complex

Parent
gambiae species complex () - (Rank: no rank)

NCBI Taxonomy ID
7165

is Taxon B an Infraspecies?
Yes

Taxon B Description
Anopheles gambiae Mosquitoes- Acerduplikis ; resistant to OP and CX insecticides ; slightly lower viability than wildtype

GENOTYPIC CHANGE

Generic Gene Name
Ace

Synonyms
AcChE; ace; ACE; ace-2; ache; AchE; AChE; CG17907; CHE; dAChE; dmAChE; DmAChE; Dmel\CG17907; Dm_ace; FBgn0000024; l(3)26; l(3)87Ed

String
7227.FBpp0289713

Sequence Similarities
Belongs to the type-B carboxylesterase/lipase family.

GO - Molecular Function
GO:0042803 : protein homodimerization activity
GO:0003990 : acetylcholinesterase activity
GO:0004104 : cholinesterase activity

UniProtKB Drosophila melanogaster
P07140

GenebankID or UniProtKB

GO:0043199 : sulfate binding

GO - Biological Process
GO:0006581 : acetylcholine catabolic process
GO:0001507 : acetylcholine catabolic process in synaptic cleft
GO:0007268 : chemical synaptic transmission
GO:0042426 : choline catabolic process
GO:0042331 : phototaxis

GO - Cellular Component
GO:0005886 : plasma membrane
GO:0005737 : cytoplasm
GO:0031225 : anchored component of membrane
GO:0030054 : cell junction
GO:0043083 : synaptic cleft

Presumptive Null
No

Molecular Type
Gene Amplification

Aberration Type
Insertion

Insertion Size
100-1000 kb

Molecular Details of the Mutation
Strict tandem duplication of 203kb encompassing 12 genes ; ace1 heterogeneous gene duplication (susceptible G119 and resistant S119 copies)

Experimental Evidence
Candidate Gene

Main Reference
The ace-1 Locus Is Amplified in All Resistant Anopheles gambiae Mosquitoes: Fitness Consequences of Homogeneous and Heterogeneous Duplications. (2016)

Authors
Assogba BS; Milesi P; DjogbÃ©nou LS; Berthomieu A; Makoundou P; Baba-Moussa LS; Fiston-Lavier AS; Belkhir K; LabbÃ© P; Weill M

Abstract
Gene copy-number variations are widespread in natural populations, but investigating their phenotypic consequences requires contemporary duplications under selection. Such duplications have been found at the ace-1 locus (encoding the organophosphate and carbamate insecticides' target) in the mosquito Anopheles gambiae (the major malaria vector); recent studies have revealed their intriguing complexity, consistent with the involvement of various numbers and types (susceptible or resistant to insecticide) of copies. We used an integrative approach, from genome to phenotype level, to investigate the influence of duplication architecture and gene-dosage on mosquito fitness. We found that both heterogeneous (i.e., one susceptible and one resistant ace-1 copy) and homogeneous (i.e., identical resistant copies) duplications segregated in field populations. The number of copies in homogeneous duplications was variable and positively correlated with acetylcholinesterase activity and resistance level. Determining the genomic structure of the duplicated region revealed that, in both types of duplication, ace-1 and 11 other genes formed tandem 203kb amplicons. We developed a diagnostic test for duplications, which showed that ace-1 was amplified in all 173 resistant mosquitoes analyzed (field-collected in several African countries), in heterogeneous or homogeneous duplications. Each type was associated with different fitness trade-offs: heterogeneous duplications conferred an intermediate phenotype (lower resistance and fitness costs), whereas homogeneous duplications tended to increase both resistance and fitness cost, in a complex manner. The type of duplication selected seemed thus to depend on the intensity and distribution of selection pressures. This versatility of trade-offs available through gene duplication highlights the importance of large mutation events in adaptation to environmental variation. This impressive adaptability could have a major impact on vector control in Africa.

Additional References
An ace-1 gene duplication resorbs the fitness cost associated with resistance in Anopheles gambiae, the main malaria mosquito. (2015)

RELATED GEPHE

Related Genes
2 (para (kdr), resistance to dieldrin)
Related Haplotypes
3

COMMENTS

@GxE - this duplication probably results from an unequal crossing-over in a heterozygote R/S