

## GEPHE SUMMARY

|  |                |            |              |
|--|----------------|------------|--------------|
|  | Gephebase Gene |            | GepheID      |
| Acetylcholinesterase (Ace-1) ( <a href="https://www.gephebase.org/search-criteria?/and+Gene">https://www.gephebase.org/search-criteria?/and+Gene</a> ) |                | GP00001374 |              |
| Gephebase="Acetylcholinesterase (Ace-1)"#gephebase-summary-title)  |                |            | Main curator |
| Published  | Entry Status   | Prigent    |              |

## PHENOTYPIC CHANGE

|   |                             |   |                             |
|---|-----------------------------|---|-----------------------------|
|   | Trait Category              |   |                             |
| Physiology ( <a href="https://www.gephebase.org/search-criteria?/and+Trait">https://www.gephebase.org/search-criteria?/and+Trait</a> )  |                             |   |                             |
| Category="Physiology"#gephebase-summary-title)  | Trait                       |   |                             |
| Xenobiotic resistance (insecticide) ( <a #gephebase-summary-title"="" href="https://www.gephebase.org/search-criteria?/and+Trait=Xenobiotic+resistance+(insecticide)">https://www.gephebase.org/search-criteria?/and+Trait=Xenobiotic+resistance+(insecticide)"#gephebase-summary-title</a> )   |                             |   |                             |
|   | Trait State in Taxon A      |   |                             |
| Anopheles gambiae Mosquitoes- AcerKisR3 ; more resistant to OP and CX insecticides ; much lower viability and fertility than wildtype   |                             |   |                             |
|   | Trait State in Taxon B      |   |                             |
| Anopheles gambiae Mosquitoes- Baguida and derived AgRR5 ; much more resistant ; slightly lower viability and fertility than AcerKisR3   |                             |   |                             |
|   | Ancestral State             |   |                             |
| Taxon A   |                             |   |                             |
|   | Taxonomic Status            |   |                             |
| Intraspecific ( <a href="https://www.gephebase.org/search-criteria?/and+Taxonomic">https://www.gephebase.org/search-criteria?/and+Taxonomic</a> )   |                             |   |                             |
| Status="Intraspecific"#gephebase-summary-title)   |                             |   |                             |
|   | Taxon A                     | Taxon B   |                             |
|   | Latin Name                  |   | Latin Name                  |
| Anopheles gambiae   |                             | Anopheles gambiae   |                             |
| ( <a #gephebase-summary-title"="" href="https://www.gephebase.org/search-criteria?/and+Taxon+and+Synonyms=Anopheles+gambiae">https://www.gephebase.org/search-criteria?/and+Taxon+and+Synonyms=Anopheles+gambiae"#gephebase-summary-title</a> )   |                             | ( <a #gephebase-summary-title"="" href="https://www.gephebase.org/search-criteria?/and+Taxon+and+Synonyms=Anopheles+gambiae">https://www.gephebase.org/search-criteria?/and+Taxon+and+Synonyms=Anopheles+gambiae"#gephebase-summary-title</a> )   |                             |
|   | Common Name                 |   | Common Name                 |
| African malaria mosquito  |                             | African malaria mosquito  |                             |
|   | Synonyms                    |   | Synonyms                    |
| Anopheles gambiae S; African malaria mosquito; Anopheles gambiae Giles, 1902; Anopheles gambia  |                             | Anopheles gambiae S; African malaria mosquito; Anopheles gambiae Giles, 1902; Anopheles gambia  |                             |
|   | Rank                        |   | Rank                        |
| species   |                             | species   |                             |
|   | Lineage                     |   | 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 |                             | 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                      |   | Parent                      |
| gambiae species complex () - (Rank: no rank)  |                             | gambiae species complex () - (Rank: no rank)  |                             |
| ( <a href="https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=44542">https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=44542</a> )   |                             | ( <a href="https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=44542">https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=44542</a> )   |                             |
|   | NCBI Taxonomy ID            |   | NCBI Taxonomy ID            |
| 7165  |                             | 7165  |                             |
| ( <a href="https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=7165">https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=7165</a> )   |                             | ( <a href="https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=7165">https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=7165</a> )   |                             |
|   | is Taxon A an Intraspecies? |   | is Taxon B an Intraspecies? |
| Yes   |                             | Yes   |                             |
|   | Taxon A Description         |   | Taxon B Description         |
| Anopheles gambiae Mosquitoes- AcerKisR3 ; more resistant to OP and CX insecticides ; much lower viability and fertility than wildtype   |                             | Anopheles gambiae Mosquitoes- Baguida and derived AgRR5 ; much more resistant ; slightly lower viability and fertility than AcerKisR3   |                             |

## GENOTYPIC CHANGE

|   |                       |  |                                   |
|---|-----------------------|--|-----------------------------------|
|   | Generic Gene Name     |  | UniProtKB Drosophila melanogaster |
| Ace   |                       | P07140 ( <a href="http://www.uniprot.org/uniprot/P07140">http://www.uniprot.org/uniprot/P07140</a> ) |                                   |
|   | Synonyms              |  | GenebankID or UniProtKB           |
| 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  |                       |  |                                   |
| ( <a href="http://string-db.org/newstring.cgi/show_network_section.pl?identifier=7227.FBpp0289713">http://string-db.org/newstring.cgi/show_network_section.pl?identifier=7227.FBpp0289713</a> ) |                       |  |                                   |
|   | Sequence Similarities |  |                                   |
| Belongs to the type-B carboxylesterase/lipase family.   |                       |  |                                   |

GO - Molecular Function

GO:0042803 : protein homodimerization activity  
 (https://www.ebi.ac.uk/QuickGO/term/GO:0042803)  
 GO:0003990 : acetylcholinesterase activity  
 (https://www.ebi.ac.uk/QuickGO/term/GO:0003990)  
 GO:0004104 : cholinesterase activity (https://www.ebi.ac.uk/QuickGO/term/GO:0004104)  
 GO:0043199 : sulfate binding (https://www.ebi.ac.uk/QuickGO/term/GO:0043199)

GO - Biological Process

GO:0006581 : acetylcholine catabolic process  
 (https://www.ebi.ac.uk/QuickGO/term/GO:0006581)  
 GO:0001507 : acetylcholine catabolic process in synaptic cleft  
 (https://www.ebi.ac.uk/QuickGO/term/GO:0001507)  
 GO:0007268 : chemical synaptic transmission  
 (https://www.ebi.ac.uk/QuickGO/term/GO:0007268)  
 GO:0042426 : choline catabolic process  
 (https://www.ebi.ac.uk/QuickGO/term/GO:0042426)  
 GO:0042331 : phototaxis (https://www.ebi.ac.uk/QuickGO/term/GO:0042331)

GO - Cellular Component

GO:0005886 : plasma membrane (https://www.ebi.ac.uk/QuickGO/term/GO:0005886)  
 GO:0005737 : cytoplasm (https://www.ebi.ac.uk/QuickGO/term/GO:0005737)  
 GO:0031225 : anchored component of membrane  
 (https://www.ebi.ac.uk/QuickGO/term/GO:0031225)  
 GO:0030054 : cell junction (https://www.ebi.ac.uk/QuickGO/term/GO:0030054)  
 GO:0043083 : synaptic cleft (https://www.ebi.ac.uk/QuickGO/term/GO:0043083)

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

Presumptive Null

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

Molecular Type

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

Aberration Type

>1 Mb

Insertion Size

Strict tandem 5 times duplication of 203kb encompassing 12 genes - ace1 homogeneous gene duplications (all 5 copies S119 resistant)

Molecular Details of the Mutation

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

Experimental Evidence

The ace-1 Locus Is Amplified in All Resistant Anopheles gambiae Mosquitoes: Fitness Consequences of Homogeneous and Heterogeneous Duplications. (2016)  
 (https://pubmed.ncbi.nlm.nih.gov/27918584)

Main Reference

Assogba BS; Milesi P; Djogb  nou LS; Berthomieu A; Makoundou P; Baba-Moussa LS; Fiston-Lavier AS; Belkhir K; Labb   P; Weill M

Authors

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.

Abstract

Additional References

RELATED GEPHE

Related Genes

3 (para (kdr), resistance to dieldrin, SAP-2) (https://www.gephebase.org/search-criteria?/or+Taxon ID=^7165^/and+Trait=Xenobiotic resistance/and+groupHaplotypes=true#gephebase-summary-title)

Related Haplotypes

3 (https://www.gephebase.org/search-criteria?/or+Gene Gephebase=^Acetylcholinesterase (Ace-1)^/and+Taxon ID=^7165^/or+Gene Gephebase=^Acetylcholinesterase (Ace-1)^/and+Taxon ID=^7165^#gephebase-summary-title)

EXTERNAL LINKS

COMMENTS

@GxE - The 5 times duplication may derived from the 3 times duplication but it is unknown whether the deletion is also present

