

GEPHE SUMMARY

	Gephebase Gene	GepheID
SAP-2 (<a +sap-2^#gephebase-summary-title"="" href="https://www.gephebase.org/search-criteria?/and+Gene+Gephebase=">https://www.gephebase.org/search-criteria?/and+Gene+Gephebase="+SAP-2^#gephebase-summary-title)	GP00002432	
	Entry Status	Main curator
Published	Courtier	

PHENOTYPIC CHANGE

	Trait Category	
Physiology (<a +physiology^#gephebase-summary-title"="" href="https://www.gephebase.org/search-criteria?/and+Trait+Category=">https://www.gephebase.org/search-criteria?/and+Trait+Category="+Physiology^#gephebase-summary-title)	Trait	
Xenobiotic resistance (insecticide; pyrethroid) (<a +xenobiotic+resistance+(insecticide;+pyrethroid)^#gephebase-summary-title"="" href="https://www.gephebase.org/search-criteria?/and+Trait=">https://www.gephebase.org/search-criteria?/and+Trait="+Xenobiotic+resistance+(insecticide;+pyrethroid)^#gephebase-summary-title)	Trait State in Taxon A	
Anopheles gambiae - sensitive	Trait State in Taxon B	
Anopheles gambiae - resistant	Ancestral State	
Taxon A	Taxonomic Status	
Intraspecific (<a +intraspecific^#gephebase-summary-title"="" href="https://www.gephebase.org/search-criteria?/and+Taxonomic+Status=">https://www.gephebase.org/search-criteria?/and+Taxonomic+Status="+Intraspecific^#gephebase-summary-title)		
Taxon A		Taxon B
Latin Name		Latin Name
Anopheles gambiae (<a +anopheles+gambiae^#gephebase-summary-title"="" href="https://www.gephebase.org/search-criteria?/and+Taxon+and+Synonyms=">https://www.gephebase.org/search-criteria?/and+Taxon+and+Synonyms="+Anopheles+gambiae^#gephebase-summary-title)		Anopheles gambiae (<a +anopheles+gambiae^#gephebase-summary-title"="" href="https://www.gephebase.org/search-criteria?/and+Taxon+and+Synonyms=">https://www.gephebase.org/search-criteria?/and+Taxon+and+Synonyms="+Anopheles+gambiae^#gephebase-summary-title)
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) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=44542)		gambiae species complex () - (Rank: no rank) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=44542)
NCBI Taxonomy ID		NCBI Taxonomy ID
7165 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=7165)		7165 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=7165)
is Taxon A an Intraspecies?		is Taxon B an Intraspecies?
No		No

GENOTYPIC CHANGE

	Generic Gene Name	UniProtKB Anopheles gambiae
SAP-2	Q6H8Z3 (http://www.uniprot.org/uniprot/Q6H8Z3)	
	Synonyms	GenebankID or UniProtKB Anopheles gambiae
1277898; AgaP_AGAP008052	String	Q6H8Z3 (https://www.ncbi.nlm.nih.gov/nuccore/Q6H8Z3)
-	Sequence Similarities	
-	GO - Molecular Function	
-	GO - Biological Process	
-	GO - Cellular Component	
-	Presumptive Null	

No (https://www.gephebase.org/search-criteria?/and+Presumptive Null=~No~#gephebase-summary-title)	Molecular Type
Cis-regulatory (https://www.gephebase.org/search-criteria?/and+Molecular Type=~Cis-regulatory~#gephebase-summary-title)	Aberration Type
Unknown (https://www.gephebase.org/search-criteria?/and+Aberration Type=~Unknown~#gephebase-summary-title)	Molecular Details of the Mutation
The gene is highly overexpressed in the appendages of pyrethroid-resistant mosquitoes and its expression is further induced by insecticide exposure. Silencing of SAP2 almost completely restored susceptibility to the pyrethroid deltamethrin and also significantly increased the susceptibility to the other two pyrethroids (permethrin and alpha-cypermethrin).	Experimental Evidence
Association Mapping (https://www.gephebase.org/search-criteria?/and+Experimental Evidence=~Association Mapping~#gephebase-summary-title)	Main Reference
A sensory appendage protein protects malaria vectors from pyrethroids. (2020) (https://pubmed.ncbi.nlm.nih.gov/31875852)	Authors
Ingham VA; Anthousi A; Douris V; Harding NJ; Lycett G; Morris M; Vontas J; Ranson H	Abstract

Pyrethroid-impregnated bed nets have driven considerable reductions in malaria-associated morbidity and mortality in Africa since the beginning of the century. The intense selection pressure exerted by bed nets has precipitated widespread and escalating resistance to pyrethroids in African Anopheles populations, threatening to reverse the gains that been made by malaria control. Here we show that expression of a sensory appendage protein (SAP2), which is enriched in the legs, confers pyrethroid resistance to Anopheles gambiae. Expression of SAP2 is increased in insecticide-resistant populations and is further induced after the mosquito comes into contact with pyrethroids. SAP2 silencing fully restores mortality of the mosquitoes, whereas SAP2 overexpression results in increased resistance, probably owing to high-affinity binding of SAP2 to pyrethroid insecticides. Mining of genome sequence data reveals a selective sweep near the SAP2 locus in the mosquito populations of three West African countries (Cameroon, Guinea and Burkina Faso) with the observed increase in haplotype-associated single-nucleotide polymorphisms mirroring the increasing resistance of mosquitoes to pyrethroids reported in Burkina Faso. Our study identifies a previously undescribed mechanism of insecticide resistance that is likely to be highly relevant to malaria control efforts.

Additional References

RELATED GEPHE

3 (Acetylcholinesterase (Ace-1), para (kdr), resistance to dieldrin) (https://www.gephebase.org/search-criteria?/or+Taxon ID=~7165~/and+Trait=Xenobiotic resistance/and+groupHaplotypes=true#gephebase-summary-title)	Related Genes
No matches found.	Related Haplotypes

EXTERNAL LINKS

COMMENTS

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