GEPHE SUMMARY

Gephebase Gene
Nav1 sodium channel (https://www.gephebase.org/search-criteria?/and+Gene Gephebase=^Nav1 sodium channel^#gephebase-summary-title)

GepheID
GP00002648

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

Trait State in Taxon A
Polistes dominula and many other hymenoptera species - sensitive

Trait State in Taxon B
Bombus impatiens and many other bee species - resistant to a particular pyrethroid: tau-fluvalinate

Ancestral State
Taxon A

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

Taxon A #1

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

Common Name
European paper wasp

Synonyms
European paper wasp; Polistes dominula (Christ, 1791); Polistes dominulus

Rank
species

Lineage
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Endopterygota; Hymenoptera; Apocrita; Aculeata; Vespoidea; Vespidae; Polistinae; Polistini; Polistes

Parent
Polistes () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 7456)

NCBI Taxonomy ID
743375 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 743375)

is Taxon A an Infraspecies?
No

Taxon B #1

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

Common Name
common eastern bumble bee

Synonyms
common eastern bumble bee; Bombus impatiens Cresson, 1863

Rank
species

Lineage
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Endopterygota; Hymenoptera; Apocrita; Aculeata; Apoidea; Apidae; Apinae; Bombini; Bombus; Pyrobombus

Parent
Pyrobombus () - (Rank: subgenus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 144703)

NCBI Taxonomy ID
132113 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 132113)

is Taxon B an Infraspecies?
No

Taxon A #2

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

Common Name
-

Synonyms
-

Rank
species

Lineage
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Endopterygota; Hymenoptera; Orussoidea; Orussidae; Orussus

Parent
Orussus () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 27529)

NCBI Taxonomy ID

Taxon B #2

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

Common Name
honey bee

Synonyms
bee; Apis mellifica; honey bee; European honey bee; Western honey bee; honeybee; Apis mellifera Linnaeus, 1758; Apis melifera

Rank
species

Lineage
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Endopterygota; Hymenoptera; Apocrita; Aculeata; Apoidea; Apidae; Apinae; Apini; Apis

Parent
Apis () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 7459)

222816
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 222816)

is Taxon A an Infraspecies?

No

Taxon A #3

Latin Name

Diachasma alloeum
(https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=^Diachasma alloeum^#gephebase-summary-title)

Common Name

-

Synonyms

Diachasma alloeum (Muesebeck, 1956)

Rank

species

Lineage

cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Endopterygota; Hymenoptera; Apocrita; Parasitoida; Ichneumonoidea; Braconidae; Opiinae; Diachasma

Parent

Diachasma () - (Rank: genus)
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 454922)

NCBI Taxonomy ID

454923
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 454923)

is Taxon A an Infraspecies?

No

NCBI Taxonomy ID

7460
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 7460)

is Taxon B an Infraspecies?

No

Taxon B #3

Latin Name

Dufourea novaeangliae
(https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=^Dufourea novaeangliae^#gephebase-summary-title)

Common Name

-

Synonyms

Dufourea nova-angliae; Dufourea novaeangliae (Robertson, 1897)

Rank

species

Lineage

cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Endopterygota; Hymenoptera; Apocrita; Aculeata; Apoidea; Halictidae; Rophitinae; Dufourea

Parent

Dufourea () - (Rank: genus)
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 178032)

NCBI Taxonomy ID

178035
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 178035)

is Taxon B an Infraspecies?

No

Taxon B #4

Latin Name

Eufriesea mexicana
(https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=^Eufriesea mexicana^#gephebase-summary-title)

Common Name

-

Synonyms

Eufriesea mexicana (Mocsary, 1897)

Rank

species

Lineage

cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Endopterygota; Hymenoptera; Apocrita; Aculeata; Apoidea; Apidae; Apinae; Euglossini; Eufriesea

Parent

Eufriesea () - (Rank: genus)
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 28644)

NCBI Taxonomy ID

516756
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 516756)

is Taxon B an Infraspecies?

No

Taxon B #5

Latin Name

Habropoda laboriosa
(https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=^Habropoda laboriosa^#gephebase-summary-title)

Common Name

-

Synonyms

Habropoda laboriosa (Fabricius, 1804)

Rank

species

Lineage

cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Endopterygota; Hymenoptera; Apocrita; Aculeata; Apoidea; Apidae; Apinae; Anthophorini; Habropoda

Parent

Habropoda () - (Rank: genus)

(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 117248)

NCBI Taxonomy ID

597456

(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 597456)

is Taxon B an Infraspecies?

No

Taxon B #6

Latin Name

Melipona quadrifasciata

(https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=^Melipona quadrifasciata^#gephebase-summary-title)

Common Name

-

Synonyms

Melipona quadrifasciata Lepeletier, 1836

Rank

species

Lineage

cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Endopterygota; Hymenoptera; Apocrita; Aculeata; Apoidea; Apidae; Apinae; Meliponini; Melipona

Parent

Melipona () - (Rank: genus)

(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 28651)

NCBI Taxonomy ID

166423

(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 166423)

is Taxon B an Infraspecies?

No

Taxon B #7

Latin Name

Megachile rotundata

(https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=^Megachile rotundata^#gephebase-summary-title)

Common Name

alfalfa leafcutting bee

Synonyms

alfalfa leafcutting bee; Megachile rotundata (Fabricius, 1787)

Rank

species

Lineage

cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Endopterygota; Hymenoptera; Apocrita; Aculeata; Apoidea; Megachilidae; Megachilinae; Megachilini; Megachile

Parent

Megachile () - (Rank: genus)

(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 132116)

NCBI Taxonomy ID

143995

(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 143995)

is Taxon B an Infraspecies?

No

Taxon B #8

Latin Name

Athalia rosae

(https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms=^Athalia rosae^#gephebase-summary-title)

Common Name

coleseed sawfly

Synonyms

coleseed sawfly; Athalia rosae (Linnaeus, 1758)

Rank

species

Lineage

cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Mandibulata; Pancrustacea; Hexapoda; Insecta; Dicondylia; Pterygota; Neoptera; Endopterygota; Hymenoptera; Tenthredinoidea; Athaliidae; Athalia

Parent

Athalia () - (Rank: genus)
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 37343)

NCBI Taxonomy ID

37344
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 37344)

is Taxon B an Infraspecies?

No

GENOTYPIC CHANGE

Generic Gene Name

SCN8A

Synonyms

MED; PN4; CIAT; BFIS5; NaCh6; CERIII; EIEE13; Nav1.6

String

9606.ENSP00000346534
(http://string-db.org/newstring_cgi/show_network_section.pl?identifier=
9606.ENSP00000346534)

Sequence Similarities

Belongs to the sodium channel (TC 1.A.1.10) family. Nav1.6/SCN8A subfamily.

GO - Molecular Function

GO:0005524 : ATP binding (https://www.ebi.ac.uk/QuickGO/term/GO:0005524)
GO:0005244 : voltage-gated ion channel activity
(https://www.ebi.ac.uk/QuickGO/term/GO:0005244)
GO:0005248 : voltage-gated sodium channel activity
(https://www.ebi.ac.uk/QuickGO/term/GO:0005248)

GO - Biological Process

GO:0007399 : nervous system development
(https://www.ebi.ac.uk/QuickGO/term/GO:0007399)
GO:0007422 : peripheral nervous system development
(https://www.ebi.ac.uk/QuickGO/term/GO:0007422)
GO:0006814 : sodium ion transport (https://www.ebi.ac.uk/QuickGO/term/GO:0006814)
GO:0019228 : neuronal action potential (https://www.ebi.ac.uk/QuickGO/term/GO:0019228)
GO:0034765 : regulation of ion transmembrane transport
(https://www.ebi.ac.uk/QuickGO/term/GO:0034765)
GO:0086010 : membrane depolarization during action potential
(https://www.ebi.ac.uk/QuickGO/term/GO:0086010)
GO:0035725 : sodium ion transmembrane transport
(https://www.ebi.ac.uk/QuickGO/term/GO:0035725)
GO:0042552 : myelination (https://www.ebi.ac.uk/QuickGO/term/GO:0042552)

GO - Cellular Component

GO:0016021 : integral component of membrane
(https://www.ebi.ac.uk/QuickGO/term/GO:0016021)
GO:0005886 : plasma membrane (https://www.ebi.ac.uk/QuickGO/term/GO:0005886)
GO:0030018 : Z disc (https://www.ebi.ac.uk/QuickGO/term/GO:0030018)
GO:0031410 : cytoplasmic vesicle (https://www.ebi.ac.uk/QuickGO/term/GO:0031410)
GO:0030424 : axon (https://www.ebi.ac.uk/QuickGO/term/GO:0030424)
GO:0001518 : voltage-gated sodium channel complex
(https://www.ebi.ac.uk/QuickGO/term/GO:0001518)
GO:0043194 : axon initial segment (https://www.ebi.ac.uk/QuickGO/term/GO:0043194)
GO:0033268 : node of Ranvier (https://www.ebi.ac.uk/QuickGO/term/GO:0033268)

UniProtKB Homo sapiens

Q9UQD0 (http://www.uniprot.org/uniprot/Q9UQD0)

GenebankID or UniProtKB

()

Mutation #1

Presumptive Null

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

Molecular Type

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

Aberration Type

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

SNP Coding Change

Nonsynonymous

Molecular Details of the Mutation

L1525F in IIIS6 and I926V in IIS5 and S841T in IIS2

Experimental Evidence

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

	Taxon A	Taxon B	Position
Codon	-	-	-
Amino-acid	Leu	Phe	1525

Main Reference

Molecular basis of selective resistance of the bumblebee BiNa1 sodium channel to tau-fluvalinate. (2017) (https://pubmed.ncbi.nlm.nih.gov/29158414)

Authors

Wu S; Nomura Y; Du Y; Zhorov BS; Dong K

Abstract

Insecticides are widely used to control pests in agriculture and insect vectors that transmit human diseases. However, these chemicals can have a negative effect on nontarget, beneficial organisms including bees. Discovery and deployment of selective insecticides is a major mission of modern toxicology and pest management. Pyrethroids exert their toxic action by acting on insect voltage-gated sodium channels. Honeybees and bumblebees are highly sensitive to most pyrethroids, but are resistant to a particular pyrethroid, tau-fluvalinate (Ï„-FVL). Because of its unique selectivity, Ï„-FVL is widely used to control not only agricultural pests but also varroa mites, the principal ectoparasite of honeybees. However, the mechanism of bee resistance to Ï„-FVL largely remains elusive. In this study, we functionally characterized the sodium channel BiNa1-1 from the common eastern bumblebee (Bombus impatiens) in Xenopus oocytes and found that the BiNa1-1 channel is highly sensitive to six commonly used pyrethroids, but resistant to Ï„-FVL. Phylogenetic and mutational analyses revealed that three residues, which are conserved in sodium channels from 12 bee species, underlie resistance to Ï„-FVL or sensitivity to the other pyrethroids. Further computer modeling and mutagenesis uncovered four additional residues in the pyrethroid receptor sites that contribute to the unique selectivity of the bumblebee sodium channel to Ï„-FVL versus other pyrethroids. Our data contribute to understanding a long-standing enigma of selective pyrethroid toxicity in bees and may be used to guide future modification of pyrethroids to achieve highly selective control of pests with minimal effects on nontarget organisms.

Additional References

Mutation #2

Presumptive Null

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

Molecular Type

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

Aberration Type

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

SNP Coding Change

Nonsynonymous

Molecular Details of the Mutation

L1525F in IIIS6 and I926V in IIS5 and S841T in IIS2

Experimental Evidence

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

	Taxon A	Taxon B	Position
Codon	-	-	-
Amino-acid	Ile	Val	926

Main Reference

Molecular basis of selective resistance of the bumblebee BiNa1 sodium channel to tau-fluvalinate. (2017) (https://pubmed.ncbi.nlm.nih.gov/29158414)

Authors

Wu S; Nomura Y; Du Y; Zhorov BS; Dong K

Abstract

Insecticides are widely used to control pests in agriculture and insect vectors that transmit human diseases. However, these chemicals can have a negative effect on nontarget, beneficial organisms including bees. Discovery and deployment of selective insecticides is a major mission of modern toxicology and pest management. Pyrethroids exert their toxic action by acting on insect voltage-gated sodium channels. Honeybees and bumblebees are highly sensitive to most pyrethroids, but are resistant to a particular pyrethroid, tau-fluvalinate (Ï„-FVL). Because of its unique selectivity, Ï„-FVL is widely used to control not only agricultural pests but also varroa mites, the principal ectoparasite of honeybees. However, the mechanism of bee resistance to Ï„-FVL largely remains elusive. In this study, we functionally characterized the sodium channel BiNa1-1 from the common eastern bumblebee (Bombus impatiens) in Xenopus oocytes and found that the BiNa1-1 channel is highly sensitive to six commonly used pyrethroids, but resistant to Ï„-FVL. Phylogenetic and mutational analyses revealed that three residues, which are conserved in sodium channels from 12 bee species, underlie resistance to Ï„-FVL or sensitivity to the other pyrethroids. Further computer modeling and mutagenesis uncovered four additional residues in the pyrethroid receptor sites that contribute to the unique selectivity of the bumblebee sodium channel to Ï„-FVL versus other pyrethroids. Our data contribute to understanding a long-standing enigma of selective pyrethroid toxicity in bees and may be used to guide future modification of pyrethroids to achieve highly selective control of pests with minimal effects on nontarget organisms.

Additional References

Mutation #3

Presumptive Null

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

Molecular Type

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

Aberration Type

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

SNP Coding Change

Nonsynonymous

Molecular Details of the Mutation

L1525F in IIIS6 and I926V in IIS5 and S841T in IIS2

Experimental Evidence

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

	Taxon A	Taxon B	Position
Codon	-	-	-
Amino-acid	Ser	Thr	841

Main Reference

Molecular basis of selective resistance of the bumblebee BiNa1 sodium channel to tau-fluvalinate. (2017) (https://pubmed.ncbi.nlm.nih.gov/29158414)

Authors

Wu S; Nomura Y; Du Y; Zhorov BS; Dong K

Abstract

Insecticides are widely used to control pests in agriculture and insect vectors that transmit human diseases. However, these chemicals can have a negative effect on nontarget, beneficial organisms including bees. Discovery and deployment of selective insecticides is a major mission of modern toxicology and pest management. Pyrethroids exert their toxic action by acting on insect voltage-gated sodium channels. Honeybees and bumblebees are highly sensitive to most pyrethroids, but are resistant to a particular pyrethroid, tau-fluvalinate (Ï„-FVL). Because of its unique selectivity, Ï„-FVL is widely used to control not only agricultural pests but also varroa mites, the principal ectoparasite of honeybees. However, the mechanism of bee resistance to Ï„-FVL largely remains elusive. In this study, we functionally characterized the sodium channel BiNa1-1 from the common eastern bumblebee (Bombus impatiens) in Xenopus oocytes and found that the BiNa1-1 channel is highly sensitive to six commonly used pyrethroids, but resistant to Ï„-FVL. Phylogenetic and mutational analyses revealed that three residues, which are conserved in sodium channels from 12 bee species, underlie resistance to Ï„-FVL or sensitivity to the other pyrethroids. Further computer modeling and mutagenesis uncovered four additional residues in the pyrethroid receptor sites that contribute to the unique selectivity of the bumblebee sodium channel to Ï„-FVL versus other pyrethroids. Our data contribute to understanding a long-standing enigma of selective pyrethroid toxicity in bees and may be used to guide future modification of pyrethroids to achieve highly selective control of pests with minimal effects on nontarget organisms.

Additional References

RELATED GEPHE

Related Genes

No matches found.

Related Haplotypes

No matches found.

EXTERNAL LINKS

COMMENTS

Phylogenetic and mutational analyses revealed that three residues (conserved in sodium channels from 12 bee species) underlie resistance to Ï„-FVL or sensitivity to the other pyrethroids.