GEPHE SUMMARY

Gephebase Gene
SCN9A (Nav1.7)

GephelD
GP00001646

Entry Status
Published

Main curator
Prigent

PHENOTYPIC CHANGE

Trait Category
Physiology

Trait
Xenobiotic resistance (TTX)

Trait State in Taxon A
TTX-Sensitive Diadophis punctatus

Trait State in Taxon B
TTX-Resistant Carphophis

Ancestral State
Taxon A

Taxonomic Status
Intergeneric or Higher

Taxon A

Latin Name
Diadophis punctatus

Common Name
Ringneck snake

Synonyms
Coluber punctatus; Ringneck snake; Diadophis punctatus (Linnaeus, 1766)

Rank
species

Lineage
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Deuterostomia; Chordata; Craniata; Vertebrata; Gnathostomata; Teleostomi; Euteleostomi; Sarcopterygii; Dipnotetrapodomorpha; Tetrapoda; Amniota; Sauropsida; Sauria; Lepidosauria; Squamata; Bifurcata; Unidentata; Episquamata; Toxicofera; Serpentes; Colubroidea; Dipsadidae; Diadophis

Parent
Diadophis () - (Rank: genus)

NCBI Taxonomy ID
158804

is Taxon A an Infraspecies?
No

Taxon B

Latin Name
Carphophis

Common Name
-

Synonyms
-

Rank
genus

Lineage
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Deuterostomia; Chordata; Craniata; Vertebrata; Gnathostomata; Teleostomi; Euteleostomi; Sarcopterygii; Dipnotetrapodomorpha; Tetrapoda; Amniota; Sauropsida; Sauria; Lepidosauria; Squamata; Bifurcata; Unidentata; Episquamata; Toxicofera; Serpentes; Colubroidea; Dipsadidae

Parent
Dipsadidae () - (Rank: family)

NCBI Taxonomy ID
186575

is Taxon B an Infraspecies?
No

GENOTYPIC CHANGE

Generic Gene Name
SCN9A

Synonyms
PN1; ETHA; NENA; SFNP; FEB3B; NE-NA; GEFSP7; HSAN2D; Nav1.7

String
9606.ENSP00000386306

Sequence Similarities
Belongs to the sodium channel (TC 1.A.1.10) family. Nav1.7/SCN9A subfamily.

GO - Molecular Function
GO:0031402 : sodium ion binding
GO:0005244 : voltage-gated ion channel activity
GO:0005248 : voltage-gated sodium channel activity

GO - Biological Process
GO:0006814 : sodium ion transport
GO:0006954 : inflammatory response
GO:0019228 : neuronal action potential
GO:0009791 : post-embryonic development
GO:0019233 : sensory perception of pain
GO:0034765 : regulation of ion transmembrane transport

UniProtKB Homo sapiens
Q15858

GenebankID or UniProtKB

GO:0086010 : membrane depolarization during action potential
GO:0035725 : sodium ion transmembrane transport
GO:0048266 : behavioral response to pain
GO:0009636 : response to toxic substance

GO - Cellular Component
GO:0005886 : plasma membrane
GO:0005887 : integral component of plasma membrane
GO:0030424 : axon
GO:0001518 : voltage-gated sodium channel complex

Presumptive Null
No

Molecular Type
Coding

Aberration Type
SNP

SNP Coding Change
Nonsynonymous

Molecular Details of the Mutation
I1677V in DIV (2x resistance)

Experimental Evidence
Candidate Gene

	Taxon A	Taxon B	Position
Codon	-	-	-
Amino-acid	-	-	-

Main Reference
Historical Contingency in a Multigene Family Facilitates Adaptive Evolution of Toxin Resistance. (2016)

Authors
McGlothlin JW; Kobiela ME; Feldman CR; Castoe TA; Geffeney SL; Hanifin CT; Toledo G; Vonk FJ; Richardson MK; Brodie ED; Pfrender ME; Brodie ED

Abstract
Novel adaptations must originate and function within an already established genome [1]. As a result, the ability of a species to adapt to new environmental challenges is predicted to be highly contingent on the evolutionary history of its lineage [2-6]. Despite a growing appreciation of the importance of historical contingency in the adaptive evolution of single proteins [7-11], we know surprisingly little about its role in shaping complex adaptations that require evolutionary change in multiple genes. One such adaptation, extreme resistance to tetrodotoxin (TTX), has arisen in several species of snakes through coevolutionary arms races with toxic amphibian prey, which select for TTX-resistant voltage-gated sodium channels (Nav) [12-16]. Here, we show that the relatively recent origins of extreme toxin resistance, which involve the skeletal muscle channel Nav1.4, were facilitated by ancient evolutionary changes in two other members of the same gene family. A substitution conferring TTX resistance to Nav1.7, a channel found in small peripheral neurons, arose in lizards â^¼170 million years ago (mya) and was present in the common ancestor of all snakes. A second channel found in larger myelinated neurons, Nav1.6, subsequently evolved resistance in four different snake lineages beginning â^¼38 mya. Extreme TTX resistance has evolved at least five times within the past 12 million years via changes in Nav1.4, but only within lineages that previously evolved resistant Nav1.6 and Nav1.7. Our results show that adaptive protein evolution may be contingent upon enabling substitutions elsewhere in the genome, in this case, in paralogs of the same gene family.

Additional References

RELATED GEPHE

Related Genes
No matches found.
Related Haplotypes
No matches found.

EXTERNAL LINKS

COMMENTS

Non-null mutation