GEPHE SUMMARY

Gephebase Gene
ATP4B

GepheID
GP00001929

Entry Status
Published

Main curator
Courtier

PHENOTYPIC CHANGE

Trait Category
Physiology

Trait
Digestion (absence of stomach)

Trait State in Taxon A
presence of stomach and gastric acid production

Trait State in Taxon B
loss of stomach and no gastric acid production

Ancestral State
Taxon A

Taxonomic Status
Intergeneric or Higher

Taxon A #1

Latin Name
Oreochromis niloticus

Common Name
Nile tilapia

Synonyms
Oreochromis nilotica; Tilapia nilotica; Nile tilapia; Oreochromis niloticus (Linnaeus, 1758)

Rank
species

Lineage
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Deuterostomia; Chordata; Craniata; Vertebrata; Gnathostomata; Teleostomi; Euteleostomi; Actinopterygii; Actinopteri; Neopterygii; Teleostei; Osteoglossocephalai; Clupeocephala; Euteleosteomorpha; Neoteleostei; Eurypterygia; Ctenosquamata; Acanthomorphata; Euacanthomorphacea; Percomorphaceae; Ovalentaria; Cichlomorphae; Cichliformes; Cichlidae; African cichlids; Pseudocrenilabrinae; Oreochromini; Oreochromis

Parent
Oreochromis () - (Rank: genus)

NCBI Taxonomy ID
8128

is Taxon A an Infraspecies?
No

Taxon B #1

Latin Name
Takifugu rubripes

Common Name
torafugu

Synonyms
Fugu rubripes; Sphaeroides rubripes; Tetraodon rubripes; torafugu; tiger puffer; Takifugu rubripes (Temminck & Schlegel, 1850)

Rank
species

Lineage
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Deuterostomia; Chordata; Craniata; Vertebrata; Gnathostomata; Teleostomi; Euteleostomi; Actinopterygii; Actinopteri; Neopterygii; Teleostei; Osteoglossocephalai; Clupeocephala; Euteleosteomorpha; Neoteleostei; Eurypterygia; Ctenosquamata; Acanthomorphata; Euacanthomorphacea; Percomorphaceae; Eupercaria; Tetraodontiformes; Tetraodontoidei; Tetradontoidea; Tetraodontidae; Takifugu

Parent
Takifugu () - (Rank: genus)

NCBI Taxonomy ID
31033

is Taxon B an Infraspecies?
No

Taxon A #2

Latin Name
Gasterosteus aculeatus

Common Name
three-spined stickleback

Synonyms
three-spined stickleback; three spined stickleback; Gasterosteus aculeatus Linnaeus, 1758

Rank
species

Lineage
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Deuterostomia; Chordata; Craniata; Vertebrata; Gnathostomata; Teleostomi; Euteleostomi; Actinopterygii; Actinopteri; Neopterygii; Teleostei; Osteoglossocephalai; Clupeocephala; Euteleosteomorpha; Neoteleostei; Eurypterygia; Ctenosquamata; Acanthomorphata; Euacanthomorphacea; Percomorphaceae; Eupercaria; Perciformes; Cottioidei; Gasterosteales; Gasterosteidae; Gasterosteus

Parent
Gasterosteus () - (Rank: genus)

NCBI Taxonomy ID
69293

is Taxon A an Infraspecies?

Taxon B #2

Latin Name
Tetraodon nigroviridis

Common Name
spotted green pufferfish

Synonyms
spotted green pufferfish; Tetraodon nigroviridis Marion de Proce, 1822

Rank
species

Lineage
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Deuterostomia; Chordata; Craniata; Vertebrata; Gnathostomata; Teleostomi; Euteleostomi; Actinopterygii; Actinopteri; Neopterygii; Teleostei; Osteoglossocephalai; Clupeocephala; Euteleosteomorpha; Neoteleostei; Eurypterygia; Ctenosquamata; Acanthomorphata; Euacanthomorphacea; Percomorphaceae; Eupercaria; Tetraodontiformes; Tetraodontoidei; Tetradontoidea; Tetraodontidae; Tetraodon

Parent
Tetraodon () - (Rank: genus)

NCBI Taxonomy ID
99883

is Taxon B an Infraspecies?

No

No

GENOTYPIC CHANGE

Generic Gene Name
ATP4B

Synonyms
ATP6B

String
9606.ENSP00000334216

Sequence Similarities
Belongs to the X(+)/potassium ATPases subunit beta family.

GO - Molecular Function
GO:0001671 : ATPase activator activity
GO:0008900 : potassium:proton exchanging ATPase activity

GO - Biological Process
GO:0007155 : cell adhesion
GO:0034220 : ion transmembrane transport
GO:0032496 : response to lipopolysaccharide
GO:0030007 : cellular potassium ion homeostasis
GO:0006883 : cellular sodium ion homeostasis
GO:1990573 : potassium ion import across plasma membrane
GO:0036376 : sodium ion export across plasma membrane
GO:0010243 : response to organonitrogen compound
GO:0010248 : establishment or maintenance of transmembrane electrochemical gradient

GO - Cellular Component
GO:0005886 : plasma membrane
GO:0005890 : sodium:potassium-exchanging ATPase complex

UniProtKB Homo sapiens
P51164

GenebankID or UniProtKB

Presumptive Null
Yes

Molecular Type
Gene Loss

Aberration Type
Deletion

Deletion Size
-

Molecular Details of the Mutation
Absence of the gene in the genome sequence - high synteny

Experimental Evidence
Candidate Gene

Main Reference
Recurrent gene loss correlates with the evolution of stomach phenotypes in gnathostome history. (2014)

Authors
Castro LF; GonÃ§alves O; Mazan S; Tay BH; Venkatesh B; Wilson JM

Abstract
The stomach, a hallmark of gnathostome evolution, represents a unique anatomical innovation characterized by the presence of acid- and pepsin-secreting glands. However, the occurrence of these glands in gnathostome species is not universal; in the nineteenth century the French zoologist Cuvier first noted that some teleosts lacked a stomach. Strikingly, Holocephali (chimaeras), dipnoids (lungfish) and monotremes (egg-laying mammals) also lack acid secretion and a gastric cellular phenotype. Here, we test the hypothesis that loss of the gastric phenotype is correlated with the loss of key gastric genes. We investigated species from all the main gnathostome lineages and show the specific contribution of gene loss to the widespread distribution of the agastric condition. We establish that the stomach loss correlates with the persistent and complete absence of the gastric function gene kit--H(+)/K(+)-ATPase (Atp4A and Atp4B) and pepsinogens (Pga, Pgc, Cym)--in the analysed species. We also find that in gastric species the pepsinogen gene complement varies significantly (e.g. two to four in teleosts and tens in some mammals) with multiple events of pseudogenization identified in various lineages. We propose that relaxation of purifying selection in pepsinogen genes and possibly proton pump genes in response to dietary changes led to the numerous independent events of stomach loss in gnathostome history. Significantly, the absence of the gastric genes predicts that reinvention of the stomach in agastric lineages would be highly improbable, in line with Dollo's principle.

Additional References

RELATED GEPHE

Related Genes
4 (ATP4A, pepsinogen A1, pepsinogen A2, pepsinogen A3)
Related Haplotypes
2

COMMENTS

Not clear if this is independent evolution inTetraodon nigroviridis and in Takifugu rubripes (no detailed phylogenetic tree in the paper)