

GEPHE SUMMARY

Gephebase Gene
ATP4A

Entry Status
Published

GepheID
GP00001928

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; Clupecocephala; Euteleosteomorpha; Neoteleostei; Eurypterygia; Ctenosquamata; Acanthomorphata; Euacanthomorphacea; Percormorphaceae; Ovalentaria; Cichlomorphae; Cichliformes; Cichlidae; African cichlids; Pseudocrenilabrinae; Oreochromini; Oreochromis

Parent

Oreochromis () - (Rank: genus)

NCBI Taxonomy ID

8128

is Taxon A an Intraspecies?

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; Clupecocephala; Euteleosteomorpha; Neoteleostei; Eurypterygia; Ctenosquamata; Acanthomorphata; Euacanthomorphacea; Percormorphaceae; Eupercaria; Tetraodontiformes; Tetraodontoidei; Tetradontoidea; Tetraodontidae; *Takifugu*

Parent

Takifugu () - (Rank: genus)

NCBI Taxonomy ID

31033

is Taxon B an Intraspecies?

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; Clupecocephala; Euteleosteomorpha; Neoteleostei; Eurypterygia; Ctenosquamata; Acanthomorphata; Euacanthomorphacea; Percormorphaceae; Eupercaria; Perciformes; Cottioidei; Gasterosteales; Gasterosteidae; *Gasterosteus*

Parent

Gasterosteus () - (Rank: genus)

NCBI Taxonomy ID

69293

is Taxon A an Intraspecies?

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; Clupecocephala; Euteleosteomorpha; Neoteleostei; Eurypterygia; Ctenosquamata; Acanthomorphata; Euacanthomorphacea; Percormorphaceae; Eupercaria; Tetraodontiformes; Tetraodontoidei; Tetradontoidea; Tetraodontidae; *Tetraodon*

Parent

Tetraodon () - (Rank: genus)

NCBI Taxonomy ID

99883

is Taxon B an Intraspecies?

No

No

GENOTYPIC CHANGE

Generic Gene Name

ATP4A

UniProtKB Homo sapiens

P20648

Synonyms

ATP6A

GenebankID or UniProtKB

String

9606.ENSP00000262623

Sequence Similarities

Belongs to the cation transport ATPase (P-type) (TC 3.A.3) family, Type IIC subfamily.

GO - Molecular Function

GO:0005524 : ATP binding

GO:0000287 : magnesium ion binding

GO:0005391 : sodium:potassium-exchanging ATPase activity

GO:0008900 : potassium:proton exchanging ATPase activity

GO - Biological Process

GO:0034220 : ion transmembrane transport

GO:0015991 : ATP hydrolysis coupled proton transport

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 - Cellular Component

GO:0005886 : plasma membrane

GO:0005887 : integral component of plasma membrane

GO:0005615 : extracellular space

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; GonÁsalves 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 (*ATP4B*, *pepsinogen A1*, *pepsinogen A2*, *pepsinogen A3*)

Related Haplotypes

2

COMMENTS

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