GEPHE SUMMARY

Gephebase Gene
pepsinogen A1 (https://www.gephebase.org/search-criteria?/and+Gene Gephebase=^pepsinogen A1^#gephebase-summary-title)

GepheID
GP00001930

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
Digestion (absence of stomach) (https://www.gephebase.org/search-criteria?/and+Trait=^Digestion (absence of stomach)^#gephebase-summary-title)

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

Taxon A #1

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

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) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 8139)

NCBI Taxonomy ID
8128 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 8128)

is Taxon A an Infraspecies?
No

Taxon B #1

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

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) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 31032)

NCBI Taxonomy ID
31033 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 31033)

is Taxon B an Infraspecies?
No

Taxon A #2

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

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;

Taxon B #2

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

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;

Eupercaria; Perciformes; Cottioidei; Gasterosteales; Gasterosteidae; Gasterosteus

Parent

Gasterosteus () - (Rank: genus)
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 69292)

NCBI Taxonomy ID

69293
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 69293)

is Taxon A an Infraspecies?

No

Tetraodon

Parent

Tetraodon () - (Rank: genus)
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 47144)

NCBI Taxonomy ID

99883
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 99883)

is Taxon B an Infraspecies?

No

GENOTYPIC CHANGE

Generic Gene Name

PGA4

Synonyms

-

String

9606.ENSP00000367391
(http://string-db.org/newstring_cgi/show_network_section.pl?identifier=
9606.ENSP00000367391)

Sequence Similarities

Belongs to the peptidase A1 family.

GO - Molecular Function

GO:0004190 : aspartic-type endopeptidase activity
(https://www.ebi.ac.uk/QuickGO/term/GO:0004190)

GO - Biological Process

GO:0006508 : proteolysis (https://www.ebi.ac.uk/QuickGO/term/GO:0006508)
GO:0044267 : cellular protein metabolic process
(https://www.ebi.ac.uk/QuickGO/term/GO:0044267)
GO:0007586 : digestion (https://www.ebi.ac.uk/QuickGO/term/GO:0007586)
GO:0030163 : protein catabolic process
(https://www.ebi.ac.uk/QuickGO/term/GO:0030163)

GO - Cellular Component

GO:0070062 : extracellular exosome (https://www.ebi.ac.uk/QuickGO/term/GO:0070062)
GO:0097486 : multivesicular body lumen
(https://www.ebi.ac.uk/QuickGO/term/GO:0097486)

UniProtKB Homo sapiens

P0DJD7 (http://www.uniprot.org/uniprot/P0DJD7)

GenebankID or UniProtKB

()

Presumptive Null

Yes (https://www.gephebase.org/search-criteria?/and+Presumptive Null=^Yes^#gephebase-summary-title)

Molecular Type

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

Aberration Type

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

Deletion Size

-

Molecular Details of the Mutation

Absence of the gene in the genome sequence - high synteny

Experimental Evidence

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

Main Reference

Recurrent gene loss correlates with the evolution of stomach phenotypes in gnathostome history. (2014) (https://pubmed.ncbi.nlm.nih.gov/24307675)

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, ATP4B, pepsinogen A2, pepsinogen A3) (https://www.gephebase.org/search-criteria?/or+Taxon ID=^8128^/and+Trait=Digestion/or+Taxon ID=^69293^/and+Trait=Digestion/or+Taxon ID=^31033^/and+Trait=Digestion/or+Taxon ID=^99883^/and+Trait=Digestion/and+groupHaplotypes=true#gephebase-summary-title)

Related Haplotypes

2 (https://www.gephebase.org/search-criteria?/or+Gene Gephebase=^pepsinogen A1^/and+Taxon ID=^8128^/or+Gene Gephebase=^pepsinogen A1^/and+Taxon ID=^69293^/or+Gene Gephebase=^pepsinogen A1^/and+Taxon ID=^31033^/or+Gene Gephebase=^pepsinogen A1^/and+Taxon ID=^99883^#gephebase-summary-title)

EXTERNAL LINKS

COMMENTS

There are three pepsinogen A genes in teleost fishes - their nomenclature and phylogenetic relationships are different from Mammals pepsinogen genes - Not clear if this is independent evolution inTetraodon nigroviridis and in Takifugu rubripes (no detailed phylogenetic tree in the paper)