GEPHE SUMMARY

Gephebase Gene

heavy metal atpase3 (HMA3) (https://www.gephebase.org/search-criteria?/and+Gene Gephebase=^heavy metal atpase3 (HMA3)^#gephebase-summary-title)

GepheID

GP00000444

Entry Status

Published

Main curator

Martin

PHENOTYPIC CHANGE

Trait Category

Physiology (https://www.gephebase.org/search-criteria?/and+Trait Category=^Physiology^#gephebase-summary-title)

Trait

Metal tolerance (https://www.gephebase.org/search-criteria?/and+Trait=^Metal tolerance^#gephebase-summary-title)

Trait State in Taxon A

Arabidopsis thaliana _ cadmium (Cd) tolerant

Trait State in Taxon B

Arabidopsis thaliana - Col0 cadmium (Cd)-sensitive

Ancestral State

Data not curated

Taxonomic Status

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

Taxon A

Latin Name

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

Common Name

thale cress

Synonyms

thale cress; mouse-ear cress; thale-cress; Arabidopsis thaliana (L.) Heynh.; Arabidopsis thaliana (thale cress); Arabidopsis_thaliana; Arbisopsis thaliana; thale kress

Rank

species

Lineage

cellular organisms; Eukaryota; Viridiplantae; Streptophyta; Streptophytina; Embryophyta; Tracheophyta; Euphyllophyta; Spermatophyta; Magnoliophyta; Mesangiospermae; eudicotyledons; Gunneridae; Pentapetalae; rosids; malvids; Brassicales; Brassicaceae; Camelineae; Arabidopsis

Parent

Arabidopsis () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 3701)

NCBI Taxonomy ID

3702 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 3702)

is Taxon A an Infraspecies?

No

Taxon B

Latin Name

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

Common Name

thale cress

Synonyms

thale cress; mouse-ear cress; thale-cress; Arabidopsis thaliana (L.) Heynh.; Arabidopsis thaliana (thale cress); Arabidopsis_thaliana; Arbisopsis thaliana; thale kress

Rank

species

Lineage

cellular organisms; Eukaryota; Viridiplantae; Streptophyta; Streptophytina; Embryophyta; Tracheophyta; Euphyllophyta; Spermatophyta; Magnoliophyta; Mesangiospermae; eudicotyledons; Gunneridae; Pentapetalae; rosids; malvids; Brassicales; Brassicaceae; Camelineae; Arabidopsis

Parent

Arabidopsis () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 3701)

NCBI Taxonomy ID

3702 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id= 3702)

is Taxon B an Infraspecies?

Yes

Taxon B Description

Arabidopsis thaliana - Col0 cadmium (Cd)-sensitive

GENOTYPIC CHANGE

Generic Gene Name

HMA3

Synonyms

-

String

-

Sequence Similarities

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

GO - Molecular Function

GO:0005524 : ATP binding (https://www.ebi.ac.uk/QuickGO/term/GO:0005524)
GO:0046872 : metal ion binding (https://www.ebi.ac.uk/QuickGO/term/GO:0046872)
GO:0008551 : cadmium-exporting ATPase activity (https://www.ebi.ac.uk/QuickGO/term/GO:0008551)
GO:0016463 : zinc-exporting ATPase activity (https://www.ebi.ac.uk/QuickGO/term/GO:0016463)

UniProtKB Arabidopsis thaliana

P0CW78 (http://www.uniprot.org/uniprot/P0CW78)

GenebankID or UniProtKB

AY434729 (https://www.ncbi.nlm.nih.gov/nuccore/AY434729)

GO - Biological Process

GO:0071585 : detoxification of cadmium ion (https://www.ebi.ac.uk/QuickGO/term/GO:0071585)

GO - Cellular Component

GO:0016021 : integral component of membrane (https://www.ebi.ac.uk/QuickGO/term/GO:0016021)

GO:0005774 : vacuolar membrane (https://www.ebi.ac.uk/QuickGO/term/GO:0005774)

Presumptive Null

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

Molecular Type

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

Aberration Type

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

Deletion Size

1-9 bp

Molecular Details of the Mutation

1-bp deletion resulting in a premature stop codon resulting in hypofunctional transporter. This is a high-frequency allele; suggesting the hyper-functional alleles are only selected in Cd-rich soils

Experimental Evidence

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

Main Reference

Genome-wide association studies identify heavy metal ATPase3 as the primary determinant of natural variation in leaf cadmium in Arabidopsis thaliana. (2012) (https://pubmed.ncbi.nlm.nih.gov/22969436)

Authors

Chao DY; Silva A; Baxter I; Huang YS; Nordborg M; Danku J; Lahner B; Yakubova E; Salt DE

Abstract

Understanding the mechanism of cadmium (Cd) accumulation in plants is important to help reduce its potential toxicity to both plants and humans through dietary and environmental exposure. Here, we report on a study to uncover the genetic basis underlying natural variation in Cd accumulation in a world-wide collection of 349 wild collected Arabidopsis thaliana accessions. We identified a 4-fold variation (0.5-2 Âµg Cd g(-1) dry weight) in leaf Cd accumulation when these accessions were grown in a controlled common garden. By combining genome-wide association mapping, linkage mapping in an experimental F2 population, and transgenic complementation, we reveal that HMA3 is the sole major locus responsible for the variation in leaf Cd accumulation we observe in this diverse population of A. thaliana accessions. Analysis of the predicted amino acid sequence of HMA3 from 149 A. thaliana accessions reveals the existence of 10 major natural protein haplotypes. Association of these haplotypes with leaf Cd accumulation and genetics complementation experiments indicate that 5 of these haplotypes are active and 5 are inactive, and that elevated leaf Cd accumulation is associated with the reduced function of HMA3 caused by a nonsense mutation and polymorphisms that change two specific amino acids.

Additional References

RELATED GEPHE

Related Genes

5 (FPN2, FRD3 (FERRIC REDUCTASE DEFECTIVE3), heavy metal atpase5 (HMA5), Molybdenum transporter1 (MOT1), heavy metal atpase4 (HMA4)) (https://www.gephebase.org/search-criteria?/or+Taxon ID=^3702^/and+Trait=Metal tolerance/and+groupHaplotypes=true#gephebase-summary-title)

Related Haplotypes

1 (https://www.gephebase.org/search-criteria?/or+Gene Gephebase=^heavy metal atpase3 (HMA3)^/and+Taxon ID=^3702^/or+Gene Gephebase=^heavy metal atpase3 (HMA3)^/and+Taxon ID=^3702^#gephebase-summary-title)

EXTERNAL LINKS

COMMENTS

@GxE