

GEPHE SUMMARY

	Gephebase Gene	GephelD
heavy metal atpase3 (HMA3) (https://www.gephebase.org/search-criteria/?and+Gene Gephebase=^heavy metal atpase3 (HMA3)^#gephebase-summary-title)	GP00000444	
Published	Entry Status	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		Taxon B
	Latin Name	Latin Name
Arabidopsis thaliana (https://www.gephebase.org/search-criteria/?and+Taxon+and+Synonyms=^Arabidopsis+thaliana^#gephebase-summary-title)		Arabidopsis thaliana (https://www.gephebase.org/search-criteria/?and+Taxon+and+Synonyms=^Arabidopsis+thaliana^#gephebase-summary-title)
thale cress	Common Name	Common Name
thale cress; mouse-ear cress; thale-cress; Arabidopsis thaliana (L.) Heynh.; Arabidopsis thaliana (thale cress); Arabidopsis_thaliana; Arbisopsis thaliana; thale kress	Synonyms	thale cress; mouse-ear cress; thale-cress; Arabidopsis thaliana (L.) Heynh.; Arabidopsis thaliana (thale cress); Arabidopsis_thaliana; Arbisopsis thaliana; thale kress
species	Rank	Rank
	Lineage	Lineage
cellular organisms; Eukaryota; Viriplantae; Streptophyta; Streptophytina; Embryophyta; Tracheophyta; Euphyllophyta; Spermatophyta; Magnoliophyta; Mesangiospermae; eudicotyledons; Gunneridae; Pentapetalae; rosids; malvids; Brassicales; Brassicaceae; Camelinae; Arabidopsis		cellular organisms; Eukaryota; Viriplantae; Streptophyta; Streptophytina; Embryophyta; Tracheophyta; Euphyllophyta; Spermatophyta; Magnoliophyta; Mesangiospermae; eudicotyledons; Gunneridae; Pentapetalae; rosids; malvids; Brassicales; Brassicaceae; Camelinae; Arabidopsis
	Parent	Parent
Arabidopsis () - (Rank: genus) (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=3701)	NCBI Taxonomy ID	NCBI Taxonomy ID
3702 (https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=3702)		
No	is Taxon A an Infraspecies?	is Taxon B an Infraspecies?
	Yes	Taxon B Description
		Arabidopsis thaliana - Col0 cadmium (Cd)-sensitive

GENOTYPIC CHANGE

	Generic Gene Name	UniProtKB Arabidopsis thaliana
HMA3	PoCW78 (http://www.uniprot.org/uniprot/PoCW78)	
-	Synonyms	GenebankID or UniProtKB
-	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)		

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 Åµg 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](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