

GEPHE SUMMARY

Gephebase Gene		GepheID
heavy metal atpase3 (HMA3) (https://www.gephebase.org/search-criteria?/and+Gene)		GP00000443
Gephebase="heavy metal atpase3 (HMA3)"#gephebase-summary-title)		Main curator
Published	Entry Status	Martin

PHENOTYPIC CHANGE

Trait Category		Trait	
Physiology (https://www.gephebase.org/search-criteria?/and+Trait)		Metal tolerance (https://www.gephebase.org/search-criteria?/and+Trait)	
Category="Physiology"#gephebase-summary-title)		tolerance"#gephebase-summary-title)	
Trait State in Taxon A		Trait State in Taxon B	
Arabidopsis thaliana _ cadmium (Cd) tolerant		Arabidopsis thaliana _ cadmium (Cd)-sensitive	
Ancestral State		Taxonomic Status	
Data not curated		Intraspecific (https://www.gephebase.org/search-criteria?/and+Taxonomic)	
Status="Intraspecific"#gephebase-summary-title)			
Taxon A		Taxon B	
Arabidopsis thaliana		Arabidopsis thaliana	
(https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms="Arabidopsis thaliana"#gephebase-summary-title)		(https://www.gephebase.org/search-criteria?/and+Taxon and Synonyms="Arabidopsis thaliana"#gephebase-summary-title)	
Common Name		Common Name	
thale cress		thale cress	
Synonyms		Synonyms	
thale cress; mouse-ear cress; thale-cress; Arabidopsis thaliana (L.) Heynh.; Arabidopsis thaliana (thale cress); Arabidopsis_thaliana; Arbisopsis thaliana; thale kress		thale cress; mouse-ear cress; thale-cress; Arabidopsis thaliana (L.) Heynh.; Arabidopsis thaliana (thale cress); Arabidopsis_thaliana; Arbisopsis thaliana; thale kress	
Rank		Rank	
species		species	
Lineage		Lineage	
cellular organisms; Eukaryota; Viridiplantae; Streptophyta; Streptophytina; Embryophyta; Tracheophyta; Euphyllophyta; Spermatophyta; Magnoliophyta; Mesangiospermae; eudicotyledons; Gunneridae; Pentapetales; rosids; malvids; Brassicales; Brassicaceae; Camelineae; Arabidopsis		cellular organisms; Eukaryota; Viridiplantae; Streptophyta; Streptophytina; Embryophyta; Tracheophyta; Euphyllophyta; Spermatophyta; Magnoliophyta; Mesangiospermae; eudicotyledons; Gunneridae; Pentapetales; rosids; malvids; Brassicales; Brassicaceae; Camelineae; Arabidopsis	
Parent		Parent	
Arabidopsis () - (Rank: genus)		Arabidopsis () - (Rank: genus)	
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=3701)		(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=3701)	
NCBI Taxonomy ID		NCBI Taxonomy ID	
3702		3702	
(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=3702)		(https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=3702)	
is Taxon A an Intraspecies?		is Taxon B an Intraspecies?	
No		No	

GENOTYPIC CHANGE

Generic Gene Name		UniProtKB Arabidopsis thaliana	
HMA3		P0CW78 (http://www.uniprot.org/uniprot/P0CW78)	
Synonyms		GenebankID or UniProtKB	
-		AY434729 (https://www.ncbi.nlm.nih.gov/nucleotide/AY434729)	
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>)

Mutation #1

Presumptive Null

No (<https://www.gephebase.org/search-criteria?/and+Presumptive Null=^No^#gephebase-summary-title>)

Molecular Type

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

Aberration Type

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

SNP Coding Change

Nonsynonymous

Molecular Details of the Mutation

Gln564Met and Tyr480Asp - both seem to affect the protein function - several haplotypes at high-frequency resulting in hypofunctional proteins; associated with hyper-accumulation of cadmium

Experimental Evidence

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

	Taxon A	Taxon B	Position
Codon	-	-	-
Amino-acid	Gln	Met	564

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

Mutation #2

Presumptive Null

No (<https://www.gephebase.org/search-criteria?/and+Presumptive Null=^No^#gephebase-summary-title>)

Molecular Type

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

Aberration Type

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

SNP Coding Change

Nonsynonymous

Molecular Details of the Mutation

Gln564Met and Tyr480Asp - both seem to affect the protein function - several haplotypes at high-frequency resulting in hypofunctional proteins; associated with hyper-accumulation of cadmium

Experimental Evidence

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

	Taxon A	Taxon B	Position
Codon	-	-	-
Amino-acid	Tyr	Asp	480

Main Reference

Genome-wide association studies identify heavy metal ATPase3 as the primary determinant of natural variation in leaf cadmium in Arabidopsis thaliana. (2012)
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Authors

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Additional References

RELATED GEPHE

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 Genes

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))

Related Haplotypes

EXTERNAL LINKS

COMMENTS

@GxE @SeveralMutationsWithEffect