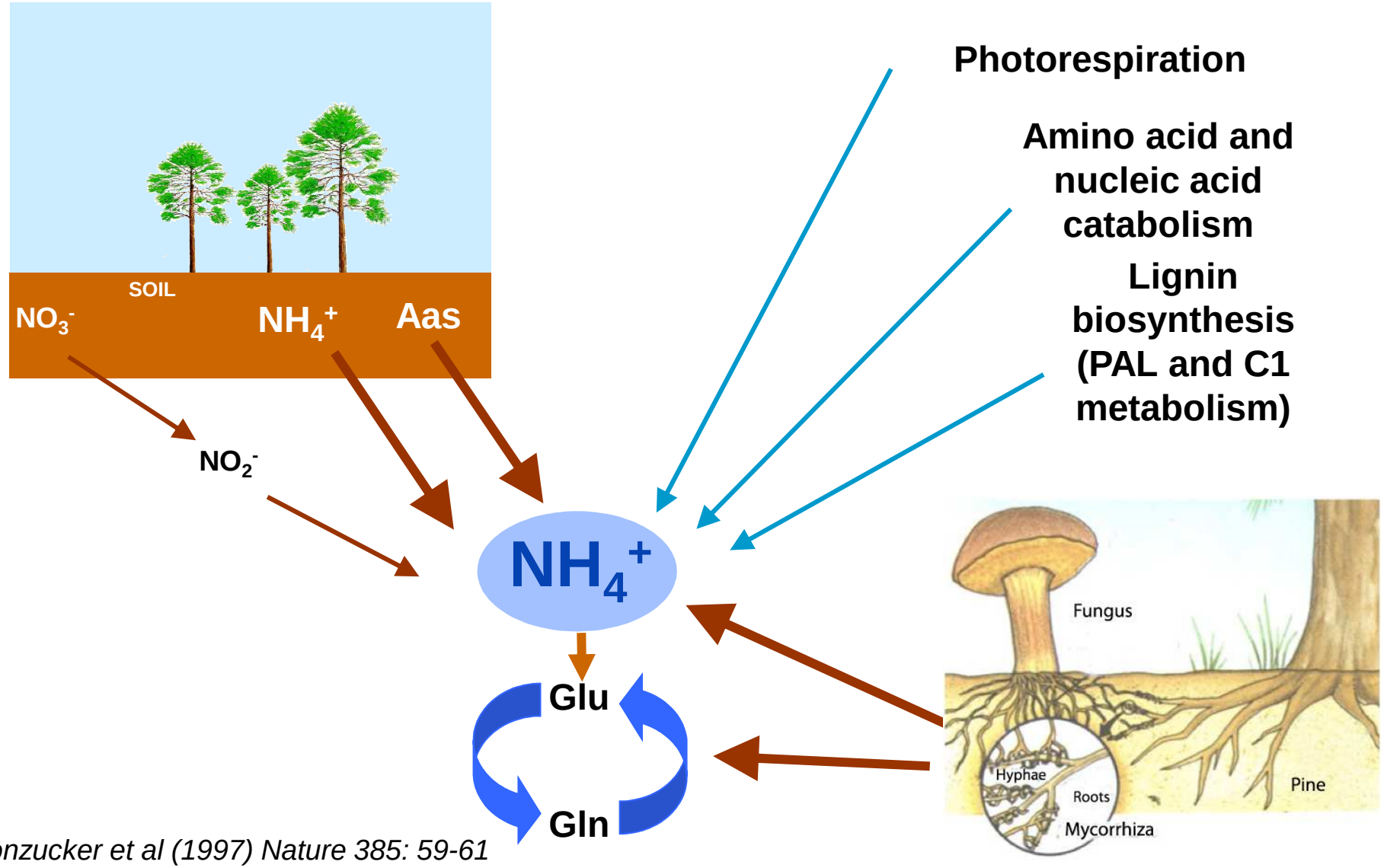
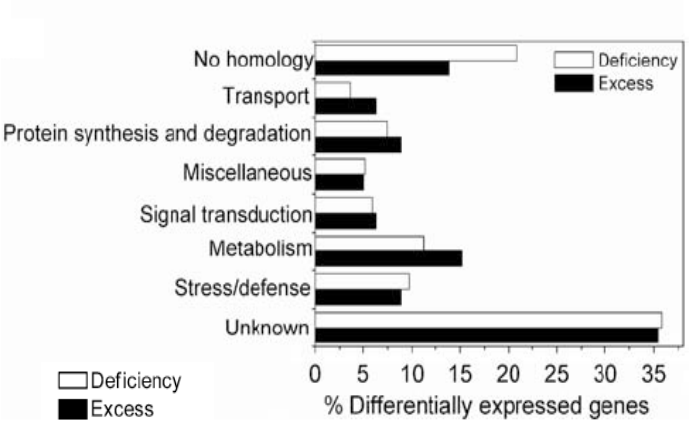
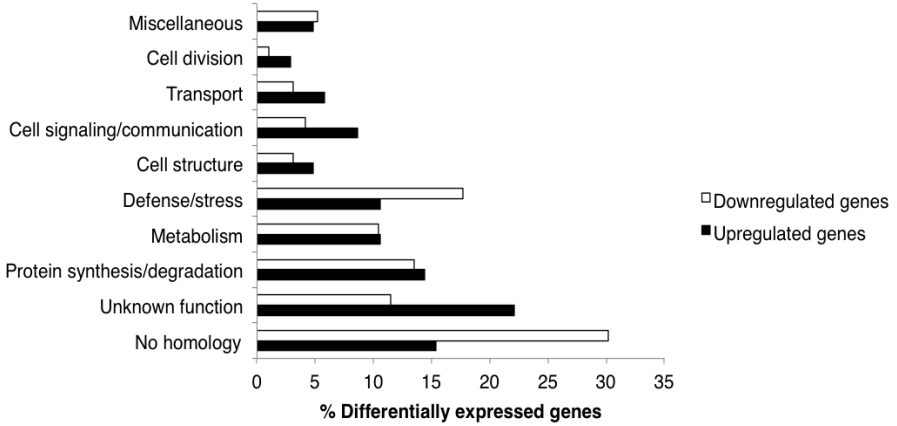
# Conifers have a preference for ammonium over nitrate as a nitrogen source

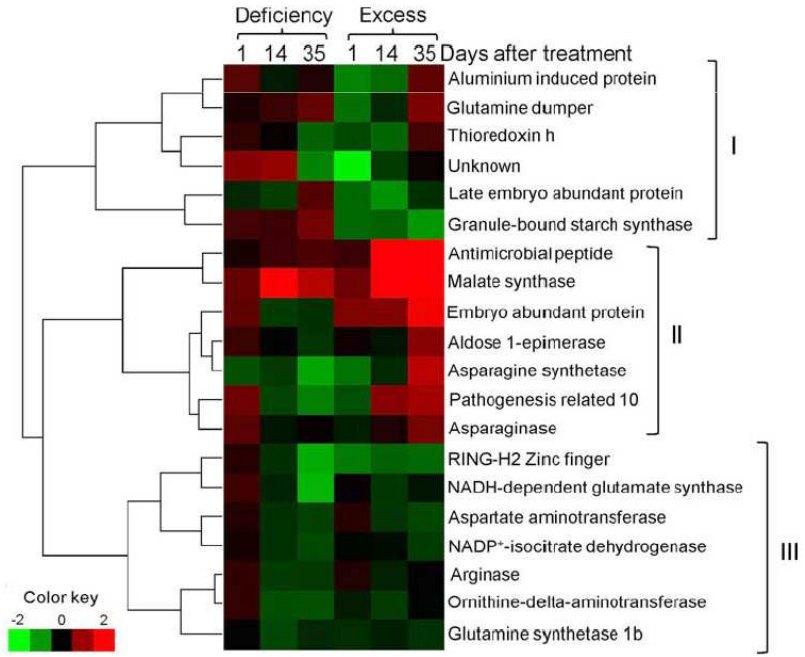


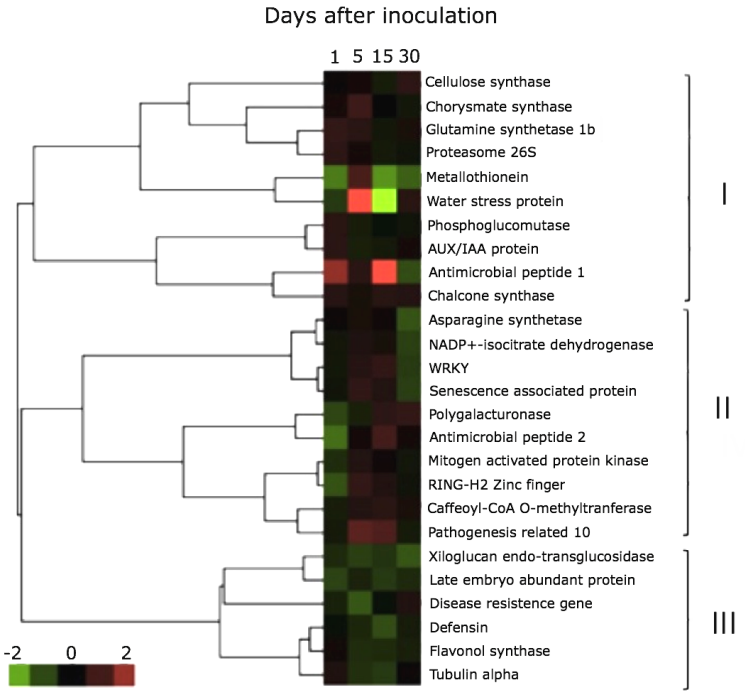

*Kronzucker et al (1997) Nature 385: 59-61*
*Cantón et al (2005) Photosynth Res 83: 265-278*

# Genes responding to ammonium nutrition and mycorrhization




*Canales et al (2010) Amino Acids 39, 991-1001*
*Flores-Monterroso et al (2013) Planta 237, 1637-1650)*

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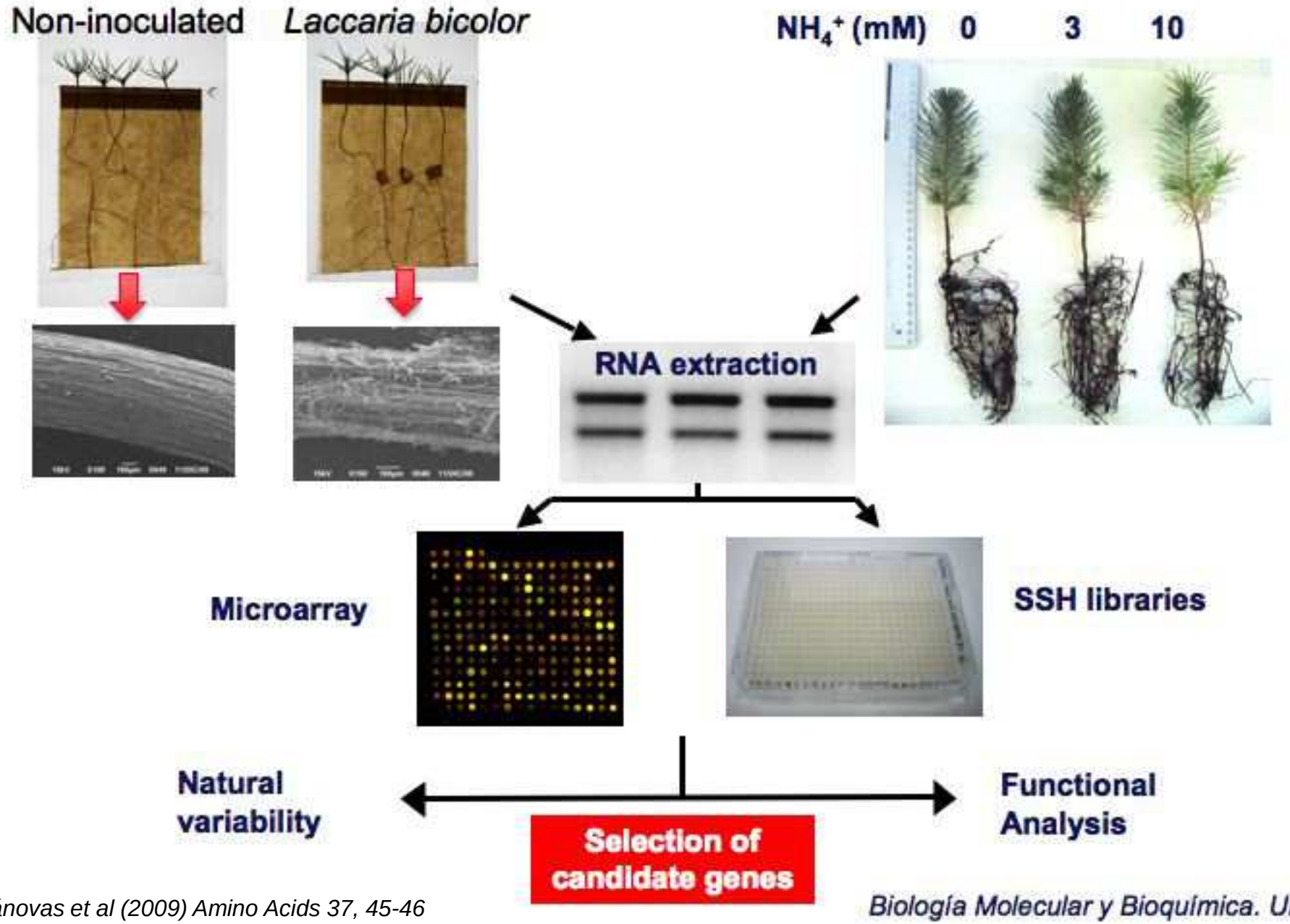
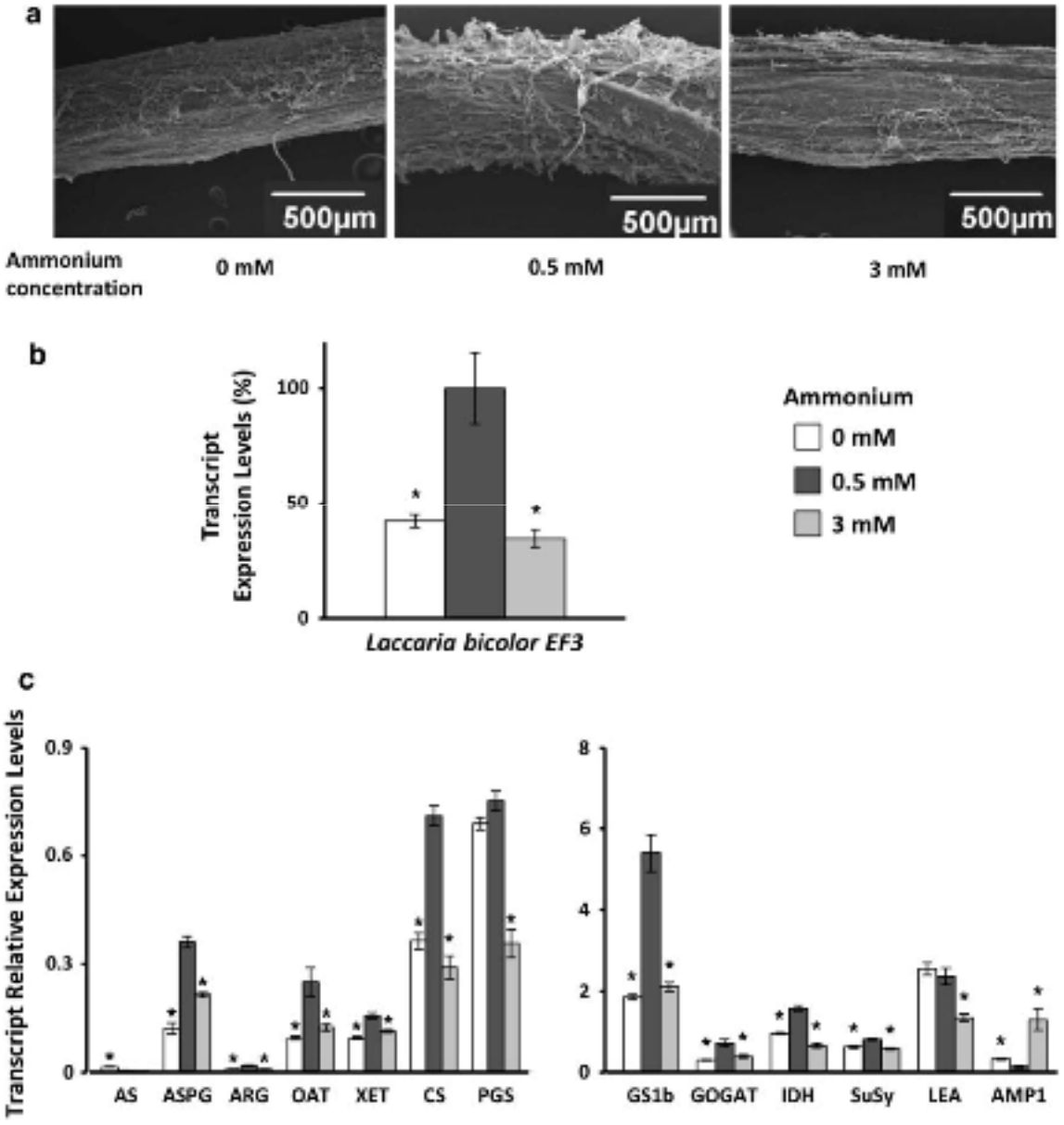
# Identification of genes regulated by ammonium nutrition




*Cánovas et al (2009) Amino Acids 37, 45-46*

*Biología Molecular y Bioquímica. UMA*

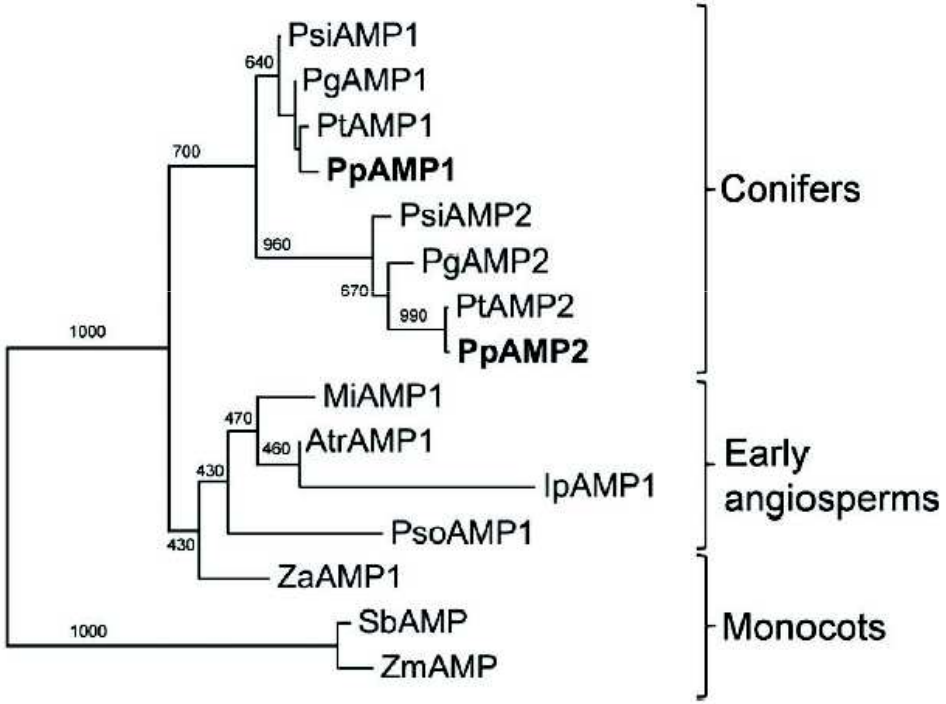
# Mycorrhization is regulated by ammonium nutrition

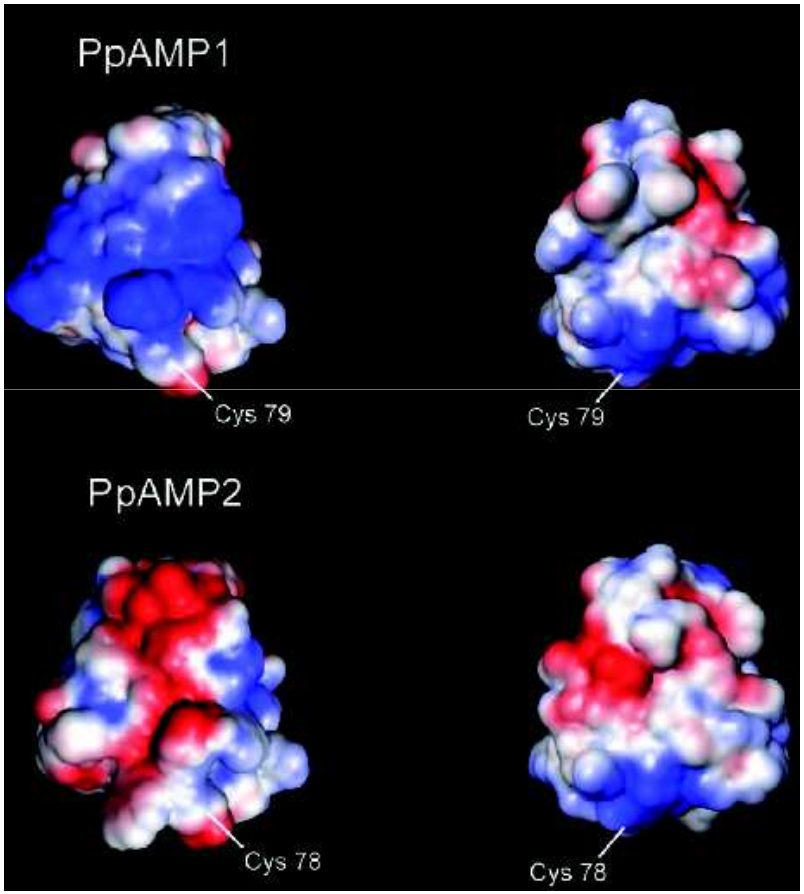



*Flores-Monterroso et al (2013) Planta 237, 1637-1650)*

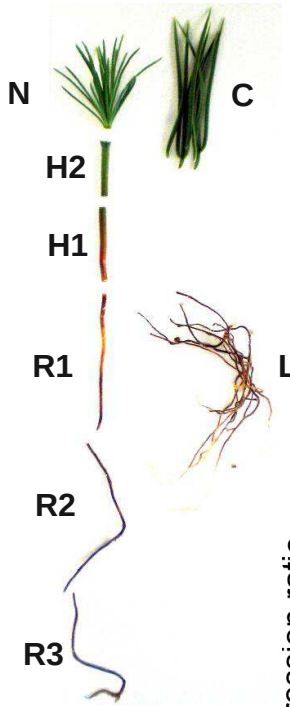
*Dpto. Biología Molecular y Bioquímica. UMA*

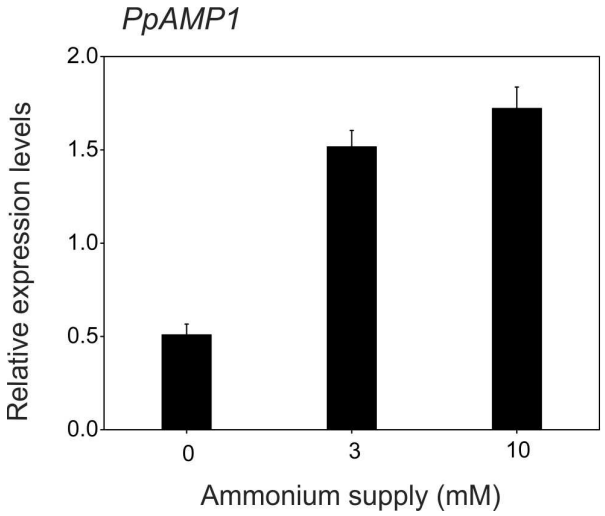
# The members of the β-barrelin family are primitive antimicrobial peptides

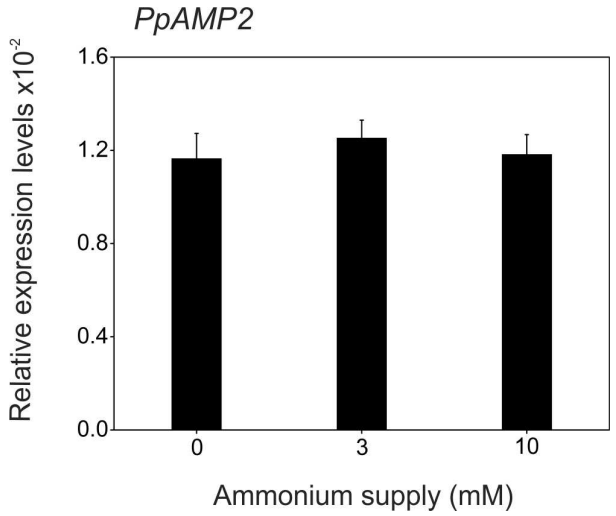


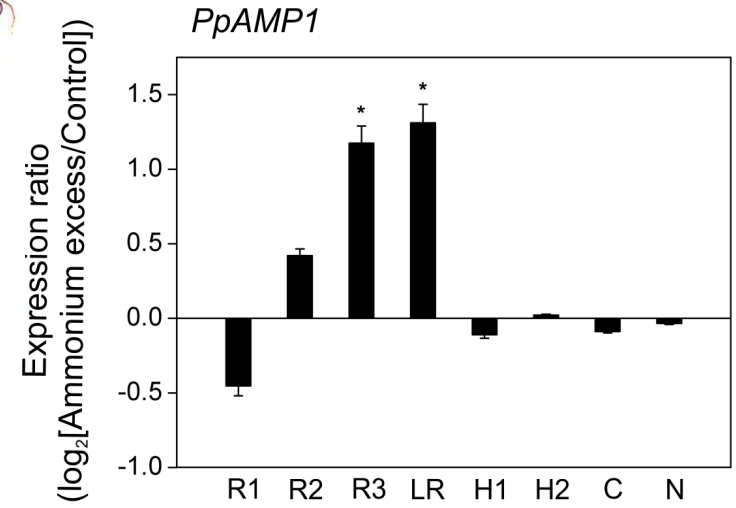



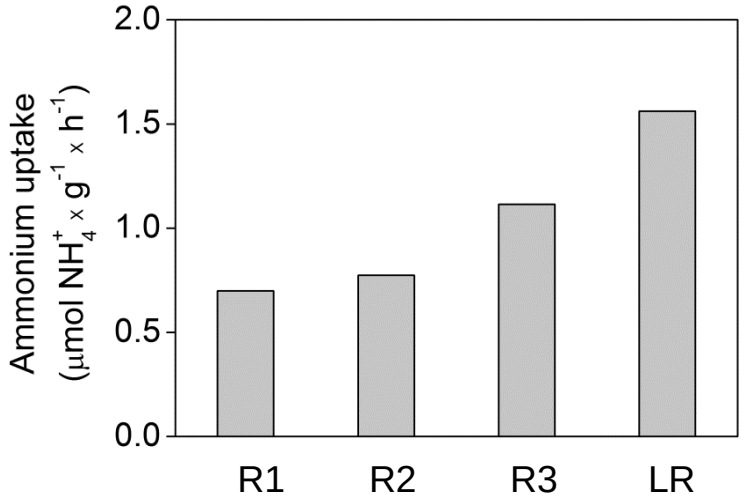
# *PpAMP1* expression is enhanced by ammonium supply in maritime pine roots




*Canales et al (2011) Plant Cell Environ 34, 1443-1453*

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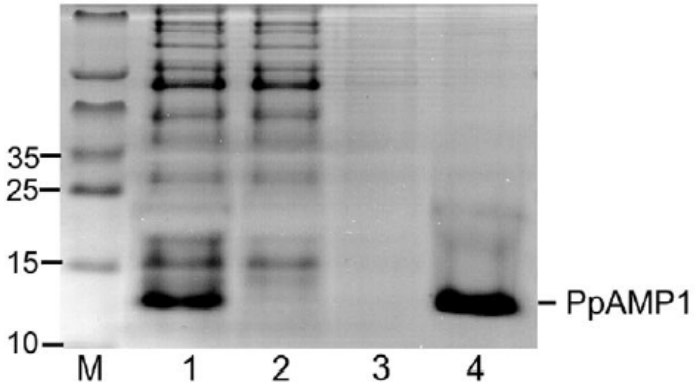
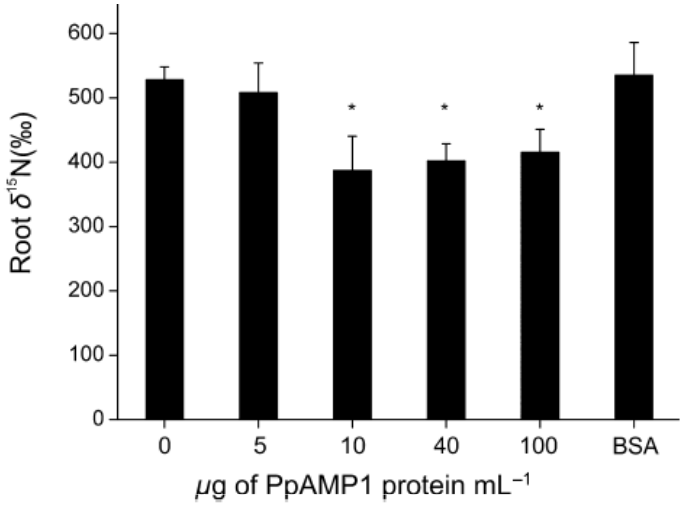
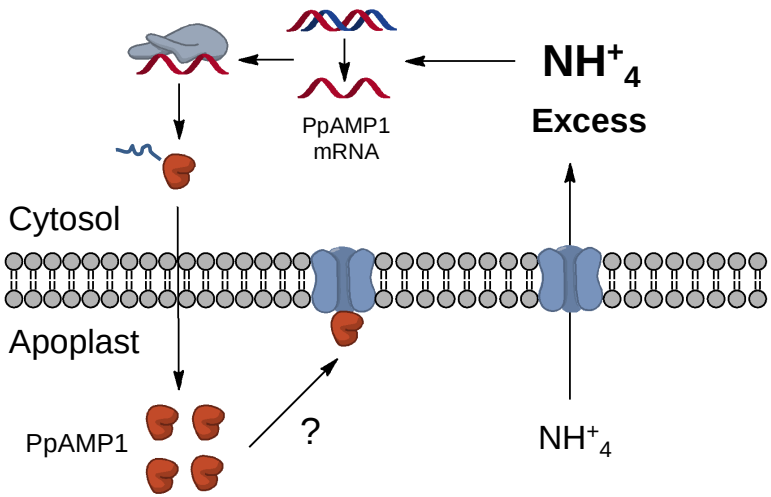
# AMP1 and ammonium uptake in maritime pine roots




**Production of recombinant PpAMP1**




**PpAMP1 inhibits $^{15}N$ labelled ammonium uptake**




*Canales et al (2011) Plant Cell Environ 34, 1443-1453*

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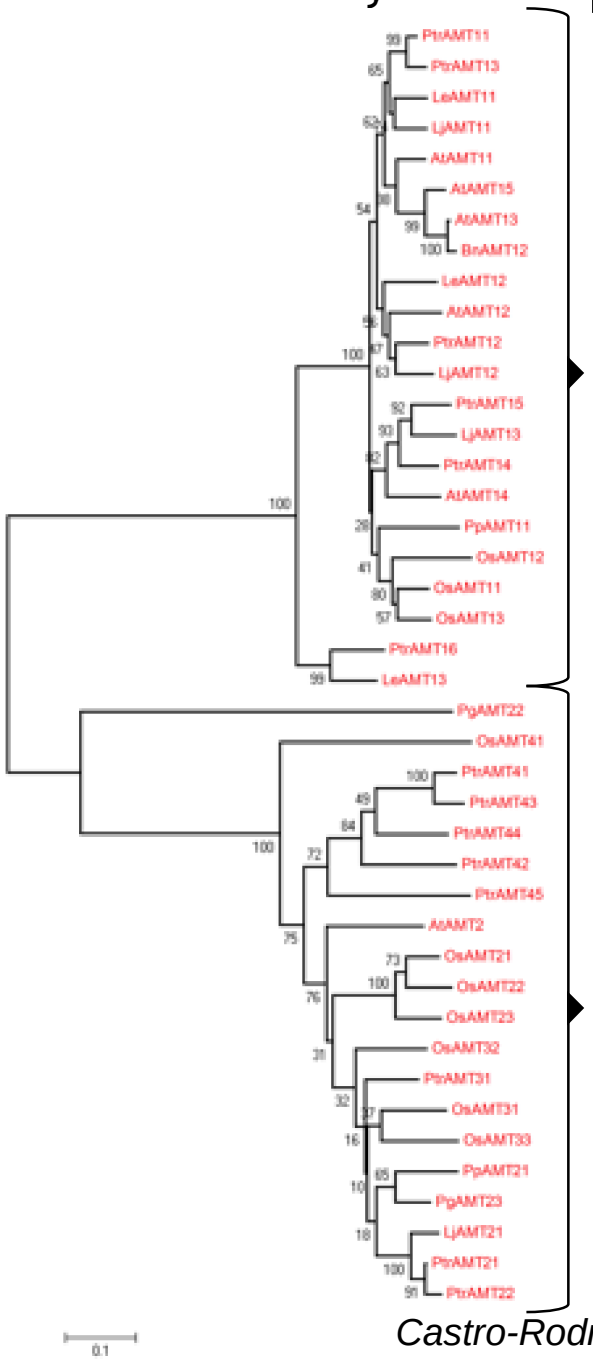
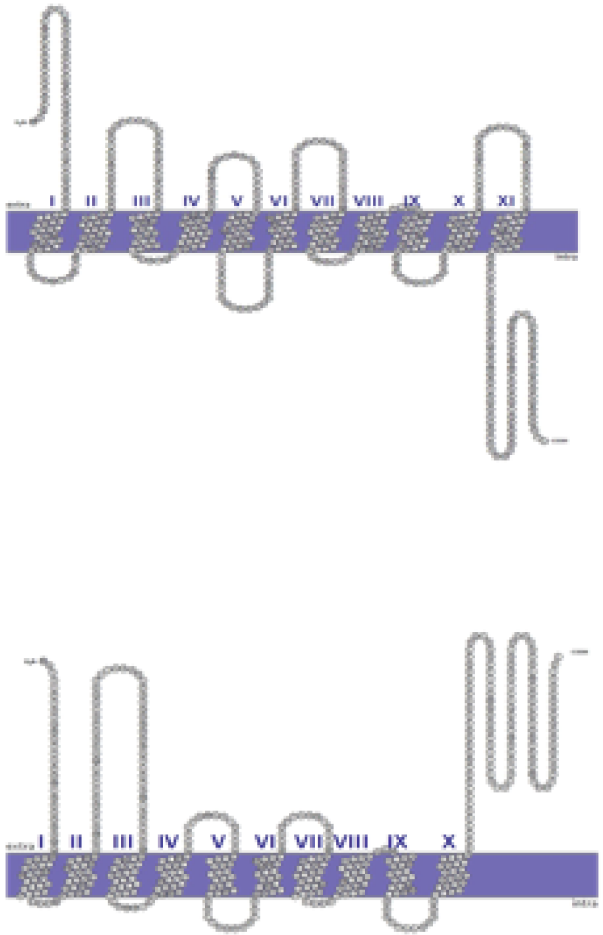
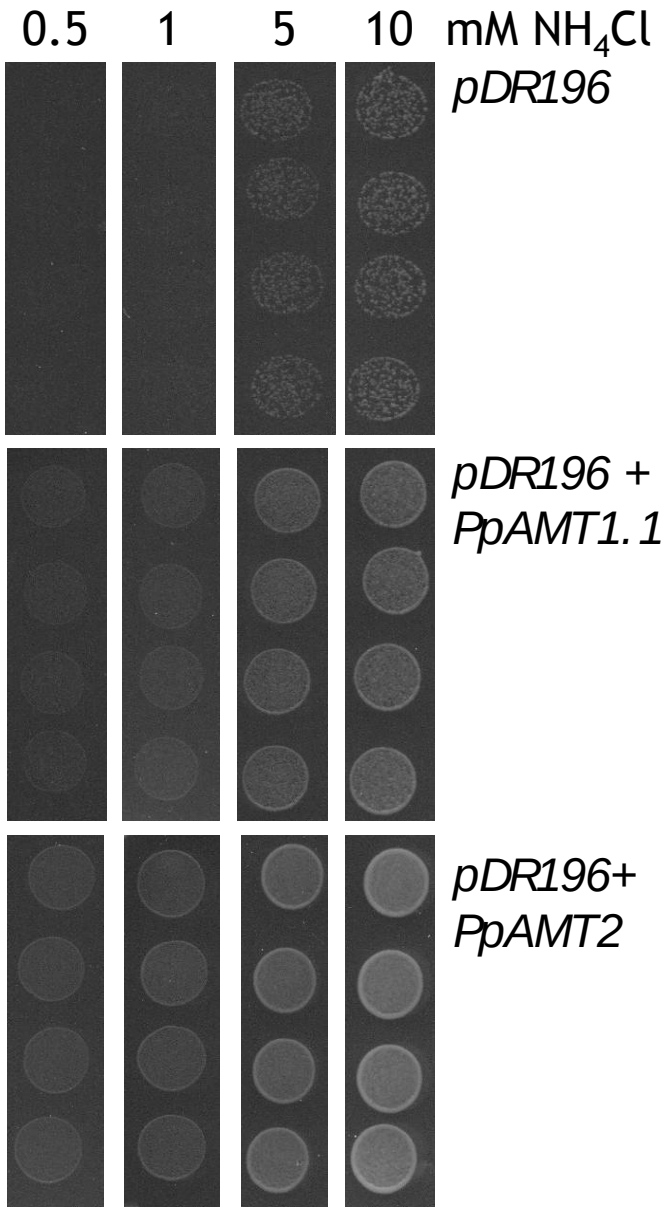
AMT1.1 Subfamily

# Functional identification of ammonium transporters




*Castro-Rodríguez et al (2014) unpublished*

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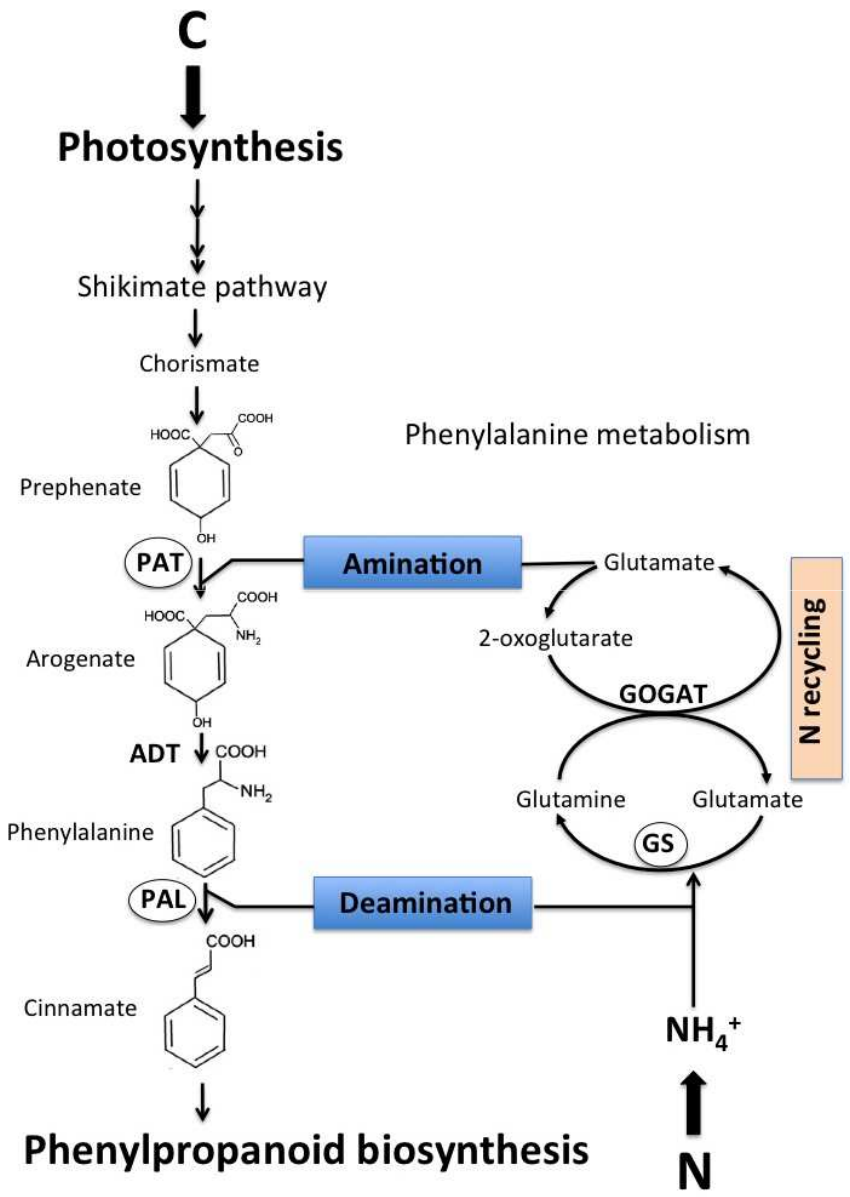
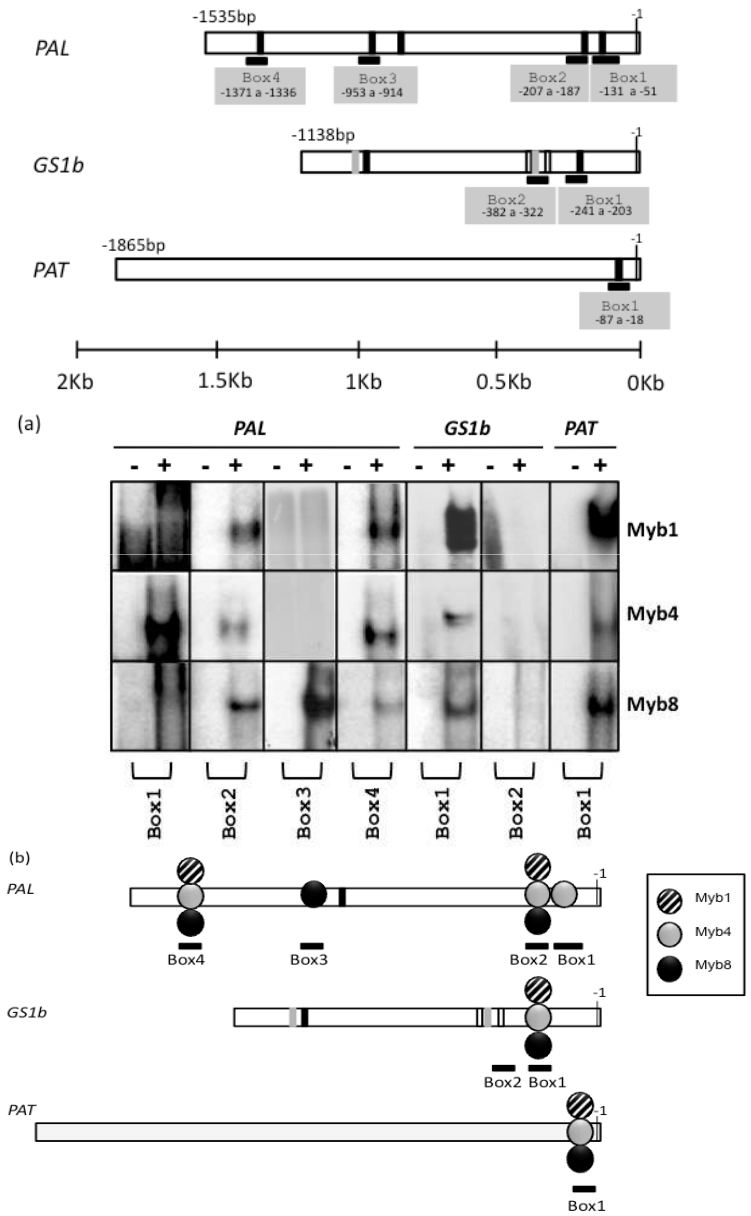
# Transcriptional regulation of phenylalanine biosynthesis

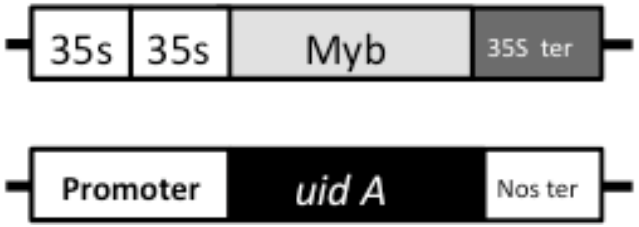


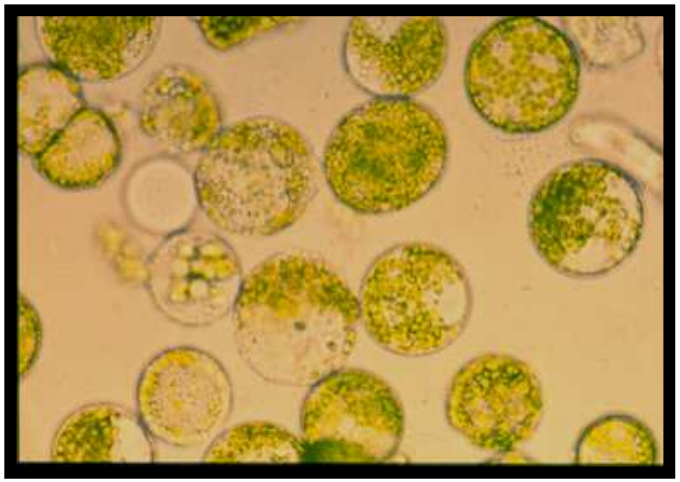

*de la Torre et al (2009) Plant Physiol 1491648-1660*
*Craven-Bartle et al (2013) Plant Journal 74, 755-766*

# Identification of a MYB 8 regulatory element in the promoters of *PAL*, *GS1b* and *PAT*

(a)




Electroporation
of maritime pine protoplasts

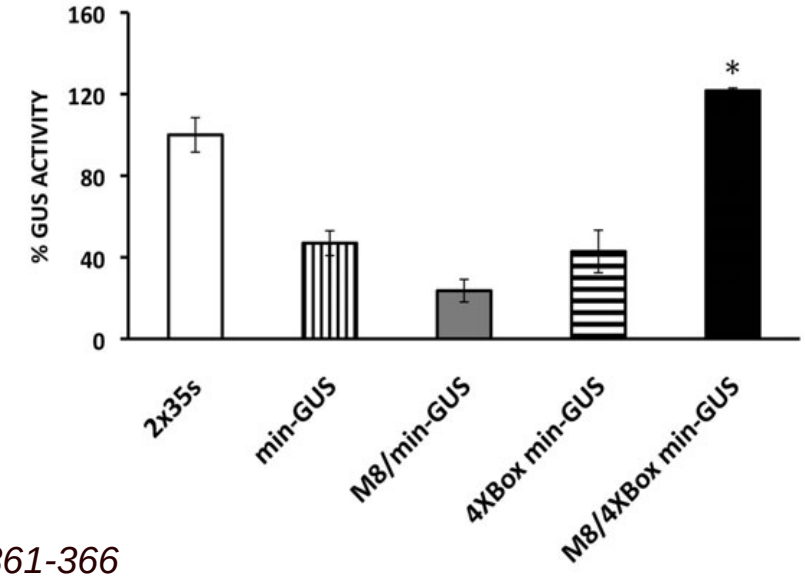


(a)

| | | | |
|---|---|---|---|
| *PAL*-Box2 | GG | CCAACCAA | CC |
| *PAL*-Box3 | AC | CCAACCAC | AT |
| *PAL*-Box4 | TG | CCAACCAC | CG |
| *PAT*-Box1 | CA | CCAACCAC | TC |
| *GS1b*-Box1 | GT | CCAACCAC | CC |

**Consensus sequence: CCAACCAC/A**

(b)




*Gómez-Maldonado et al (2001) Plant Mol Biol Rep 19,361-366*
*Craven-Bartle et al (2013) Plant Journal 74, 755-766*

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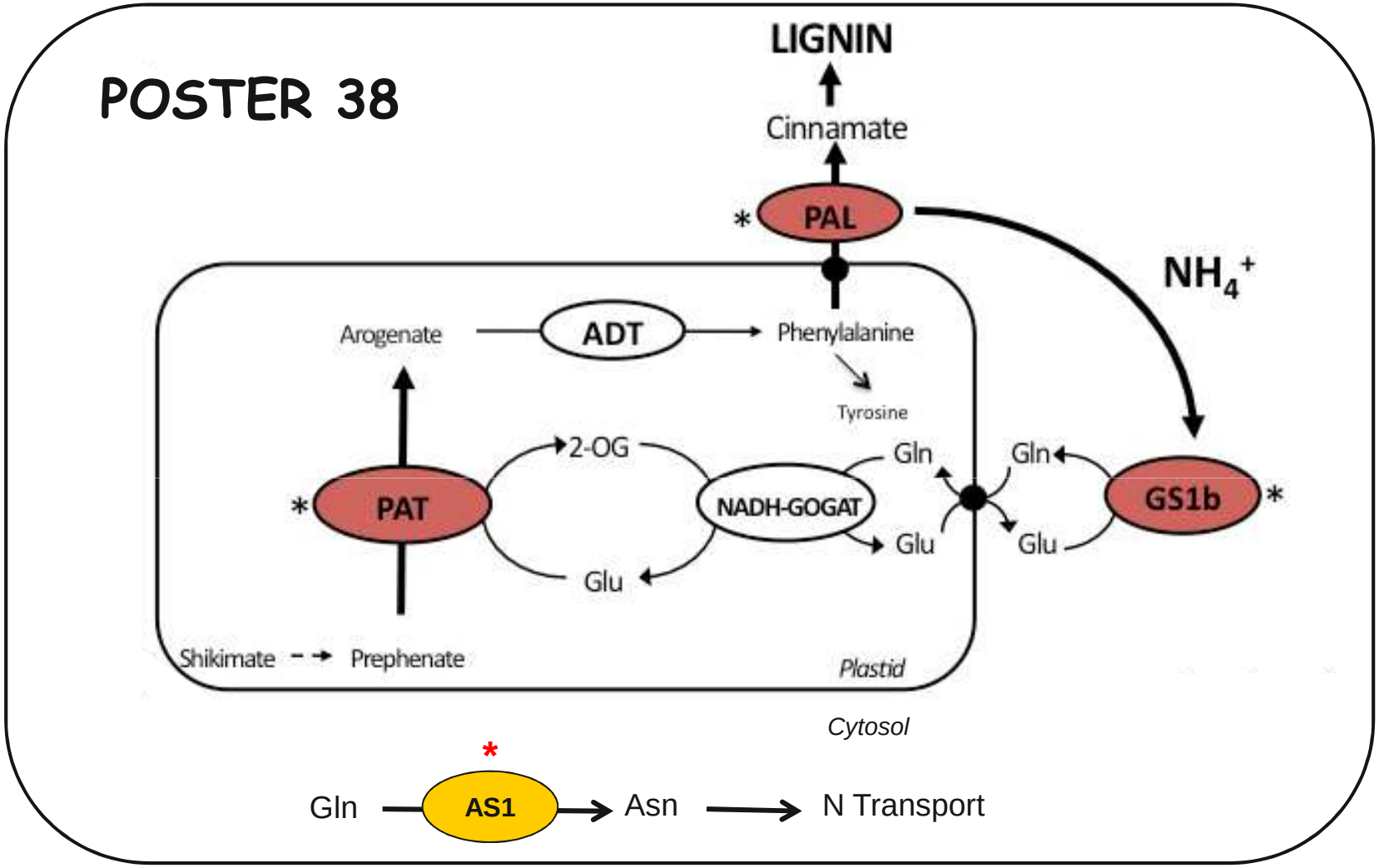
# Myb factors regulate phenylalanine biosynthesis in maritime pine




*** Myb8 activation** *** Myb1 inhibition**

*Canales et al (2012) Front Plant Sci* 3, 100
*Craven-Bartle et al (2013) Plant Journal 74, 755-766*

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# Concluding remarks

**New developments in structural and functional genomics of pine**

**Functional and regulatory analysis of key genes/pathways**

**New knowledge for the production of biotech trees with increased N use efficiencies and enhanced biomass**

Nitrogen 2013

# Acknowledgements


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THEME [KBBE.2011.1.1-01 KBBE.2011.1.1-01 KBBE]
[Promoting conifer genomic resources
Promoting conifer genomic resources Food,
Agriculture and Fisheries, and Biotechnology]


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**Universidad de Málaga**