



HAL
open science

Functional PTB phosphate transporters are present in streptophyte algae and early diverging land plant

C. Bonnot, H el ene Proust, Beno t Pinson, Florine P L Colbalchini, Alexis Lesly-Veillard, Giulia Morieri, Holger Breuninger, Cl ement Champion, Alexander Hetherington, Steven Kelly, et al.

► To cite this version:

C. Bonnot, H el ene Proust, Beno t Pinson, Florine P L Colbalchini, Alexis Lesly-Veillard, et al.. Functional PTB phosphate transporters are present in streptophyte algae and early diverging land plant. EMBO Workshop on New model systems for early land plant evolution, Jun 2016, Vienne, Austria. . hal-04187819

HAL Id: hal-04187819

<https://hal.science/hal-04187819>

Submitted on 25 Aug 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destin ee au d ep ot et  a la diffusion de documents scientifiques de niveau recherche, publi es ou non,  emanant des  tablissements d'enseignement et de recherche fran ais ou  trangers, des laboratoires publics ou priv es.

Functional PTB phosphate transporters are present in streptophyte algae and early diverging land plants



Clémence Bonnot¹, Hélène Proust^{1,+}, Benoît Pinson^{2,3}, Florine Colbalchini¹, Alexis Lesly-Veillard¹, Giulia Morieri¹, Holger Breuning¹, Clément Champion¹, Alexander J. Hetherington¹, Steven Kelly¹ and Liam Dolan¹

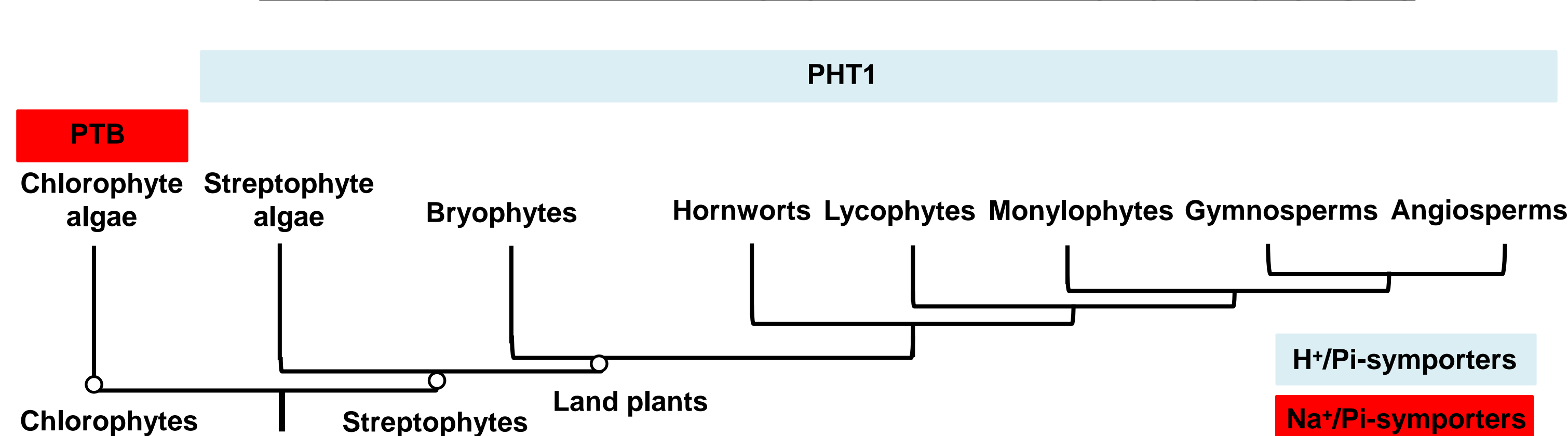
¹ Department of Plant Sciences, Oxford University, South Parks Road, OX13RB Oxford, United Kingdom, ² CNRS, UMR 5095, IBGC, Bordeaux F-33077 Cedex, France, ³ Université de Bordeaux, Bordeaux F-33000, France., + Université Paris Denis Diderot (Paris VII)

Introduction

- Angiosperms, the most diverged group of land plants, use plasma membrane H⁺/Pi-symporters called PHT1 to absorb Pi from the environment.
- In chlorophytes, the PTB proteins are hypothesised to be plasma membrane Na⁺/Pi-symporters responsible for Pi-uptake.
- PHT1 sequences are present in early diverging land plant and streptophyte algae but Na⁺-uptake is required for Pi-uptake in streptophyte algae implying that both H⁺/Pi- and Na⁺/Pi-symporters are active in streptophytes.

To understand the evolution of Pi-uptake during land adaptation we set out to determine if PTB proteins were present and functional in streptophyte lineages.

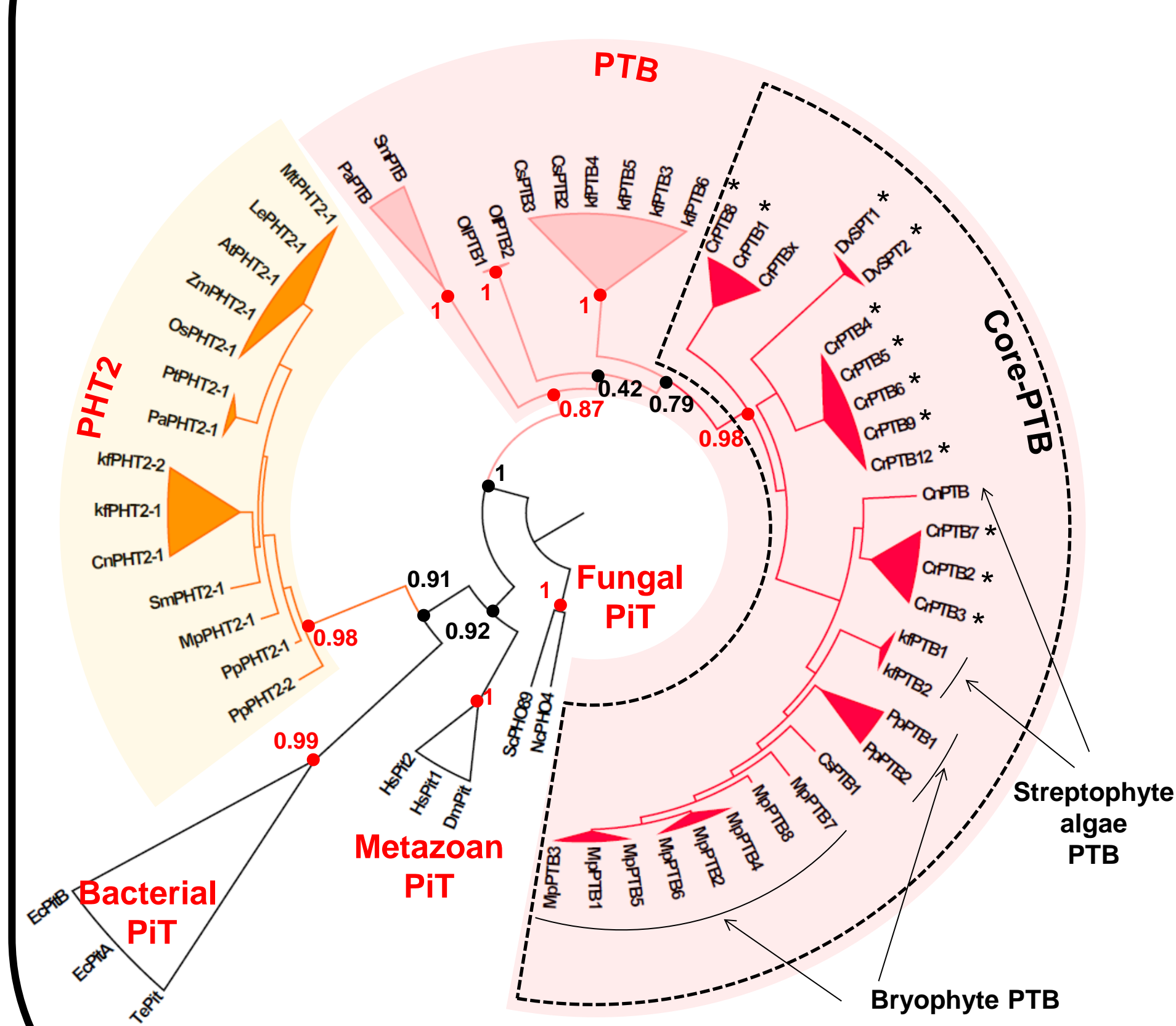
Pi-uptake mechanisms and Pi-symporters in the streptophyte phylogeny



After Wickett *et al.*, 2014, *PNAS*; Moseley *et al.*, 2006, *Euka cell*; Li *et al.*, 2006, *BBRC*; Nussaume *et al.*, 2011, *Front plant Sci*; Delaux *et al.*, 2015, *PNAS*

I. PTB proteins are present in streptophytes

Maximum-likelihood phylogeny of the PTB proteins across the green plants



- Core-PTB clade = PTB proteins from streptophyte algae (*Kelbsormidium flaccidum* (Kf) and *Coleochaete nitellarum* (Cn)) and bryophytes (*Marchantia polymorpha* (Mp) and *Physcomitrella patens* (Pp)) and published chlorophytes PTB proteins (*) (*Dunaliella viridis* (Dv) and *Chlamydomonas reinhardtii* (Cr)).

PTB and PTB-related protein amino acid conserved motifs

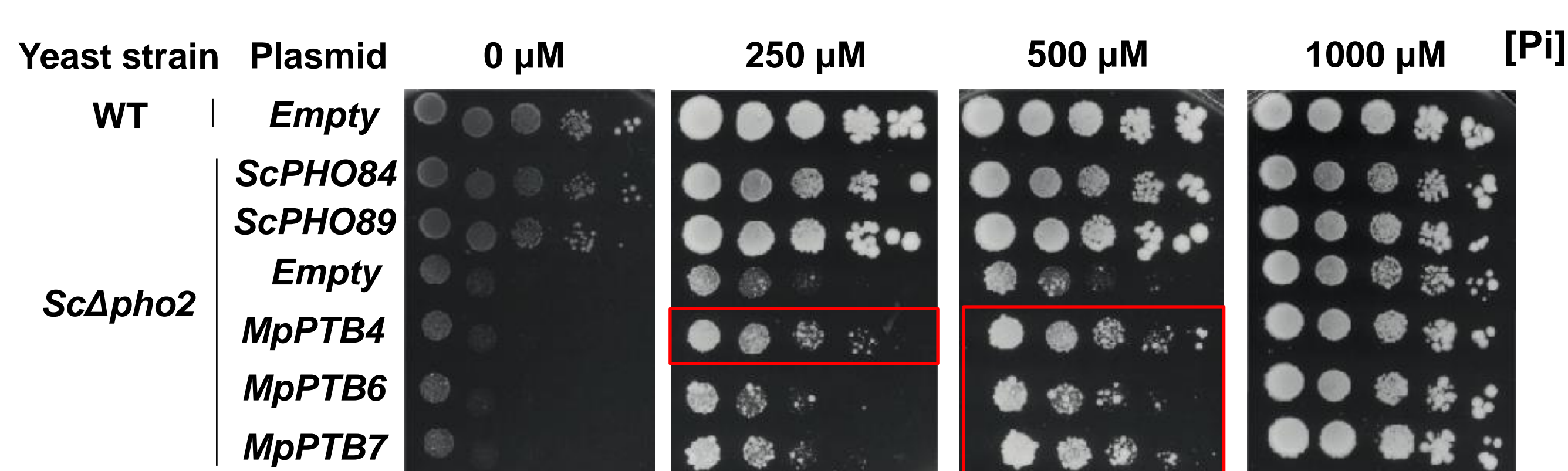
Motifs	AA	Sequence	PHT2	Bacterial PIT	Metazoan PIT	Fungal PIT	Chlorophyte Core-PTB	Streptophyte Core-PTB
Motif 1	14	GaNDVANafgTsvG	ok	ok	ok	ok	ok	ok
Motif 2	15	lpsStTHxixGaxxG	ok	ok	ok	ok	ok	ok
Motif 3	6	SWfxSP	ok	ok	ok	ok	ok	ok
Motif 4	14	FaHGaNVDVxnaXGP	ok	ok	ok	ok	ok	ok
Motif 5	34	TPxRgFxaElaxaxxxxxASxxGLPxStTxxxxG	ok	ok	ok	ok	ok	ok
Motif 6	12	HaxAEVfDpXtE	-	-	-	ok	ok	ok
Motif 7	8	FpyxxGxV	-	-	-	-	ok	ok
Motif 8	12	kaAWVxaxxaaG	-	-	-	-	ok	ok
Motif 9*	8	KxaaxxGx	-	-	-	-	ok	ok
Motif 10	12	AAXfAXGayaPS	-	-	-	-	ok	ok
Motif 11	7	kdxkYe	-	-	-	-	ok	ok
Motif 12	5	lNxxl	-	-	-	-	ok	ok
Motif 13*	8	nxSxxTxG	-	-	-	-	ok	ok

- Core-PTB are extremely conserved between streptophytes and chlorophytes.

There is little sequence diversification of the core-PTB proteins since the divergence of chlorophytes and streptophytes

II. *M. polymorpha* PTB genes expression rescues a yeast mutant defective in Pi-uptake

Growth phenotype of the yeast mutant *Scpho2* expressing *M. polymorpha* (*Mp*)PTB



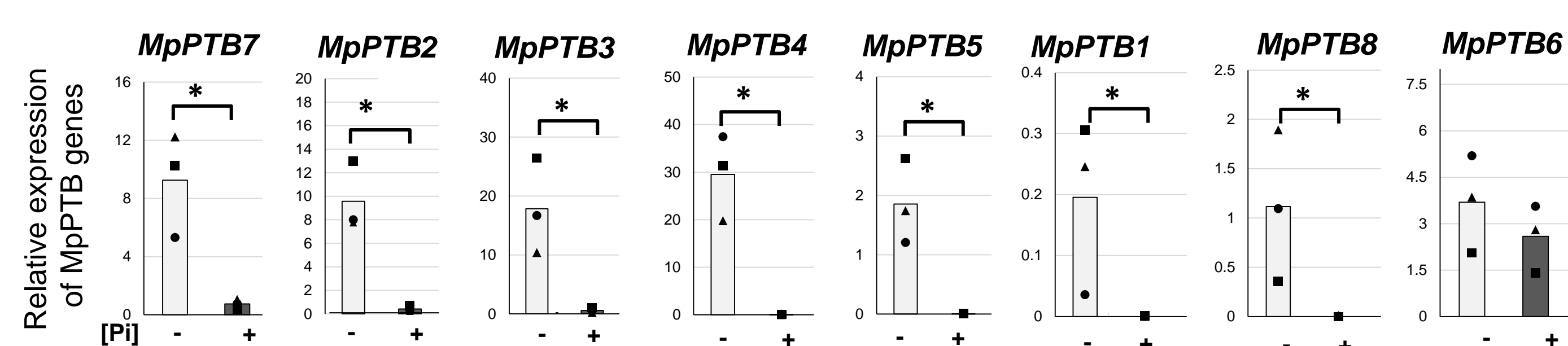
- The transcription factor *ScPHO2* is required for the expression of the *S. cerevisiae* high-affinity Pi-transporters (*ScPHO84* and *ScPHO89*) (Pinson *et al.*, 2004, *J Bio Chem*).

- MpPTB4*, *MpPTB6* and *MpPTB7* expression rescue *Scpho2* mutant growth in low-Pi.

This suggests that core-PTB proteins are Pi-transporters

III. *M. polymorpha* PTB genes expression is induced in low-Pi environments

Effect of the Pi-concentration of the environment on *MpPTB* genes expression



The star indicates that the transcript levels measured are significantly different (P < 0.05, Kruskal-Wallis test).

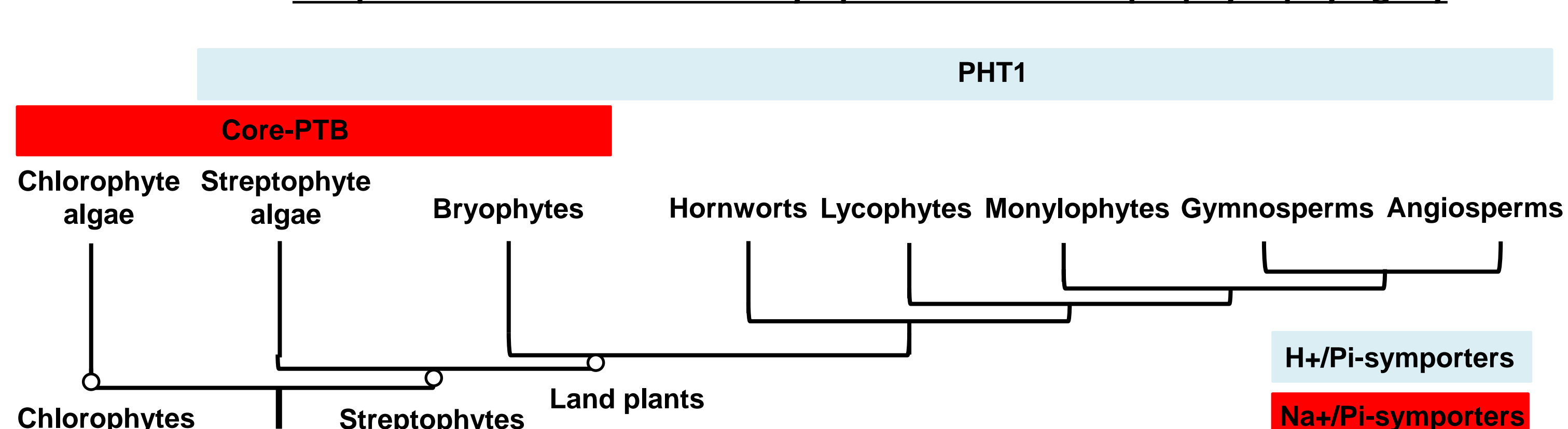
- The expression of *CnPTB* and of 7 *MpPTB* genes is higher in low-Pi than replete-Pi.

This suggests that core-PTB proteins are involved in Pi-uptake

Conclusion

- PTB Pi-transporters are present in streptophytes.
- Two Pi-uptake systems co-exist in streptophyte algae and bryophytes

Pi-uptake mechanisms and Pi-symporters in the streptophyte phylogeny



After Wickett *et al.*, 2014, *PNAS*; Moseley *et al.*, 2006, *Euka cell*; Li *et al.*, 2006, *BBRC*; Nussaume *et al.*, 2011, *Front plant Sci*; Delaux *et al.*, 2015, *PNAS*