



Differential response to Cadmium exposure by expression of a two and a three-domain metallothionein isoform in the land snail *Pomatias elegans*: Valuating the marine heritage of a land snail

Lara Schmielau^{a,1}, Martin Dvorak^{a,1}, Michael Niederwanger^a, Nicole Dobieszewski^a, Veronika Pedrini-Martha^a, Peter Ladurner^a, Jaime Rodríguez-Guerra Pedregal^b, Jean-Didier Maréchal^b, Reinhard Dallinger^{a,*}

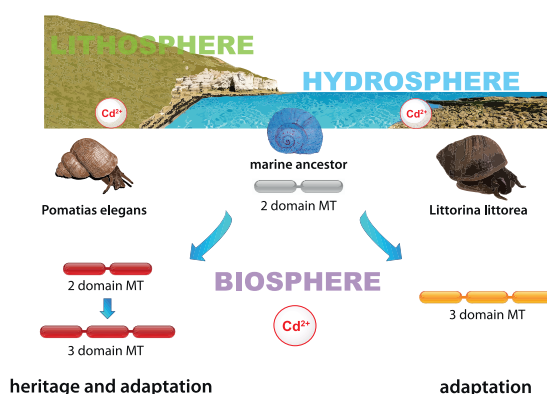
^a Department of Zoology and Center of Molecular Biosciences Innsbruck, University of Innsbruck, Technikerstraße 25, 6020 Innsbruck, Austria

^b Insilichem, Departament de Química, Universitat Autònoma de Barcelona, 08193 Bellaterra, Barcelona, Spain

HIGHLIGHTS

- *Pomatias elegans* is a land snail closely related to the marine periwinkle, *Littorina littorea*.
- Under Cd stress, the two MT genes of *Pomatias elegans* are upregulated differentially, expressing in the midgut gland a two and a three-domain metallothionein, respectively
- Primary sequence analysis of MTs of both species suggest origin from a common marine ancestor
- However, the three-domain MTs of both species have evolved independently
- The MT system of *Pomatias elegans* is suggested as a valuable biomarker tool in ecotoxicology

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:

Received 28 March 2018

Received in revised form 16 July 2018

Accepted 30 July 2018

Available online 07 August 2018

Editor: Henner Hollert

Keywords:

Pomatias elegans

Littorina littorea

Cadmium detoxification

Metallothionein upregulation

Biomarker

Evolution

ABSTRACT

Through evolution, marine snails have adapted several times independently to terrestrial life. A prime example for such transitions is the adaptation to terrestrial conditions in members of the gastropod clade of *Littorinoidea* (*Caenogastropoda*). Some species of this lineage like the periwinkle (*Littorina littorea*), live in intertidal habitats, where they are intermittently exposed to semi-terrestrial conditions. *Pomatias elegans* is a close relative of *Littorina littorea* that has successfully colonized terrestrial habitats. Evolutionary transitions from marine to terrestrial conditions have often been fostered in marine ancestors by acquisition of physiological pre-adaptations to terrestrial life. Such pre-adaptations are based, among others, on the optimization of a wide repertoire of stress resistance mechanisms, such as the expression of metal inactivating metallothioneins (MTs). The objective of our study was to explore the Cd handling strategy in the terrestrial snail *Pomatias elegans* in comparison to that observed previously in *Littorina littorea*. After Cd exposure, the metal is accumulated mainly in the midgut gland of *Pomatias elegans*, in a similar way as in its marine relative. Upon Cd exposure, *Pomatias elegans* expresses Cd-specific MTs, as also described from *Littorina littorea*. In contrast to the latter species, however, the detoxification of Cd in *Pomatias elegans* is mediated by two different MT isoforms, one two-domain and one three-domain MT. Although the MT proteins of both species are homologous and clearly originate from one

* Corresponding author at: Department of Zoology, Universität Innsbruck, Technikerstraße 25, 6020 Innsbruck, Austria.

E-mail address: Reinhard.Dallinger@uibk.ac.at (R. Dallinger).

¹ Both authors contributed equally to this study.