



# Spatial and Temporal Distribution of the Multi-element Signatures of the Estuarine Non-indigenous Bivalve *Ruditapes philippinarum*

Soraia Vieira<sup>1</sup> · Pedro Barrulas<sup>2</sup> · Paula Chainho<sup>3,4,5</sup> · Cristina Barrocas Dias<sup>2,6</sup> · Katarzyna Sroczynska<sup>1</sup> · Helena Adão<sup>1</sup>

Received: 10 December 2020 / Accepted: 7 February 2021

© The Author(s), under exclusive licence to Springer Science+Business Media, LLC part of Springer Nature 2021

## Abstract

Filter-feeder bivalves such as non-indigenous *Ruditapes philippinarum* absorb and accumulate metals, resulting in multi-element profiles. The goal of this study was to analyse spatial and temporal distributions of the multi-element signatures in *R. philippinarum* populations of the Tagus and Sado estuaries (SW coast, Portugal). The clam and sediment samples were collected at three sampling sites in each estuary, on three sampling occasions, and the analysis were done by ICP-MS (inductively coupled plasma mass spectrometry). The chemical elements were categorized according to estuarine geomorphology sources (Se, Co, Ni and Cu), elements with function in metabolic processes of the clams (Mn, Fe, Zn and Cr) and elements derived from the anthropogenic inputs (As, Pb and Cd). Zinc, Co, Ni and Pb were the main contributors for the chemical signatures of Tagus estuary populations, whilst for the Sado estuary populations were Cu, Fe, Cr, As and Cd. They were representative of all elemental categories and proved to be spatial and temporal habitat discriminators of bivalves' estuarine populations. The multi-element signatures of *R. philippinarum* as a natural tag derived from the physical and chemical conditions of its habitat is a potential rapid tool to use in ecological monitoring and habitat assessment.

**Keywords** Multi-element signatures · *R. philippinarum* · Spatial and temporal distributions · Traceability · Elemental discriminators

## Introduction

The non-indigenous benthic bivalve *Ruditapes philippinarum* (Adams & Reeve, 1850), commonly named as Manila clam, is a well-succeeded invasive species in worldwide estuaries and

coastal systems. It represents one of the most commonly consumed bivalve species extensively cultivated all over the world [1]. Originally native to the Indo-Pacific region, it was introduced into the west coast of North America, the East Atlantic (Portugal, France, Spain, Ireland, England) and Mediterranean European coasts (France, Italy) [2]. In Portugal, it was introduced in the 1980 in Ria Formosa (South of Portugal), rapidly invading estuaries and coastal systems over all of the country, including the Sado estuary [3] and the Tagus estuary [2, 3]. With a large geographical spatial distribution and increasing abundance in recent years, *R. philippinarum* gained a significant economic relevance for fisheries and aquaculture, being intensively harvested in Europe [4–7]. In Portugal, it is one of the most important commercial bivalves [1], with an intensive exploitation, particularly in the Tagus estuary, though it is an illegal harvesting, involving a serious risk for human consumption due to microbiological and metal contamination.

The Manila clam has also been recognized as an appropriate bioindicator and/or sentinel species of environmental quality in aquatic systems [8, 9]. Filter-feeding species have a natural bias to absorb and accumulate metals, resulting on

✉ Helena Adão  
hadao@uevora.pt

<sup>1</sup> MARE, Marine and Environmental Sciences Centre, University of Évora, School of Sciences and Technology, Apartado 94, 7002-554 Évora, Portugal

<sup>2</sup> Laboratório HERCULES, Universidade de Évora, Palácio do Vimioso, Largo Marquês de Marialva 8, 7000-09 Évora, Portugal

<sup>3</sup> MARE, Marine and Environmental Sciences Centre, Lisbon University, Faculty of Sciences, Campo Grande, 1749-016 Lisbon, Portugal

<sup>4</sup> Department of Animal Biology, Faculty of Sciences, University of Lisbon, Lisbon, Portugal

<sup>5</sup> Polytechnic Institute of Setúbal, Setúbal, Portugal

<sup>6</sup> Chemistry Department, School of Science and Technology, Évora University, Rua Romão Ramalho, 59, 7000-671 Évora, Portugal