Heavy metal bioaccumulation trends in the shell of two Bivalve species: a comparative study

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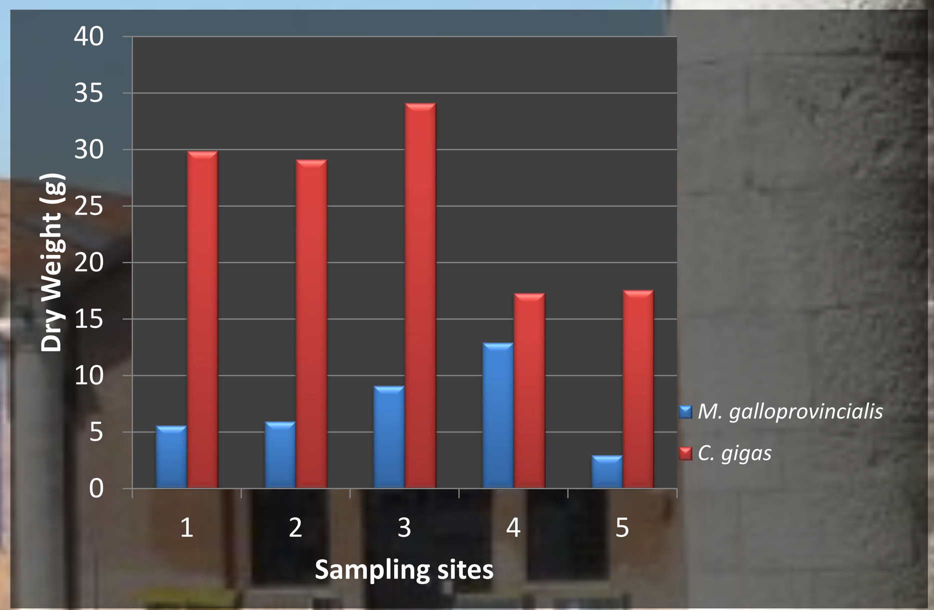
introduction

Bivalves are extensively used in biomonitoring programmes because they're known to be efficient accumulators of contaminants and ideal indicators organisms. Various species have been used for assess toxic metals levels in marine environment but the most favourite ones are filter feeding Bivalves such as mussels and oysters. In most cases the laboratory experiments are conducted to evaluate the metals concentration levels in soft tissues: few works concentrate their attention also in shell levels. In the optic of a more exhaustive comprehension of the mechanisms that undergo the transfer of inorganic contaminants to organism's hard parts, it was decided to operate a comparison between two different bivalve species on their ability to accumulate metals.

keywords

Bivalve
shell
bioaccumulation
heavy metal



The detection of the crushing method was particularly difficult due to the fact that it was necessary to pay particular attention to potential contamination issues, and that none of the considered works specified the method used for crushing the shells up to the optimum size for the subsequent disintegration step.

Crassostrea gigas

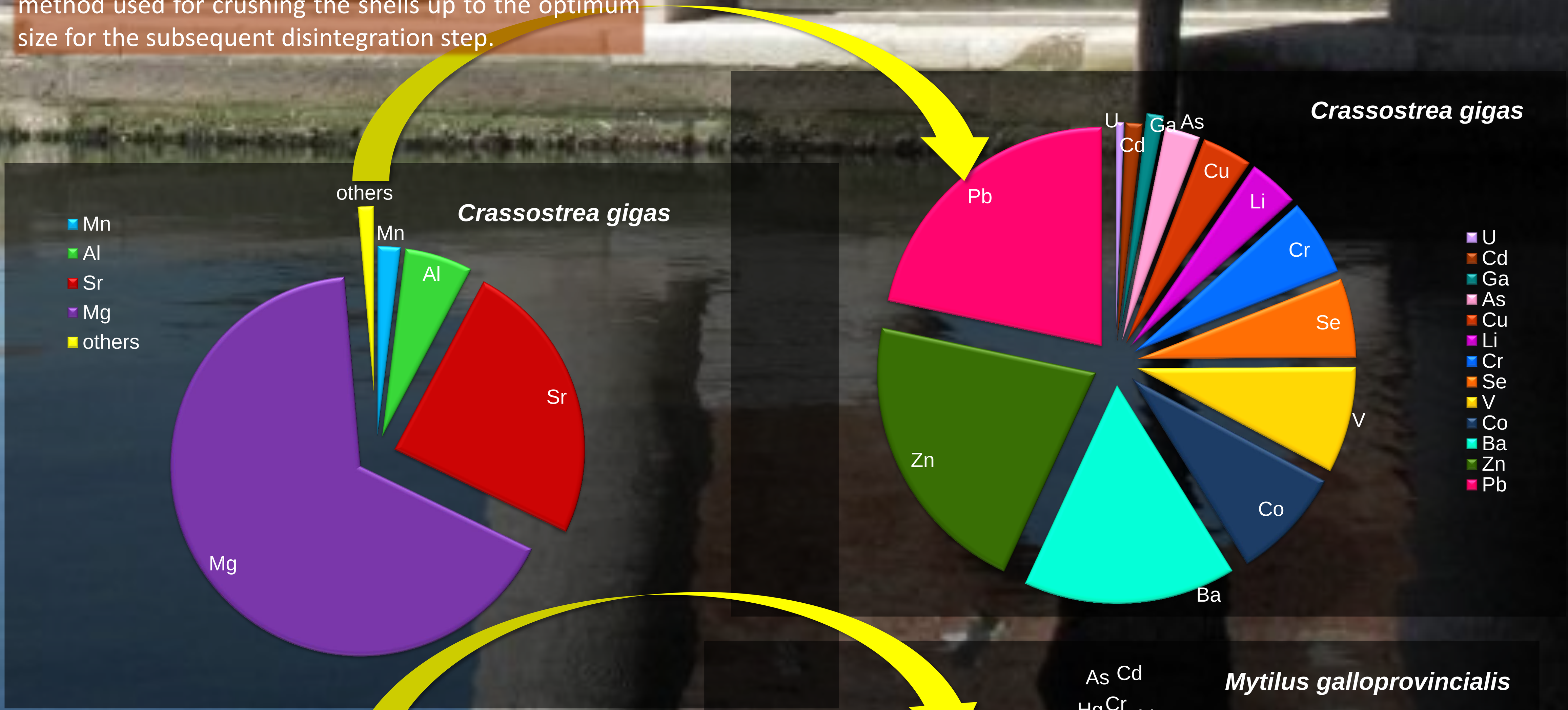
Mytilus galloprovincialis

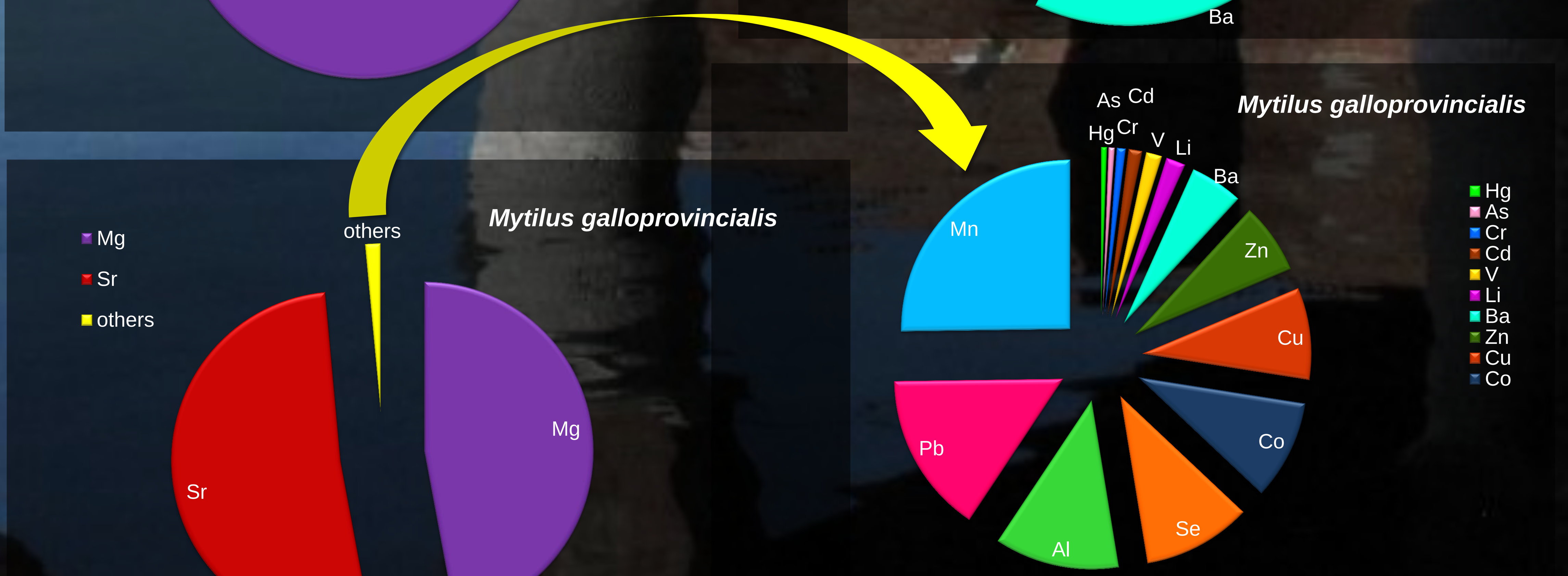
Samples of *Mytilus edulis* and *Crassostrea gigas* were collected in 2006 in the area of Arsenale Vecchio. The valves were kept in refrigerator before cleaning and preparation steps. The cleaning phase was carried out in water with a plastic bristles brush, with subsequent rinsing with deionized water. The shells were dried in an oven at 80 ° C for 48 hours, after which the dry weight was determined with an analytical balance. The left valve was then ground with a teflon instrument, resting on a slider suitable for finely chopped sample collection (tool developed by the workshop of the University Ca' Foscari of Venice). Subsequently an aliquot of the fragmented shell is subjected to treatment with nitric acid and hydrogen peroxide and placed in the digester for 45 minutes for complete disintegration of the sample. The digest is then analyzed as such in ICP-MS (Inductively Coupled Plasma Mass Spectrometry).

sampling site

The Lagoon of Venice, located in the northern part of the Adriatic Sea, is a shallow basin with a surface area of about 550 Km^2 and an average depth of 0.6 m. It is a transitional environment which has suffered an heavy impact of industrial, agricultural and urban pollution during the last century.

A shipyard dock called Arsenale Vecchio is located in the eastern part of Venice, covering an area of about 46 ha, of which 11 ha are water. Arsenale Vecchio basin was chosen for our experiment because of its limited size, shallow water and reduced boat traffic.





Metals present in quantities less than 10 mg / kg ("others" in the pie chart) are most likely associated with the organic component of the valve. From comparison of the percentage distributions is evident that the two Bivalves are able to include these metals in the shell structure in a different way that depends on the specific characteristics of the species.

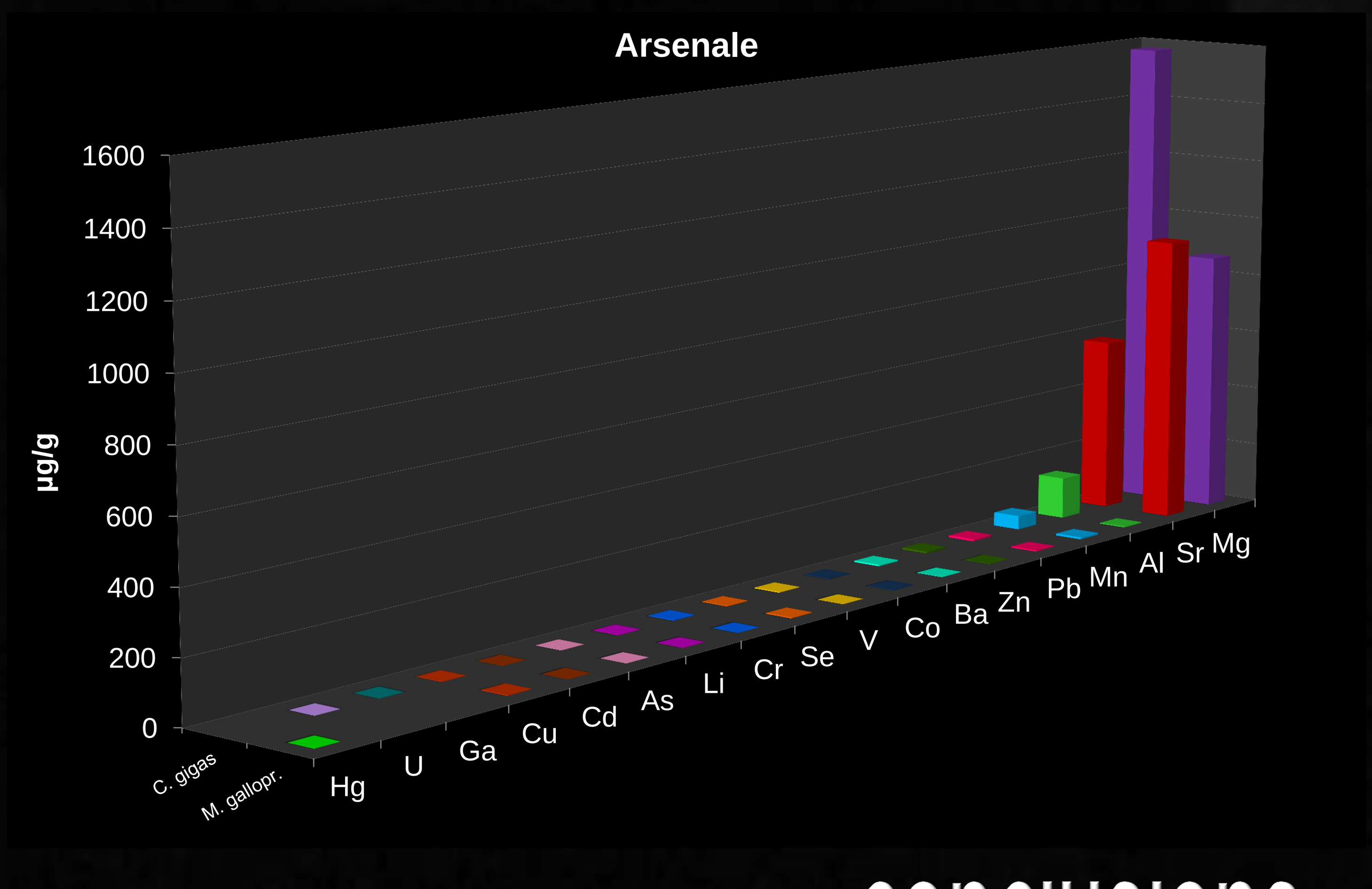
Comparing the graphs it is noted that the elements more widely present in both species are Mg and Sr: this is easily understandable since these elements are both substituents of the Ca in the crystal structure of the valve.

However, pie charts reveal that strontium is present with a higher percentage in *M. galloprovincialis* (51% compared to 24% in C. gigas). From the literature we know that the divalent metal ions that have an ionic radius greater than the Ca^{2+} (eg, Sr^{2+}, Pb^{2+}) generally replace it in the orthorhombic structure of aragonite more easily than in the structure of the rhombohedral calcite. This happens because the Ca^{2+} in calcite is arranged in a structure with 6 oxygens coordinated, while in aragonite it has a structure with 9 O atoms coordinated (greater length of the links Ca-O). For this reason it is more likely that the Sr^{2+} is incorporated into the structure of Bivalve aragonite rather than in the calcite, as it tends to form a carbonate with a coordination to 9 atoms, which is isostructural with aragonite.

So the results obtained are not surprising because it is known that the percentage by weight of aragonite in *M. galloprovincialis* is greater than that present in *C. gigas*.

The content of trace elements in the carbonate structure can be regulated by several factors: the mineralogy of the carbonaceous structure, water chemistry, physiology of the organism and other environmental parameters. The best-documented environmental effects on the chemical composition of the shells are about the influence of temperature on Sr and Mg content and the influence of the salinity on the concentration of Mg. However in this case, the changes in the concentrations of Mg and Sr can not be attributed to environmental factors (site and date of sampling are the same), but rather to the characteristics of individual species.

The graph on the right shows the average concentrations trend of the elements determined in samples of *C. gigas* and *M. galloprovincialis*.



essential references

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conclusions

The two species considered show different responses to the same environmental condition towards that they are exposed during their lives. So there's the necessity to prosecute the study in order to better understand the species-specific biochemical paths of metals bioaccumulation in the shell. This skill could be used in future applications concerning the comprehension and the following exploitation of Bivalves role in water basin self-purification mechanisms.