

Contribution of RAMAN spectroscopy to assess cadmium toxicity on marine mussel (*Mytilus edulis*)

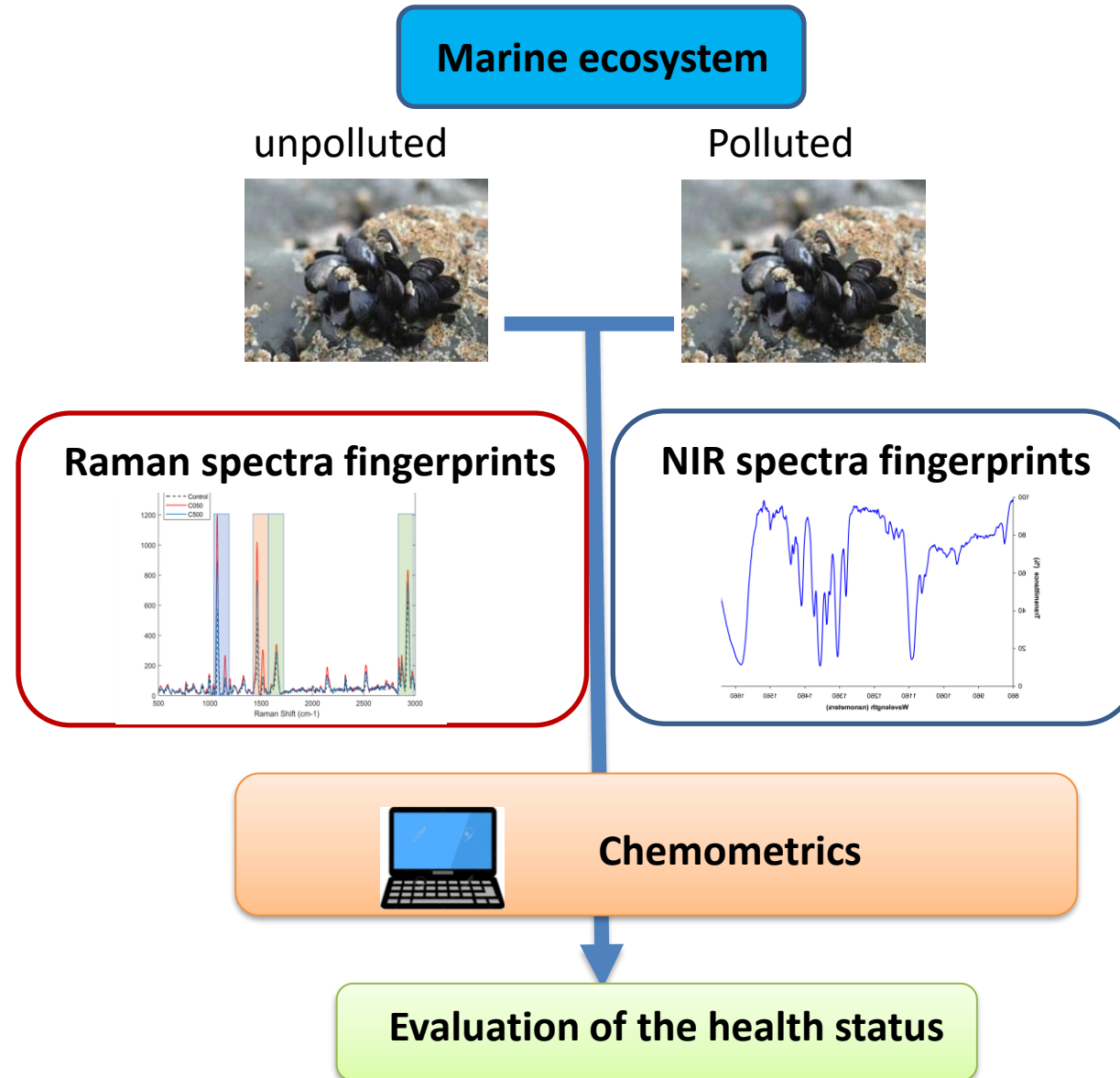
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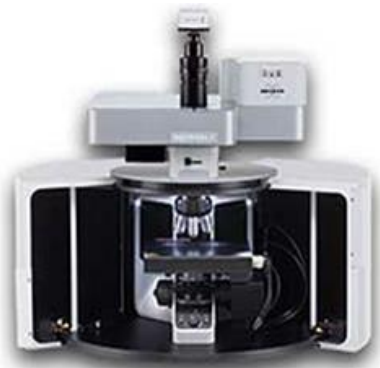
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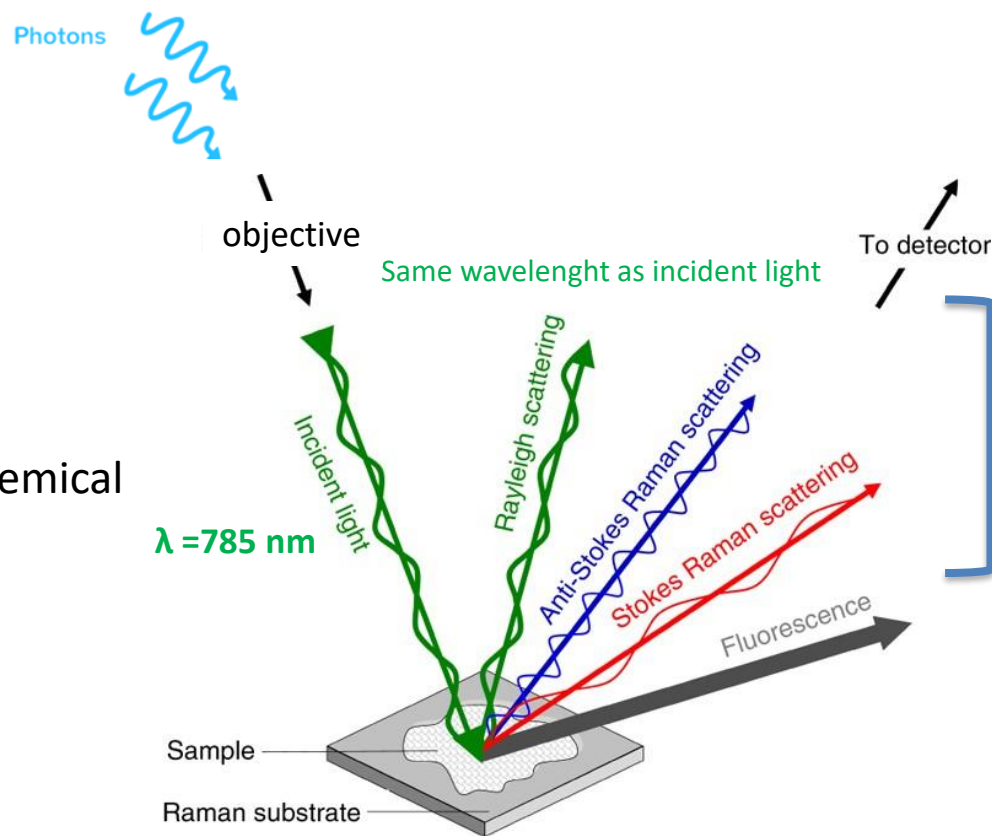
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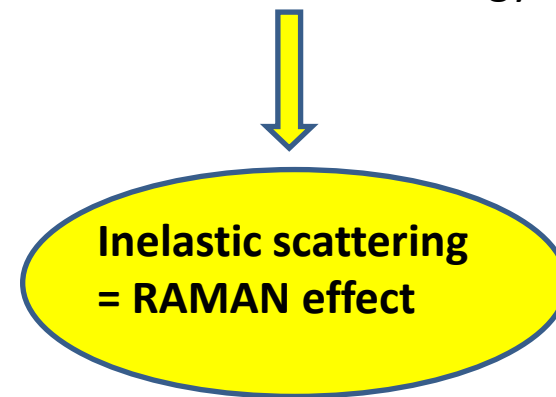


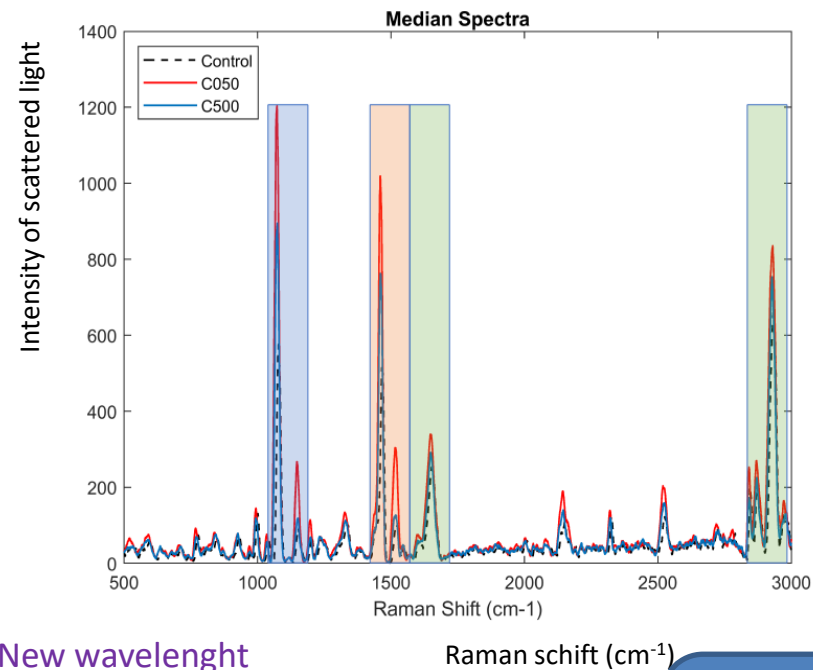
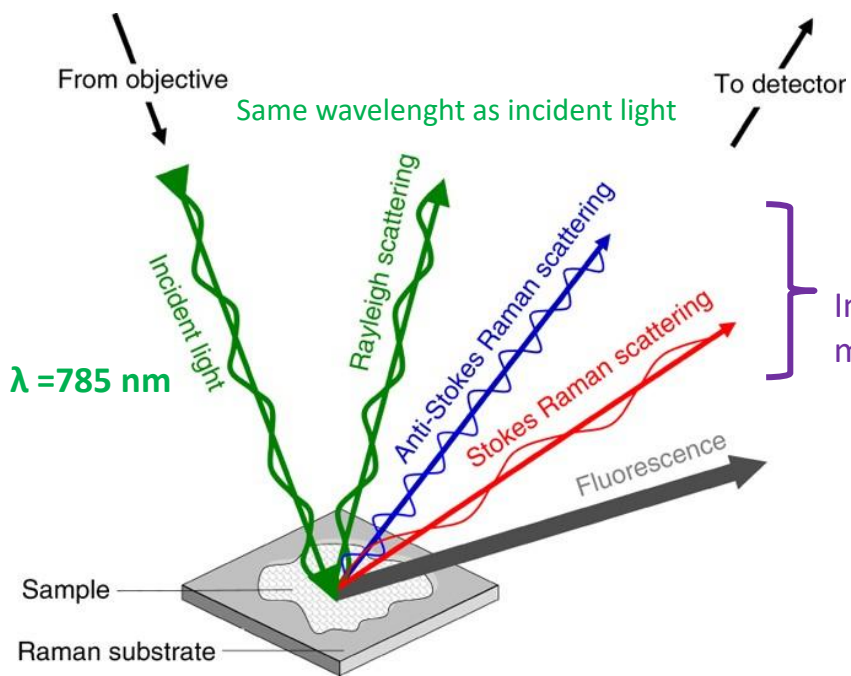


Photons interact with chemical bounds of molecules



Diffusion: at different energy levels





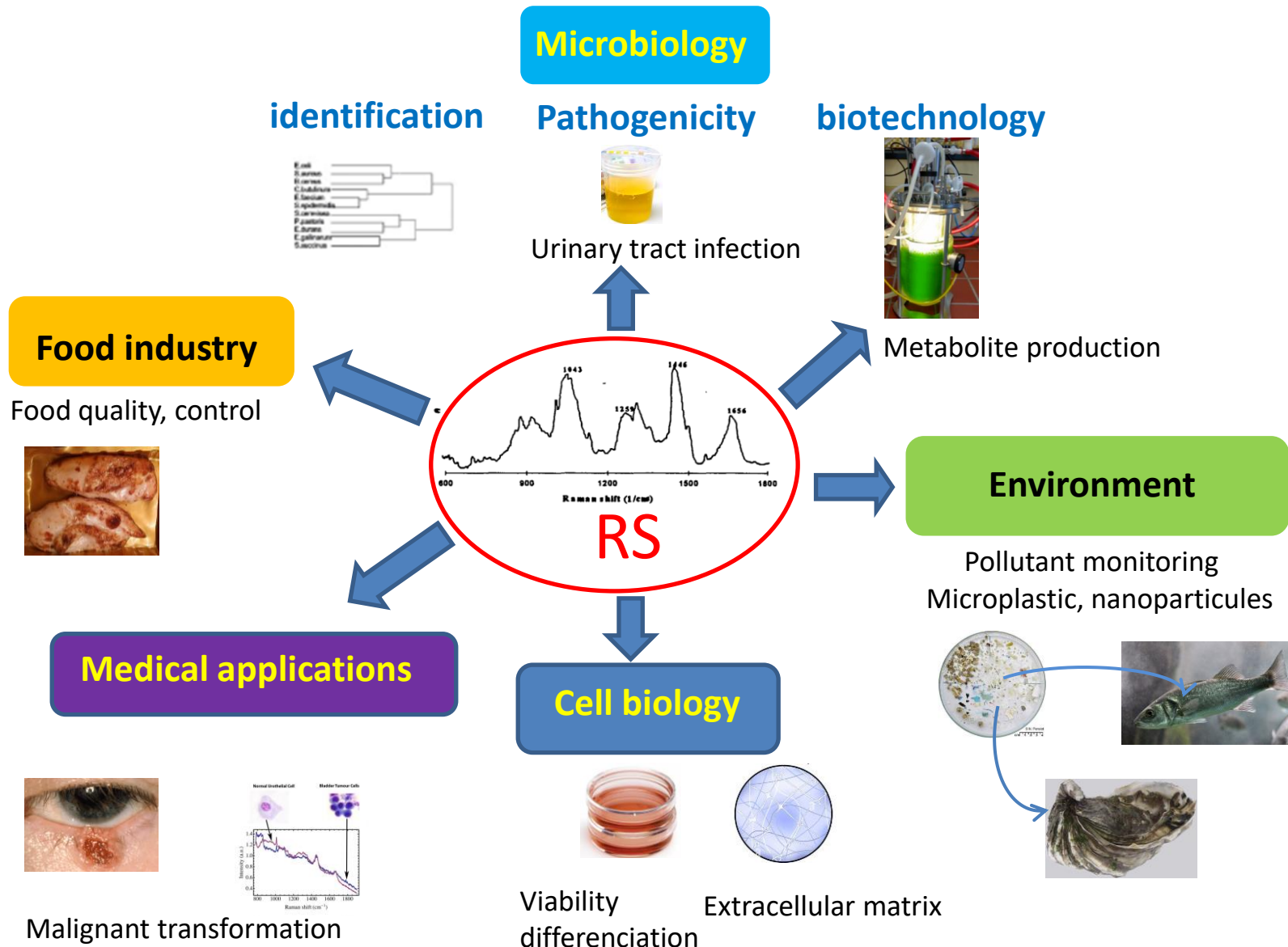
**Spectrum :
Representation of
chemical
composition**

New wavelength
↑
Inelastic scattering of photons by
molecular bounds

**Non destructive and
non invasive
analytical technique**

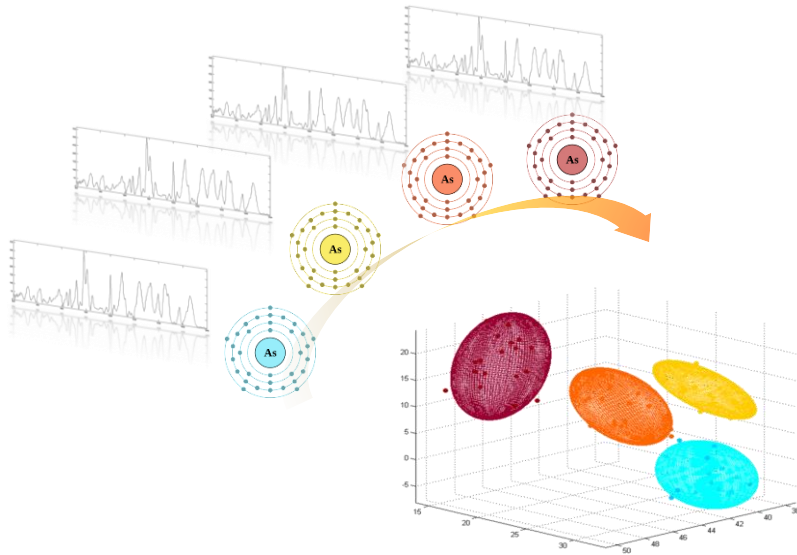


**Sophisticated data analysis
chemometric tool needed**



Bittel M, et al, 2015, Environ. Science & Techn., 49:12324-32.

Dose –response effect

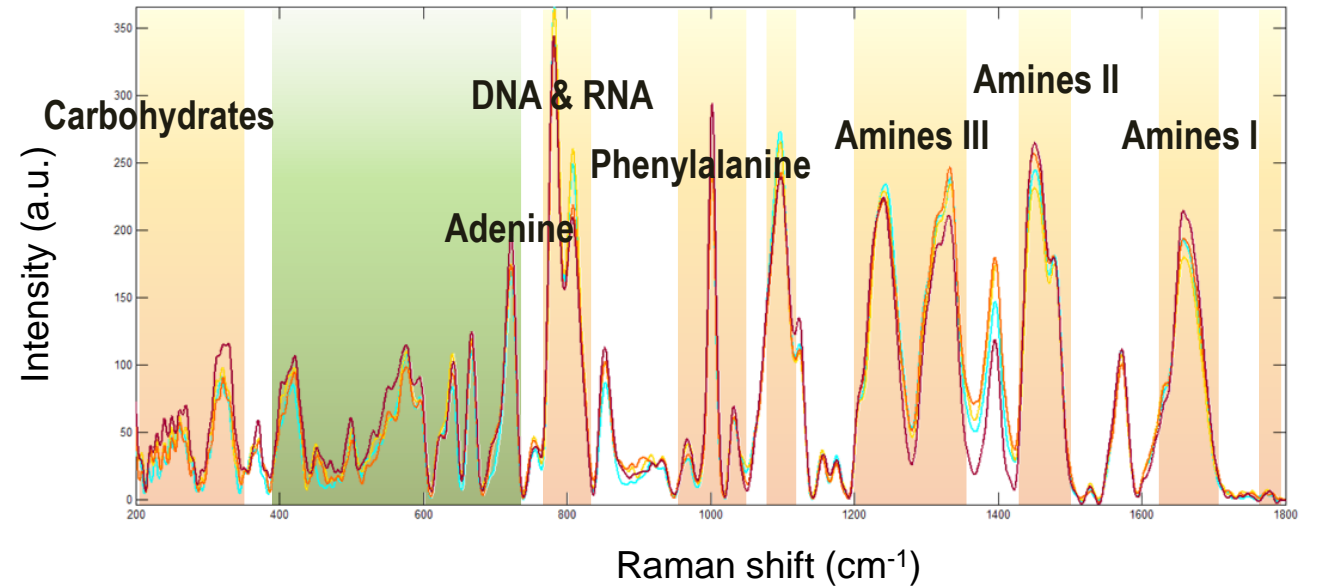


GOOD CLASSIFICATION DEPENDING ON ARSENIC CONCENTRATION

■ 0 μM ■ 5 μM ■ 50 μM ■ 500 μM

Spectral «fingerprints»

E. coli – average spectra, 90 min exposition with Ars



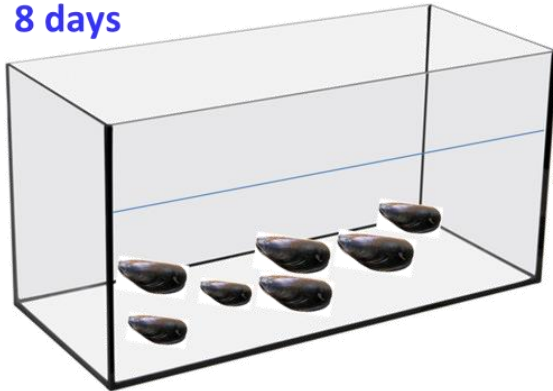
Classification of Raman effect

- Level 1: Very significant
- Level 2: Low significant
- Level 3: No significant

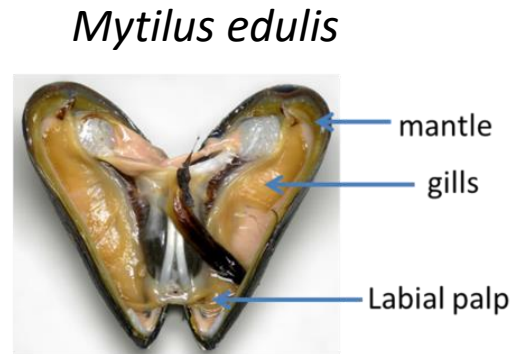
Probable toxic effect

- Membranes impact ✓
- (Specific transporter ?)
- Proteins impact ✓
- DNA Impact ✓
- RNA decrease ✓

10 mussels
Synthetic sea water
15°C
8 days

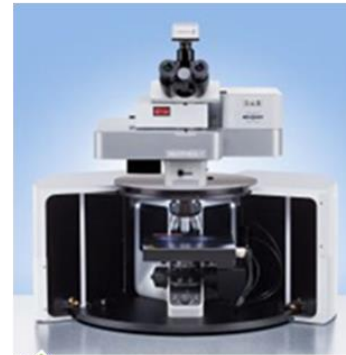


3 tanks for control,
3 tanks contaminated with cadmium ($50 \mu\text{g.L}^{-1}$)
3 tanks contaminated with cadmium ($500 \mu\text{g.L}^{-1}$)

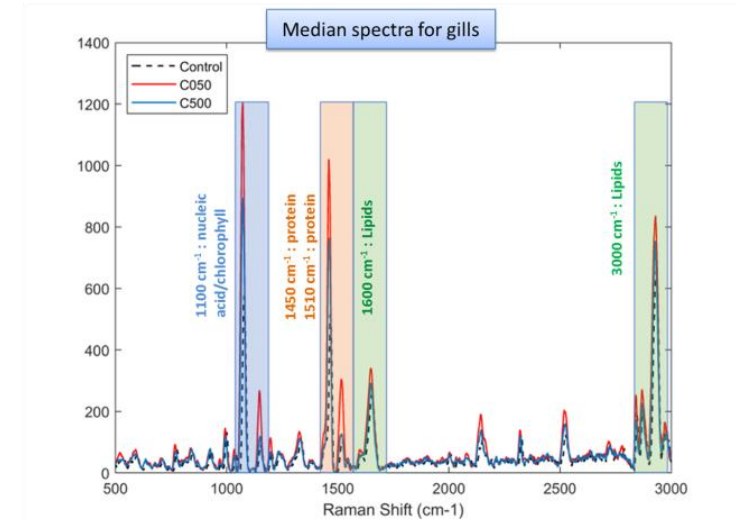


Tissue analysis

Senterra II Bruker

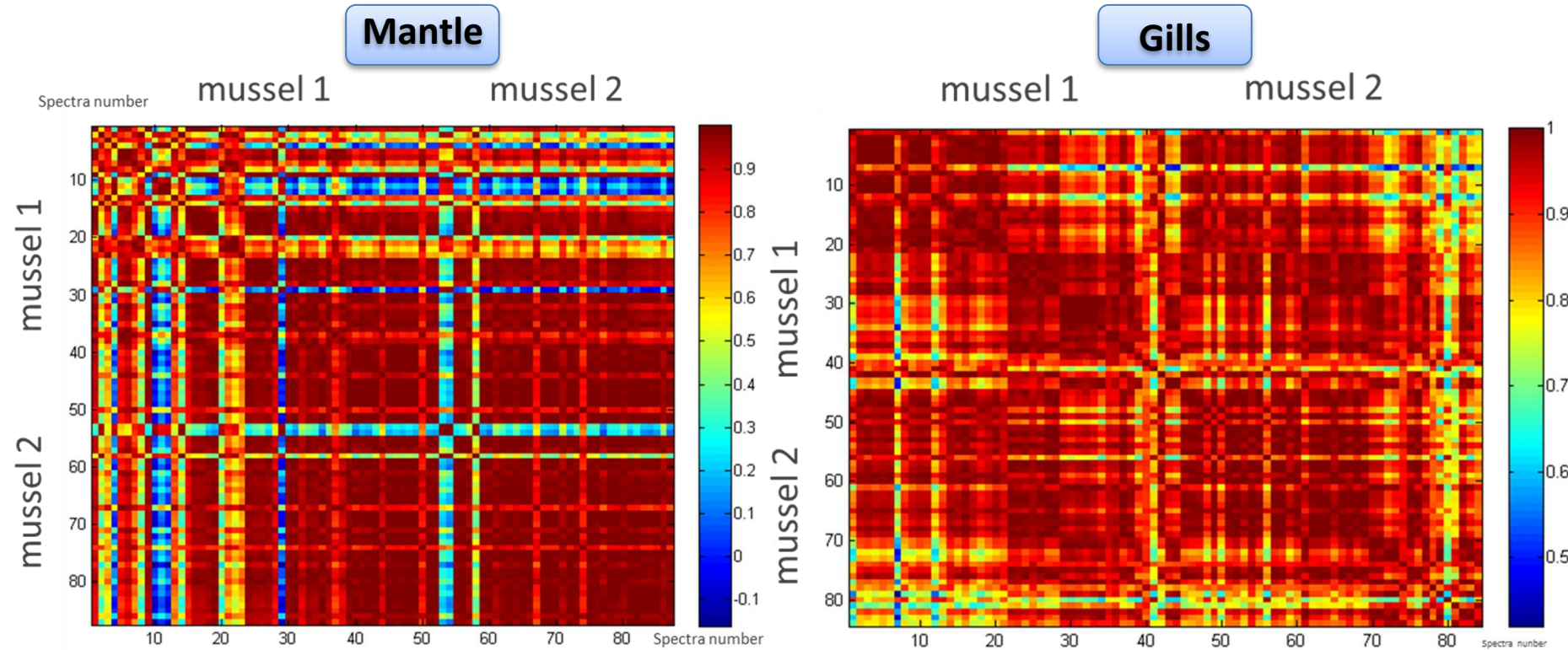


- Objective X10
- 785 nm
- 100 mW
- Acquisition time 10s
- Tissue was spread onto aluminium surface



Spectral pre-processing (Opus software; 250 to 3100 cm^{-1} ; baseline correction, normalization with protein band at 1245 cm^{-1})

➔ 45 spectra recorded for one tissu



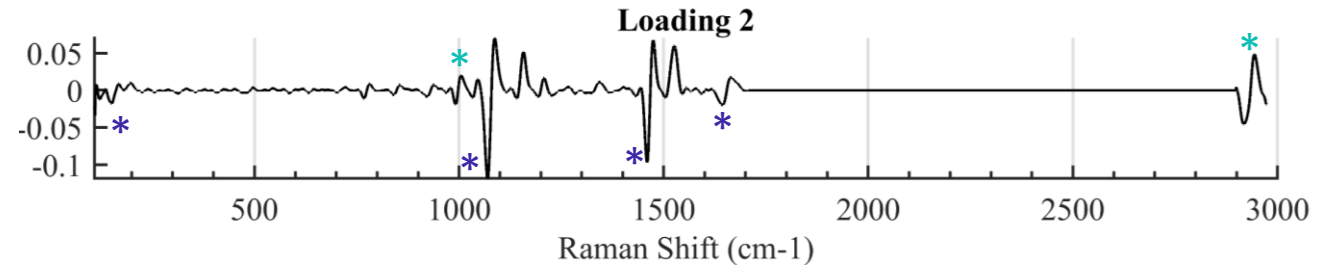
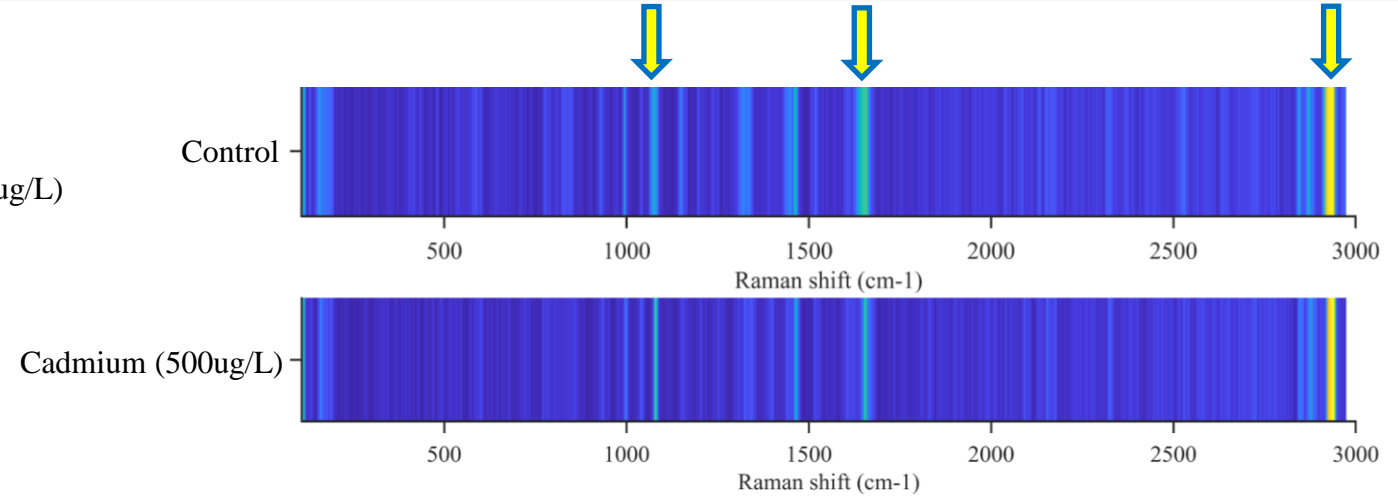
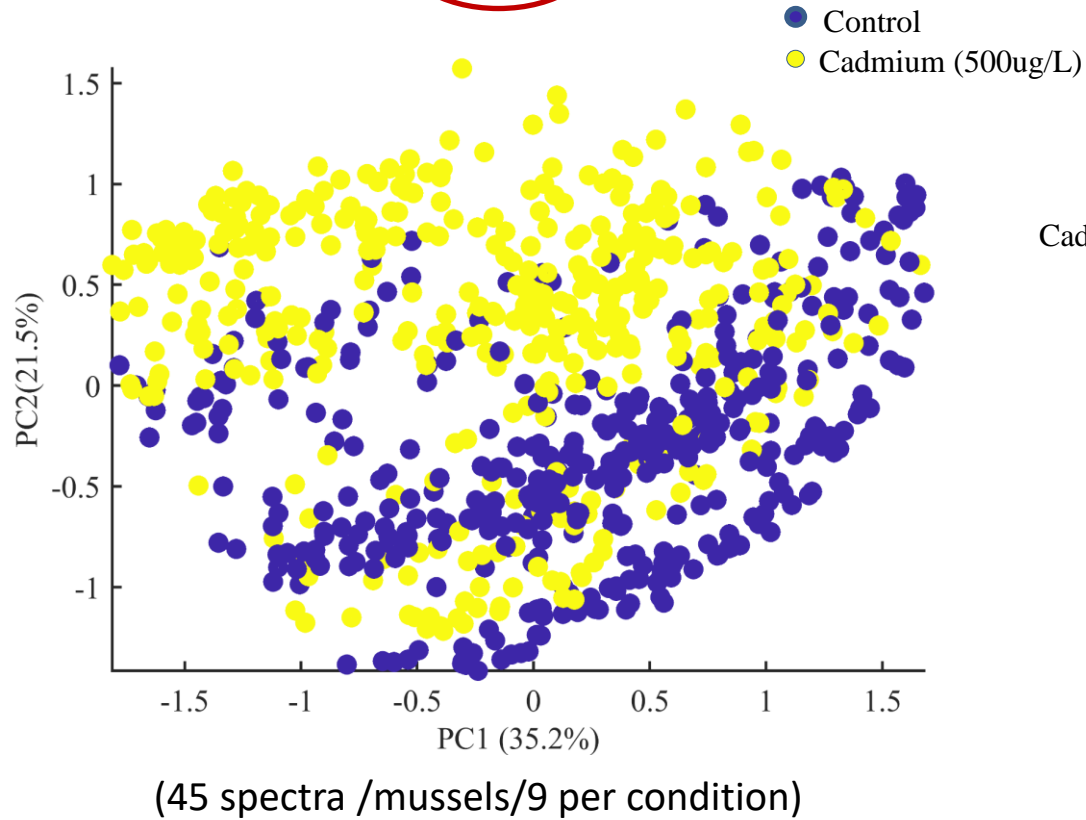
Scale: 1 pixel = 1 spectrum

A total of 90 spectra per line and per column (Matlab-Pack Saisir)

Heat maps are used to assess the reproducibility of the recorded spectra for one tissu of two control mussels

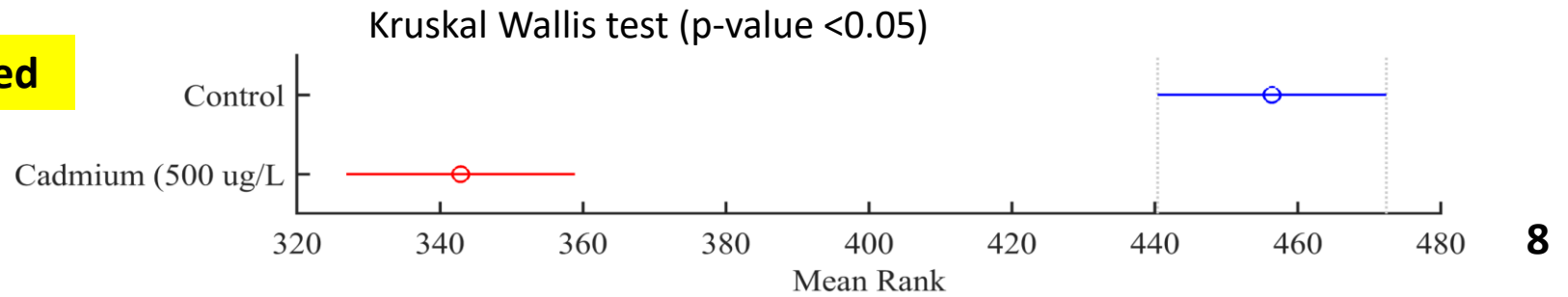
For the mantle the variability of the Raman spectra is greater than for the gill

Gills

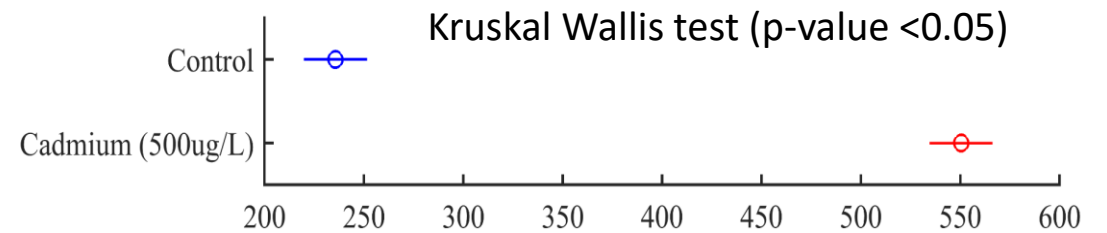
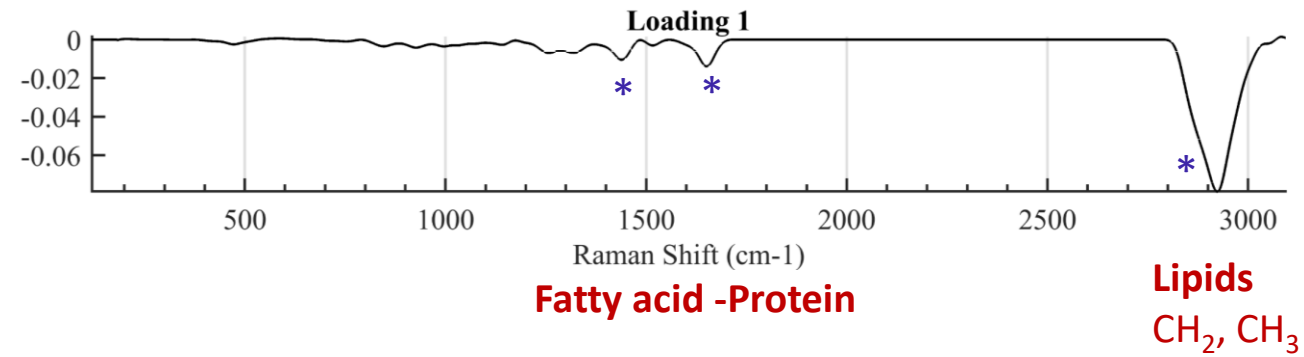
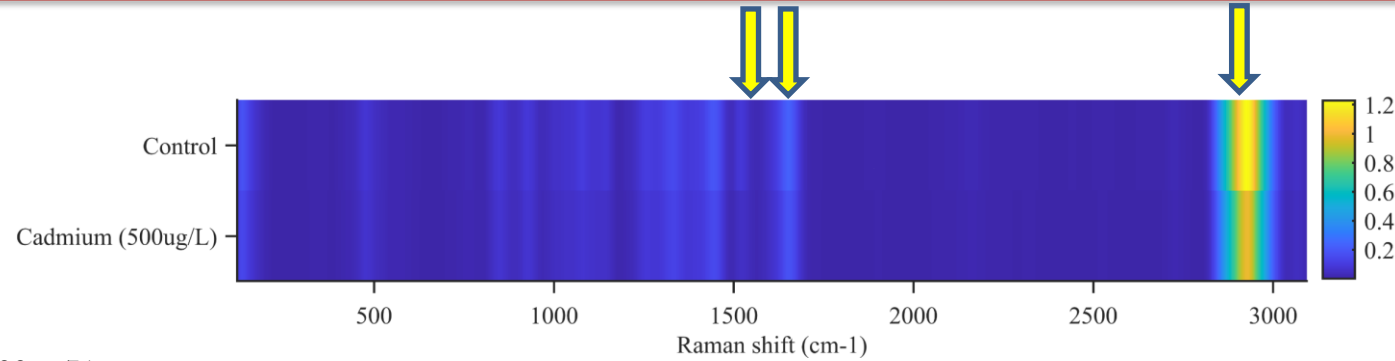
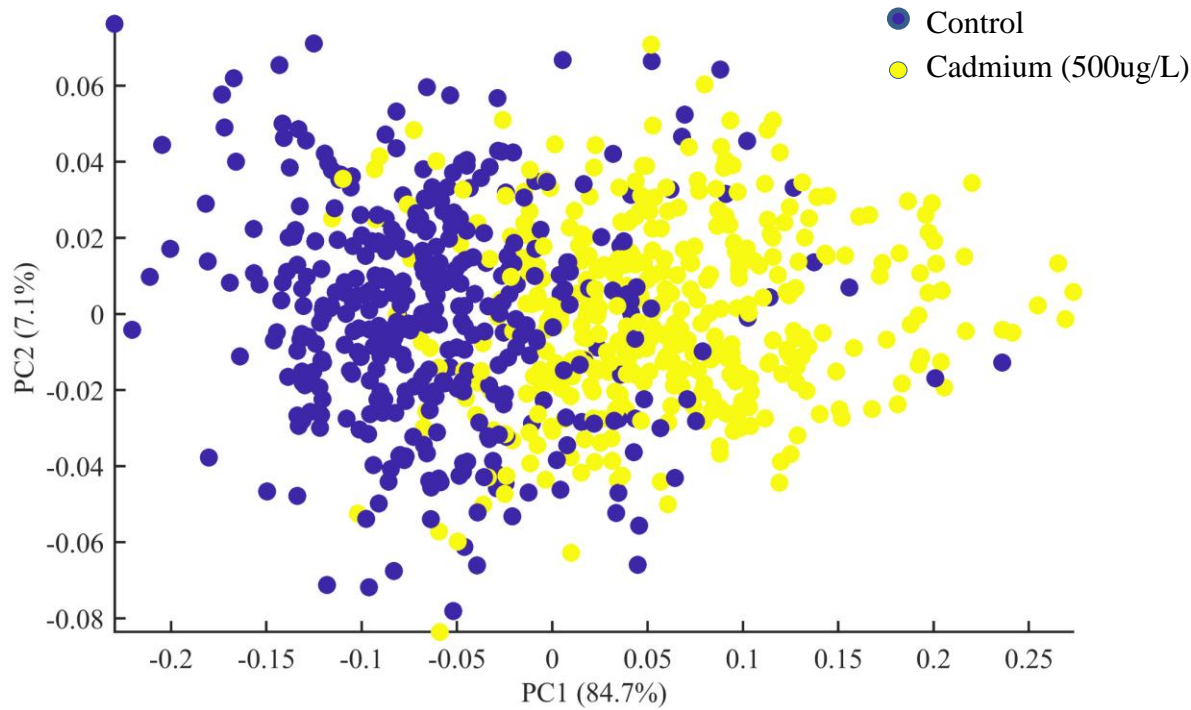


Nucleic Acid **Fatty acid -Protein** **Lipids**
 C-O C-H₂- Amine I CH₂, CH₃
 C-O-C
 PO₃⁻

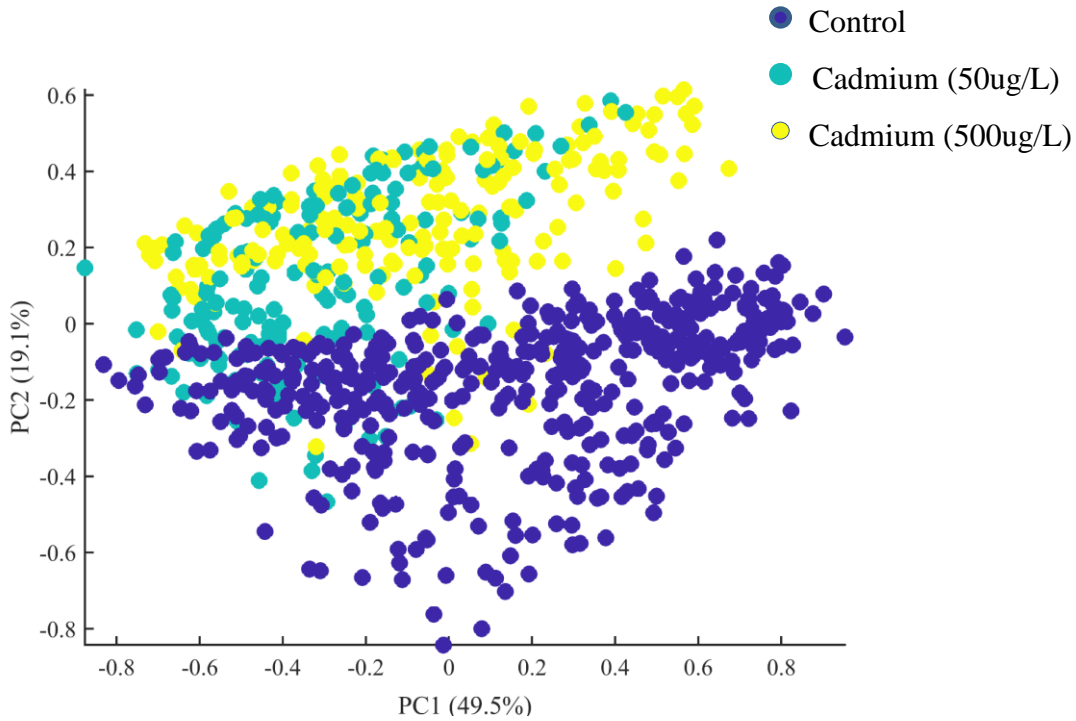
Control and exposed mussels are separated



Mantel

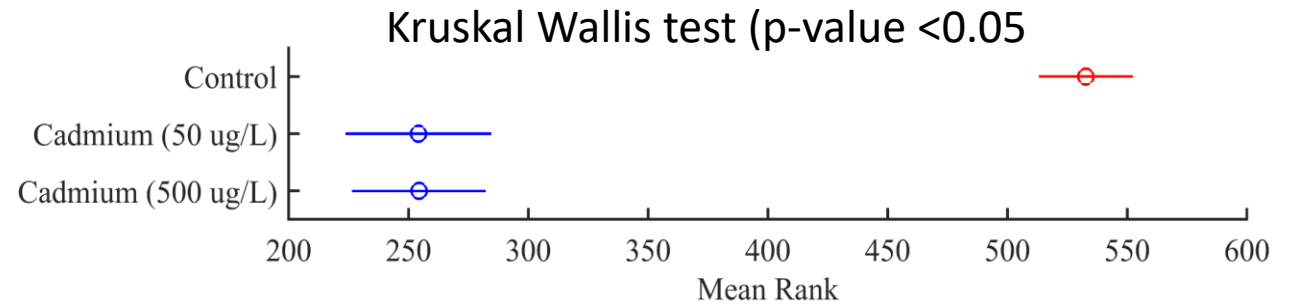
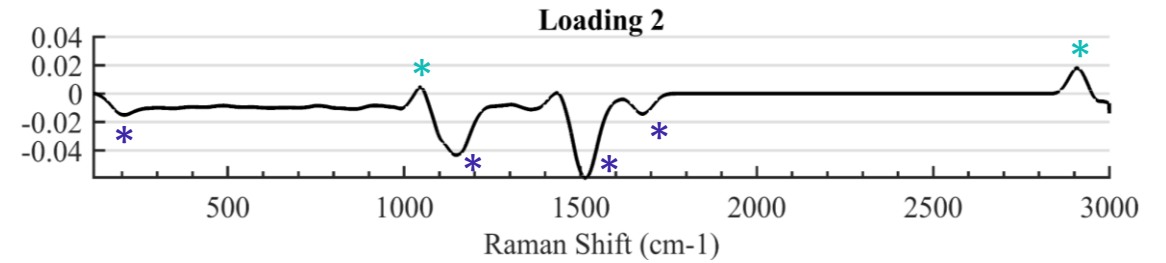
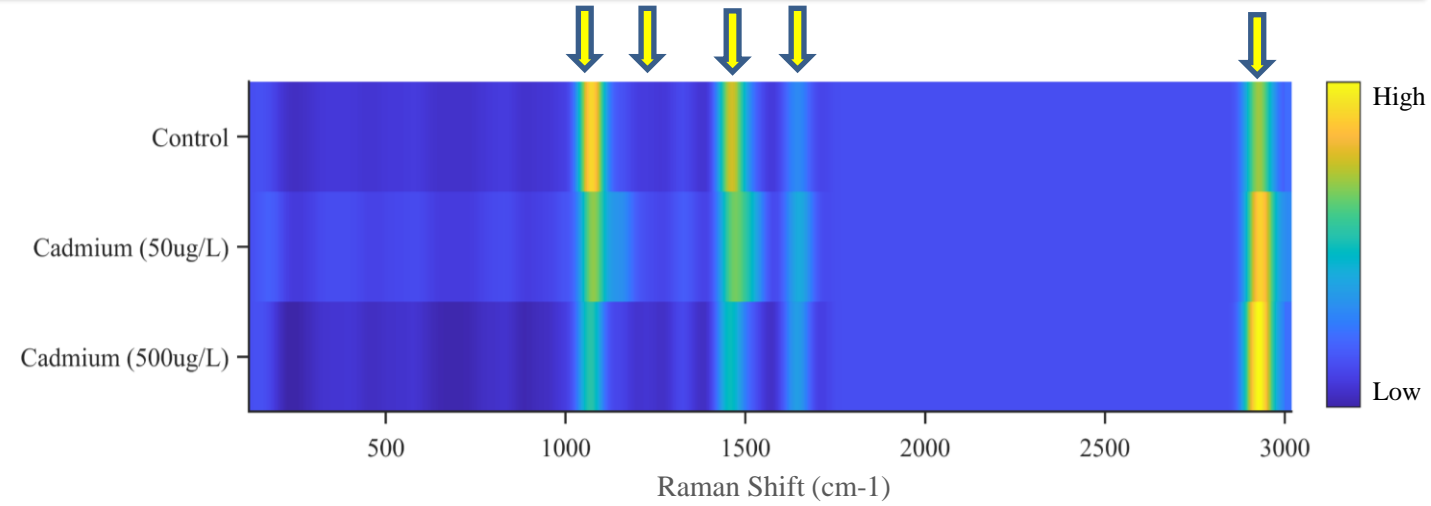


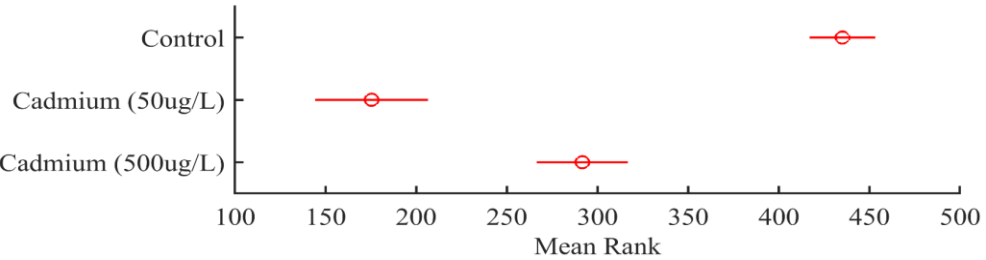
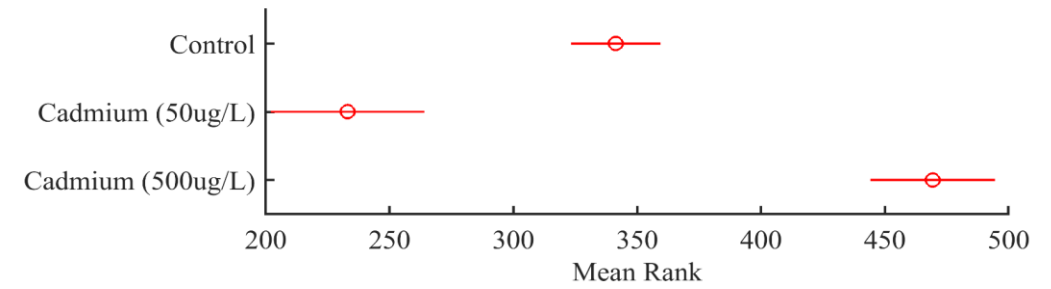
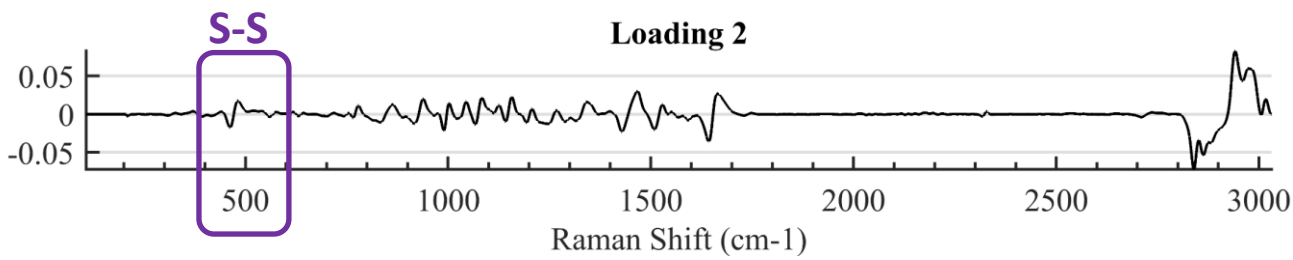
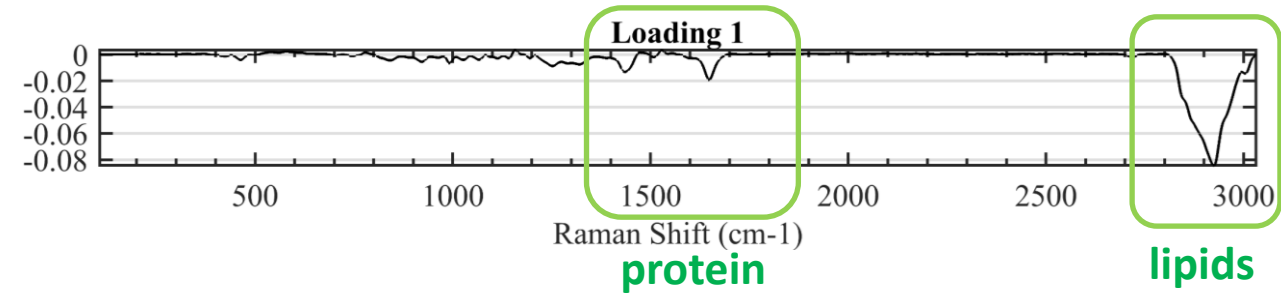
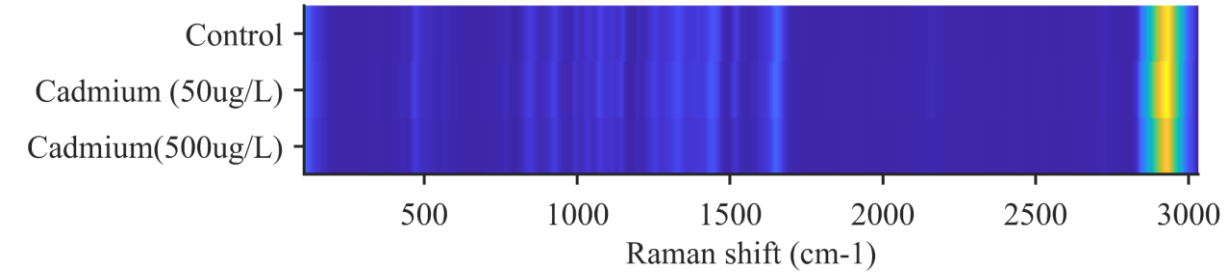
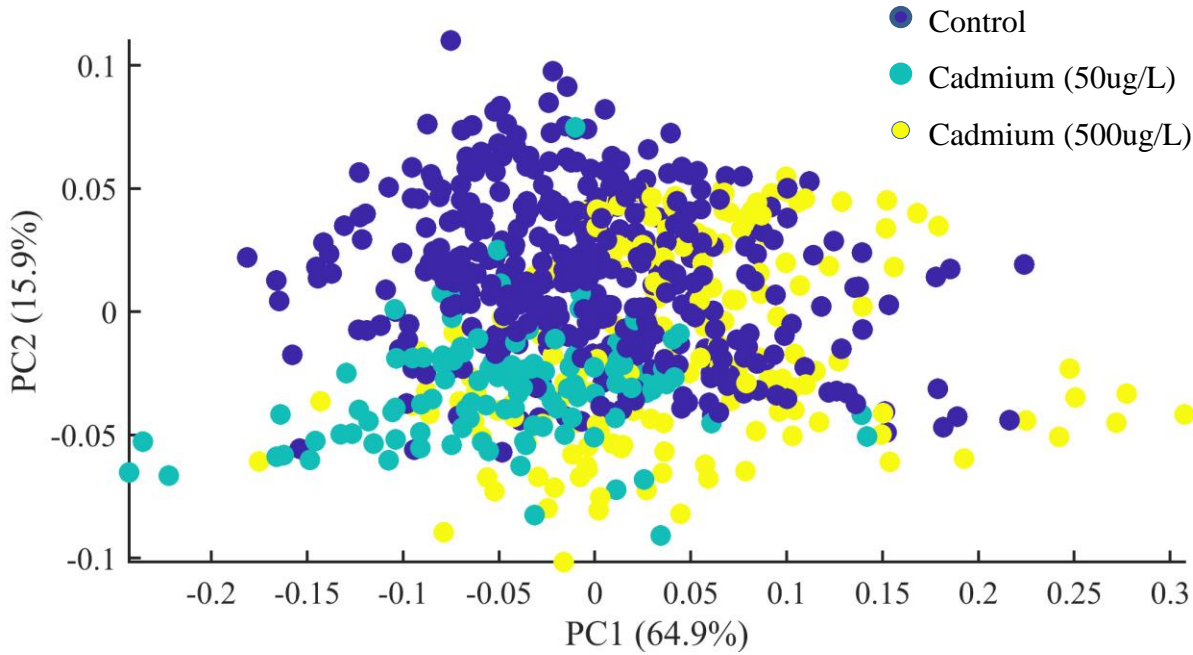
Control and exposed mussels are separated



Control and exposed mussels are separated

no difference between the two concentrations of Cd





Control mussels and two Cd concentration were separated

- Chemometric analysis of Raman spectra show that mussels exposed to cadmium could be separated from the control
- Cadmium is a non-essential metal and exhibits several cellular injuries. Cadmium ions suppress the activity of antioxidant enzymes and increase lipid peroxidation.
- The main Raman bands impacted by cadmium exposure are proteins and lipids
 - ➔ these results are consistent with cadmium ion toxicity
- These results are promising BUT :
 - ➔ must be confirmed and correlated with biomarkers : lipid peroxidation, metallothionein, Superoxide dismutase

Thank you for your attention

thanks to :



Dr Omar Dib
(post-Doc)



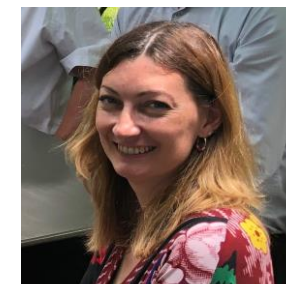
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Financial support :