Exposure-dose-response of *Saccostrea glomerata* (Sydney rock oyster) to cadmium obtained from suspended sediments and phytoplankton

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Dedicated to my Great Grandparents
Anecía and Michael Hodikoff.

And to my Attuan Ancestors whose lives wholly depended on the ocean.

(Photos: University of Alaska Anchorage/Fairbanks)
Thanks for supporting my dreams Brad!

- Helena 💖
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**Abstract**

Estuaries can receive anthropogenic contamination from both land and ocean sources making estuaries susceptible to contaminants such as cadmium. A common inhabitant of Eastern Australia estuaries is the oyster, *Saccostrea glomerata* which is able to uptake cadmium through three pathways: 1) suspended sediments, 2) water column, and/or 3) diet.

In this study, *Saccostrea glomerata* were exposed to cadmium through cadmium-spiked suspended sediments (19 & 93 mg/kg) and cadmium-enriched phytoplankton (2-3 μg/g) under controlled laboratory conditions. Cadmium uptake and effect measurements, total antioxidant capacity, lipid peroxidation, and lysosomal stability were measured.

The oyster tissue from the suspended sediments (SS) experiment accumulated cadmium from both treatments (Low-Cd SS; 2-10 mg/kg & High-Cd SS, 15-49 mg/kg). Some cadmium desorbed from the sediment within 6 days of the suspended sediments experiment. The oysters could have obtained cadmium both from the suspended sediments and the water column. Oysters accumulated less cadmium in the phytoplankton experiment with final tissue concentrations between 0.7 μg/g and 4.1 μg/g.

In both experiments, cadmium-exposed oysters showed a significant reduction of total antioxidant capacity compared to the controls’ total antioxidant capacity. In the suspended sediments experiment, the Low-Cd SS treatment had a higher mean total antioxidant capacity of 18.0 ± 5 mM/mg protein compared to the High-Cd SS treatment of 14.0 ± 5 mM/mg protein. Oyster fed cadmium-enriched phytoplankton had a reduction in total antioxidant capacity with 18.0 ± 4 mM/mg protein. Comparison between both experiments with the cadmium-exposed
oysters the total antioxidant capacity reduction was not significantly different between experiments.

Thiobarbituric acid reactive substances, an oxidative damage assay, showed similar patterns. In the suspended sediments experiment the Low-Cd SS treatment had lower thiobarbituric acid reactive substances (93.0 ± 22 MDA nmol/mg protein) compared to the High-Cd SS treatment (139.0 ± 41 MDA nmol/mg protein). The thiobarbituric acid reactive substances for the phytoplankton experiment were 127.0 ± 11 MDA nmol/mg protein. In both experiments thiobarbituric acid reactive substances concentrations were similar.

In both experiments, cadmium-exposed oysters had lysosomal destabilization percentages that were significantly higher than the controls’ percentages (Control averages: 34 ± 8% & 35 ± 9%). Lysosomal destabilization for the Low-Cd SS treatment was 38 ± 12% and 42 ± 9% for the High-Cd SS treatment. Lysosomal destabilization for the oysters fed cadmium-enriched phytoplankton was 46 ± 2 %. Comparison between both experiments showed that the lysosomal destabilization percentages were not significantly different between experiments.

*Saccostrea glomerata* experienced oxidative stress and lysosomal destabilization from a low dose of cadmium derived from phytoplankton and experienced oxidative stress from cadmium ingestion via suspended sediments and the water column high cadmium concentrations. These results from both experiments support the hypothesis that *Saccostrea glomerata* can take cadmium up through suspended sediments and the water column and can cause oxidative stress and lysosomal destabilization. Results also showed that low concentrations of cadmium through phytoplankton (diet) can cause cadmium stress.
# Table of Contents

Certificate of Copyright.................................................................I
Acknowledgements........................................................................II
Abstract.......................................................................................III
List of Tables..................................................................................X
List of Figures................................................................................XI
List of Appendices.........................................................................XIII
Objectives & Hypotheses.............................................................XV
Chapter 1 Background and Rationale..........................................1
Chapter 2 Literature Review.........................................................4
  2.1 Anthropogenic Marine and Estuary Contamination..................4
    2.1.1 Australian Estuaries..........................................................7
    2.1.2 Contaminations in Australian Estuaries.............................8
    2.1.3 Metals as Contaminants: Essential versus Non-Essential Metals...11
  2.2 Cadmium in the Environment..................................................17
    2.2.1 Cadmium in the Marine Environment.................................17
    2.2.2 Factors Affecting Uptake of Dissolved Cadmium....................17
      2.2.2.1 Estuary pH.................................................................18
      2.2.2.2 Estuary Salinity.........................................................19
      2.2.2.3 Estuary Temperature..................................................20
      2.2.2.4 Hardness.................................................................22
      2.2.2.5 Dissolved Organic Carbon............................................23
    2.2.3 Factors Affecting Uptake and Binding of Cadmium by Sediments and Organisms.........................................................24
    2.2.4 Ion Exchange Capacity.....................................................28
    2.2.5 Cadmium and pH............................................................29
    2.2.6 Cadmium and Oxidation-Reduction Reactions......................30
    2.2.7 Overview of Cadmium: Comparative Analysis Between Soil, Sediment and Seawater.................................................................31
2.3 Phytoplankton Uptake Pathway

2.3.1 Phytoplankton Accumulation of Cadmium

2.3.2 Oyster Metal Assimilation Efficiency

2.3.2.1 Phytoplankton species

2.3.2.2 Gut Chemistry of Oysters Modifying Metal Bioavailability

2.3.3 Cadmium Dietary Exposure Examples

2.4 Sediment, Suspended Sediments, and Phytoplankton Correlations with Cadmium Bioavailability

2.5 Saccostrea glomerata as Biomonitor

2.5.1 Saccostrea glomerata Tissue Cadmium Concentrations

2.5.2 Oyster Physiology

2.5.2.1 Intracellular Digestion

2.5.2.2 Lysosomal Destabilization

2.5.2.3 Digestive Gland

2.5.3 Estuarine Aquatic Organism’s Dose-Response to Cadmium

2.5.3.1 Oyster Species Dose-Response to Cadmium

2.5.4 Oxygen-Reduction Metabolism and Lipid Peroxidation

2.5.4.1 Lipid Peroxidation Induced by Cadmium

2.6 Evolution and Molecular Mechanisms of Metal Metabolism

2.6.1 Costs of Tolerance and Cost of Genetic Variability

2.7 Literature Review Conclusion

Chapter 3 Methods

3.1 Collection and Maintenance of Oysters

3.1.1 Organism Collection

3.1.2 Phytoplankton

3.1.3 Maintaining the Oysters

3.2 Sediment Collection for Suspended Sediments Experiment

3.2.1 Sediment Collection

3.2.2 Grain Size Analysis
3.3 Experimental Design

3.3.1 Preparation of Cadmium-Spiked Sediments

3.3.2 Saccostrea glomerata Exposure to Suspended Sediments

3.4 Phytoplankton Exposure Experiments

3.4.1 Pilot Study with Chaetoceros muelleri

3.4.2 Continuous Culture of Chaetoceros muelleri

3.4.3 Saccostrea glomerata Exposure to Phytoplankton

3.5 Metal Analysis

3.5.1 Sediment Metal Analysis

3.5.2 Chaetoceros muelleri Metal Analysis

3.5.3 Oyster Metal Analysis

3.6 Effect Measurements

3.6.1 Assay Preparation

3.6.2 Total Antioxidant Capacity Assay (TAOC)

3.6.3 Thiobarbituric Acid Reactive Substances Assay (TBARS)

3.6.4 Protein Analysis

3.6.5 Lysosomal Destabilization

3.7 Statistical Analysis

Chapter 4 Results

4.1 Quality Assurance Results

4.1.1 Sediment Quality Assurance

4.1.2 Phytoplankton Quality Assurance

4.1.3 Oyster Tissue Quality Assurance

4.2 Cadmium-Spiked Suspended Sediments Experiment

4.2.1 Total Tissue Cadmium Concentrations

4.2.1.1 Cadmium Distribution

4.2.2 Water Column Cadmium Concentrations

4.2.2.1 Comparison between Cadmium Water Column and Oyster Tissue Concentrations
5.2.1 Roles of Antioxidant Enzymes and Non-enzymes with Oxidative Stress.............142

5.3 Thiobarbituric Acid Reactive Substances Biomarker ..............................................145
5.3.1 Oxidative Stress ..........................................................................................148

5.4 Lysosomal Destabilization ....................................................................................149
5.4.1 Oxidative Stress and Lysosomal Destabilization .........................................150
5.4.2 Lysosomal Destabilization Increase Due to Laboratory Settings ...............151

5.5 Cadmium Affects on Saccostrea glomerata ................................................................152
5.5.1 Cadmium Tissue Concentration in Relation to Cadmium-Induced Stress ..........................................................152
5.5.1.1 Cadmium Pathways: Dietborne versus Waterborne........................................153
5.5.2 Relevance of Laboratory Research in Relation to Field Situations ...............158
5.5.3 Relevance to Environmental Guidelines .........................................................163
5.5.3.1 Cd Water Column Concentrations .................................................................163
5.5.3.2 Surface Sediments & Suspended Sediments Cd Concentrations ............166
5.5.3.3 Cd Dietborne Pathway ..................................................................................166

Chapter 6 Synopsis ........................................................................................................168

6.1 Research Hypotheses Overview ........................................................................168
6.1.1 Suspended Sediments and Phytoplankton Experiments with Tissue Concentration ......................................................168
6.1.2 Overall Stress Experienced by Saccostrea glomerata due to Cd-Exposure ......169
6.1.3 Cadmium-Dose-Response Relationship .........................................................170

Chapter 7 Future Research ........................................................................................173
List of Tables

Table 2.1: Marine Sources of Contamination and Untreated Sewage.................................4
Table 2.2: Sedimentary metal concentrations (µg/g) and metal enrichment in Georges River/Botany Bay & Port Jackson, New South Wales..............................................................9
Table 2.3: Complexed Forms of Cadmium Both in Sediment-Interfacial Seawater (a &b) & Soil (c).................................................................................................................................33
Table 2.4 Research with Saccostrea glomerata Cadmium Tissue Concentrations................46
Table 2.5 Research with High Saccostrea glomerata Cadmium Tissue Concentrations........47
Table 4.1: Sediment Quality Assurance..............................................................................97
Table 4.2: Phytoplankton Quality Assurance........................................................................97
Table 4.3: Oyster Tissue Quality Assurance........................................................................97
Table 4.4: Saccostrea glomerata Cadmium Accumulation from the Suspended Sediments Experiment.............................................................................................................................99
Table 4.5: Saccostrea glomerata Cadmium Accumulation from the Phytoplankton Experiment........................................................................................................................................118
Table 5.1: TBARS: MDA product levels in nmol/g protein or wet weight amongst bivalve species........................................................................................................................................146
Table 5.2: Water Concentration Guidelines Compared to Low & High-Cd SS Treatments....163
Table 5.3: Low & High-Cd SS Treatment Biomarker Responses, Tissue Concentrations, and Dissolved Cd Enrichment Factor..................................................................................165
List of Figures

Figure 2.1: River Contamination Sources and Industrial and Sewage Waste Plumes ...............6
Figure 2.2: Human Modified Australian Estuaries ...............................................................7
Figure 2.3: Essential vs. Non-Essential Metals ....................................................................12
Figure 2.4: Exposure-Fate Model .......................................................................................15
Figure 2.5: Cadmium Speciation Due to Salinity .................................................................20
Figure 2.6: *Crassostrea virginica* Respiration Graph (Heart Rate, beats per minute) Due to Temperature .............................................................................................................21
Figure 2.7: Cd Uptake Rate Constant in Relation to Dissolved Carbon ...............................23
Figure 2.8: Estuary Sedimentation & Sources of Suspended Sediments .............................25
Figure 2.9: Sediment Contaminant Hydrogeochemical Cycle Diagram .............................27
Figure 2.10: Example of Diatom & Growth after Cadmium Exposure ...............................35
Figure 2.11: Artificial oyster gut environment copper remained after the *Tetraselmis suecica* was exposed at different pH gradients .........................................................38
Figure 2.12: Biology of *Saccostrea glomerata* (Sydney Rock Oyster) ...............................50
Figure 2.13: *Crassostrea virginica* Digestive System .......................................................51
Figure 2.14: Intracellular Digestion .....................................................................................53
Figure 2.15: Oxygen Reduction Metabolism ......................................................................61
Figure 2.16: Non-Essential Metal Flow Chart: detoxification or non-detoxification that can result in antioxidant stress, lipid peroxidation, & lysosomal destabilization .......63
Figure 2.17: *Crassostrea gigas* Gill:Palp Ratio ..................................................................67
Figure 2.18: Organisms’ Genetic Response to Chemical Exposure ..................................72
Figure 3.1: Photo: Soil collection location at Bega River, New South Wales .......................79
Figure 3.2: Photo: Suspended sediment experiment design with conical shaped containers .................................................83
Figure 3.3: Photo: Continuous Culture of *Chaetoceros muelleri* dosed with [Cd$^{2+}$] 1.46 µg/L ........................................................................................................................................86
Figure 3.4: Photo: Phytoplankton experimental design .....................................................89
Figure 4.1: Boxplot of mean total cadmium tissue concentrations in µg/g dry weight for controls, Low & High-Cd SS treatments, and comparison between all SS treatments ......100-101
Figure 4.2: Suspended sediments experiment *S. glomerata* total mean tissue cadmium concentrations in whole tissue (hepatopancreas, visceral mass, mantle, & muscle) and gills in µg/g dry weight .............................................................................................................102-103
Figure 4.3: Suspended sediments experiment seawater samples cadmium concentrations .................................................................................................................105-106
Figure 4.4: Suspended sediments experiment oyster tissue cadmium in µg/g dry weight compared to dissolved cadmium (ug/l) in water column .................................................107
Figure 4.5: Suspended sediments experiment TAOC average results in mM/mg protein from all treatment replicates .........................................................................................108-110
Figure 4.6: Suspended sediments experiment TBARS average results in MDA nmol/mg protein from all SS treatment replicates .................................................................111
Figure 4.7: Suspended sediments experiment lysosomal destabilization results in percentage for all SS treatments ................................................................................................113
Figure 4.8: *Chaetoceros muelleri* Total Cadmium Accumulation over 28-days in µg/g for Bottle A & Bottle B............................115
Figure 4.9: *Chaetoceros muelleri* Continuous Growth Curve Bottle A & Bottle B.................116

Figure 4.10a: *S. glomerata* total tissue cadmium concentrations (µg/g dry weight) from 28-day phytoplankton cadmium exposure..............................................................................................................119

Figure 4.10b: *S. glomerata* whole tissue and gill tissue cadmium concentration (µg/g dry weight) from 28-day phytoplankton cadmium exposure.................................................................119

Figure 4.11: Phytoplankton experiment TAOC mean results in mmol/mg protein from all treatment replicates.........................................................................................................................121

Figure 4.12: Phytoplankton experiment TBARS average results in MDA nmol/mg protein from all treatment replicates................................................................................................................122

Figure 4.13: Phytoplankton experiment lysosomal destabilization results in percentage for pre-experiments, controls, and replicates.................................................................124-125

Figure 4.14: *S. glomerata* cadmium tissue concentrations in µg/g dry weight for whole tissue and gills in all treatments from suspended sediments and phytoplankton experiments........127

Figure 4.15: TAOC results in mM/mg protein for control and all cadmium treatments from suspended sediments and phytoplankton experiments.........................................................128

Figure 4.16: TAOC and Tissue Cadmium Concentrations........................................................................129

Figure 4.17: TBARS results in MDA nmol/mg protein for control and all cadmium treatments from suspended sediments and phytoplankton experiments...........................................130

Figure 4.18: TBARS and Tissue Cadmium Concentrations................................................................131

Figure 4.19: TBARS and TAOC Comparison Graph.........................................................................132

Figure 4.20: Lysosomal destabilization results in percentage from suspended sediments and phytoplankton experiments.........................................................................................133

Figure 4.21: Lysosomal destabilization (%) response compared to average cadmium tissue cadmium concentrations from suspended sediments and phytoplankton experiments........134

Figure 4.22: Lysosomal destabilization and TAOC........................................................................135

Figure 4.23: Lysosomal destabilization and TBARS......................................................................136
List of Appendices with Appendices’ Table & Figures

Appendix I: Coastal Energy..............................................................................................................199
  Figure I: Categorization of coastal areas that includes estuaries.................................................200
Appendix II: Saccostrea glomerata Distribution & Mining Locations..............................................201
  Figure II a: Saccostrea glomerata (Sydney Rock Oyster) Australia Distribution &
Locations of Sources of Contaminants......................................................................................201
  Figure II b: Uranium Mines and Tailing Deposits in Northern Territory.................................202
Appendix III: Oyster Measurements Before and After Experiments...........................................203-209
  Table III: Suspended Sediments Experiment Replicate #1 for controls, Low-Cd
  & High-Cd SS Treatments (Prior to Experiment).......................................................................203
  Table III A: Suspended Sediments Experiment Replicate #2 for controls, Low-Cd
  & High-Cd SS Treatments (Prior to Experiment).......................................................................204
  Table III B: Suspended Sediments Experiment Replicate #3 for controls, Low-Cd
  & High-Cd SS Treatments (Prior to Experiment).......................................................................205
  Table III C: Suspended Sediments Experiment Oyster Size and Weight,
  Pre-Experiment Measurements.................................................................................................206
  Table III D: Suspended Sediments Experiment Replicate #1 for controls, Low-Cd
  & High-Cd SS Treatments (After to Experiment)......................................................................207
  Table III E: Suspended Sediments Experiment Replicate #2 for controls, Low-Cd
  & High-Cd SS Treatments (After to Experiment)......................................................................208
  Table III F: Suspended Sediments Experiment Replicate #3 for controls, Low-Cd
  & High-Cd SS Treatments (After to Experiment)......................................................................209
Appendix IV: Seawater Measurements (ph, temperature, conductivity, and turbidity)..........210-213
  Table IV: Suspended Sediments Experiment Seawater Measurements.................................210-211
  Table IV A: Phytoplankton Experiment Measurements for Controls.................................212
  Table IV B: Phytoplankton Experiment Measurements for Replicates.................................213
Appendix V: Alga Counts.................................................................................................................214
  Table V: Chaetoceros muelleri Algae Counts.............................................................................214
  Table V A: Tetraselmis chuii Algae Counts...............................................................................214
Appendix VI: Grain Size Analyses Results....................................................................................215-216
Appendix VII: Bega River Soil Samples Analyzed for Cadmium Before and After
Suspended Sediments Experiment...............................................................................................217
  Table VII: Pre-Experiment Soil Samples..................................................................................217
  Table VII A: Cadmium-Spiked Soil Samples..........................................................................217
  Table VII B: Post-Experiment Soil Samples............................................................................217
Appendix VIII: ANOVA Results .....................................................................................................218-241
  Table VIII: Suspended Sediments Treatments and Total Tissue Cadmium
  Concentrations.........................................................................................................................218
  Table VIII A: Low & High-Cd SS ANOVA between each treatments replicates
  with tissue cadmium concentrations.......................................................................................219
  Table VIII B: Low-Cd SS ANOVA between each treatments replicates with gill
  and whole tissues.....................................................................................................................220
  Table VIII C: High-Cd SS ANOVA between each treatments replicates with gill
  and whole tissues.....................................................................................................................221
Table VIII D: Suspended Sediments Treatments and Seawater Cadmium Concentrations........................................................................................................222
Table VIII E: Suspended Sediments Treatments and TAOC Results..................223
Table VIII F: TAOC ANOVA with control treatments between control replicates.....224
Table VIII G: TAOC ANOVA with High-Cd SS Treatments between treatment replicates........................................................................................................225
Table VIII H: Suspended Sediments Treatments and TBARS Results..................226
Table VIII I: Suspended Sediments Treatments and Lysosomal Destabilization........227
Table VIII J: Phytoplankton Experiment Replicates and Total Tissue Cadmium Concentrations........................................................................................................228
Table VIII K: Phytoplankton Experiment Replicates and TAOC Results..............229
Table VIII L: Phytoplankton Experiment Replicates and TBARS Results.............230
Table VIII M: Phytoplankton Experiment Replicates and Lysosomal Destabilization........................................................................................................231
Table VIII N: Phytoplankton Experiment Lysosomal Destabilization between Control replicates........................................................................................................232
Table VIII O: Suspended Sediments and Phytoplankton Experiments and Total Tissue Cadmium Concentrations........................................................................233-234
Table VIII P: Suspended Sediments and Phytoplankton Experiments and Cadmium Distribution Concentrations...........................................................................235
Table VIII Q: Suspended Sediments and Phytoplankton Experiments and TAOC Results........................................................................................................236-237
Table VIII R: Suspended Sediments and Phytoplankton Experiments and TBARS Results........................................................................................................238-239
Table VIII S: Suspended Sediments and Phytoplankton Experiments and Lysosomal Destabilization..............................................................................240-241
Objectives & Hypotheses

Objectives of this research were to:

1) Understand how *Saccostrea glomerata* accumulates cadmium,

2) Determine how much stress is caused by cadmium to *Saccostrea glomerata* through measuring the total antioxidant capacity, lipid peroxidation, and lysosomal destabilization.

3) Determine the most important pathway by which cadmium is obtained by *Saccostrea glomerata* in relationship to metal toxicity.

Similarly, these questions are to aid in addressing the objectives of the research:

4) At what concentration of cadmium do you first see the signs of response?

5) At what amount of cadmium do you see the least and greatest effects? Is this linear?

6) How much cadmium will the oyster uptake through a diet of algae?

7) How can these research results be related back to the estuary environment?

The hypotheses are:

[H1]: *Saccostrea glomerata* can accumulate cadmium from suspended sediments.

[H2]: Accumulation of cadmium from sediments results in a decreased antioxidant capacity, and an increase in lipid peroxidation and in lysosomal destabilization.

[H3]: *Saccostrea glomerata* can accumulate cadmium from phytoplankton.

[H4]: Accumulation of cadmium from phytoplankton results in a decreased antioxidant capacity and an increase in lipid peroxidation and in lysosomal destabilization.