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Accessory publication – Pb, Cd, Zn, Ni

Modelling copper uptake by *Saccostrea glomerata* with diffusive gradients in a thin film measurements

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Experimental

- Tissue digestion recoveries for all other metals studied: 80 ± 1% for Pb; 100 ± 10% for Ni; 93 ± 4% for Cd; and 120 ± 0% for Zn.
- Water samples analysed at Australian Laboratory Services, Brisbane. Reported detection limits: 0.15 μg L^{-1} for Ni; 0.47 μg L^{-1} for Zn; and 0.12 μg L^{-1} for Pb and Cd (Table A1).

Field measurement of bioaccumulation rates

- Fig. A1 shows the instances in which metals were not continually bioaccumulated within *Saccostrea glomerata*. Most of the time-series actually exhibit a general decrease in metal concentrations (usually over 2–3 weeks) before stabilising around a lower concentration than that measured in the control oysters (Cd at all three sites, Pb at Eph. Is., and Ni at RBM and MS). Some of the other series remained relatively constant (Ni in Eph. Is., Zn at all sites, except for RBM in which there was an increase after 28 days) indicating that the metal levels to which the oysters were exposed were similar to those at the commercial oyster farm at Redland Bay, Brisbane. Pb at MS increased initially before levelling off and decreasing after 21 days. The Zn responses in RBM are likely to be related to a rainfall event (63 mm) that occurred over the 7 days leading up to Day 28. Urban run-off may have caused the Zn mass accumulated to increase. A slight increase in tissue burden can be seen at Day 28 for Cd at RBM as well. The tissue burden is seen to decrease within 2 weeks for both Zn and Cd.
- *Saccostrea glomerata* laboratory uptake rates have not been determined experimentally for Cu but have been for Zn and Cd.[30] At ambient concentrations (10 μg L^{-1} for Zn and 0.5 μg L^{-1} for Cd) similar to background levels in the present study, the influx rates of Zn (13 μg g^{-1} d^{-1}) and Cd (0.15 μg g^{-1} day^{-1}) were higher than those reported for field deployments in the present study for Cu and Pb respectively, although they are still quite comparable.[30] The uptake rate of Cu and Pb has been determined experimentally for the mussel *Mytilus edulis*.[28] At comparable ambient concentrations (i.e. 5 μg L^{-1} for Cu and 10 μg L^{-1} for Pb), the rate of Cu (1.6 μg g^{-1} day^{-1}) and Pb (3.3 μg g^{-1} day^{-1}) accumulation in the mussels was quite similar to rates in the current study.

- Loss of assimilated Zn and Cd over a 30-day period in *Saccostrea glomerata* has been reported to be only ~10 and 20% respectively,[30] which is similar to our findings. After the initial egestion of unassimilated Zn and Cd in the present study, the tissue concentrations were relatively stable or decreased much more slowly (Fig. A1). It is thought that *S. glomerata* is a strong bioaccumulator of Zn and Cd primarily owing to the low efflux rate in conjunction with relatively high AEs of 34–65% and 30–67% respectively,[30] depending on the food source. Many of the other factors controlling bioaccumulation in *S. glomerata* have not been determined experimentally, especially those influencing the absorption efficiency from the dissolved phase.

- Despite comparable affinities for bioaccumulating Cd and Zn in *Saccostrea glomerata*, the bioaccumulated Cd concentrations were found to be considerably lower over the 6-week period (Fig. A1). This is a consequence of the far lower ambient concentrations of Cd, which are not displayed in Table A1 as they were reported below the method LOD (0.12 μg L^{-1}) in each case.

Table A1. Mean acid-soluble and 0.45-μm-filterable concentrations and the mean proportions of the total concentration measured as the 0.45-μm-filterable fraction from all sites during the preliminary study

Concentrations above Australian water quality guidelines (95% protection) are in bold. Relative standard deviation (RSD%) displayed in parentheses

Site	Acid-soluble and 0.45-μm-filterable metal concentrations (μg L^{-1})							
	Copper		Zinc		Lead		Nickel	
	0.45 μm	Total	0.45 μm	Total	0.45 μm	Total	0.45 μm	Total
MS (n = 6)	0.78	0.95	5.1	7.2	0.27	0.12	0.38	0.36
	(10)	(6.2)	(41)	(52)	(54)	(26)	(7.2)	(8.9)
0.45 μm (%)	82		71		>100		100	
RBM (n = 13)	**3.8**	**4.8**	10	10	0.12	0.14	0.44	0.61
	(32)	(31)	(75)	(49)	(64)	(43)	(17)	(34)
0.45 μm (%)	79		99		90		72	
Eph Is. (n = 4)	0.70	0.96	**16**	**24**	0.15	0.15	0.36	0.47
	(65)	(48)	(120)	(95)	(68)	(31)	(28)	(27)
0.45 μm (%)	73		67		98		77	

Figure A1. Mean time-series bioaccumulation and loss of Pb, Cd, Ni and Zn at Marine Stadium, Runaway Bay Marina and Ephraim Island during the preliminary study.