

**The ecology of the grazing urchin *Echinometra mathaei* at
Ningaloo Marine Park.**



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Declaration

I declare that this thesis is a record of my own research and contains work that has not been presented for the award of any degree at another tertiary institution.

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Abstract

Sea urchins can have a significant influence upon the ecological structure of coral reefs through both bioerosion of substrata and by affecting competition for space. Loss of reef structure can limit space for algal and coral recruitment which further alters the balance between reef growth and reef destruction. Urchins are important grazers in many marine systems and can cause major ecosystem changes when their numbers reach high levels (generally after a decline in the numbers of their fish predators). However, the relative importance of the role of urchins in influencing the composition and structure of coral reef habitats has rarely been explored.

This thesis investigated the habitat preferences, distribution, grazing, bioerosion, and behaviour of the grazing urchin *Echinometra mathaei* at Ningaloo Marine Park (NMP), Western Australia. Coral reef habitats of the NMP were characterised using field surveys and validations of broad-scale hyper-spectral benthic habitat maps; the effects of habitat type and different closure regimes (e.g. Sanctuary zones) on urchin distribution and abundance were then examined and compared. This thesis represents the first study to quantify the grazing and consequent bioerosion rates of *E. mathaei* at Ningaloo Reef and the first to study their animistic behaviour and diurnal movement patterns.

Data were collected from over 100 sites within the Marine Park, focussing on near shore, lagoonal and back reef areas within Sanctuary zones and adjacent Recreation zones. Data analyses indicated that the distribution of urchins was variable and appears not to be affected by the management zones of the park (i.e. no significant evidence has been found of indirect effects from fishing of known urchin predators).

However, habitat type had a major influence on urchin distribution; urchin abundances were higher on nearshore intertidal and sub-tidal reef platforms, lagoonal patch reefs and shallow backreef platforms than in other habitats. Data analysis showed strong positive correlations between urchin densities and habitats that contained turf algae, and a combination of limestone pavement and turf algae.

Grazing and bioerosion studies demonstrated that although *E. mathaei* grazing plays an important ecological role, concomitant bioerosion may play a more central role in influencing the structure of coral reef communities than grazing at the NMP. Urchin, morphometrics and gut content analyses from different habitats in four regions of the NMP indicated higher mean urchin densities, size and subsequent bioerosion rates in southern regions than in the north of the park. Bioerosion rates from Ningaloo Reef (1.0 - 4.5 kg m⁻² year⁻¹ of CaCO₃) were found to be comparable to degraded (overfished) reef systems in other parts of the world, but without accurate estimates of CaCO₃ accretion rates it is difficult to determine the degree to which bioerosion is affecting reef growth at the NMP or if it is any more or less significant than in other parts of the world. Results from this study suggest that habitats at Ningaloo with high *E. mathaei* densities are more likely to be niche habitats that co-exist with other coral reef habitats as part of a healthy ecosystem.

Video footage of diurnal movement revealed that *E. mathaei* did not leave their burrows to graze but were systematically “gardening” turf within longitudinal burrows at night and sheltering from predators during the day. Observations of animistic behaviour experiments showed that they would also defend their burrows when threatened by intruding conspecifics but the majority of interactions would result in

urchins coexisting in the same longitudinal burrow. This type of territorial grazing behaviour within long, tube-like burrows has been documented for other urchin species (e.g. the northern Atlantic echinoid, *E. lucunter*) but never for *E. mathaei*. Defence of (and sharing of) longitudinal burrows may also be associated with other predation avoidance behaviour.

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Table of Contents

DECLARATION	I
ABSTRACT	II
ACKNOWLEDGEMENTS	V
LIST OF TABLES	IX
LIST OF FIGURES	XII
1: GENERAL INTRODUCTION	1
1.1 SEA URCHINS	3
1.2 THE TROPHIC EFFECTS OF URCHIN HERBIVORY AND BIO-EROSION	5
1.3 MARINE PROTECTED AREAS	8
1.4 NINGALOO MARINE PARK	9
1.5 THESIS AIMS AND OVERVIEW	11
2: CHARACTERISATION OF LAGOONAL CORAL REEF HABITATS IN NINGALOO MARINE PARK	14
2.1 INTRODUCTION	14
2.1.1: <i>Remote sensing</i>	15
2.1.2: <i>Habitat mapping at Ningaloo Marine Park</i>	17
2.2 METHODS	19
2.2.1 <i>Study area</i>	19
2.2.2 <i>Sampling approach and sites</i>	20
2.2.3 <i>Additional habitat surveys</i>	23
2.2.4 <i>Data analysis</i>	28
Mapping Validations	28
Habitat data homogeneity.....	29
Multivariate analyses	29
2.3 RESULTS	31
2.3.1 <i>Site Characteristics</i>	32
(a) NW Cape Region	32
(b) Tantabiddi to Yardie Creek Region	34
(c) Point Cloates Region	39
(d) Coral Bay Region	40
(e) South Ningaloo Region.....	42
2.3.2 <i>Multivariate analyses - substrate composition</i>	46
a) Comparisons between regions.....	46
b) Comparisons between management zones.....	48
c) Comparisons between areas within lagoonal regions	49
2.4 DISCUSSION	52
3: MACROINVERTEBRATE DISTRIBUTION AND ABUNDANCE IN NINGALOO MARINE PARK (FOCUSSING UPON SEA URCHINS)	62
3.1: INTRODUCTION	62
3.1.1: <i>Larval dispersal, settlement and recruitment</i>	62
3.1.2: <i>Environmental factors (habitat)</i>	63
3.1.3: <i>Anthropogenic factors</i>	65
3.1.4: <i>Competition (for space)</i>	66
3.2 FIELD SURVEYS: MATERIALS AND METHODS	69
3.2.1 <i>Study site descriptions</i>	69
3.2.2 <i>Sampling approach</i>	69
3.2.3 <i>Additional habitat surveys</i>	70
3.2.4 <i>Data analysis</i>	75
Macroinvertebrate data homogeneity	75
Multivariate analyses	75
Univariate analysis	76
Correlations: Habitat types v Macroinvertebrate densities	76
3.3 RESULTS	76
3.3.1 <i>Macroinvertebrate surveys</i>	76

(a) NW Cape Region	77
(b) Tantabiddi to Yardie Creek Region	77
(c) Point Cloates Region	80
(d) Coral Bay Region	81
(e) South Ningaloo Region.....	84
3.3.2 <i>Multivariate analyses – Macroinvertebrates</i>	87
a) Comparisons between regions.....	88
b) Comparisons within regions and sub-regions (Sanctuary v Rec zones).....	91
c) Comparisons between locations within lagoonal regions.....	94
d) Correlations: Habitat types v Macroinvertebrate densities.....	94
3.4 DISCUSSION	97
4: FIELD EXPERIMENTS: URCHIN HERBIVORY AND BIOEROSION	103
4.1 INTRODUCTION	103
4.2 METHODS: IN SITU CAGE EXPERIMENTS.....	108
4.2.1 <i>Study site descriptions: Coral Bay</i>	108
4.2.2 <i>Experimental design: initial issues and solutions</i>	110
Pilot Study.....	110
Issues.....	111
Solutions: Cage and settlement tiles experimental design.....	112
4.2.3 <i>Data analysis</i>	116
4.3 METHODS: GUT CONTENT ANALYSES AND URCHIN MORPHOMETRICS.....	116
4.3.1 <i>Study site descriptions</i>	116
4.3.2 <i>Sampling design and methods</i>	118
4.3.3 <i>Data analysis</i>	120
Morphometrics.....	120
Gut content (organic composition).....	120
Gut content (fractional composition - organic, CaCO ₃ and inorganic residue).....	120
Bioerosion rates.....	121
4.4 RESULTS: IN SITU CAGE EXPERIMENTS	121
4.4.1 <i>Temporal and spatial changes in algal cover</i>	121
4.4.2 <i>Univariate comparisons (ANOVA)</i>	123
4.5 RESULTS: GUT CONTENT ANALYSES AND URCHIN MORPHOMETRICS	125
4.5.1 <i>Comparisons of urchin size, weight and gut fullness between regions</i>	125
a) Lighthouse Bay	125
b) Point Cloates.....	125
c) Coral Bay	125
d) Red Bluff	125
Data Analysis	127
4.5.2 <i>Comparisons of urchin gut content between sampling sites</i>	130
4.5.3 <i>Bioerosion rates</i>	135
4.6 DISCUSSION	138
5: FIELD EXPERIMENTS: URCHIN BEHAVIOUR.	148
5.1: INTRODUCTION	148
5.2 MATERIALS AND METHODS.....	152
5.2.1 <i>Study site description</i>	152
5.2.2 <i>Materials</i>	153
a) Underwater video system.....	153
b) Time-lapse photography	154
5.2.3 <i>Sampling design and methods</i>	154
a) Underwater video system.....	154
b) Time-lapse photography	156
5.2.4 <i>Data analysis</i>	156
a) Underwater video analysis	156
b) Time-lapse photography analysis.....	156
5.3 RESULTS	157
5.3.1 <i>Underwater video - diurnal movement</i>	157
5.3.2 <i>Time-lapse photography – animistic behaviour</i>	161
5.4 DISCUSSION	162
6: GENERAL DISCUSSION.....	167
REFERENCES	174

List of Tables

Table 2.1: Benthic life form categories used for substrate cover identification in the field (English et al. 1994, Abdo et al. 2004).....	22
Table 2.2: Sampling effort for mapping validations at Ningaloo Marine Park 2008..	23
Table 2.3: Condensed substrate categories and descriptive definitions (adapted from Abdo <i>et al.</i> , 2004).....	30
Table 2.4: Ningaloo Marine Park Major regions and sub-regions, North to South (* indicates regions with lagoonal areas)	31
Table 2.5: Regional Summary: Substrate % cover from Tantabiddi - Yardie Creek..	37
Table 2.6: Pairwise ANOSIM comparisons between sub-regions (where $R > 5.0$), NW = Northwest Cape, Rd Blf = Red Bluff, Gn = Gnaraloo, T-Y = Tantabiddi to Yardie creek. F = Cape Farquhar * Denotes significant R statistic.....	47
Table 2.7: Regional SIMPER results output – substrate category comparisons between sub-regions, indicating average abundance, dissimilarity and % contribution of categories. NW = Northwest Cape, Rd Blf = Red Bluff, Gn = Gnaraloo, T-Y = Tantabiddi to Yardie creek. F = Cape Farquhar.	48
Table 2.8: Tantabiddi to Yardie Creek Region: SIMPER results output for substrate category comparisons between backreef and nearshore areas, indicating average abundance, dissimilarity and % contribution of categories.....	50
Table 3.1: Regional SIMPER results output – North West Cape v Tantabiddi to Yardie Creek.....	89
Table 3.2: Regional SIMPER results output – South Ningaloo v Tantabiddi to Yardie Creek.....	90
Table 3.3: Management zoning SIMPER results output – Coral Bay (Maude Sanctuary).....	91
Table 3.4: Management zoning SIMPER results output – Ningaloo south (Gnaraloo Sanctuary).....	93
Table 3.5: Results of 2-way ANOVA on invertebrate densities, with invertebrates and area (backreef or nearshore) as factors; $n = 6$, $\alpha = 0.05$. ** denotes a significant result.....	94
Table 3.6: Significant results of Pearson Correlation Tests for Urchins v Habitat type. LP = Limestone Pavement, all correlations are significant ** ($n = 103$)..	96

Table 4.1: Change in algal cover on recovered settlement tiles expressed as dry weight ($\pm 0.001\text{g}$) and % change ($\pm 0.001\%$) for each treatment and location (in or out of <i>E. mathaei</i> burrows). Negative values indicate a net loss of algae.....	122
Table 4.2: Results of 2-way ANOVA on the changes in algal cover, with treatments (control, open and closed cages) and burrows (in or out) as factors; $n = 33$, $\alpha = 0.05$	124
Table 4.3: Results of 3-way ANOVA on the temporal changes of dried tile weights, with time (before and after), treatments (control, open and closed cages) and burrows (in or out) as factors; $n = 33$, $\alpha = 0.05$. ** denotes a significant result.....	124
Table 4.4: Results of one way ANOVA between regions with urchin size (test diameter and test height), weight and gut fullness as dependent variables; $n = 40$, $\alpha = 0.05$. * denotes a significant result.....	127
Table 4.5: Results of Dunnett's T3 post hoc pair wise comparisons between regions with urchin size (test diameter and test height), weight and gut fullness as factors; $n = 40$, $\alpha = 0.05$. * denotes a significant result.....	129
Table 4.6: Regional breakdown of dominant functional groups (most dominant algae is ranked 1, x = not ranked for that region) in gut content samples collected at the NMP; $n = 40$	131
Table 4.7: Results of one way ANOVA between regions with composition (organic, CaCO_3 and residue) as dependent variables; $n = 40$, $\alpha = 0.05$. * denotes a significant result.....	133
Table 4.8: Results of Dunnett's T3 post hoc pair wise comparisons between regions with urchin fractional gut composition (organic, CaCO_3 and residue) as dependent variables; $n = 40$, $\alpha = 0.05$. * denotes a significant result...	134
Table 4.9: Regional and overall urchin densities, CaCO_3 consumption and subsequent mean bioerosion rates ($\text{g m}^{-2} \text{day}^{-1}$ and $\text{Kg m}^{-2} \text{Year}^{-1}$ of CaCO_3 , ± 1 SE).....	136
Table 4.10: <i>E. mathaei</i> size, density (abundance) and bioerosion rates at similar coral reef habitats in different locations. Adapted from Carreiro-silva and McClanahan (2001).....	137
Table 5.1: Daily breakdowns of video footage indicating number of files, length of footage and number of urchins observed for each time period (day, night, sunrise and sunset) on each day.....	156
Table 5.2: Results of one way ANOVAS comparing total individual urchin movement between Day and Night and hourly individual movement rates between Day, Night and Sunrise time periods (D = Day, N = Night, SR = Sunrise) $\alpha = 0.05$. * denotes a significant result.....	159

Table 5.3: Results of animistic behaviour experiment in *E. mathaei* burrows at Coral Bay. Number of observations and (percentages) are presented for each interaction type and outcome, (n = 21).....160

List of Figures

Figure 1.1: Locality map of Ningaloo Marine Park & Muiron Islands (including DEC zoning scheme) (CALM 2005).....	10
Figure 2.1: Sampling overview - NW Cape to Red Bluff.....	24
Figure 2.2: Sampling sites - Coral Bay Region.....	25
Figure 2.3: Sampling sites - NW Cape to Yardie Creek.....	26
Figure 2.4: Sampling sites - Cape Farquhar to Red Bluff.....	27
Figure 2.5: Sampling sites - Point Cloates Region.....	28
Figure 2.6: Percent cover of benthic habitats at Bundegi, using broad sampling categories.....	32
Figure 2.7: Percent cover of benthic habitats north of Jurabi, using broad sampling categories.....	33
Figure 2.8: Regional overview of percent cover of substrate types in the nearshore habitats in the Tantabiddi to Yardie Creek region.....	34
Figure 2.9: Regional overview of percent cover of substrate types in the lagoonal habitats in the Tantabiddi to Yardie Creek region.....	35
Figure 2.10: Regional overview of percent cover of substrate types in the back reef habitats in the Tantabiddi to Yardie Creek region.....	36
Figure 2.11: Regional overview of percent cover of substrate types in the backreef and nearshore habitats in the Point Cloates region.....	39
Figure 2.12: Regional overview of percent cover of substrate types in the nearshore habitats in the Coral Bay region.....	41
Figure 2.13: Regional overview of percent cover of substrate types in the lagoonal habitats in the Coral Bay region.....	41
Figure 2.14: Regional overview of percent cover of substrate types in the back reef habitats in the Coral Bay region.....	42
Figure 2.15: Regional overview of percent cover of substrate types in the nearshore habitats in the Cape Farquhar region.....	43
Figure 2.16: Regional overview of percent cover of substrate types in the nearshore habitats in the Gnarlloo Bay region.....	44

Figure 2.17: Regional overview of percent cover of substrate types in the nearshore habitats in the 3 mile region.....	45
Figure 2.18: Regional overview of percent cover of substrate types in the nearshore habitats in the Red Bluff region.....	46
Figure 2.19: nMDS plot indicating differences in substrate community composition of benthic habitats between nearshore (N) and backreef (B) areas in the Tantabiddi to Yardie Creek region.....	49
Figure 3.1: Sampling overview - NW Cape to Red Bluff.....	71
Figure 3.2: Sampling sites - Coral Bay Region.....	72
Figure 3.3: Sampling sites - NW Cape to Yardie.....	73
Figure 3.4: Sampling sites - Cape Farquhar to Red Bluff.....	74
Figure 3.5: Sampling sites - Point Cloates Region.....	75
Figure 3.6: Densities of key macroinvertebrate groups in the nearshore habitat north of Jurabi Point.....	77
Figure 3.7: Densities of key macroinvertebrate groups in all habitats in the Tantabiddi to Yardie Creek region.....	78
Figure 3.8: Densities of key macroinvertebrate groups in the nearshore habitat in the Tantabiddi to Yardie Creek region.....	78
Figure 3.9: Densities of key macroinvertebrate groups in the lagoonal habitat in the Tantabiddi to Yardie Creek region.....	79
Figure 3.10: Densities of key macroinvertebrate groups in the back reef habitat in the Tantabiddi to Yardie Creek region.....	80
Figure 3.11: Densities of key macroinvertebrate groups in backreef and nearshore habitats in the Point Cloates region.....	81
Figure 3.12: Densities of key macroinvertebrate groups in all habitats in the Coral Bay region.....	81
Figure 3.13: Densities of key macroinvertebrate groups in the nearshore habitat in the Coral Bay region (Maud Sanctuary zone).....	82
Figure 3.14: Densities of key macroinvertebrate groups in the nearshore habitat in the Coral Bay region (southern recreational zone).....	82
Figure 3.15: Densities of key macroinvertebrate groups in the lagoonal habitat in the Coral Bay region (Maud Sanctuary zone).....	83

Figure 3.16: Densities of key macroinvertebrate groups in the lagoonal habitat in the Coral Bay region (southern recreational zone).....	83
Figure 3.17: Densities of key macroinvertebrate groups in the back reef habitat in the Coral Bay region.....	84
Figure 3.18: Densities of key macroinvertebrate groups in the nearshore habitat in the Cape Farquhar region.....	85
Figure 3.19: Densities of key macroinvertebrate groups in the nearshore habitat in the Gnarlloo region.....	85
Figure 3.20: Densities of key macroinvertebrate groups in the nearshore habitat in the 3mile region.....	86
Figure 3.21: Densities of key macroinvertebrate groups in the nearshore habitat in the Red Bluff region.....	87
Figure 3.22: nMDS plot indicating differences in macroinvertebrate composition of nearshore benthic habitats between regions (North West Cape (NW) vs. Tantabiddi to Yardie Creek (T-Y)).....	88
Figure 3.23: nMDS plot indicating differences in macroinvertebrate composition of nearshore benthic habitats between regions (Tantabiddi to Yardie Creek (blue) and South Ningaloo (red)).....	90
Figure 3.24: nMDS plot indicating differences in macroinvertebrate composition of nearshore benthic habitats between sanctuary (S) and recreation (R) zones in the Coral Bay region.....	91
Figure 3.25: nMDS plot indicating differences in macroinvertebrate composition of nearshore benthic habitats between sanctuary (S) and recreation (R) zones in the Gnarlloo region.....	93
Figure 3.26: Scatter plot with +ve trend line for urchin density v turf algae (n = 103).	95
Figure 3.27: Scatter plot with +ve trend line for urchin density v limestone pavement (LP), (n = 103).....	95
Figure 3.28: Scatter plot with +ve trend line for urchin density v LP + turf algae (n = 103).....	95
Figure 3.29: Scatter plot with –ve trend line for urchin density v sand (n= 103).....	95
Figure 4.1: Sampling sites – two locations (one lagoonal patch reef and one nearshore subtidal platform) south of Coral Bay.....	109
Figure 4.2: Photograph of typical <i>E. mathaei</i> longitudinal burrows on a lagoonal patch reef near Coral Bay, Western Australia.....	110

Figure 4.3: Examples of <i>in situ</i> tile experimental treatments used outside burrows (a) control (b) open and (c) closed cage.....	114
Figure 4.4: Photograph of <i>E. mathaei</i> in the process of removing a caged treatment from its burrow (note the galvanised concrete nail has been dislodged).....	115
Figure 4.5: Location of collection sites at Ningaloo Marine Park. <i>E. mathaei</i> were collected (n=20) from each site in December 2011.....	117
Figure 4.6: The mean change in algal cover (dry weight \pm 1SE) for treatments outside and inside of <i>E. mathaei</i> burrows at Coral Bay, March-June 2011.....	123
Figure 4.7: Regional comparison of urchin morphometrics (mean \pm 1 SE) for a) Test diameter (mm), b) Test height (mm), c) Wet weight (g) and d) Gut fullness (1-8).....	126
Figure 4.8: Regional comparisons (mean % \pm 1 SE) of fractional gut composition.	132
Figure 4.9: Regional comparisons (mean g \pm 1 SE) of fractional gut composition..	132
Figure 4.10: Mean (\pm 1SE) regional daily and annual urchin bioerosion rates.....	135
Figure 5.1: Diver positioning the stainless steel photo-quadrat frame with video camera, lights and cabling attached.....	154
Figure 5.2: Total daily urchin movements for day v night sampling periods.....	157
Figure 5.3: Total urchin movements for day, night, sunrise and sunset sampling periods, observed over eight days.....	158
Figure 5.4: Mean hourly frequency of movement (\pm 1 SE) for each time period, observed over eight days.....	159