Distribution, abundance and bioerosion of the grazing sea urchin *Echinometra mathaei* at Ningaloo Marine Park, Western Australia *

M W LANGDON [1*], M VAN KEULEN [1] & E I PALING [2]

[1] *School of Biological Sciences & Biotechnology, Murdoch University, South Street, Murdoch, WA, 6150, Australia.*

[2] *Sinclair Knight Merz, 263 Adelaide Terrace, Perth, WA 6001, Australia.*

* *Corresponding author ✉ m.langdon@murdoch.edu.au*

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 study investigated the habitat preferences, distribution, grazing, bioerosion and behaviour of the grazing urchin *Echinometra mathaei* at Ningaloo Marine Park, Western Australia. Coral reef habitats of the Ningaloo Marine Park were characterised using field surveys and validations of broad-scale hyperspectral 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 is 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, focusing on nearshore, lagoonal and backreef 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 subtidal 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 Ningaloo Marine Park. Urchin morphometrics and gut content analyses from different habitats in four regions of the Ningaloo Marine Park 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 $CaCO_3$) were found to be comparable to degraded (overfished) reef systems in other parts of the world, but without accurate estimates of $CaCO_3$ accretion rates it is difficult to determine the degree to which bioerosion is affecting reef growth at the Ningaloo Marine Park 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 coexist 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.

ACKNOWLEDGEMENTS

MWL wishes to thank his PhD supervisors Mike van Keulen (Murdoch University) and Erik Paling (Sinclair Knight Merz); research assistants Fionna Cosgrove and Kimberly Marrs-Ekamper; Frazer McGregor and Lauren Jakson at Coral Bay Research Station; staff from DEC Exmouth; Murdoch University, Neil Loneragan and the CSIRO Wealth from Oceans Ningaloo Collaboration Cluster for financial support.

* Extended abstract of a paper presented at the Royal Society of Western Australia Postgraduate Symposium 2012 held at Curtin University on 29 September 2012.