Numerical modelling of the mean flow characteristics of the Leeuwin Current System.Michael J. Meuleners, Charitha B. Pattiaratchi and Gregory N. Ivey.

A numerical study of the eddying characteristics of the Leeuwin Current System. Michael J. Meuleners, Gregory N. Ivey and Charitha B. Pattiaratchi.

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3.3.2 Spatial patterns in sessile benthic sponge and ascidian communities of the Recherche Archipelago

Investigators / Institutions

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Introduction

The southwestern region of Western Australia is a relatively pristine environment of great diversity with high levels of endemism recognised in some groups of crustaceans and molluscs (Morgan & Wells, 1991). It is estimated that at least 60 percent of the Australian sponge fauna is undescribed, with the Demosponge fauna of temperate southwestern Western Australia being the most poorly known of all (Hooper & Lévi, 1994). Presently our knowledge of the sponge and ascidian fauna of the southwest is from a limited number of papers, most of which were published more than half a century ago (*e.g.* Lamarck, 1813-1814; Bowerbank, 1876; Lendenfeld, 1888). None of these early studies examined the fauna in the Esperance region and many of the publications only document fauna as far south as Albany. Indeed most of the historical collections were conducted in metropolitan waters (Cockburn Sound, Fremantle, Cottesloe and Rottnest Island). Poore (1995) has recorded high levels of endemic species in southern temperate regions of Australia and suggests that it is in the south that the majority of 'native' marine fauna resides. Yet for much of the temperate marine benthic fauna nothing is known of their distribution patterns or levels of endemism.

A recent 'biological survey of the major benthic habitats of the south coast' conducted by Colman (1997) in the Fitzgerald Biosphere Reserve identified 102 different sponges. Of this number, however, only one was identified to species level. The lack of taxonomic detail illustrates the importance of the present study in the Recherche Archipelago. There is an urgent need to correctly describe and quantify the sponge and ascidian communities. This study addresses the critical need for correct taxonomic identifications and statistically sound quantitative sampling of the sessile benthic communities from the Recherche Archipelago, and indeed the entire southwestern Australian region.

Aims/objectives

The primary goal of the proposed research is to provide a biological inventory of sessile benthic communities within the Recherche Archipelago and quantitatively identify the spatial patterns that exist within these communities. Within this goal there are three specific aims:

Study sites

In October 2002 fauna were collected from horizontal substrata at five islands: Black, Thomas, Woody, Figure of Eight, Mondrain Island. Habitats were sampled at sheltered and exposed sites, and at a range of depths: waters 0-10m, 10-20 m, and waters 20-25 m depth, with equal numbers of quadrats taken from each exposure and depth. As a result of the 2002 collections the sampling design was modified to capture habitats associated with vertical substrata in addition to the horizontal substrata. However, the addition of vertical substrata to the design effectively doubled the sampling and processing effort, and it was therefore decided that sampling would only occur at a single depth (between 10-20 m; generally 15 m). The 15 m depth was chosen as species diversity and numbers were greatest at this depth. This new sampling regime commenced at Figure of Eight and Mondrain Islands (Fig. 3.13). In October 2003 the final field trip sampled the more remote islands: Mart Group, Twin Peaks and Middle Island. These islands were sampled at sheltered and exposed sites, the single depth of 15m but sampled horizontal and vertical substrata.

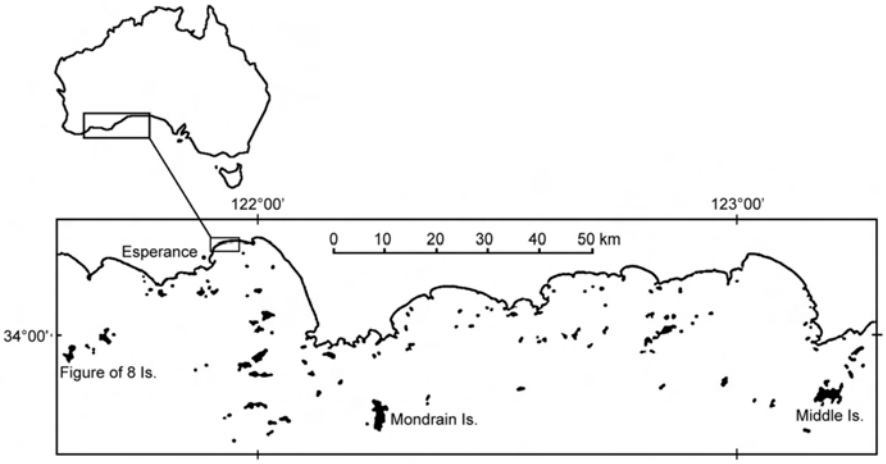

Figure 3.13: Map of the Recherche Archipelago study sites.

Aim 1. Describe the distribution and abundance of the sponge and ascidian dominated communities from the Recherche Archipelago

Major findings of aim 1:

Of the six phyla examined in this study, the sponges were the dominant taxa. Sponges represented approximately 72% of all fauna collected, bryozoans 10%, ascidians and sea-stars 7%, and hydroids and corals both 2%.

A total of 644 individual Demosponges were collected, representing 11 of the 15 orders of Demospongiae currently recognised. Demosponge orders were dominated by the Poecilosclerida and the Dictyoceratida, which in combination made up approximately 60% of the sponges identified to date. Sponges were consistently the most abundant organisms recorded for each island. No patterns in sponge community composition (using a full assemblage at order level) were associated with any of the factors tested (exposure, depth or substrata orientation). There were no significant differences in the number of sponges collected among exposures, depths or substratum orientation for the Chondrosidae,

Dictyoceratida, Hadromerida or the Halichondrida. The Astrophorida had significantly more individuals in exposed sites and significantly more on vertical substrata (Figure 3.14). The Dendroceratida also had significantly more individuals on vertical than on horizontal substrata. The Haplosclerida showed significant differences associated with increasing depth, with significantly more individuals at 20+ m depth. The Poecilosclerida had significantly fewer individuals with increasing depth, with more individuals in <10 m depth (Figure 3.15). The Poecilosclerida also had had significantly more individuals in exposed than sheltered sites.

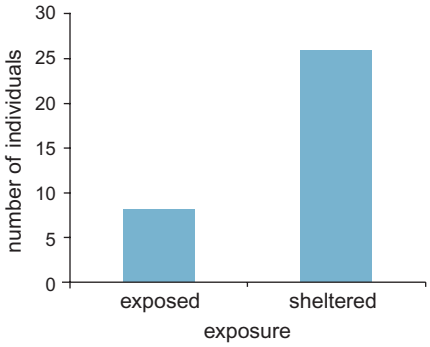

Figure 3.14: Number of Astrophorida individuals recorded from (a) exposed and sheltered sites (all islands (n=310 quadrats).

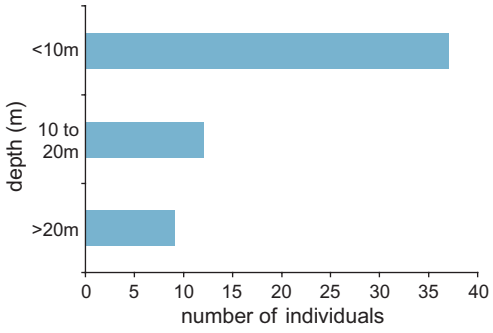

Figure 3.15: Decrease in the number of Poecilosclerid sponges with increasing depth.

Ascidian faunal structure differed at the island (kilometre scale; ANOSIM global R value: 0.32) (Figure 3.16) and regional scales (10-100 km; ANOSIM global R: 0.167).

There was no pattern in benthic assemblages associated with exposure (sheltered/ exposed)(global R value: -0.014) nor with substratum orientation (horizontal/ vertical)(global R value: 0.063).

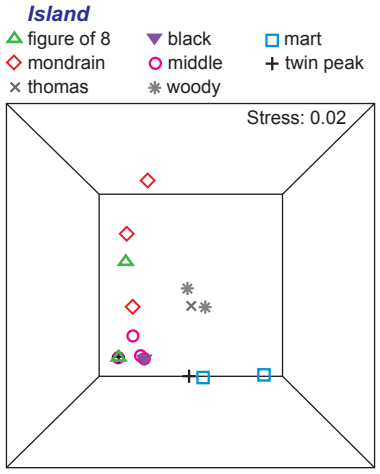

Figure 3.16: A two dimensional nMDS plot showing the pattern in ascidian assemblage across islands (100's m - km).

Ascidians were present in all three depth regimes sampled, however only one species, *Pyura gibbosa,* was recorded in all three depths. Ascidian fauna was numerically dominated by representatives of *Clavelina ostrearium* and *Herdmaina grandis*, which in combination made up approximately 69% of the ascidians recorded. *Herdmania grandis* showed a significant change with depth, individuals were completely absent at depths greater than 20 m (chi^2 10.7; chi^2 critical 5.99). *Clavelina ostrearium* and *Pyura spinifera* had the converse pattern no individuals present in shallow waters <10 m deep (chi^2 7.42 and 7 respectively; chi^2 critical 5.99).

The undescribed ascidian fauna consists mainly of colonial species, the majority of which are Didemnid species. The introduced pest *Ciona intestinalis* was recorded in Bandy Creek Harbour but was not observed at any of the sites targeted in this study.

Aim 2. Compile a taxonomic database of specimens collected during this study.

Major findings of aim 2:

A web-site has been constructed as part of the FRDC Recherché project and can be accessed from the http address below. This site has a page on the sponge and ascidian communities of the Recherche Archipelago.

http://www.marine.uwa.edu.au/recherche/

A web-based site specifically on the SRFME based research is currently under development. The site will outline the nature of the research and its primary findings. A menu page will list the fauna available for further examination. Users will then be able to select a desired subject *e.g.* seastars, and will be transferred to a seastar menu where they can browse a collection of thumbnail images. They then select the thumbnail image they are interested in and are provided with taxonomic and ecological information pertinent to that species. The database will be incorporated in FaunaBase on the website of the Western Australian Museum (WAM) (www.museum.wa.gov.au/FaunaBase), and will be accessible *via* this public interface and using web links from the UWA website. Note that an enormous number of species were collected and cannot all be processed during the scope of this study. As such only the most abundant species from each group will be available to web users.

Aim 3. Provide a comprehensive voucher collection of sponge, ascidian and associated macro invertebrate species from the region

Major findings of aim 3:

A comprehensive collection of sponge and ascidians has been collected through this study. The collection is very extensive, with 409 species of sponge, 11 species of ascidian, 12 species of seastar, 16 species of hydroid and over 100 species of bryozoan. Once all data processing has finalised the material will be deposited at WAM.

Discussion

The objectives of the study were to investigate the sessile benthic sponge and ascidian communities of the Recherche Archipelago and determine if there were any patterns associated with islands, exposure, depth, or substratum orientation.

Sponges were the dominant fauna and were highly diverse recorded from every island, exposure, depth and substrata orientation. There was considerable variation in the numbers of animals and the species richness among islands with no significant relationship evident between these factors recorded at any island. This suggests a fragmented distribution of sponge orders across all sites sampled.

Sponge composition using order level data differed with islands examined. Thomas and Middle Islands had individuals from nine orders, while Black and Twin Peak had only five orders present. There was, however, no difference in sponge composition between exposures indicating that orders were not exposure specific and occurred at both sheltered and exposed sites. There was a significant difference in the number of sponges, but not assemblage structure, associated with horizontal and vertical substrata.

The lack of differences in sponge assemblage structure among exposures, depths or orientation of substrata indicated that the distribution of sponge orders were not specific to

these categories. This was evident in orders such as the Poecilosclerida, which occurred at every island, exposure, depth and orientation. The absence of pattern may, however, be related to the use of high taxonomic (order) level data masking any lower taxonomic variation present at family or genus levels. For groups such as sponges which require considerable time and effort in processing for identification, it may be that lower taxonomic level species data would be required to identify any assemblage level patterns that may exist.

Univariate examination of individual orders revealed that the sponges were dominated by the orders Poecilosclerida and the Dictyoceratida, which combined made up approximately 60% of the sponges identified to date. The Poecilosclerida are one of the most species rich orders in the Demospongiae (akin to the Phaeophyta in the algal realm) and consequently it is not surprising that they were recorded in every island, exposure, depth and orientation, dominating the sponge fauna of the Recherche Archipelago. Despite the cosmopolitan nature of the Poecilosclerida, they exhibited distinct preferences for exposure and depth, with significantly more individuals recorded from exposed sites and shallow depths (< 10 m). Several other sponge orders such as the Astrophorida, Haplosclerida and Dendroceratida showed significant differences in abundance associated with exposure, depth or substratum orientation, indicating a distinct preference in these orders for a particular habitat.

The ascidian fauna identified to date was dominated by six species of solitary ascidia belonging to three families, the Cionidae, the Clavelinidae and the Pyuridae. Many samples are still to be identified and consist mainly of colonial ascidians belonging to the family Didemnidae. The species described in this study are common throughout much of Australia's southern temperate waters. See McDonald 2004 in References for more details of this group.

Ascidian faunal structure differed at the island scale. These differences in assemblage structure require further investigation, however they are likely to be linked to differences in an environment variables such as nutrient content of the surrounding water column. As with the sponge assemblages there was no pattern in ascidian assemblages associated with exposure nor with substratum orientation. Indicating that these animals are more influenced by larger landscape scale environmental factors such as nutrient availability than smaller habitat specific attributes.

Ascidians were present in all three depth regimes sampled, however only one species, *Pyura gibbosa,* was recorded in all three depths. Multivariate analysis divided the sites based upon their species compliment. The species *Clavelina ostrearium* were completely absent from shallow waters less than 10 m deep. This species has a soft gelatinous head situated upon a short flexible stalk. It is this soft structure that may restrict this species to the calmer waters greater than 10 m deep where they are less likely to be negatively influenced by wave action. The habitat and anatomy (thin test) of *C. ostrearium* may make it vulnerable to UV damage as with *Corella inflata*. The thicker test of *H. grandis* and the darker opaque tests of the Pyurid species may provide protection from UV damage.

Conclusions

The data in this report provides valuable baseline data on the distribution of benthic invertebrates within the Recherche Archipelago. Furthermore it provides data on the distribution patterns in these fauna and sponge morphologies across a range of spatial scales.

The results of this study raise several questions. Are the spatial patterns recorded in sponge and ascidian communities determined by larval behaviour and morphology, physically mediated patterns in recruitment or are their distinct physiologically parameters of each species that restrict them to depths? Larval behaviour is proposed to be one of the primary determinants of species distribution. Direct observations on the settlement and mortality of larvae would be the most accurate way to measure depth preference, however given the difficulties of such a study the approach used in this study of recording adult presence/absence indicates a distinct pattern of distribution that provides the basis for further investigation.

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McDonald J.I. (2004). Sponge and ascidian communities of the Recherche Archipelago Department of Conservation & Land Management (Marine Division) Lecture series, Fremantle, Western Australia.

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3.3.3 Understanding the natural variability of currents along the Western Australian coastline: Inter-annual variability of the Leeuwin Current

Investigators / Institutions

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Executive Summary

The Leeuwin Current is a warm, lower salinity, poleward flowing current, which flows along the continental shelf break of Western Australia and plays an important role in the region's marine environment and climate. The Current is driven by an alongshore steric height gradient, due to the meridional ocean cooling and the inter-connection between the Indian and Pacific oceans through the Indonesian Throughflow. In this study, the Simple Ocean Data Assimilation (SODA 1.4.2) reanalysis data for the 44-year period from 1958 to 2001 were used to determine the latitudinal variability of the Leeuwin Current along the coast of Western Australia in response to inter-annual variability. Results showed the alongshore slope was generally stronger (i.e. steeper slope) during La Niña years and weaker during El Niño years. The slope presented a positive (negative) linear trend during the PDO cool phase (warm phase). Composite maps also suggested the effect of ENSO was manifested in the simulated Leeuwin Current in the May–July period preceding the peak of ENSO in the Pacific Ocean and the response decays at higher latitudes.