



**EOCENE BRYOZOA OF THE ST VINCENT BASIN,
SOUTH AUSTRALIA –
TAXONOMY, BIOGEOGRAPHY AND PALAEOENVIRONMENTS**

Rolf Schmidt

B.Sc. (Hons.) Geology, 1996
University of Adelaide



Department of Geology and Geophysics
University of Adelaide

This thesis is submitted in fulfillment
of the requirements for the degree of
Doctor of Philosophy
in Geology
at the University of Adelaide

July 2003

ABSTRACT

The first extensive and stratigraphically detailed taxonomic study of fossil bryozoans within the Late Eocene sediments of the St Vincent Basin has revealed a range of faunas from very high abundance and diversity to almost monotypic assemblages. Overall 177 species of Cheilostomes and 33 species of cyclostomes were positively identified, with an additional 35 and 30 unclassified taxa respectively.

Biogeographic comparisons show a mixture of temporal and spacial components. Approximately two thirds of the species are new, and therefore regarded as 'basin endemic'. The common Cellariidae are represented by 20 species, none of which can confidently be assigned to species of the equally diverse fauna of the Otway Basin Tertiary in Victoria. Seven new genera are also only known to occur in the St Vincent Basin. All the previously described species are endemic to the Australian region. Many of the genera are equally restricted to Australia throughout the Tertiary to the Recent. This distinct endemism is typical of the isolated Australia in the Neogene. Minor links with other continents still exist as well. Shared taxa include *Reticrescis* (Eocene, Antarctica) and a potentially new genus of Romancheinidae (Eocene Eastern Europe and North America). Taxa considered to have originated in the Eocene, which rapidly dispersed throughout the world before the end of that Epoch, occur commonly, such as the Philoloporidae (13 species in 6 genera) and the Smittinidae (19 species in 3 genera). This shows strong dispersal links still existed between all continents. The fauna has a distinct Cretaceous character, characterised by the abundance and diversity of erect Onychocellidae, which are generally rare after the earliest Palaeogene. Four species are tentatively assigned to species which still exist in Recent waters of the Australian region (*Rhamphosmittina lateralis*, *Hiantopora quadricornis*, *Melicerita angustiloba*, *Arachnopusia unicornis*). The implied time range is very long for bryozoan species. Nine genera have their oldest recorded occurrence here (*Antropora*, *Chaperiopsis*, *Hippoporina*, *Dactylostega*, *Foveolaria* (*Odontionella*), *Ottonellina*, *Acerinucleus*, *Strophipora*, *Stenostomaria*). Wide dispersal of genera and families was probably facilitated by interconnected continental shelves and low latitudinal temperature gradients. Species level endemism is promoted by the short range of dispersal of most larvae.

Palaeoenvironmental analysis indicates that within the small geographic area and relatively short period of deposition in the Eocene, St. Vincent Basin saw a wide range of depositional facies. The initial transgressive marine facies on all margins saw the greatest diversity and abundance of bryozoans. These basal facies also contained most of the 'deep water' taxa and sand-fauna growth forms. This represents a well oxygenated and moderate energy environment. Higher sea levels probably flooded the Kangaroo Island basement high to allow sufficient open ocean access. The very different overlying assemblages indicate a more restricted environment, which represents a shallowing, with the Kangaroo Island High restricting open ocean access. The embayments on the eastern margin became very silica and organic carbon rich, with a low diversity and low abundance bryozoan fauna. Occasional fossiliferous beds dominated by *Celleporaria* and a few other erect ascophorans represent a brief reprieve allowing a few opportunists to flourish, but too short for any others. Bryozoa are essentially absent on the western margin, with only a few rooted forms occurring in the siliclastic sediments of the Rogue Formation. This margin was dominated by rivers and the resulting high sedimentation rate and low salinity inhibited bryozoan colonisation. The shallow sediments of the Lower Kingscote Limestone on the southern margin are dominated by infaunal echinoids, and bryozoans are occasionally sub-dominant. This was probably a shallow passage through a chain of 'Kangaroo Islands'.

TABLE OF CONTENTS

ABSTRACT, DECLARATION, ACKNOWLEDGEMENTS, DEDICATION
TABLE OF CONTENTS	i
LIST OF TEXT FIGURES, & TABLES	iv
TAXONOMIC TABLE OF CONTENTS	v
PREFACE	xiii
Rationale, Specific Aims, Structure of Thesis	xiii
CHAPTER 1: INTRODUCTION	
PART 1: GEOLOGY & ENVIRONMENTS	1
1.1. Eocene Environments & Geological Evolution	1
1.2. St. Vincent Basin Geology	4
1.2.1. Sediments & Stratigraphy	5
1.2.2. Eastern Basin Margin	5
1.2.2.1. North Maslin Sands	5
1.2.2.2. South Maslin Sands	5
1.2.2.3. Tortachilla Limestone	6
1.2.2.4. Blanche Point Formation	6
1.2.2.5. Post-Eocene Formations	7
1.2.3. Western Basin Margin	7
1.2.3.1. Mulloowurtie Formation	7
1.2.3.2. Throoka Silts	8
1.2.3.3. Rogue Formation	8
1.2.3.4. Post-Eocene Formations	8
1.2.4. Southern Basin Margin	8
1.2.4.1. Kingscote Limestone	8
1.2.5. Intrabasin Correlations and the Nature of the Sequence	8
1.2.6. Diagenetic History	9
1.2.7. Previous Palaeontological Work	9
1.3. Geology of other Australian Cretaceous to Cainozoic Basins	10
1.3.1. Carnarvon Basin	10
1.3.2. Bremer Basin	11
1.3.3. Eucla Basin	11
1.3.4. Murray Basin	11
1.3.5. Gambier Embayment (Otway Basin)	12
1.3.6. Otway, Gippsland & Bass Basins	12
1.3.7. Eromanga Basin <i>sensu lato</i> & Queensland subsurface Cainozoic	13
1.3.8. Papuan Basin	13
1.3.9. New Zealand	13
1.3.10. Palaeogene Bryozoa of other Gondwana Regions	14
PART 2: BRYOZOA	15
1.4. Bryozoan Evolution	15
1.5. Colonial Growth Forms	15
1.6. Ecological Factors in Bryozoan Occurrence	16
1.6.1. Temperature	16
1.6.2. Nutrients and Food	16
1.6.3. Salinity	17
1.6.4. Oxygen	17
1.6.5. Hydrodynamic Factors	17
1.6.6. Light and 'depth'	17
1.6.7. Sedimentation Rates and Turbidity	18
1.6.8. Substrate Availability and Selection	18
1.7. Reproduction	18
1.8. Predation	19
1.9. Competition for Nutrients	19
1.10. Bryozoan Taxonomy	19

CHAPTER 2: SIGNIFICANCE & AIMS	20
2.1. Bryozoan Taxonomy	20
2.2. Bryozoan Biogeography	20
2.3. Bryozoan Palaeoenvironments	21
CHAPTER 3: MATERIALS & METHODS	22
3.1. Sampling Strategy and Methodology	22
3.2. Sample Preparation	22
3.2.1. Friable samples	23
3.2.2. Cemented	24
3.3. Data Acquisition	24
3.4. SEM Image Recording.....	26
3.5. Taxonomic Measurements	26
3.6. Growth Form Classification Scheme.....	26
CHAPTER 4: SYSTEMATIC PALAEOLOGY	27
4.1. Introduction.....	27
4.1.1. Scope	27
4.1.2. Repositories of Material studied	27
4.1.3. Species descriptions.....	28
4.1.4. Occurrences.....	29
4.1.5. Measurements	30
4.1.6. Analytical Bryozoan Growth Habit Classification.....	31
4.1.7. Comparisons with species of other authors.....	32
4.1.8. Plates.....	32
Chelostomata	33
Cyclostomata	275
CHAPTER 5: BIOGEOGRAPHY	277
5.1. Introduction.....	277
5.2. Biogeographic Elements	278
5.2.1. Distributions within St Vincent Basin.....	278
5.2.2. Local Basin Endemic Taxa.....	279
5.2.3. Regional Australasia Endemic Taxa.....	279
5.2.4. Widespread Taxa.....	280
5.2.4.1. Indo-Pacific/Tethyan Taxa	280
5.2.4.2. Southern Taxa.....	280
5.2.4.3. Global Taxa	281
5.2.5. Cretaceous Tethyan Component	281
5.2.6. 'Living Fossils'.....	282
5.2.7. Ranges of taxa.....	282
5.2.7.1. First Occurrences of Species	282
5.2.7.2. First Occurrences of Genera	282
5.2.7.3. First Occurrences of Families.....	283
5.2.7.4. Last Occurrences of Taxa.....	284
5.2.8. Conspicuous Absences	284
5.3. Bryozoan Dispersal	284
5.3.1. Larval Dispersal.....	285
5.3.2. Adult Dispersal.....	286
5.3.3. Comparisons with Biogeography of other Fauna	286
5.4. Evolutionary Trends	287
5.5. Conclusions.....	288

CHAPTER 6: PALAEOENVIRONMENTS	289
6.1. Introduction	289
6.1.1. Taxonomic Ecology	290
6.1.2. Growth Form Ecology.....	290
6.1.2.1. Encrusting	291
6.1.2.2. Erect Rigid.....	291
6.1.2.3. Erect Flexible	292
6.1.2.4. Multilaminar Massive.....	292
6.1.2.5. Free-Living.....	293
6.1.2.6. Relative Abundances	293
6.2. Bryozoan Assemblages – Results & Discussion	294
6.2.1. Tortachilla Limestone.....	294
6.2.1.1. Lower Tortachilla Limestone Unit Assemblage.....	294
6.2.1.2. Middle Tortachilla Limestone Unit Assemblage	294
6.2.1.3. Upper Tortachilla Limestone Unit Assemblage.....	295
6.2.1.4. Discussion of Tortachilla Limestone.....	296
6.2.2. Blanche Point Formation.....	297
6.2.2.1. Tuketja Member Assemblage	297
6.2.2.2. Gull Rock Member Assemblage	297
6.2.2.3. Perkana Member Assemblage	297
6.2.2.4. Discussion of the Blanche Point Formation.....	298
6.2.3. Mulloowurtie Formation	301
6.2.3.1. Basal Facies Assemblage	301
6.2.3.2. General Silt Facies Assemblage.....	301
6.2.3.3. Discussion of Mulloowurtie Formation.....	301
6.2.4. Rogue Formation.....	302
6.2.4.1. Limestone Facies Assemblage	302
6.2.4.2. Sandy Facies Assemblage.....	302
6.2.4.3. Discussion of Rogue Formation.....	302
6.2.5. Lower Kingscote Limestone	303
6.2.5.1. lowest Lower Kingscote Limestone.....	303
6.2.5.2. lower Lower Kingscote Limestone.....	303
6.2.5.3. middle Lower Kingscote Limestone	303
6.2.5.4. upper Lower Kingscote Limestone.....	303
6.2.5.5. top Lower Kingscote Limestone.....	304
6.2.5.6. Discussion of Lower Kingscote Limestone	304
6.3. General Trends	304
6.3.1. Encrusters	305
6.3.2. Sand Fauna.....	305
6.3.3. Zooidal Measurements.....	306
6.3.4. Multilaminar Bloherms	306
6.3.5. Other considerations	306
6.4. Conclusions	307
REFERENCES	308
APPENDICES	325
A1. Stratigraphic Sections	
A1.1. Maslin Beach - Tortachilla Limestone / Blanche Point Formation (composite section)	
A1.2. Yorke Peninsula (Sliding Rocks) - Mulloowurtie Formation (composite section)	
A1.3. Yorke Peninsula (Sheoak Flat South) - Lower Rogue Formation	
A1.4. Kangaroo Island (Ozone Hotel) - Lower Kingscote Limestone	
A1.5. Kangaroo Island (Type Section) - Kingscote Limestone	
A1.6. Kangaroo Island (Yacht Club) - Lower Kingscote Limestone	
A2. Data Tables	
A2.1. Specimens per species:	
A2.2. Species per growth form:	
A3. Publication List	
A3.1. Journal Articles	
A3.2. Conference Proceedings	
A3.3. Conference Abstracts	