Terra Australis reports the results of archaeological and related research within the region south and east of Asia, though mainly Australia, New Guinea and Island Melanesia - lands that have remained terra australis incognita to generations of prehistorians.

Its subject is the settlement of the diverse environments in this isolated quarter of the globe by peoples who have maintained their discrete and traditional ways of life into the recent recorded or remembered past and at times into the observable present.

Cover map 'Hollandia Nova', Thevenot 1663
by courtesy of the National Library of Australia
TERRA AUSTRALIS

9

COASTAL SOUTHWEST TASMANIA
the prehistory of Louisa Bay and Maatsuyker Island

Ron Vanderwal  David Horton

Department of Prehistory, Research School of Pacific Studies
The Australian National University  Canberra
1984
FOREWORD

Terra Australis is a monograph series principally devoted to the publication of research projects done by members of the Department of Prehistory, Research School of Pacific Studies, Australian National University. On two occasions (volumes 3 and 6) we have published appropriate work by scholars elsewhere in the University. The present monograph is the first example where the project which is its subject was done totally outside the University. Dealing with Tasmania, it is, however, concerned with a field in which members of our Department have been active both in archaeological research and in the political dimensions of its exercise for many years. Moreover, the principal author, Ron Vanderwal, was a PhD scholar in our Department from 1969-72, working on the prehistory of the south Papuan coast, while his co-author, David Horton, contributed to Andrée Rosenfeld's volume on the Early Man site in north Queensland (Terra Australis 6).

Born in Michigan in 1938, Ron Vanderwal took a BA in Anthropology at Michigan State University, East Lansing, in 1961 and an MA in Anthropology at the University of Wisconsin, Milwaukee, in 1969. From 1965-9 he was Archaeologist with the Institute of Jamaica in Kingston. On completion of his PhD at ANU in 1972, he spent a year as Research Officer with the Australian Institute of Aboriginal Studies, doing archaeological fieldwork in Torres Strait, after which he took up a post with the Tasmanian Museum, Hobart. It was during his three years there (1973-6) that he carried out the work reported in this volume. From 1976-81 he tutored in the Division of Prehistory, La Trobe University, Melbourne. He is now Curator of Anthropology at the National Museum of Victoria.

David Horton was born in Perth, Western Australia, in 1945 and took his first degree, a BSc in Zoology, from the University of Western Australia in 1965. He has an MSc and a PhD, both in Zoology, as well as a BA, in English and Prehistory, from the University of New England (Armidale, New South Wales). His PhD was awarded in 1973 for work on the zoogeography of reptiles and he conducted post-doctoral research in biogeography in England at the University of York during 1973 and 1974. In 1974 he was appointed to his present position as Palaeoecologist at the Australian Institute of Aboriginal Studies in Canberra. Here he has worked with prehistorians on the identification and interpretation of faunal remains over a wide range of sites and has been particularly active in collaborative research into the problem of megafaunal extinctions.

Jack Golson
I began my job as research archaeologist with the Tasmanian Museum and Art Gallery in 1973 with a view toward investigating man-land relationships in a climatically hostile environment. It took me many months in the field before I found Louisa Bay in southwest Tasmania, having first looked for suitable sites in the plateau country of the island's rugged interior, then along the stormy west coast south of Macquarie Harbour. Most sites on the plateau had become victims of hydro-electric schemes, and while sites were located on the west coast they did not meet my requirements. The climate of the deep southwest had twice defied my attempts to go there, but finally in October 1974, in the company of Peter Murray and Carol Watson, I reached Melaleuca Lagoon and walked to Cox Bight and Louisa Bay. Having visited Maatsuyker Island some months previously and confirming a site there, I was delighted to find that Louisa Bay offered what I required - a number of sites close together in a circumscribed area and each adjacent to locally diversified environments. The first research trip, of eight weeks, was made in January 1975; the second trip, of six weeks, was made in February-March 1976.

In 1974 David Horton joined the staff of the Australian Institute of Aboriginal Studies as palaeoecologist. I asked him to join me in the Louisa Bay project and this monograph is the result of our long and productive association.

Ron Vanderwal
# CONTENTS

**FOREWORD**  
v

**PREFACE**  
vii

**ACKNOWLEDGEMENTS**  
[xv

I  INTRODUCTION

II  THE NATURAL ENVIRONMENT

- Geology
- Landforms and Vegetation
- Climate
- Fauna
  - Invertebrate Animals of the Seashore
  - The Vertebrate Fauna
- Summary

III  LOUISA BAY AND MAATSUYKER ISLAND

- The Environment
  - The Eastern Cliffs
  - Louisa Island
  - Louisa River
  - The Central Cliffs
  - Anchorage Cove
  - The Western Cliffs
  - Maatsuyker Island and the Big Witch
- The Excavations
  - The Louisa River Sand Dune Sites
  - The Louisa River Caves
  - The Louisa Creek Site
  - The Anchorage Cove Site
  - The Maatsuyker Island Site
  - Summary of Site Excavation

IV  ANALYTICAL METHODOLOGY

- Vertebrates
- Invertebrates
- Analysis
  - Concentration
  - Diversity
  - Statistics

V  ANALYSIS OF VERTEBRATE REMAINS

- The Animals
  - Mammals
  - Reptiles and Fish
  - Birds
- The Sites
  - Louisa River Site 1
  - Louisa River Site 2
  - Louisa River Site 3
  - Louisa River Cave Site 1
  - Louisa River Cave Site 2
  - Louisa Creek Site 1
  - Anchorage Cove Site 1
  - Maatsuyker Island Site 1
  - Comparisons Between all Sites

VI  ANALYSIS OF THE INVERTEBRATES

- The Categories
- Beach
15 Metrical and ordinal data on fur seal upper canines 51
16 Yearling fur seal bones and teeth 52
17 Sex ratios for fur seal canine teeth 52
18 Postcranial seal bones: proportions present 54
19 Metrical and ordinal data on elephant seal mandibles 55
20 Metrical and ordinal data on elephant seal canines 56
21 Metrical and ordinal data on elephant seal postcranial bones 56
22 Distribution of fish remains in various sites 58
23 LR 1: vertebrate analysis 65
24 LR 2: vertebrate analysis 65
25 LR 3: vertebrate analysis 67
26 LRC 1: vertebrate analysis 70
27 LRC 2: vertebrate analysis 71
28 AC 1: vertebrate analysis 75
29 MAT 1: vertebrate analysis 76
30 LR 1: invertebrate analysis 81
31 LR 2: invertebrate analysis 82
32 LR 3: invertebrate analysis 83
33 LRC 1: invertebrate analysis 85
34 LRC 2: invertebrate analysis 85
35 LC 1: invertebrate analysis 87
36 AC 1: invertebrate analysis 88
37 All sites: invertebrate analysis 90
38 Louisa Bay and Maatsuyker Island fauna 94
39 Relative collection strategies based on MNI 95
40 Relative consumption based on minimum weights 95
41 A schedule for the exploitation of Maatsuyker Island 99
42 Comparisons between southeast and northwest Tasmanian exploitation patterns 108
43 Rocky Cape vertebrate fauna 109
44 Comparisons of Louisa Bay and Rocky Cape subsistence patterns 113
45 Hunter Island vertebrate fauna 114
46 Shellfish contributions to the faunal diet at Cave Bay Cave and the Mutton Bird Midden 115
47 LR 1: quartz artefacts 119
48 LR 2: quartz artefacts 119
49 LR 3: quartz artefacts 120
50 LRC 2: quartz artefacts 120
51 AC 1: quartz artefacts 121
52 MAT 1: quartz artefacts 122
53 All sites: quartz artefacts 122
54 LR 1, LR 2, LR 3, LRC 1, LRC 2 and AC 1: exotic stone 123
55 MAT 1: exotic stone 124
56 All sites: secondarily altered artefacts 124
57 LR 1: secondarily worked stone and stone with use-wear 125
58 LR 2, LR 3, LRC 2 and AC 1: secondarily worked stone and stone with use-wear 125
59 MAT 1: secondarily worked stone and stone with use-wear 126
60 MAT 1: secondarily altered artefacts 127
61 Spearman rank correlation analysis: utilised flakes, length with width 127
62 Spearman rank correlation analysis: flakes, length with length of use-wear 127
63 Spearman rank correlation analysis: scrapers, LR 1, LR 2, LR 3, AC 1 128
64 Spearman rank correlation analysis: scrapers, MAT 1 128
65 Summary of altered stone 129

FIGURES
1 Map of southwest Tasmania 4
2 Louisa Bay: environments and archaeological sites 16
3 Maatsuyker Island 21
4 Louisa River sand dune sites
5 Stratigraphic section of LR 1
6 Stratigraphic section of LR 2
7 Stratigraphic section of LR 3
8 Stratigraphic section and plan view of LRC 2
9 Stratigraphic section of LC 1
10 Plan of MAT 1
11 An example of graphing concentration
12 An example of graphing Heterogeneity and Divergency
13 Measurements made on fur seal mandibles and canines
14 Anatomical position of bones and percentage of burnt bones
15 LR 1: Concentration bar graphs, vertebrates
16 LR 1: procurement and consumption, vertebrates
17 LR 2: Concentration bar graphs, vertebrates
18 LR 2: procurement and consumption, vertebrates
19 LR 3: Concentration bar graphs, vertebrates
20 LR 3: procurement and consumption, vertebrates
21 LRC 2: Concentration bar graphs, vertebrates
22 LRC 2: procurement and consumption, vertebrates
23 AC 1: Concentration bar graphs, vertebrates
24 AC 1: procurement and consumption, vertebrates
25 MAT 1-5: Concentration bar graphs, vertebrates
26 MAT 1-5: procurement and consumption, vertebrates
27 All Louisa Bay sites and Maatsuyker Island: procurement and consumption, vertebrates
28 LR 1: Concentration bar graphs, invertebrates
29 LR 1: procurement and consumption, invertebrates
30 LR 3: Concentration bar graphs, invertebrates
31 LR 3: procurement and consumption, invertebrates
32 LRC 2: Concentration bar graphs, invertebrates
33 LRC 2: procurement and consumption, invertebrates
34 LC 1: Concentration bar graphs, invertebrates
35 LC 1: procurement and consumption, invertebrates
36 AC 1: Concentration bar graphs, invertebrates
37 AC 1: procurement and consumption, invertebrates
38 All Louisa Bay sites and Maatsuyker Island: procurement and consumption, invertebrates
39 Rocky Cape: procurement and consumption, vertebrates
40 Rocky Cape: Concentration bar graphs, vertebrates
41 Hunter Island: procurement and consumption, vertebrates
42 LR 1: Concentration bar graphs, quartz
43 LR 2: Concentration bar graphs, quartz
44 LR 3: Concentration bar graphs, quartz
45 LRC 2: Concentration bar graphs, quartz
46 AC 1: Concentration bar graphs, quartz
47 MAT 1: Concentration bar graphs, quartz
48 Bone point from LR 1

PLATES
1 The Ironbound Range, with Louisa Bay in the foreground
2 A panoramic view of Louisa Bay, De Witt Island and Maatsuyker Island
3 A general view of a portion of the Louisa Bay sand dune complex
4 The excavated trench at LR 1
5 The excavated trench at LR 2
6 The excavated unit at LR 3
7 The entrance to LRC 1
8 The interior of LRC 1
9 The entrance to LRC 2
<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>The excavated trenches at LRC 2</td>
<td>31</td>
</tr>
<tr>
<td>11</td>
<td>Stratigraphic section at LRC 2</td>
<td>33</td>
</tr>
<tr>
<td>12</td>
<td>The excavated square at LC 1</td>
<td>34</td>
</tr>
<tr>
<td>13</td>
<td>Part of the eroded face of AC 1</td>
<td>36</td>
</tr>
<tr>
<td>14</td>
<td>The foreshore platform at MAT 1</td>
<td>37</td>
</tr>
<tr>
<td>15</td>
<td>Square MAT 1-1A</td>
<td>38</td>
</tr>
</tbody>
</table>
ACKNOWLEDGEMENTS

The research in this very isolated and extremely wild part of southwest Tasmania quite literally could not have been carried out without the aid of a large number of institutions and individuals. The Tasmanian Museum and Art Gallery and the Australian Institute of Aboriginal Studies (Canberra) must head the list, for they funded the fieldwork. The 5th Army in Hobart willingly supplied most of our support equipment, including field radios for our link with civilisation via the head keeper at Maatsuyker Island, John Cook. The Commonwealth Department of Transport was very co-operative in allowing visits to Maatsuyker Island, and they also authorised our fortnightly supplies to be carried by their chartered boat during the first season and by helicopter during the second. Various fishermen agreed to take crew and equipment to and from Louisa Bay, and to them special thanks is owed. I regret their anonymity but I failed to record that information beyond the boat names of Sea Hound and Wetna.

My two crews often endured hardship and privation, as well as foul weather, and I thank them. During the first season they were Roger Byard, Helen Gee, David Hammond, Alan Milne and Mark Titchener; during the second season the crew consisted of Joan Crawley, Adrian Howard, Ann Piesse, Lisa Seaton and Michael Turner. Jane Burrell, then at the Tasmanian Museum and Art Gallery, accompanied the second expedition as photographer. Also involved in the fieldwork were Jim Stockton and Peter Murray, both at various times with the Tasmanian National Parks and Wildlife Service. The only southwest resident at that time was Denis King, who often showed us great hospitality at his Melaleuca Lagoon home. Thanks are also given to the many fishermen who dropped in from time to time, often leaving welcome gifts of crayfish and abalone, and to the Maatsuyker Island light-station crew, John Cook and John Dennan, who did all they could to help us while on the island. Those who suffered most during my many field trips were my children, Katharine, Lisa and Peter, and Susan Stratigos, all of whom I thank for putting up with my long absences.

In Hobart I wish to thank Don Gregg, Director of the Tasmanian Museum and Art Gallery, who was always helpful and encouraging, and other staff members at the Museum, in particular Elizabeth Turner, who did the shellfish identifications.

I am extremely grateful to colleagues and students at La Trobe University for their critical comments on various drafts of the manuscript. It is to Nigel Oram, Gae Ramsay, David Frankel and Paul Ossa that I owe a special debt of gratitude for distributing my course load between them, allowing me six months free of teaching duties during 1980. Johan Kamminga commented on the stone artefact analysis. In the Department of Mathematical Statistics I wish to thank David Scott for his advice and guidance. Thanks go to Rudi Frank who provided the darkroom expertise for producing the plates, while Jiri Novak prepared the figures.

Grants from the La Trobe University Publications Committee (for drawings) and the Humanities Research Grants Committee (for typing) allowed the production of the manuscript.

Helen Ferguson-Pik supplied me with endless encouragement over the many months of manuscript preparation. I especially want to thank Jeannette Hope for spotting many inconsistencies, making helpful suggestions for clarity, and offering advice which aided in making the manuscript a much more sound piece of work. I am very grateful to Leigh Hawking for the many hours spent labouring over a computer terminal.

I would also like to thank Winifred Mumford for redrawing some of the figures and for her design work, and Jeanine Mummery for typing some of the tables. Finally, and very importantly, I would like to thank Maureen Swanage for her patience and encouragement in guiding this manuscript through to publication - her efforts have been greatly appreciated.
Map of Tasmania showing places mentioned in text
I INTRODUCTION

This is a volume on subsistence behaviour as observed in and interpreted from the archaeological record at Louisa Bay and Maatsuyker Island in southwest Tasmania. All faunal remains have been subjected to rigorous analyses, using a methodology especially developed for the project, and these are integrated to form, with the aid of a poorly known ethnography, a model for southwest Tasmanian economic activities.

This study of the prehistory of southwest Tasmania is important for three reasons. Firstly, it reports the most complete analysis yet undertaken of any Tasmanian archaeological sites. Other sites either have scanty faunal remains, or have not yet been analysed in any detail. In this sense southwest Tasmania becomes the definitive area with which others can be compared, though the restricted time of occupation means that such comparisons are available only for the last 3000 years. Secondly, it completes a triangle whose first two points comprise northwest Tasmania (Rocky Cape, West Point, Hunter Island) and southeast Tasmania (Little Swanport). This now provides a good geographical coverage from which to generate more general models of Tasmanian prehistory (although clearly it is important that further investigations be carried out in the northeast and in the highlands). Thirdly, it is the first area in which a number of sites in close proximity have been excavated, thus allowing a detailed investigation of different types of sites, occupied for reasons such as resource availability and shelter, and seasonal occupation of different sites.

The two main models which have been generated for Tasmanian prehistory are those of Lourandos (1968) and Jones (e.g. 1966, 1977). Lourandos suggested that there was a seasonal pattern to the occupation of Tasmania's east coast whereby people hunted land mammals in the interior during summer and moved to the coast during winter to eat shellfish. Furthermore, he suggested that in contrast to the mobility of the eastern population, the people of the west coast had a much more sedentary lifestyle. The clearest visible expression of this is the difference seen in the housing styles of the two areas, the east coast with temporary lean-tos, the west with large semi-permanent houses.

Jones (1975:28, 1978:36) suggested that the west coast economic pattern was one of summer plenty/winter stress, with the population being dispersed during winter and living primarily on shellfish. He suggested further that the archaeologically observed loss of fish from the diet (around 3500 BP) would have greatly accentuated the problems of obtaining food in winter and that therefore the decision not to eat fish must have been a 'cultural' one. Jones (1977, 1978) went on to argue that the Tasmanians could only have made and maintained such a decision because their geographic isolation prevented intellectual stimulation from outside Tasmania, and posed the question (1977:203) 'were they in fact doomed - doomed to a slow strangulation of the mind?' He also argued that the intellectual isolation had resulted in cultural deprivation in Tasmania in contrast to the mainland (particularly Arnhem Land) where people 'invested the advantages of new tools into the realms of the ego, the mind and the soul' (1977:202).

This hypothesis has been attacked in several ways in recent publications. Lourandos (1977) argued that in fact the Tasmanian population was relatively low so that the 'cultural lack' idea was irrelevant. Bowdler (1979) has questioned the archaeological evidence, suggesting that there is a correlation between the loss of bone points and the loss of fish from the diet; Jones had seen these as being two separate lines of evidence for his hypothesis. Bowdler has also suggested that fish were not really such a major loss from the diet after all, and Horton (1979) argued that fish were not an important loss in the sense that they were replaced, and furthermore that they were replaced for sound economic reasons rather than on a cultural whim. Allen (1979) reached similar conclusions independently. Horton (1979) went on to suggest that Tasmanian culture was in fact considerably richer than Jones had thought and that the technological simplification was an adaptation to a rich environment, not an example of maladaptation. Vanderwal (1978a, 1978b) also suggested that there had been continuing adaptation in Tasmania, with boats a recent development at least in the southwest, and that there was a population expansion into southwest Tasmania. These last two hypotheses were based on the evidence from Louisa Bay. We present that evidence here in full for the first time.

The people who in contact times lived at Louisa Bay, the Needwonne, are only shadowy figures on the landscape. Kelly (1921) saw them in 1815 but did not describe
them beyond noting that they were friendly. George Augustus Robinson, who travelled extensively in the area from 1830-4 (Plomley 1966), did not observe them himself but recounts some of the second-hand descriptions he was given, and also describes the inhabitants of the coastal areas on both sides of Louisa Bay. This analysis is an attempt to determine how the Needwonne were able to live successfully in one of the most inhospitable parts of Tasmania, and indeed of Australia. Their ability to adapt to this environment provides a crucial test for the hypotheses developed for Tasmanian prehistory in less extreme parts of this island.

The archaeological record presented in this volume is necessarily interpreted in the light of ethnographic evidence. The danger of this approach has been well documented by a number of critics (Chang 1967; Yellen 1977). The direct historical approach clearly provides a strong a priori argument for the continuity of a cultural tradition isolated for as long as 10,000 years (Jones 1968), but such a continuity has yet to be demonstrated. In acknowledging the problem we prefer to use the term Aboriginal Tasmanian rather than Tasmanian Aborigine.

We divide this work into a further seven chapters. The final version of each chapter is the end-product of our collective writing skills and interpretive talents, though one of us more than the other may be seen as responsible for the major content of some chapters. Chapter II is a largely joint effort in which we describe the southwest Tasmanian environment as known today, its geology, landforms and vegetation, climate, invertebrate animals of the seashore and vertebrate fauna.

Chapter III (RV) discusses the various geographic aspects of southwest Tasmania, and describes details of the eight sites excavated at Louisa Bay and Maatsuyker Island.

The analytical methodology, consisting of a series of diversity and concentration measures, is the topic of Chapter IV (RV). This methodology is innovative without being overly complex, allowing visual means of portraying data through time and across space.

In Chapter V the analytical methodology is applied to the vertebrate fauna. The first part of the chapter provides details of the analysis (DH); in the second part we discuss the results of the analysis, site by site, and in the final section we make comparisons and draw conclusions.

Analysis of the invertebrate fauna is the subject of Chapter VI. Research methodology, where the samples are divided into eight categories, is discussed first, followed by a detailed site by site analysis (RV). We compare these sites in the final section and draw conclusions about procurement strategies.

Our reconstruction of southwest Tasmanian economic prehistory is the topic of Chapter VII. Here the archaeological data are juxtaposed with the ethnographic, in discussion of summer and winter subsistence. In synthesising the results we produce our economic model.

In the final chapter (VIII) we compare the results of our analysis, particularly with those from Rocky Cape and Hunter Island in northwest Tasmania, and to a lesser degree with southeast Tasmania. Our summary and conclusions are directed primarily at a west coast subsistence model for the Aboriginal Tasmanians during the late Holocene period.

There are two appendices. The first is the artefactual analysis, mainly stone (RV). In the second appendix, J. Kamminga describes the bone point recovered from Louisa River site 1 (Vanderwal 1978a, 1978b).
II THE NATURAL ENVIRONMENT

The area of southwest Tasmania particularly relevant to the research described in this volume is bounded by the coastal universal grid references DM 175910 (1:100,000 sheet 8011) and DMS 03796 (sheet 8110), marking respectively the eastern side of Port Davey and the western side of New Year Bay. The Port Davey/Bathurst Harbour waterway and the Ironbound Range (of mountains), roughly delimited by these co-ordinates, give this part of southwest Tasmania geographical distinction. (The localities mentioned are shown in Figure 1.)

GEOLGY

Most of the rock forms of southwest Tasmania can be assigned to block quartzites and associated phyllite/schist deposits. Quartzite outcrops can be seen on many of the lowland coastal hills and, more spectacularly, on the higher slopes of the Ironbound Range (Plate 1). This stable rock forms the base for most of the southwest's high country, and for the off-lying coastal islands, being more impervious to weathering processes.

Schist and phyllite deposits, being considerably less resistant to disintegrative processes, are found sandwiched between quartzites, and commonly are over lain by the wet sedgeland (herbland) or button grass plains. Less common rocks are seen outcropping in various other localities. Cherts, mudstones, sandstones and dolomites occur along Bathurst Channel and the Ironbound Range (Boulter 1978). Small granite outcrops appear on South West Cape and at Cox Bight.

LANDFORMS AND VEGETATION

The many rivers and creeks rapidly rise and fall in response to weather conditions, though rarely overflow their banks because of the normally steep gradients. Conversely they never dry out because of the vast water reserves held in the saturated peats and alluvia (Stephens 1978). These waterways and their lower valleys on the coastal plain are universally masked by dense heath vegetation, here generally referred to as scrub. The upper valley slopes are dominated by heathlands, whose groundcover consists of button grass (Gymnoschoenus sphaerocephalus), tea-trees (Leptospermum glaucescens and Melaleuca squarrosa), and various casuarinas, banksias and acacias. The lower lying plains are mostly wet, covered by herbland communities consisting of grasses, sedges, ferns and mosses (Edwards 1978); the most abundant plant is button grass. True scrub areas, consisting of horizontal scrub (Anodopetalum biglanduloseum), tea-trees, banksias and eucalypts are sometimes encountered and are almost impossible to penetrate. Eucalypt-dominated open forests are occasionally found in isolated and protected coastal localities, but more often typify the rising foothills marking the edge of the coastal strip, which is seldom more than 5 km wide, and the mountain slopes themselves. Closed forest, generally dominated by myrtle (Nothofagus cunninghamii), is the climax vegetation on the adjacent mountains.

The coastline was created by the post-Pleistocene rise in sea level, and exhibits features of a typical drowned landscape. Bathurst Harbour and Port Davey were river valleys during the Pleistocene. Once submerged, the coast underwent extensive modification by the sea. Where the original slopes were steep there are now cliffs, while on more moderate slopes erosion has created rock stacks and gulches. Platformed areas are relatively rare, created mainly where the rock has been horizontally bedded. The few large sand beaches and associated dunes have formed where there is relatively flat land behind the coast.

The offshore islands were originally hills on a coastal landscape. Most of these are small, generally smaller than Louisa Island, but major exceptions are those of the Maatsuyker Group. The largest is De Witt, or the Big Witch (Lord 1927), 6.5 km directly south of Louisa Bay and 354 m in elevation. It has a single landing point in the middle of its northern aspect, but it can be approached only on relatively calm days. The island furthest away is Maatsuyker itself, 13 km to the south and 278 m high. It has a fair-weather landing and is considerably smaller than the Big Witch. Since 1890 a manned light-station has been maintained at the south end of the island, opposite the Needles (Cook 1978). Flat Witch, lying 2 km
Plate 1  The Ironbound Range, with Louisa Bay in the foreground

Fig. 1  Map of southwest Tasmania
to the north of Maatsuyker, is inaccessible except during dead calm days.

Vegetation in all the coastal environments consists of salt-tolerant herbs and shrubs, while many heath species grow on the stabilised sand dunes. Whatever the vegetation, it is uniformly wind-pruned to a relatively constant height of 1-2 m (Edwards 1978:90). Horizontal shrubs, 10 cm high and 2 m long, are not uncommon on the extremely exposed southwestern face of Maatsuyker Island.

The current vegetational mosaic on the mainland reflects the mosaic of generally poor soils which have created relatively static boundaries (Kirkpatrick 1978). Fire plays some role in maintaining this mosaic. Bushfires occur today, but their frequency may have been greater when Aborigines inhabited the area, a hypothesis that receives some support from the apparent recent incursion of closed forests into grassland areas.

CLIMATE

Tasmania, lying between 41°S and 44°S, is in the direct path of 'the roaring forties', a westerly wind regime extending across the Indian Ocean. To the north are continental anticyclones; Tasmania's cool and changeable maritime climate is the result of these two interacting systems (Nunez 1978). In the southwestern part of the island these produce one of the cloudiest and wettest areas of Australia (MacPhail 1978).

Southwest Tasmania has a well-earned reputation for extremities in its weather. Winter is perhaps the most stable period, at its worst characterised by a 'stormy westerlies' regime:

This is an intense westerly flow usually resulting from one or more cyclonic centres moving to the south of the island. Surface isobars are aligned east-west and gale force winds may occur shifting from northwest to southwest. These winds are caused by a series of cold fronts which pass through the region, bringing also heavy rain, and a drop in temperature. Typically this pattern will last up to five days giving overcast conditions and continuous rainfall. Eventually the system will weaken and the weather will clear as an anticyclone approaches from the northwest (Nunez 1978:67).

Trough conditions are also typical of winter, often bringing days of rain and overcast conditions. Like the 'stormy westerlies', the arrival of an anticyclone brings clearer weather.

The weather becomes less harsh as the passage is made from winter into summer, though even then gale-force winds are occasionally generated. Mean temperatures rise and precipitation decreases considerably although many weak fronts bring cloud masses but little rain. A summer day can change from completely overcast conditions to scattered clouds, or no clouds, within the space of one or two hours, but the days are considerably brighter than during winter.

There are two established weather observation points in coastal southwest Tasmania, at Melaleuca Lagoon and at Maatsuyker Island. Many of the observations made at Maatsuyker are almost certainly ameliorated versions of those made at Port Davey, so that in general Maatsuyker should have less rainfall and be colder. Table 1 (compiled from Bennett and Pope 1960, and Nunez 1978), though incomplete, can therefore be extrapolated in the light of the stations' geographical positions.

<table>
<thead>
<tr>
<th>Port Davey</th>
<th>Maatsuyker Island</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall (mm)</td>
<td>Rainfall (mm)</td>
</tr>
<tr>
<td>Maximum annual</td>
<td>2400</td>
</tr>
<tr>
<td>July (winter) mean</td>
<td>260</td>
</tr>
<tr>
<td>January (summer) mean</td>
<td>130</td>
</tr>
<tr>
<td>Raindays per year</td>
<td>-</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>Temperature (°C)</td>
</tr>
<tr>
<td>July mean maximum</td>
<td>-</td>
</tr>
<tr>
<td>July mean minimum</td>
<td>-</td>
</tr>
<tr>
<td>January mean maximum</td>
<td>-</td>
</tr>
<tr>
<td>Extremes</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 1 Southwest Tasmania: rainfall and temperature (compiled from Bennett and Pope 1960, and Nunez 1978)
<table>
<thead>
<tr>
<th>Species</th>
<th>Common name</th>
<th>Length (mm)</th>
<th>Class</th>
<th>Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amblychilepas nigrata</td>
<td>Black keyhole limpet</td>
<td>20</td>
<td>G</td>
<td>Under-surface of stones</td>
</tr>
<tr>
<td>Antisalia foliosea</td>
<td>Bonnet limpet</td>
<td>12</td>
<td>G</td>
<td>Under-surface of stones</td>
</tr>
<tr>
<td>Argopecten vexillum</td>
<td>Flag triton (rock whelk)</td>
<td>100</td>
<td>G</td>
<td>Rocky surfaces</td>
</tr>
<tr>
<td>Austropecten conoformata</td>
<td>Wavy-top shell</td>
<td>25</td>
<td>G</td>
<td>Rocky cracks and under ledges</td>
</tr>
<tr>
<td>A. constricta</td>
<td>Ribbed-top shell</td>
<td>25</td>
<td>G</td>
<td>Rocky surfaces</td>
</tr>
<tr>
<td>A. odontis</td>
<td>Checkerered-top shell</td>
<td>25</td>
<td>G</td>
<td>Rock pools at low water</td>
</tr>
<tr>
<td>Branchidontes rostratus</td>
<td>Beaked mussel</td>
<td>40</td>
<td>P</td>
<td>Mid-tide rocky platform</td>
</tr>
<tr>
<td>Cabestana spengleri</td>
<td>Spengler's rock whelk</td>
<td>150</td>
<td>G</td>
<td>Deep water, but tidal pools oviposition</td>
</tr>
<tr>
<td>Cellana solida</td>
<td>Orange-edged limpet</td>
<td>50</td>
<td>G</td>
<td>Rocky surfaces</td>
</tr>
<tr>
<td>Chiasaoma flavescens</td>
<td>Flamed limpet</td>
<td>12</td>
<td>G</td>
<td>Quiet bays near low tide</td>
</tr>
<tr>
<td>Clanclus limbatua</td>
<td>Keel-edged limpet</td>
<td>20</td>
<td>G</td>
<td>Many coastal localities</td>
</tr>
<tr>
<td>Clathrus lutescens</td>
<td>Jukes wentletrap</td>
<td>25</td>
<td>G</td>
<td>Many coastal localities</td>
</tr>
<tr>
<td>Cominella lineolata</td>
<td>Lineated whelk</td>
<td>25</td>
<td>G</td>
<td>Rock pools</td>
</tr>
<tr>
<td>Dicathais testilosa</td>
<td>Dog winkle</td>
<td>75</td>
<td>G</td>
<td>Half-tide pools and rocky crevices</td>
</tr>
<tr>
<td>Floraoma anemone</td>
<td>Anemone cone shell</td>
<td>50</td>
<td>G</td>
<td>Rock pools</td>
</tr>
<tr>
<td>Hippomys ocellus</td>
<td>Bonnet limpet</td>
<td>20</td>
<td>G</td>
<td>Under stones at low water</td>
</tr>
<tr>
<td>Lepsieilla vinosa</td>
<td>Wine-mouthed lepsiella</td>
<td>12</td>
<td>G</td>
<td>Intertidal rocks</td>
</tr>
<tr>
<td>Macocheira tasmaniae</td>
<td>Tasmanian keyhole limpet</td>
<td>25</td>
<td>G</td>
<td>Under rocks at low tide</td>
</tr>
<tr>
<td>Melanaphia praetermissa</td>
<td>Checked australwink</td>
<td>12</td>
<td>G</td>
<td>Open coast</td>
</tr>
<tr>
<td>M. unifasciata</td>
<td>Banded australwink</td>
<td>12</td>
<td>G</td>
<td>Open coast rock platform</td>
</tr>
<tr>
<td>Micrastra equa</td>
<td>Golden star</td>
<td>12</td>
<td>G</td>
<td>Many coastal localities</td>
</tr>
<tr>
<td>Montfortula rugosa</td>
<td>Rugose slit limpet</td>
<td>12</td>
<td>G</td>
<td>Rock surfaces at low tide</td>
</tr>
<tr>
<td>Mytilus plumulatus</td>
<td>Mussel</td>
<td>125</td>
<td>P</td>
<td>Colonies on intertidal rocks</td>
</tr>
<tr>
<td>Notopecten granulosa</td>
<td>Granulated limpet</td>
<td>12</td>
<td>G</td>
<td>Rock platforms at high tide</td>
</tr>
<tr>
<td>N. sebaebrilata</td>
<td>Scaly lined limpet</td>
<td>12</td>
<td>G</td>
<td>Under stones above low tide</td>
</tr>
<tr>
<td>Notochalina ruber</td>
<td>Abalone</td>
<td>125</td>
<td>G</td>
<td>Rocks below low tide to the infralittoral fringe</td>
</tr>
<tr>
<td>Patallana peroni</td>
<td>Scaly limpet</td>
<td>40</td>
<td>G</td>
<td>Rock platforms at low tide to the infralittoral fringe</td>
</tr>
<tr>
<td>Patelloidea alticoeptata</td>
<td>Tall ribbed limpet</td>
<td>40</td>
<td>G</td>
<td>Rock surfaces at or below low tide</td>
</tr>
<tr>
<td>P. latiarigrata</td>
<td>Lateral striped limpet</td>
<td>12</td>
<td>G</td>
<td>Exposed intertidal rocks</td>
</tr>
<tr>
<td>P. victoriana</td>
<td>Liver-coloured limpet</td>
<td>25</td>
<td>G</td>
<td>Rocky surfaces, infralittoral fringe</td>
</tr>
<tr>
<td>P. victoriana alida</td>
<td>White pomerplax</td>
<td>50</td>
<td>A</td>
<td>Rock platforms at low tide</td>
</tr>
<tr>
<td>Siphonaria diemenensis</td>
<td>VDL siphon shell</td>
<td>25</td>
<td>G</td>
<td>Intertidal rocks</td>
</tr>
<tr>
<td>Subminella undulata</td>
<td>Warriner or wavy turbo</td>
<td>50</td>
<td>G</td>
<td>Rocky platforms at low tide to infralittoral fringe</td>
</tr>
</tbody>
</table>

Class: G = gastropod, P = pelecypod, A = amphineura

Table 2  Louisa Bay: rock-dwelling shellfish
The animals discussed in this chapter are in general only those represented among the archaeologically preserved remains. This is intentional, for a complete compendium of all fauna is beyond the scope of this volume and does not bear directly on the descriptions and analyses pursued in later chapters.

The species described include almost all the vertebrates and invertebrates of potential economic importance in Tasmania (except, of course, fish). There are however four notable omissions. Both echidnas and pelicans are commonly found in the southwest but no remains of either species have been found in the sites excavated at Louisa Bay. Conversely, neither the forester kangaroo, *Macropus giganteus*, nor the sea slug, *Scutus antipodes*, apparently occur in the area, although both are of some importance in archaeological sites in other parts of Tasmania. In general, the southwest of Tasmania has a very good representation of the total Tasmanian biota.

### Invertebrate Animals of the Seashore

The waters of Tasmania have what is generally referred to as a Cool Temperate Maugean biota (Bennett and Pope 1960), not Cold Temperate as suggested by Knox (1963), because of the absence of definite Antarctic fauna (Dartnall 1974). However, the Tasmanian fauna demonstrates a clear attenuation in numbers of species of northern origin, a trend noted also for terrestrial animals (Darlington 1965).

The southwest coast, except for certain sheltered localities, is part of a high energy maritime environment where maximal surf conditions prevail for most of the year (Bennett and Pope 1960). The result is that the lateral width of the zonation pattern is exaggerated far beyond that implied by a tidal range of 1.27 m (Bennett and Pope 1960).

On the rock platform itself (see Bennett and Pope 1960; Guiler 1954 – but refer to Bennett and Pope 1960:199-204) the highest zone is the supralittoral, reached only by spray. The dominant shells represented here are the littorinid species *Melaraphe unifasciata* and *M. praetermissa*.

The midlittoral zone is dominated by limpets. These shellfish are more prominent on Tasmanian rocky shores than they are on those of the Australian mainland (Bennett and Pope 1960). The upper midlittoral is characterised mostly by limpets and mussels. *Lepsiella vinosa*, a predatory gastropod, is a common shellfish. The dominant species is *Patelloida altitrigata*, and while *Brachidontes rostratus* is locally common it prefers only moderate exposure to surf. The large limpet, *Cellana solid*, is found at the lower part of this zone, but occurs more frequently in the lower midlittoral.

Within the lower midlittoral itself, the lower part of which is never exposed, the limpet, *Patallanox peroni*, is dominant. Two other limpets also occur here: *Pomercoplex albida* which is a good indicator of maximal surf conditions, and *Patelloida alticoostata* in more moderate surf. The large turbo, *Subminella undulata*, and abalone, *Notohaliotis ruber*, are common in the deeper waters of the lower midlittoral, and the crayfish, *Jasus lalandei*, is also found here.

The infralittoral fringe is characterised by the large kelp, *Darvillea potatorum*, its holdfasts interspersed with the limpet, *Patelloidea victoriana*, and with *N. ruber*. The latter species, together with *S. undulata* and *J. lalandei*, is commonly found on the sea bed within the infralittoral.

Many more species were found in the survey of the Louisa Bay rock platforms. These are listed in Table 2. Other shellfish and their habitats are listed in Tables 3 and 4; the former, shellfish of beaches and sands, the latter, shellfish collected

<table>
<thead>
<tr>
<th>Species</th>
<th>Common name</th>
<th>Length (mm)</th>
<th>Class</th>
<th>Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ctenocypus australis</td>
<td>Screw shell</td>
<td>25</td>
<td>G</td>
<td>Sandy beaches</td>
</tr>
<tr>
<td>Ophiactella verrucosa</td>
<td>Warted sand whelk</td>
<td>20</td>
<td>G</td>
<td>Underwater sand</td>
</tr>
<tr>
<td>Dentimitra semiconvexa</td>
<td>Dove shell</td>
<td>20</td>
<td>G</td>
<td>Underwater sand</td>
</tr>
<tr>
<td>D. angusta</td>
<td>Narrow-wedge shell</td>
<td>25</td>
<td>P</td>
<td>Sand just below surface</td>
</tr>
<tr>
<td>D. erythinae</td>
<td>Eyx-wedge shell</td>
<td>25</td>
<td>P</td>
<td>Sand banks</td>
</tr>
<tr>
<td>Katelysia rhizophora</td>
<td>Rridged venerid</td>
<td>50</td>
<td>P</td>
<td>Sand and sandy mud</td>
</tr>
<tr>
<td>Mastra rufescens</td>
<td>Reddish trough shell</td>
<td>65</td>
<td>P</td>
<td>Sand and sandy mud</td>
</tr>
<tr>
<td>Myadora complexa</td>
<td>Rounded myadora</td>
<td>25</td>
<td>P</td>
<td>Underwater sand</td>
</tr>
<tr>
<td>Pullastra fabegella</td>
<td>Little bean</td>
<td>25</td>
<td>P</td>
<td>Gravelly sand</td>
</tr>
<tr>
<td>Sydaphera lactea</td>
<td>Smooth cancellaria</td>
<td>25</td>
<td>G</td>
<td>Sand banks</td>
</tr>
<tr>
<td>Triaenilia striatularis</td>
<td>Striated dog cockle</td>
<td>40</td>
<td>P</td>
<td>Sand banks</td>
</tr>
</tbody>
</table>

Table 3 Louisa Bay: shellfish of beaches and sands
Table 4  Louisa Bay: shells found on beaches as castups

The Vertebrate Fauna

The following accounts of the biology of the animals of southwest Tasmania are based almost entirely on published information, except for some incidental observations made during the excavation. There is unfortunately no survey of the land mammals of the area, so it is impossible to be sure where particular species might be most plentiful. In many cases however it is possible to make tentative suggestions based on a knowledge of the biology of a particular species.

The situation with seals is the same - there is now no elephant seal colony in Tasmania, and the fur seal colony on the Needles has not been studied. However the two species have been studied on Antarctica and in Bass Strait respectively, and it is likely that these observations will be valid when applied to southwest Tasmania, although it is possible that the timing of various parts of the breeding cycle may be slightly different.

The birds of the area are much better known, because of surveys along the coast and on Maatsuyker Island. There is also a considerable amount of general information available on the biology of sea birds.

The species dealt with in this section are only those whose remains have been found in excavation, but these include all the land mammals (except echidnas) and most of the sea birds of the area. The main species not covered are the smaller land birds.

Terrestrial Mammals

Brush wallaby - Macropus rufogriseus

This animal is particularly plentiful in the dry open forests but is found in a variety of habitats, including the verges of rainforests and heathland. Green (1973:7) gives the following description of its habits:

It is usually active only in the evening, night or early morning. Occasionally it may be seen abroad during the day, but this is likely to be the result of its having been disturbed. It customarily hides and rests by day in the partial shelter of thick scrub, beneath a log or in some other protected situation. Such sites are often well worn, indicating repeated use...The brush wallaby is capable of surprising agility and body control when moving at speed over rough, rocky, timber strewn or steep terrain. When first disturbed it usually avoids dense scrub, depending for escape on its ability to outrun its pursuers...It is a grazing animal, and it will travel a considerable distance to reach a good feeding ground. In doing so it forms a clearly defined runway through the scrub...It is along this track that the tractor sets his snare...Breeding occurs mainly during the winter months and the young leave the pouch in the spring, but it is not unusual to find young in the pouch throughout the year.

Pademelon - Thylogale billardierii

The pademelon prefers densely vegetated areas like fern gullies, verges of rain-
forest and the drainage areas of heathland where tall scrub is provided. Green (1973:9) says it likes:
good cover and seclusion, and beneath which it forms well defined runways ...
...When pursued it avoids open terrain, seeking escape among the dense
dergrowth. It is mostly nocturnal, remaining well hidden by day in the
thick scrub and forming well worn sleeping places. At dusk it emerges to
feed on the grassy verges...Breeding takes place throughout the year,
though most births occur during the winter months.

Potoroo - *Potorous tridactylus*

Green (1973:13) notes:
In Tasmania it is common and fairly widely distributed, preferring the
denser forests, edges of thick tea tree swamps and scrubby heathland.
Beneath such cover it forms well defined runways, hiding by day in the
thickest scrub, often in small family groups. At dusk it may move out to
feed on the grassy verges but it rarely ventures far from cover.

Heinsohn (1968:32) says that:
*Potorous tridactylus* apparently requires a habitat of dense natural vege-
tation which is provided by dense heath scrub in the Smithton [northwest
Tasmania] area. If the habitat is opened by either fire or land clearing
operations, potoroos disappear until the vegetation has suitably recovered.
One area of dense heath that had been completely cleared...developed into
suitable *Potorous* habitat in less than 13 years. Most other areas of
heath which support potoroos showed signs of past burning. Potoroos
apparently will not even emerge from dense vegetation to feed on adjacent
lush pasture forage.

Guiler (1958:45) observed that the species is strictly nocturnal: 'They do not
come out at twilight but wait until darkness has fallen'.

Ringtail possum - *Pseudocheirus peregrinus*

Green (1973:15) describes the biology of this species as follows:
Common and widely distributed in a range of habitats including forests,
tea tree scrub and agricultural areas...Sleeps by day in a domed nest
built of sticks, bark, leaves or similar material, placed in the hollow
of a tree or amongst dense shrubby foliage such as in the tops of tea
trees. At dusk it leaves its nest to feed amongst the foliage, returning
again before daylight...the favoured environment...is the tree tops, where
it shows itself an active and efficient climber...It is not often found on
the ground, where its short legs make it relatively slow and clumsy...It
prefers to travel from tree top to tree top if within reach, and is able
to jump a span of several metres...Breeding takes place in the winter and
spring, with the young in the pouch, in some instances, as late as December
...When the young are too large for the pouch but still dependent upon
their mother, they cling to her body fur. Most are weaned by the end of
the year.

Brushtail possum - *Trichosurus vulpecula*

According to Green (1973:14) this species was originally confined to the forests
and mountainous areas, but has increased and spread since 1940:
It is strictly nocturnal and rests by day, usually in the hollow of a tree
or log, but sometimes in a hole in the ground, rock crevice or cave.
According to Guiler and Banks (1958), brushtail possums do not occur at Louisa
Bay, but little data are available for the area.

Wombat - *Vombatus ursinus*

The favourite habitats are coastal areas of heathland and dry open forests. The
animal digs burrows where the soil is suitable:
elsewhere it occupies a cave or hollow log. Hides by day until late after-
noon or evening, and then comes out to graze. If disturbed while feeding
it hurries back to the safety of its den...Breeding takes place during the
winter months, and young may be found in the pouch from May to the end of
the year [Green 1973:25].
Brown bandicoot - *Isoodon obesulus*

Green (1973:26) notes that this species is:
Common and widely distributed, its favoured habitat being the scrubby areas, where it finds good shelter and seclusion. It will move out into open areas...beneath the cover of darkness, but prefers to remain close to cover. It hides by day in a covered grass nest, which it forms in a depression in the ground concealed among litter and debris or among dense vegetation...Breeding takes place throughout most of the year, the autumn being excepted...Three or four litters may be reared annually, the weaning of one being quickly followed by the appearance of another. Development is rapid, females starting to breed at about 3 months of age, well before they are fully grown.

Heinsohn (1968) found that the species preferred heath, scrub or recently burned scrub. This bandicoot has not been recorded in southwest Tasmania (Hocking 1978:124).

Eastern native cat - *Dasyurus viverrinus*

Green (1973:31) notes that the preferred habitat of this animal:
is the sclerophyll forests, scrub and heathland but it occurs also in many rural localities. It is nocturnally active, hiding by day in a secluded retreat such as a hollow log or beneath dense surface vegetation...Though usually a ground dweller, it does on occasions climb into the lower branches of trees in search of prey. Pairs usually live and hunt together...
Breeding commences in June, with most females carrying pouch young over winter.

Tiger cat - *Dasyurus maculatus*

Green (1973:30) notes that the distribution of this species is patchy in Tasmania:
It occurs mainly in the north east, north west and western highlands, its favoured habitat being the rainforests and adjacent bushland. It is rarely seen during the day, preferring to spend the diurnal hours hiding in a hollow log, dense vegetation or similar cover.
This species is perhaps unexpected at Louisa Bay.

Platypus - *Ornithorhynchus anatinus*

Green (1973:63) notes that this species:
is common in most water catchments, creeks and rivers from the highlands to the sea. It is not often seen abroad during the day, preferring to remain hidden in a burrow dug in a bank by the water's edge, but in the quiet of evening it comes out to swim and feed near its burrow.

Broad-toothed rat - *Mastacomys fuscus*

Green (1973:46) records that in Tasmania this species:
lives in the western region and has been found near Waratah, Cradle Valley, Lake Pedder and Port Davey. Within this range it is further restricted by the small area of its normal habitat. This is the wet sedgeland and the associated drainage systems of this exposed terrain, which in winter may be covered with snow for weeks at a time. The density of ground cover must be sufficient to provide good protection and to permit the formation of systems of runways beneath the vegetation. It finds waterlogged or swampy areas congenial, but it shuns the nearby rainforests. Within the limits of such habitat it is reasonably common. It may be abroad by day or night, but usually stays in or near its runways. Its retreat or nest, a mass of finely shredded material, is formed beneath dense vegetation, often in the middle of a stand of Buttongrass...breeding extends from October to March.

Green (1968:12) adds that this species 'invariably occurs in association with *Rattus lutreolus* velutinus and *Antechinus m. minimus*, all three species sharing the same labyrinth of runways which are formed among the dense vegetation'.
Eastern swamp rat - *Rattus lutreolus*

Green (1973:43) describes this rat as:

- common and widespread, occurring in coastal swamp and heathland, rainforests and sedgelands, where it often forms extensive systems of runways beneath the dense vegetation. In the coastal heathland where the soil is free and dry, it excavates shallow burrows, in some cases developed into a warren-like labyrinth. In the subalpine rainforests its retreats are to be found in cavities beneath the accumulated rubbish of the forest floor, or in rotating logs and tree stumps. In the sedgeland areas the soil is usually too sodden for burrows, and here it forms its nest on a dense clump of Buttongrass, clear of the wet ground. It is active by day and night, usually remaining on or near to its regular runways.

Long-tailed rat - *Pseudomys higginsi*

Green (1973:49) records this species as being:

- common in the rainforests, especially in the western region, rarely being found in any other habitat. It is mostly nocturnal, hiding by day in a nest of shredded grass or bark, placed in a hole in a rotten stump or log beneath the accumulated forest litter.

Green (1968) noted specimens from Port Davey and Bond Bay in Southwest Tasmania and observed that localities where they had been collected ranged in altitude from 'near sea level to about 3,000 feet. All known occurrences have been in or near rainforest'. He adds (1968:1):

- on occasions it has been trapped in the *Mesomelaena sphaerocephala* ([Gymnoscopoeus sphaerocephalus] (button grass) sedgelands. It is considered that the occurrence in sedgeland is exceptional and that the individuals involved were footloose vagrants on exploratory excursions.

Swamp antechinus - *Antechinus minimus*

Green (1973:37) reports that this species is:

- common in its preferred habitat, which is the dense wet sedgeland and adjacent swampy drainage system, where it inhabits the runways formed by native rats. Such areas are to be found mostly in the western half of the island. It is common also on Maatsuyker Island...It may be abroad at any time of the day or night, but it appears most active at twilight or early evening. Its nest is well secluded, being built among dense vegetation, such as the base of Button grass or similar cover.

Dusky antechinus - *Antechinus swainsonii*

Green (1973:35) says this species is 'confined principally to the rainforests' and is 'mostly nocturnal, its daytime retreat being a nest in the cavity of a tree or rotten log, or deep among the accumulated moss-covered litter of the forest floor'.

Sea Mammals

Fur seal - *Arctocephalus pusillus doriferus*

The common seal off southern Tasmania is the Australian fur seal, *Arctocephalus pusillus doriferus*. The New Zealand fur seal, *A. p. forsteri*, also occurs around southern Australia, but has not been recorded historically from Tasmania. The present colony on Maatsuyker Island is the Australian fur seal.

Warneke (1966, 1968, 1975 and pers. comm.) has provided details of the structure of the colony of Australian fur seals on Seal Rocks, Victoria, and the same pattern would probably have applied to Maatsuyker Island. The colony is divided into two basic groups of animals, the breeding and non-breeding, located in two different areas. The breeding section consists of a number of breeding bulls, who hold territory on any suitable ground (which consists essentially of a rock platform with water available in rock pools); mature females, who are loosely connected with each territory; and pups, who are distributed through and on the edge of the breeding area.

The other section of the colony is composed of non-breeding males, those
which are too young or too weak to obtain and hold a territory. The area where they stay is not suitable for breeding, and their only requirement is access to the sea.

Two types of animals are not rigidly restricted to these two sections: yearlings (male and female) and immature females. Both of these groups are free to move throughout the colony and may form clusters with pups, or with other animals their own age in any area.

The breeding timetable for this species is detailed in Chapter V.

Elephant seal - *Mirounga leonina*

An elephant seal colony has a very similar structure to that of a fur seal colony, being composed of a breeding group (territorial bulls, breeding females and pups) and a non-breeding group (young males). The main difference between the two species is that female elephant seals appear to be much more rigidly restricted to territories (more definite harems are maintained) than are fur seal females.

The annual breeding of elephant seals on Macquarie Island (Carrick *et al.* 1962) takes place between August and November. Breeding bulls and cows leave the beaches by early November and pups leave in December to mid-January. Immature animals come ashore from November to January, while breeding animals come ashore to moult from January to April (cows, January-February; bulls, February-April). Some immatures and a few pregnant cows come on to the beaches between mid-February and September, with a peak in numbers between April and May. Males over 4-5 years apparently do not haul out (i.e. come on to the beaches) in winter. Cows are beginning to mature in their fifth year and come ashore in the September of that year with the breeding animals. The first bachelor bulls make their equivalent appearance in the breeding season in their seventh year, and by 9 years of age they begin to challenge the harem bulls.

Leopard seal - *Hydrurga leptonyx*

This large seal is seen only on rare occasions, 'presumably as a wanderer from Macquarie Island 1367 km to the south, where it is common' (Green 1974:392).

Reptiles

Only three snakes, all elapids, occur in Tasmania; two large species, *Notechis ater* (the black tiger snake) and *Austrelaps superbus* (the copperhead) and one small one, *Drysdalia coronoides* (the white-lipped snake).

Sea Birds

Mutton-bird - *Puffinus tenuirostris*

Mutton-birds nest in very large colonies, although each pair of birds occupies an individual nest. On average there may be one nest per square metre of suitable ground (Serventy *et al.* 1971). The nests are constructed in burrows, consisting of a chamber lined with nesting material, connected to the surface by an access tunnel about 1 m long. Tussock-covered ground seems to be ideal for nest construction.

Birds arrive at nesting islands during the last week in September (Serventy *et al.* 1971). After mating they leave the area and then return between 19-21 November to begin laying eggs. The eggs are all laid between that date and 2 December, with most laid between 24-26 November. Approximately every two weeks the parents alternate incubation duties until the eggs hatch after 52-55 days (about 17 January on average). The chick is deserted by day after 23 days and fed at night by both parents, almost nightly for the first week and then at increasing intervals. The last feeding takes place on average two weeks before the young finally leave the area, which is between the third week in April and the first week in May.

Breeding begins at between 5 and 8 years of age. One-year-olds do not make landings on the breeding area, and few 2 or 3-year-olds do either. Most immatures make their first appearance as 4-year-olds. The growth rate of the young is very rapid, with hatching weight being doubled in four to six days. Adult weight is exceeded for a time (presumably at the point where feeding ceases, because the weight falls to only just above adult weight when the young
finally leave the nest).

Milledge (1972:168) describes the colony at Maatsuyker as follows:

The whole of Maatsuyker is one huge mutton bird colony and the total breeding population must amount to nearly half a million birds. Burrows honeycomb the surface of the ground from shoreline to summit.

Milledge and Brothers (1976:34) suggest that 'The colony is supersaturated, with many surface nesting pairs in overcrowded situations and areas of shallow soil'.

**Fairy prion - Pachyptila turtur**

Birds begin appearing in August (Serventy et al. 1971) and the peak of egg laying occurs at the beginning of November. Both sexes brood the eggs, alternating in weekly periods. Most hatching occurs between 25-30 December. Chicks are deserted by day after 24 days and are completely abandoned from one to six nights before they fly. Departure period is from 5-28 February, mainly between 8-19 February. This date comes from New Zealand studies, but the timetable in Australia seems to be similar.

Milledge and Brothers (1976) note that on Maatsuyker the fairy prion colonies do not overlap with the mutton-bird breeding areas, being placed on steeper slopes between those areas. They exist as mixed colonies with the common diving petrel:

- In all except the 'lighthouse' colony, Fairy Prion burrows outnumber those of the Diving-petrel in the ratio of 2 to 1...
The entrances to the Prion burrows are often concealed by Poa tussocks or pigface...Nesting chambers are branched with two or three entrances and extend to a depth of two metres, although burrows in the 'northern' colony average only about one metre in depth due to the heavy clay subsoil [Milledge and Brothers 1976:33].

Milledge and Brothers estimate that about 600 breeding pairs are present on Maatsuyker.

**Fairy penguin - Eudyptula minor**

Green and Mollison (1961:225) note: 'This penguin breeds in large numbers in rocky clefts and burrows on the coast and islands' (in the southwest). Milledge and Brothers (1976:33) note that:

- A breeding colony is located among boulders near the landing jetty [on Maatsuyker]...Probably breeds elsewhere on the island. Estimated 30 breeding pairs in the 'landing' colony.

Milledge (1972:168) observed that this species 'breeds under boulders in sheltered situations'.

**Other penguins**

Green and Mollison (1961) record observations of large penguins ashore in moult at Port Davey, and Vanderwal saw what were probably rock hopper penguins ashore at Louisa Bay.

**Cormorant - Phalacrocorax carbo**

Green and Mollison (1961) note that this species is common along the coast. It is not present on Maatsuyker, although the black-faced cormorant (Phalacrocorax fuscescens) is plentiful there (Milledge and Brothers 1976). There is a small breeding colony on the Needles, offshore from Maatsuyker. Serventy et al. (1971:163) note that P. carbo

- normally a colonial nester but occasionally breeds singly among other species of cormorants. Nests along rivers, lakes and in flooded areas...
- Rookeries are often composed of this species mixed with other kinds of cormorant and with ibis, herons and spoonbills, and in such situations the Black Cormorant selects the highest positions for its nest...Where conditions are favourable nesting may be continuous from early summer through to autumn, with a short break in winter and then nesting beginning again in early spring and continuing through to midsummer.

**Shy albatross - Diomedea cauta**

Green and Mollison (1961) report the presence of around 2000 individuals of this
species on the Mewstone. Milledge (1972:168) says:

Quite common around [Maatsuyker] and frequently in feeding groups... offshore. There is a large breeding colony on the Mewstone, a rock 13 km SE of Maatsuyker. All birds seen were adults.

Serventy et al. (1971) describe this species as nesting at the end of September and early October. The young hatch about the end of November. By mid-April they are full grown and take their first flights. In the related species, D. exulans, breeding does not begin until 9 years of age, and adolescents do not return to the breeding island until 5 years of age.

Green and Mollison (1961) observed a wandering albatross near Whale Head. They also observed a species of sooty albatross (Phoebetria) in the area. This is a small species, and there are probably other species of small albatross which make occasional visits to the area.

Diving petrel - Pelecanoides urinatrix

There is a small breeding colony of this species on Maatsuyker (Milledge and Brothers 1976). Green and Mollison (1961) report seeing flocks at sea on a few occasions.

Milledge (1972:168) found:

A breeding colony of several hundreds...at the southwestern end of Maatsuyker. The burrows were from 0.6-1.0 m long and about 60 mm in diameter...The burrows were in groups of about fifty interspersed through the mutton bird colony.

Milledge and Brothers (1976) found the burrows of this species interspersed with those of the fairy prion. Burrows were about 1 m in depth.

Seagull - Larus novaehollandiae

There is a small breeding colony of this species on Maatsuyker (Milledge and Brothers 1976). It is relatively rare along the southwest coast - in 1961 the only breeding colony in Louisa Bay was one with about six nesting pairs on a small rocky island (Green and Mollison 1961). Seagulls breed only on areas surrounded by water (Murray and Carrick 1964). Milledge (1972:169) described the species 'nesting on the cliffs among Poa and Tetragonia' and estimated the breeding population at about 100 pairs on Maatsuyker.

Water Birds

Duck

The black duck (Anas superciliosa) and the grey teal (A. gibberifrons) are reported to be common in the area, and the chestnut teal (A. castanea) and musk duck (Biziura lobata) also occur less commonly (Green and Mollison 1961).

Swan - Cygnus atratus

Green and Mollison (1961) suggest that the number of black swans in the southwest had decreased from some thousands in the 1920s to less than 200 in 1961.

Land Birds

Forest raven - Corvus tasmanicus

Green and Mollison (1961:234) report the presence of C. coronoides (=C. tasmanicus) in the area as:

Plentiful...along the coast. Green noted them on Flat Island...they are usually timid, coming to feed on worms and land crabs [after bulldozer operations]...they will follow hunters for the offal from wallabies and...may have accompanied men in this way from the time of the aborigines. Ravens gather on the mutton bird islands in summer.

Milledge (1972:169) reports their presence on Maatsuyker Island in February:

Common, especially along the cliffs and shore. As with the currawongs, ravens moved from island to island and no doubt also to the Tasmanian mainland. Two birds were seen to raid the nest of a silver gull and take an egg.

Serventy et al. (1971:132) observed that 'ravens easily overpower [mutton-birds] and...take many young and eggs, usually from shallow and poorly sited nests'.
Similarly Green and Mollison (1961:226) found that in February 'Pacific Gulls, Silver Gulls, Black Currawongs and Ravens were "quarreling over the eggs" [of the mutton-birds]'.

Currawong - *Strepera fuliginosa*

Green and Mollison (1961:234) note that this species is:

Numerous and widespread, but more plentiful on the coast where kelp flies and maggots abound. They go to the high country in late summer for berries and form small flocks at times. They suggest that some were residing on Flat Island, 'in the dense scrubs growing to 12 ft. in height' (1961:234). Milledge (1972:169) observed them to be common on Maatsuyker and 'on many occasions parties flew between Maatsuyker, De Witt and Flat Witch Islands'.

Blue-winged parrot - *Neophema chrysostoma*

Green and Mollison (1961) report this parrot as quite common in the area.

**SUMMARY**

Southwest Tasmania is climatically hostile and its topography is rugged. There are a number of natural habitats supporting nearly 50 edible marine invertebrates, nearly 20 mammalian species, and only slightly fewer common birds. With this background we may now examine Louisa Bay and Maatsuyker Island in more detail.
III LOUISA BAY AND MAATSUYKER ISLAND

The first section of this chapter provides an overview of Louisa Bay and Maatsuyker Island, summarising marine and terrestrial environments, their occupants, and the archaeological sites on that landscape. The second part is devoted to the descriptions of excavation and the analysis of each site's stratigraphic components.

Stockton and Waterman (1977) refer to sites by number and universal grid reference in their survey report of southwest Tasmanian archaeology. Those numbers and grid references (1:100,000 sheet 8110, South West Cape) are supplied here as each site is introduced, though specific site names and initials will thereafter be used.

THE ENVIRONMENT

The various environmental features encountered in the area of our research may be thought of as representing the range of those found in southwest Tasmania, though of course nothing like the massive inland waterway of Port Davey and Bathurst Harbour is present. Louisa Bay does, however, possess a large river and creek system with adjacent marshy areas, and there are wet herblands, drier heathlands, rainforest, open forest, sandy beaches, cliffs, nearby offshore islands and a range of underwater environments. Maatsuyker Island lies several kilometres to the south in a marine environment completely separate from Louisa Bay.

For the purposes of our discussion, the area may be divided into the following somewhat arbitrary headings (see Fig. 2 and Plate 2):

1. The Eastern Cliffs
2. Louisa Island
3. Louisa River
4. The Central Cliffs
5. Anchorage Cove
6. The Western Cliffs
7. Maatsuyker Island.

The Eastern Cliffs

To the east of Louisa Point, a series of quartz cliffs form the lower parts of the Ironbound Range. These cliffs are inaccessible for more than 20 km eastward, and though the high energy wave regime is very productive of many smaller gastropods as well as of warrener and abalone, the vertical nature of the cliffs would probably have prevented exploitation except in a very limited way. Small shell scatters on upper rock ledges appear to be the only archaeological remains.

Louisa Island

At the southeastern corner of Louisa Bay is Louisa Island, the south side of which is very steep and exposed to the sea. Its inner side is more approachable, with a number of small embayments and offshore submerged and partially submerged boulder galleries. A variety of rocky area shellfish, including large numbers of abalone and warrener, and crayfish, abound in the surrounding waters.

At its widest, the island is only 500 m across, and is 700 m long. Pademelons were observed on the island, though a large population is precluded by the island's size. Exchanges between the mainland and island population are limited by the nature of the tombola connecting the island to Louisa Beach, which is only occasionally above water. On the south side is a colony of fairy penguins, and mutton-birds dig their burrows mainly on the eastern third of the island. A single archaeological site is recorded for Louisa Island (site 9, DM686795). It is perched on a small ridge, and debris is eroding out from both sides. The site was not excavated.

Louisa River

This is the largest province, consisting of Louisa Beach, the sand dune system
Plate 2 A panoramic view of Louisa Bay, De Witt Island and to the east and the river. The beach is 1.9 km long and nearly 300 m wide along most of its length. Its southern two-thirds are bordered by the Louisa River, flowing adjacent to an extensive sand dune system. A narrow band of open forest separates the dunes from wet sedgelands. These two habitats are particularly rich in native cats, possums, long-tailed rats and eastern swamp rats. The remains of archaeological occupation are seen eroding out of the face of the sand dunes (Stockton and Waterman refer to this site complex as site 1, DM490795), and consist for the most part of debris lenses up to a few metres long and up to 20 cm thick, though there are many more smaller ones than larger. At no one point along the face of the dune can the entire stratigraphic sequence be seen, so two of the larger areas were chosen for excavation. Louisa River site 1 (LR 1: DM491799) is earlier in time and separated from Louisa River site 3 (LR 3: DM491800) by a thick band of black sand representing a major stable period in the history of the dune complex (Plate 3). A third site excavated was Louisa River site 2 (LR 2: DM492795) whose deposition could not be tied into the sequence of dune formation, but whose radiocarbon date equates it with site LR 1.

The Louisa River curves behind the beach where open forests flank both its banks, an environment particularly suited to potoroos, possums and rats. The slow-moving river is inhabited by ducks, swans and eels.

Further inland and to the west the river approaches the land system behind the Central Cliffs. At the foot of this bluff and near the river are five caves, none reaching the proportions reported by Robinson (8.2.30:117): 'Saw several caverns, one through which I passed upon my hands and knees for three or four hundred feet'. All caves show traces of occupation, though three appear to be too wet to have comfortably supported much occupation. Two caves, Louisa River Cave site 1 (LRC 1) and Louisa River Cave site 2 (LRC 2) were excavated, though the major part of the work was confined to LRC 2. (This entire cave site complex was called site 2, DM482817, by Stockton and Waterman.)

The Central Cliffs

Between the Louisa River caves and Louisa Creek is a large area of relatively dry and hilly sedgeland in which there are numbers of brush wallabies and wombats. On the coast the Louisa River beach and Louisa Creek are separated by a series of extremely rugged inlets, most of which are fronted on the sea by steep hills, cliffs and gigantic quartz boulders. The waters within the inlets are particularly abundant in mussels and many other smaller shellfish, with abalone and warrener also represented.

At the mouth of and to the east of Louisa Creek are about 400 m of sandy beach. At the extreme eastern end of the beach is a small dune containing an archaeological deposit (site 3, DM470817; excavation site LC 1). There are other archaeological deposits on the rocky headlands to the east, manifested by two small areas of shell midden (site 162, DM472814).

To the west of Louisa Creek is a 1.7 km stretch of cliffs and rugged embayments broken only by the occasional tiny beach, each with ephemeral streams, and backed by}

1 References to the journals of George Augustus Robinson are to the edition of Plomley 1966. The date of reference is given first (8.2.30 = 8 February 1830) then the Plomley pagination.
Maatsuyker Island as seen from the Red Point Hills

heath and scrub similar to that between Louisa River and Louisa Creek. There are two small archaeological deposits at different beaches, identified on the original survey as Green Beach (site 4, DM466814) and Shingle Beach (site 5, DM463811). Neither site was excavated.

At the extreme southwestern end of these cliffs is a large unnamed bay which is well watered and is contiguous with a number of seemingly attractive resource zones (Fig.2). Yet the area is devoid of any archaeological deposits, which may be explained by inadequate terrestrial diversity; such diversity is seen at all other site areas. Or perhaps the ochre cliffs (site 6, DM460810) were considered to be community property, and camping adjacent to them forbidden. This particular quarry may be the source from which Robinson (8.6.30:170) was told the Too Gee obtained ochre at Cox Bight. The only other ochre deposits reported for the area are to the north of Port Davey (Plomley 1966:227-8) and near Melaleuca Lagoon (D. King pers. comm.). Traces of ochre were found at all excavated sites.

Anchorage Cove

The sandy beach at Anchorage Cove is 600 m long and about 100 m wide. Directly behind it is herbland which itself is flanked by scrub, while heath is close by. The area is particularly attractive to a number of animals, including native cat, possum, wombat, pademelon, wallaby and potoroo.

The major archaeological deposit is the excavated site AC 1 (site 7, DM450801), adjacent to a small creek. Two other smaller open sites are located behind small gravelly beaches between site AC 1 and the boundary marking the Western Cliffs (Fig.2), while a small rockshelter (site 8, DM452796, which Stockton and Waterman (1977:33) erroneously report as excavated) opposite the island has preserved some deposit.

The Western Cliffs

South and west beyond Anchorage Cove are a number of marine environments supporting large populations of rock-dwelling shellfish. Particularly plentiful are wrarreners, limpets and abalone. Seals have been observed resting in the exposed water-cut caves of the coast to the west. The nature of the marine and terrestrial contact resembles that of the Eastern Cliffs. No archaeological sites were located in the very exposed high energy environment.

Maatsuyker Island and the Big Witch

While the Maatsuyker Island group (Plate 2) is obviously not geographically part of Louisa Bay, it did form a part of the initial survey and became important to the general study of human adaptation to southwest Tasmania.

Midway along the north and leeward (protected) side of the Big Witch (De Witt Island) is a creek emptying onto a gravelly beach. Numerous penguin and mutton-bird burrows covering about 25 ha are found on gently sloping heathland on both sides of the creek. Despite the disturbances caused by these burrows, close examination of the most likely sites for human occupation failed to produce results (Vanderwal 1978b:19). The rest of the island is unapproachable due to high cliffs and unfavour-
Plate 3  A general view of a portion of the Louisa Bay sand dune complex. Note the central band of dark soil which is interpreted as a period of major stability from one end of the complex to the other. The Ironbound Range is in the background.
able wind conditions. Inland areas are dominated by scrubland communities.

Maatsuyker Island can be approached only at the northeastern side (Fig. 3); the remaining coastline presents a practically unbroken face of precipitous cliffs. The island is one vast mutton-bird rookery, and penguins dig their burrows close to the waterline. Other birds nesting and breeding on the island are fairy prion, the common diving petrel, black-faced cormorant and the silver gull (Miledge and Brothers 1976). Jutting southward are the Needles, jagged quartz rocks which are home to thousands of seals (Cook 1978). The only land mammal present today is the swamp antechinus (Antechinus minimus).

Two archaeological sites have been located. One, 180 m above the landing, has slumped under the weight of modern European rubbish accumulation and its contents are scattered along the upper part of the valley. The other (DM418681) is located at the landing itself, and has been excavated (MAT 1).

![Fig. 3 Maatsuyker Island](image)

**THE EXCAVATIONS**

The research effort about to be described examines occupation and resource utilisation in a variety of habitats as reflected in the debris recovered from the open and rockshelter sites of Louisa Bay and Maatsuyker Island. There are, however, certain limitations to that research which were imposed by the research design and by the realities of climate and local terrain.

The research design has been discussed elsewhere (Vanderwal 1978a), but can briefly be summarised as an investigation of how this part of southwest Tasmania, with its rugged coastal terrain and hostile climate, had been exploited prior to
European colonisation. Such a design demanded a methodology allowing the investigation of as many sites as possible in order to maximise the opportunities for recovery of faunal remains representing all available resource zones. Most sites, however, are in some way disturbed, the sand dune sites by winds eroding the dune face thus exposing the sites in cross-section, the beach sites by encroaching waters; unknown portions of such deposits had clearly been destroyed. The only visible site on Maatsuyker Island is currently a mutton-bird rookery and must by virtue of that fact alone be disturbed.

The terrain and climate imposed restrictions through simple logistics. The excavation of the site at Anchorage Cove was carried out by two people over two weeks, a limit dictated by the ability of a fishing dinghy to get there, off-load the equipment and get back before heavy seas made the return impossible. The result was that only a single 1 x 1 m square was excavated in the two weeks before final pick-up. Maatsuyker Island was similar. Vanderwal initially sampled the site on his own with three 50 x 50 cm squares in two weeks between light-station provisioning trips, and later with two others returned by helicopter under similar conditions to continue excavation.

Because it was impossible to transport people to, or remain at the sites for long periods, sample sizes are often not as large as might have been desired. It was also difficult to estimate the volume of uneroded sites, especially in sand dunes, where neither time nor labour were available to remove deep overburdens.

Despite these problems, it is considered likely that the recovered samples are representative of local resources and therefore consist of the kinds of data necessary for interpreting subsistence patterns.

We may, then, proceed to the detailed descriptions of the excavated sites, their excavation, stratigraphy and chronological position. Tables 5 to 11 provide summary data on the excavations and the way in which they are divided into stratigraphic units at some sites. This information is useful for understanding and manipulating the data contained in Chapters V and VI (faunal analysis). Volumetrics, where given in excavation levels rather than spits, apply to the total of all excavation levels within a stratigraphic deposit; the significance of such measures is made clear in Chapter IV where the analytical methodology is developed. Soil volumes were calculated as accurately as possible using solid geometrical formulae programmed into a Hewlett-Packard 67 calculator. Rod and level readings were to the nearest centimetre.

Owing to the way the deposits are thought to have formed, i.e. in discrete lenses often seen only in plan and not extending to the sections drawn, certain discrepancies will be noted between the names of deposits as they appear in tables and the way such deposits are seen in the drawn sections. The latter, while accurate renditions of the sections as they appeared at the time of excavation, must be seen as generalised pictures of the stratigraphy; the named and listed stratigraphic units or deposits are interpreted from the excavation records and field notes, and as such represent the reality of deposition much more closely than do the section drawings. It was felt that an attempt at terminological marriage of the two records would falsify one or the other; instead, correlations are sought in the descriptions of excavation.

The Louisa River Sand Dune Sites

The Louisa River sand dunes vary in height between 5 and 15 m. Dividing the length of the dune into an upper part and a lower part is an organic sand horizon interpreted as representing a widespread period of local sand dune stability (Plate 3). Both above and below this horizon are numbers of discrete shell accumulations seen eroding out of the dune face, their thickness ranging from a few centimetres to about 40 cm. In only a few localities are there more than two such deposits lying in stratigraphic superposition. In no instance was it possible to estimate the area of these lenses as wind transgression had destroyed unknown proportions of them. Even on those sites excavated, exploratory lens definition would have involved the removal of massive amounts of sand, and such attempted definitions of the extent of lower and smaller deposits would have been blocked by larger upper ones. The combination of these two problems meant that any attempts to define the size of these lenses would have been futile.

Excavation sites were chosen so as to maximise return for effort. Site LR 1 consists of a series of stratified lenses below the major soil horizon, and LR 3 consists of a thick deposit above that horizon. Site LR 2 appeared to consist of a
Fig. 4  Louisa River sand dune sites: Louisa River 1, Louisa River 2 and Louisa River 3
Plate 4  The excavated trench at Louisa River site 1 (see Fig. 5)
single thick midden deposit; it could not be stratigraphically correlated with the other two. Figure 4 is a schematisation of the Louisa River sand dunes showing the relative positions of the three sites.

**Louisa River Site 1**

This site is stratigraphically earlier than LR 3, lying below the widespread organic sand horizon discussed above. A 2 x 5 m trench, whose long axis was at right angles to the dune face, was dug to remove a vertical metre of sterile sand overburden. A trench 1 m wide and 4 m long was then laid out so that a 50 cm shelf would be formed on the ends and sides of the trench. As excavation progressed, the amount of loose sand falling directly into the main trench was therefore minimised. The trench was stratigraphically excavated in four 1 m squares. The stratigraphic section is shown in Plate 4 and Figure 5. All cultural debris retained by a 6 mm sieve was kept.

![Fig. 5 Stratigraphic section of Louisa River site 1 (see Plate 4). The section shown is the north side of the 4 m long trench.](image)

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Square 1</th>
<th>Square 2</th>
<th>Square 3</th>
<th>Square 4</th>
<th>Volume* (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark Organic</td>
<td>1, 2, 3</td>
<td>1</td>
<td>1A, 1B</td>
<td>1</td>
<td>0.94</td>
</tr>
<tr>
<td>Dense Shell</td>
<td>4, 5</td>
<td>2, 3</td>
<td>2</td>
<td>2</td>
<td>0.47</td>
</tr>
<tr>
<td>Sandy Soil</td>
<td>6, 7</td>
<td>4, 5</td>
<td>3</td>
<td>-</td>
<td>0.30</td>
</tr>
<tr>
<td>Sterile Soil</td>
<td>8</td>
<td>6</td>
<td>-</td>
<td>-</td>
<td>0.30</td>
</tr>
<tr>
<td>Tan Sand</td>
<td>9, 10, 11</td>
<td>7, 9</td>
<td>4</td>
<td>3</td>
<td>0.44</td>
</tr>
<tr>
<td>Grey Sand</td>
<td>12</td>
<td>8, 10</td>
<td>5</td>
<td>-</td>
<td>0.30</td>
</tr>
<tr>
<td><strong>Total volume</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>2.75</strong></td>
</tr>
</tbody>
</table>

* soil volumes for all sites were calculated as closely as possible using solid geometrical formulae programmed into a Hewlett Packard 67 calculator. Rod and level readings were to the nearest centimetre.

**Table 5** Louisa River site 1: deposits, excavation levels and soil volumes
Plate 5 The excavated trench at Louisa River site 2 (see Fig. 6)
Depositional details of the culture-bearing deposits underlying the lowermost layer of the Sterile Grey Sand overburden (Fig.5) are shown in Table 5. It should be noted that the interpretation of the excavated remains (Table 5) is somewhat at variance with the record as seen in the stratigraphic section of the north face of the trench (Fig.5); the Dark Grey Sand and Grey Sand generally equate respectively with the Dark Organic and Sandy Soil deposits, while the Dense Shell deposit occurred only in the southern part of the trench. Below the sterile deposit, the Tan Sand deposit derives mainly from the Yellow Sand of Figure 5, but also includes the overlying Grey Sand stratigraphic feature which was not detected while excavating. The Grey Sand deposit is a combination of the Grey Sand and Black Sand seen in Figure 5.

The debris lenses, contrary to expectation, were spread along the front or windward face of the dune. It is therefore possible that the lenses represent reworked and eroded aprons of debris falling from the exposed face of a sand dune and subsequently incorporated into the main dune corpus, though this is considered unlikely considering the stratigraphy of the lenses and the low angle of deposition. A second possibility is that another parallel dune, now deflated, afforded protection from the forces of the wind. Finally the deposit may have simply formed in the direct face of the wind, although all other observations indicated that occupation normally occurred on the leeward slope.

Charcoal was rare to non-existent. The single date for the site was obtained on the charcoal-rich Black Sand lens at the base of the Grey Sand shown in Figure 5. The radiocarbon determination for the sample is 2970 ± 200 BP (ANU-1771).

Louisa River Site 2

The site lies above a 4 m phyllite cliff, separated from it by up to 10 cm of sterile, though stained, sand. Bone and shell were well preserved, so the staining is thought to be the result of water percolating through the overlying deposits rather than in situ disintegration of debris. The face of the archaeological deposit appears to be eroding at about the same rate as the soft phyllite is being worn away.

Excavation consisted of a 1 x 2 m trench whose long-axis was at right angles to the dune face. Only two distinct deposits could be defined, a Sandy Soil (Grey Sand in Fig.6) and an upper Dense Shell. As with all the dune-sited archaeological deposits, there is an overburden of windblown sands, in this case with a single organic deposit separating two episodes of dune-building activity (Plate 5). Unlike site LR 1, however, the sand overburden at LR 2 is not deep. This is attributed to the position of the site in the lee of Louisa Island.

A 6 mm screen was used for sieving. All material was retained, but only stone and bone could be analysed, the other samples being lost. No charcoal date is available, but two bone fractions gave dates of 2830 ± 155 BP (apatite carbon dioxide, SUA-1063A) and 2580 ± 100 BP (organic fraction, SUA-1 063B). Table 6 summarises the excavation data relevant to the two cultural deposits underlying the Dark Grey Sand of Figure 6.

![Stratigraphic section of Louisa River site 2](Plate 5). The section shown is the south end of the 1 m wide trench
Plate 6  The excavated unit at Louisa River site 3 (see Fig. 7)

Fig. 7  Stratigraphic section of Louisa River site 3 (see Plate 6). The section shown is the east side of a 2 m long trench
Site LR 3 was deposited after the major epoch of stability and is located some 200 m to the north of LR 1. Like the other sites located in the sand dunes, its contents were eroding out of the dune face. The excavation was laid out by dressing 2 m of this face, and measuring 1 m back into the dune, after which the overburden was removed (Plate 6 and Fig.7). A 6 mm screen was used to recover cultural material, all of which was retained. Table 7 summarises the excavation data. As before, the deposits observed during excavation and those shown on the stratigraphic section do not match. For instance, the Dark Grey and Mottled White Sands are considered to be cultural, but that interpretation is based on the recovery of a few shells. These were too few to be analysed but are not thought to have been derived from underlying deposits. The Dense Shell unit is shown as being minor, but was discovered to be a major deposit as it expanded into the western part of the trench. Conversely, the Mussel Shell layer became attenuated in the same direction. The Light Sand, Organic Sand and Light Organic Sand of Table 7 are all facies of the Light Grey Sand shown in Figure 7.

A carbon sample, from LR 3/2 (Dense Shell), dated to 630 ± 90 BP (GaK-6599).

Table 6 Louisa River site 2: deposits, spits and soil volumes

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Spit</th>
<th>Volume (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dense Shell</td>
<td>1</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>0.19</td>
</tr>
<tr>
<td>Sandy Soil</td>
<td>5</td>
<td>0.19</td>
</tr>
<tr>
<td>Total volume</td>
<td></td>
<td>0.86</td>
</tr>
</tbody>
</table>

Table 7 Louisa River site 3: deposits, excavation levels and soil volumes

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Excavation levels</th>
<th>Volume (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dense Shell</td>
<td>1, 2, 3</td>
<td>0.46</td>
</tr>
<tr>
<td>Mussel Shell</td>
<td>4</td>
<td>0.06</td>
</tr>
<tr>
<td>Light Sand</td>
<td>5, 6</td>
<td>0.11</td>
</tr>
<tr>
<td>Organic Sand</td>
<td>7, 8</td>
<td>0.27</td>
</tr>
<tr>
<td>Light Organic</td>
<td>9</td>
<td>0.37</td>
</tr>
<tr>
<td>Total volume</td>
<td></td>
<td>1.27</td>
</tr>
</tbody>
</table>

Plate 7 The entrance to Louisa River Cave site 1 is lighted from within by a gas lantern.
Plate 8  The interior of Louisa River Cave site 1. Note the height of the ceiling and the floor debris consisting of phyllite tablets

The Louisa River Caves

Louisa River Cave Site 1

This is a small circular cave, about 5 m in diameter, whose entrance is 1 m high and 50 cm wide (Plate 7). The present floor of the cave is littered with phyllite tablets of various sizes which have exfoliated from the roof (Plate 8), and shell and bone are also in evidence.

A trench measuring 1 x 1.5 m was opened, though its real size at any subsequent point in excavation is problematical because the corner pegs could not be accurately driven in through the phyllite tablets; the differing sizes of the tablets prevented a uniform floor from being made; and large flakes shingling together at the wall precluded the possibility of retaining the original measurements of the trench. Given these conditions it was not possible to conduct a controlled excavation of the site, so that after having excavated three spits, the attempt was abandoned. The recovered materials from this site were analysed in the same way as those from the other sites, but interpretations have been tempered by the problems of excavation.

Louisa River Cave Site 2

This cave (Plate 9) is much larger - 12 m long, 3 m wide, 3.5 m high - and must almost certainly be one of those referred to by Robinson in the summer of 1830 (8.2.30:117): 'Removed my tent under some steep cliffs where there was caverns to shelter the natives and the party'. The northern end of the cave is covered by a large rock fall, while the remainder of the floor is marked by a scatter of small stones and the occasional large boulder (Fig.8, Plate 10).

Excavation consisted of three 1 x 1 m squares, and a single 1 x 0.5 m extension, with baulks left standing and unexcavated between the squares (Fig.8). Most soils were sieved through 6 mm screen, though the wetter clay deposits were water sieved through 3 mm screen. The deepest and most complex section is shown between points A-B (Fig.8), and the deposits gradually attenuate toward the north, as can be seen by reference to Table 8.

The cave stratigraphy (Fig.8, Plate 11) was very complex, and many of the deposits were so thin as to defy separation in the excavation process, while others consisted of relatively thick but rapidly attenuating lenses. Stratigraphic analysis
Plate 9  The entrance to Louisa River Cave site 2

Plate 10  The excavated trenches at Louisa River Cave site 2 (see Fig. 8)
Fig. 8 Stratigraphic section and plan view of Louisa River Cave site 2 (see Plate 10)
Table 8 Louisa River Cave site 2: deposits, excavation levels and soil volumes

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Square 1</th>
<th>Square 2</th>
<th>Square 3</th>
<th>Extension</th>
<th>Volume (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last Occupation</td>
<td>1, 2, 3B</td>
<td>1, 3</td>
<td>1, 2</td>
<td>1</td>
<td>0.44</td>
</tr>
<tr>
<td>Dense Shell II</td>
<td>3A, 3C</td>
<td>2, 4, 5, 6</td>
<td>3</td>
<td>2</td>
<td>0.41</td>
</tr>
<tr>
<td>Brown Soil</td>
<td>4A, 5A</td>
<td>7, 8</td>
<td>-</td>
<td>-</td>
<td>0.04</td>
</tr>
<tr>
<td>Dense Shell I</td>
<td>5B</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.06</td>
</tr>
<tr>
<td>Organic Soil</td>
<td>6</td>
<td>9</td>
<td>4</td>
<td>3, 4</td>
<td>0.27</td>
</tr>
<tr>
<td>Grey Soil</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>0.02</td>
</tr>
<tr>
<td>Total volume</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.24</td>
</tr>
</tbody>
</table>

here is only a best approximation to reality, the major divisions created from the excavated units being fairly gross and probably generally including more than a single occupation. Be that as it may, the sequence of events which appears to be represented here is as follows. The final event before human occupation appears to have been inundation, the sand grains being rounded, not facettet. The Grey Soil, seen only in the extension, might represent a change imparted by first occupation, or perhaps simply by its position in the cave. The presence of water-deposited sand suggests that the cave (and others along the cliff face) was uninhabitable prior to about 900 years ago, probably because the river (or an anabranch of it) was flowing at the foot of the cliff before that time. Thus it is possible that this soil at the lowest point in the cave is the remains of a deposit whose volume was perhaps reduced by water entering the cave as the river was migrating away from the cliffs. This explanation would account for the high density of debris in the deposit, relevant to some of the analyses reported in Chapters V and VI.

Overlying this soil is a deposit called Organic Soil because of its very dark colour. A dense shell deposit (Dense Shell I) seen only in square 1 is overlain by a brown soil characterised by a local shell concentration. This in turn is overlain by what appears to be one of the two major deposits in the cave, a very densely packed layer of shell (Dense Shell II). The site is capped by an equally thick layer of brownish soil containing quantities of small stones which have fallen from the roof.

A carbon sample removed from the lowermost of the charcoal concentrations, seen in Figure 8, dated to 870 ± 90 BP (GaK-5990).
The Louisa Creek Site

This site (Plate 12) is small, located within a dune formation surmounting a phyllite base. Mussel shells were visible on the eroded face, and as they were initially considered rare, the site was excavated. Most of the site was overgrown by heavy scrub, so an area sufficient to excavate a 1 x 1 m square was cleared. The original alignment of the excavation square, 2 m in from, and parallel with, the eroded face of the deposit did not allow the removal of what turned out to be a very small but relatively thick lens of mussel shell. Therefore an extension, with the east wall in line with the north and south corners of the original square, was laid out. The shape of the final trench was therefore that of an arrow pointing east.

The stratigraphic section, shown in Figure 9, is much more complex than the derived analytic units (Table 9) because of subsequent decisions made about the nature of the deposits. The Dark Sand and the Silver Grey Sand of Figure 9 are thought to represent the same depositional event, and have been combined to form the Stained Sand of Table 9. The White Sand in the south section lenses out to the north and is sterile. The next significant unit is Shell, so labelled in Figure 9, but which also includes a minor component of the underlying Tan Sand. Overlying Shell are two significant lenses of densely packed mussel shell. The remaining unit
combines what is shown in Figure 9 as various coloured sands (the Shell deposit shown in section is a very minor lens undetected while excavating), and is shown simply as Sandy Soil in Table 9. It is thought that these sandy deposits accumulated rapidly, and that the hearth shown in Figure 9 is a single short-term event within the broader archaeological sequence of these sandy soils.

A carbon sample removed from the fire pit (Fig.9) dated to 1250 ± 100 BP (GaK-5989).

The Anchorage Cove Site

Time and logistics allowed the excavation of only a single 1 x 1 m square in the middle of this 12 m diameter rubbish mound (Plate 13 shows a sea-eroded section of the deposit), so that probably less than 1% of the site was sampled. There was no visible stratigraphy through the 1 m deep deposit and excavation was conducted in approximately 10 cm spits (Table 10).

A carbon sample taken from spit 10 dated to 250 ± 80 BP (GaK-5991), interpreted as indistinguishable from modern.

<table>
<thead>
<tr>
<th>Spit</th>
<th>Volume (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.08</td>
</tr>
<tr>
<td>2</td>
<td>0.08</td>
</tr>
<tr>
<td>3</td>
<td>0.08</td>
</tr>
<tr>
<td>4</td>
<td>0.09</td>
</tr>
<tr>
<td>5</td>
<td>0.10</td>
</tr>
<tr>
<td>6</td>
<td>0.08</td>
</tr>
<tr>
<td>7</td>
<td>0.09</td>
</tr>
<tr>
<td>8</td>
<td>0.12</td>
</tr>
<tr>
<td>9</td>
<td>0.13</td>
</tr>
<tr>
<td>10</td>
<td>0.03</td>
</tr>
<tr>
<td>Total volume</td>
<td>0.88</td>
</tr>
</tbody>
</table>

Table 10 Anchorage Cove site 1: spits and soil volume
The Maatsuyker Island Site

Midden debris is scattered in distinct pockets rather than spread evenly over the entire area of the foreshore platform (Plate 14). On two separate occasions excavations were carried out at Maatsuyker Island site 1. During the first visit, three 50 x 50 cm squares (MAT 1-1, MAT 1-1A and MAT 1-2) were excavated, while a fourth (MAT 1-3) further upslope was sterile. Only MAT 1-1A was excavated with notional vertical control. On the second visit three 1 x 1 m squares (MAT 1-4, MAT 1-5 and MAT 1-6) were excavated, aligned with the slope of the site (Fig. 10). None of the squares could be said to demonstrate much meaningful stratigraphy through their 35 cm maximum deposit. Table 11 presents the excavation data for squares 4, 5 and 6.
Plate 14 The foreshore platform at Maatsuyker Island site 1. Flat Witch Island is on the left and Big Witch on the right.
Square MAT 1-1A showing the clay deposit separating the two carbon samples dating the site

A carbon sample from below a 10 mm clay deposit in MAT1-1A (Plate 15), thought to have been laid down by slope wash during the occupation of the site, dated to 400 ± 90 BP (GaK-5988). This thin clay lens was seen only rarely in the other excavated squares, and usually as a much thinner deposit. The charcoal for sample GaK-5988 was also associated with a number of burnt mutton-bird and fairy prion bones, but no seals (see Chapter V). While it is possible that the charcoal could have resulted from a bushfire, and the clay was laid down after it, the presence of prion bones argues against this (prions would roost elsewhere, on steep slopes). It is considered most likely that the event described is a result of human activity. It was probably a single event, but the mutton-bird rookery here must have subsequently disturbed much of the site.

A second sample, taken from immediately above the clay, dated to 570 ± 100 BP (GaK-5987). The two radiocarbon determinations do not differ significantly (Polach and Golson 1966).

**Summary of Site Excavation**

A total of over 9 m$^3$ of soil was removed from eight different sites spanning a period from essentially modern to about 3000 years ago. These data are summarised in Table 12.

<table>
<thead>
<tr>
<th>Site</th>
<th>Soil volume (m$^3$)</th>
<th>Years BP</th>
<th>Laboratory number</th>
</tr>
</thead>
<tbody>
<tr>
<td>LR 1</td>
<td>2.75</td>
<td>3170-2770</td>
<td>ANU-1771</td>
</tr>
<tr>
<td>LR 2</td>
<td>0.86</td>
<td>2985-2675</td>
<td>SUA-1063A</td>
</tr>
<tr>
<td>LR 3</td>
<td></td>
<td>2480-2680</td>
<td>SUA-1063B</td>
</tr>
<tr>
<td>LRC 2</td>
<td>1.27</td>
<td>720-540</td>
<td>GaK-6599</td>
</tr>
<tr>
<td>LC 1</td>
<td>1.24</td>
<td>960-780</td>
<td>GaK-5990</td>
</tr>
<tr>
<td>AC 1</td>
<td>1.10</td>
<td>1350-1150</td>
<td>GaK-5991</td>
</tr>
<tr>
<td>MAT 1</td>
<td>0.91</td>
<td>330-170</td>
<td>GaK-5988</td>
</tr>
</tbody>
</table>

Table 12 Summary of excavation and chronological data
IV ANALYTICAL METHODOLOGY

VERTEBRATES

The main problem in analysing the vertebrate fauna was the sheer quantity of bone, particularly from Maatsuyker Island. In one square more than 6000 bones of the mutton-bird alone were analysed. For this reason, and because they are often difficult to identify to species, ribs, vertebrae (except for fish and reptiles) and phalanges have not been counted or analysed. Two of the excavated squares on Maatsuyker (MAT 1-4 and MAT 1-6) have also not been analysed, but were checked for the occurrence of any unusual species (those other than seal, mutton-bird or prion).

For the bird species the following bones were analysed: synsacroium, pelvis, femur, tibia, metatarsus, humerus, radius, ulna, metacarpus, carpus, sternum, coracoid, scapula, mandibles, upper beak, parietal and periotics. For the seals: pelvis, femur, tibia, scapula, humerus, radius, ulna, mandibles, periotics and upper and lower canine teeth. For the other mammals the analysis is based largely on jaws and teeth, although where possible postcranial remains are also considered (these are often difficult to assign to species).

The bones were characterised as left/right, adult/juvenile, burnt/unburnt, whole/broken (and the nature of the breakage considered). For the mammal jaws, ages have been assigned to the individual animals, but the accuracy with which this can be done varies accordingly to the species. It is probably most accurate for the seals, and the sex of these animals can also be determined.

Minimum numbers have been calculated for all deposits. This was done in the standard way using the most numerous element - greatest number of left or right. This has been modified slightly in the case of bird minimum numbers, where we have most numerous element, highest number, left or right, then minimum number = number of whole bones + highest number, distal or proximal (where bone is broken centrally) + (radius and ulna only) number of 'broken' bones (i.e. those with the articular ends missing).

Meat weights are not available for any of these species. It would be possible to calculate very approximate figures for the macropods, but not for any other group. Total body weights (which are available, although approximate, for all species except some birds) have therefore been used (Table 13), which provide a reasonable interspecies comparison, although there will clearly be differences between the proportions of meat available in such diverse groups as birds, seals and marsupials.

For the birds and seals, total bone counts and minimum numbers are given. Only minimum numbers are used for the land mammals, because the number of postcranial bones which are potentially identifiable varies between species. Postcranial elements which have been identified are included in the tables simply to give added information about the presence of a species; occasionally they show the presence of a species in a particular level where teeth and jaws are absent.

INVERTEBRATES

The method of calculating minimum numbers for shellfish species depends on the morphology of each species. For species with a single shell, minimum numbers can be generally obtained from a straightforward count. Two exceptions to this are the abalone (Notohaliotis ruber), whose large shells are often fragmented, so only fragments with the central body whorl and a substantial portion of the outer lip were counted; and Subminella undulata, whose calcareous operculae were counted. Minimum numbers for bivalve species (e.g. the mussels, Mytilus and Brachidontes) were obtained by dividing the total shell numbers by two. In a similar way, minimum numbers for Poneroplas albida were obtained by dividing the total plate count by eight. For the spiny crayfish (Jasus lalandei) minimum numbers were determined from the greatest number (either left or right) of mandibular tips (Vanderwal 1975; Leach and Anderson 1979).

Translating these minimum numbers to meat weight is, as for the vertebrates, a difficult task. The estimates we have used here (on the basis of Vanderwal's continuing work with living shellfish populations in central coastal Victoria) are based on assigning an arbitrary value of one unit to Subminella undulata. Given this value, Notohaliotis ruber equals 15 units, Jasus lalandei equals 30, and all
other species equal 0.25 units each. Although crude, these relative measures are thought to approximate reality.

ANALYSIS

The analysis of economic data from a site is often felt to be complete when minimum numbers and meat weights are calculated. From these data inferences are made about the number of people occupying the site per unit of time, which translates to carrying capacity (see Anderson 1979 for several examples of this; Clark 1954, 1972; Shawcross 1967; Kirch 1979). We have not carried out such calculations ourselves (although we have provided the data from which this could be done) because we feel that the number of variables involved, including depositional rates, total site sizes, inadequate chronological controls, and protein and kilocalorie estimates, make this analysis impossible (see Hayden 1975 for a critique).

Our interest at Louisa Bay was to examine the economic patterns (the use of resources) which made the occupation of this area possible. Accepting that the archaeological evidence provides only a sample of those patterns, we need analytic methods which will enable us to standardize and compare a large number of different excavation levels from a number of different sites. We are not trying to draw conclusions from a comparison of archaeological evidence with the real world, but rather to compare archaeological excavation units with one another through time and across space. In our analysis we have developed two different measures as aids towards interpreting the archaeological data. The first records concentration of debris from deposit to deposit within any faunal class. The second consists of two diversity measures. While we express these various measures in relation to faunal debris, artefacts are also appropriate subjects for this form of analysis.

Concentration

This measure compensates for the fact that excavation units vary in volume. One method of solving this problem is to cross-tabulate classes so as to compare them within one deposit and then between deposits, a method used by Vanderwal (1973) for pottery. However, for smaller samples and for hugely disparate class sizes, the results would be largely unreadable (cf. Wilkinson 1971). Weighted classes were also tried, but this was highly artificial and also meant that the relative importance of classes could not be accurately reflected. The most effective method, and the one used here, is considered to be the routine calculation of concentration values.

Concentration is far from a new technique in describing the contents of archaeological deposits. More than 20 years ago Willey and McGimsey (1954) developed a 'concentration index', usually expressed as quantity per unit volume. In recent years a renewed interest in such measures has been generated, as in Egloff's (1979) study of Wanigela ceramic assemblages in Papua New Guinea, Hallam's (1974) analysis of Orchestra Shell Cave in Western Australia, Bailey's (1975) discussion of the role of oysters in New South Wales, and Bowdler's (1979) conversion of quantities to densities for direct comparisons of Rocky Cape and Cave Bay Cave in Tasmania. To our knowledge there has never been an attempt to use the concept in any methodological manner, though Egloff (1979) does compare intersite assemblages.

It is argued that a concentration measure should only be used when depositional environments are similar. Therefore, open sites normally should not be compared with caves, caves with rockshelters or open sites in differing depositional environments. It is even probable that sites like Nelson Bay Cave in South Africa (Klein 1972) and Cave Bay Cave (Bowdler 1979), whose deposits were laid down over multiple climatic regimes, are not internally comparable.

Volumes and volume indices of deposits or spits within each site, and total volume for the site, were presented in Tables 5 to 11. Concentration is obtained simply by dividing the number of individuals in each observation by the volume of the relevant deposit. An absolute figure of the number of individuals per volume of deposit, usually 1 m³, could also be calculated, but since we are interested only in trends, we express the calculated densities in proportional bar graphs totalling 100% for each faunal class.

In our example of Concentration (Fig.11) each of the seven species (1-7) in each of five deposits is plotted. Species 5 has the most even occurrence through all levels, while species 4 has the most uneven distribution. This analysis shows us the degree of change through time within each species, and a visual comparison can
Fig. 11 An example of graphing concentration (not the same data set as in Fig. 12)

be made to see where those changes occur in relation to those in other species. This information may then be helpful, in conjunction with the diversity measures and their graphs, in arriving at interpretations perhaps not otherwise obtainable.

Diversity

Although Concentration compensates for volume, it gives us information only about the relative numbers of individuals or animal weights between levels or between sites. Clearly the composition of these numbers (i.e. their diversity) is also important. Two sites (or levels) could each have 1000 individuals per unit of volume, but if in one of those sites 1000 were all of one species and in the other there were 100 species represented, these compositions would reflect radically different economic strategies.

A measure used by biologists to reflect such differences is species diversity, $H'$ (Pielou 1977:293-9). This relates number of species to number of individuals such that low values reflect the presence of few species, most or all with many individuals, and high values the presence of many species, most or all represented by few individuals. In essence, the higher the species diversity the lower the probability of being able to predict the species of an individual drawn at random from the population (Pielou 1977). Yellen (1977:107) adopted such a measure for application in prehistory which he called richness (see also Hardesty 1977:115 for a similar approach, called ecological width), and we have used the same basic formula here but have called this particular measure of diversity Heterogeneity.

$$H' = -\sum \frac{n_i}{N_0} \log \left(\frac{n_i}{N_0}\right)$$

where

- $s =$ number of calculations
- $n_i =$ number of individuals in the $i$th species
- $N_0 =$ total number of individuals.

Deposits in a site, or sites within a sample, can have very different proportions of various resources and still have identical diversity. We have therefore introduced another measure which allows us to examine the way these internal components are arranged - their relative proportions when compared with all deposits in the site or with all sites in a sample. We have accomplished this with a geographers' measure (Wright 1937:188-92), brought to our attention by Frankel (1979:190; see also Whallon 1968:232). We call this measure Divergency since it represents the extent to which diversity diverges from Heterogeneity.

Divergency is calculated on the basis of cumulative percentages; it is therefore necessary that the species in each set, whether deposits in a site or sites in a sample, are ranked in the order of highest to lowest frequency. Calculations for the species frequency composition (or weight, below) of each deposit or site in the set, including zeroes when any species is unrepresented, are made in the order of that ranking.

$$D' = 2 \left[N_s - \sum \frac{s}{N_s} \left(\sum \frac{n_i}{N_0}\right)\right] / N_s - 1$$

where

- $s =$ number of calculations
- $n_i =$ number of individuals in the $i$th species
- $N_0 =$ total number of individuals
- $N_s =$ total number of species in the set.

While it may be possible to devise a significance test for the relationship
between Heterogeneity and Divergency, we have not attempted to do so. Instead, our interpretations are based on graphical representations of divergence, where the composition of species in a deposit or site can be clearly seen to differ significantly from that of other deposits or sites.

In our graphic analysis we have examined two different aspects of economic behaviour, one of which we have chosen to call procurement. This is simply a statement on animals collected or hunted, and we have not attempted to quantify the energy expenditure of the diverse activities involved in procurement, such as rock-platform foraging and diving. The other aspect we have called consumption, which is roughly equated with earned energy, and is measured by assessing the average body weight of each species represented (as in Table 13). Sahlin (1972) provides some comparable examples of the use of procurement and consumption. Clearly it would be possible (if the data were available) to considerably refine this by calculating usable meat weights per individual animal and assessing caloric and protein contents (e.g. Shawcross 1967; Meehan 1977a, 1977b).

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birds:</td>
<td></td>
</tr>
<tr>
<td>Shy albatross</td>
<td>3.3 A</td>
</tr>
<tr>
<td>Fairy penguin</td>
<td>0.75 A</td>
</tr>
<tr>
<td>Royal penguin</td>
<td>3.7 A</td>
</tr>
<tr>
<td>Mutton-bird</td>
<td>0.5 A</td>
</tr>
<tr>
<td>Seagull</td>
<td>0.3 A</td>
</tr>
<tr>
<td>Wandering albatross</td>
<td>8.0 A</td>
</tr>
<tr>
<td>Fairy prion</td>
<td>0.1 B</td>
</tr>
<tr>
<td>Small albatross</td>
<td>2.3 E</td>
</tr>
<tr>
<td>Cormorant</td>
<td>2.0 E</td>
</tr>
<tr>
<td>Large duck</td>
<td>2.0 E</td>
</tr>
<tr>
<td>Small duck</td>
<td>1.5 E</td>
</tr>
<tr>
<td>Intermediate penguin</td>
<td>2.0 E</td>
</tr>
<tr>
<td>Swan</td>
<td>5.0 D</td>
</tr>
<tr>
<td>Currawong</td>
<td>0.3 D</td>
</tr>
<tr>
<td>Seals:</td>
<td></td>
</tr>
<tr>
<td>Fur seal, yearling</td>
<td>34 E</td>
</tr>
<tr>
<td>Fur seal, other</td>
<td>70 E</td>
</tr>
<tr>
<td>Elephant seal</td>
<td>200 E</td>
</tr>
<tr>
<td>Terrestrial mammals:</td>
<td></td>
</tr>
<tr>
<td>Wallaby</td>
<td>16 C</td>
</tr>
<tr>
<td>Pademelon</td>
<td>8.5 C</td>
</tr>
<tr>
<td>Potoroo</td>
<td>1.0 C</td>
</tr>
<tr>
<td>Brushtail possum</td>
<td>3.8 C</td>
</tr>
<tr>
<td>Ringtail possum</td>
<td>1.0 C</td>
</tr>
<tr>
<td>Wombat</td>
<td>23 C</td>
</tr>
<tr>
<td>Bandicoot</td>
<td>1.5 C</td>
</tr>
<tr>
<td>Tiger cat</td>
<td>3.5 C</td>
</tr>
<tr>
<td>Native cat</td>
<td>1.0 C</td>
</tr>
<tr>
<td>Eastern swamp rat*</td>
<td>0.15 C</td>
</tr>
<tr>
<td>Broad-toothed rat</td>
<td>0.2 C</td>
</tr>
<tr>
<td>Platypus</td>
<td>2.7 C</td>
</tr>
</tbody>
</table>

* All mammals, except for the antechinus at Maatsuyker Island, are included in our analyses.

Sources:
A Serventy et al. (1971)
B Green and Molisson (1961)
C Green (1973)
D AIAS reference specimens
E These values are rough estimates. These were necessary in the absence of documentation for some of the larger or frequently occurring bird species in the sites. Exact calculations of weight for each individual seal are impossible to make, but the estimate for elephant seal and the division of fur seal into two weight categories are accurate enough for our purposes

Using these figures - minimum numbers of individuals and animal weights - we can calculate both Heterogeneity and Divergency for both procurement and consumption. There are thus four diversity figures generated from each data set:

1. Procurement (number) Heterogeneity
2. Procurement (number) Divergency
3. Consumption (weight) Heterogeneity

The relationship between these sets of figures allows us to interpret economic
strategies. It tells us, in effect, whether the economic strategy was a good one (minimum effort for maximum return) or a poor one.

Figure 12 uses an imaginary set of data to demonstrate the graphical method used in illustrating the various relationships between the procurement and consumption values of Heterogeneity and Divergency. At the bottom of the figure, each pair of bar graphs represents the species in that analytic unit (whether it be a spit, deposit, or site), first by number, then by weight. In this example, the fauna from spit e is dominated, in number of individuals, by species 1; species 2-5 occur in such low numbers that they are grouped together as 'combination'. However, in terms of weight, species 1 is relatively less important, and species 2-5 contribute to a much greater extent. Each set of graphs from each unit (successive and stratigraphically more recent units of spits or deposits in a site) represents the numbers and weights of the species in the same way. Species 1 remains numerically high in d, but declines in its contribution to the amount of food consumed. Species 4, numerically unimportant in the first unit, increases its contribution in both numbers and weight until in units b and a it dominates the faunal assemblage.

The figures calculated for procurement and consumption Heterogeneity and Divergency are graphed in the upper part of Figure 12. The procurement Heterogeneity figures are higher in units d and e, indicating that more species are present, and at the same time these units are shown to be similar in another way because the procurement Divergency figures are also consistently high. However, in units c-a there is an inversion of the Heterogeneity/Divergency relationship which tells us that the composition of species in each set of units (d and e on the one hand and c-a on the other) is very different. A closer inspection of the bar graphs (lower half of Fig.12) will reveal the nature of these differences.

In contrast, the consumption data (shaded portion of the graph) shows that there is a similar high diversity (Heterogeneity) in units d and e, and a corresponding low diversity in c-a, but the more nearly parallel Divergency graphs indicate that many of the same sources contribute to overall consumption. Differences in the width of the consumption band, however, indicate that the species contribute variable propor-
tions; their nature can be assessed by closer inspection of the bar graphs.

Thus, the upper part of Figure 12 serves as a summary statement of the contents of the analytical units, while the lower part shows the components in greater detail. When all analytical units are similar in composition and consumption, then the Heterogeneity and Divergency values maintain a relatively constant relationship. Anomalies, as shown in the procurement band, require investigation.

Statistics

Statistics used in this work include several non-parametric methods consisting of $\chi^2$ (contingency tables), the Mann-Whitney U test, the Spearman rank correlation coefficient and the Fisher exact probability test. All are standard formulae and can be found in Siegel (1956) and Sokal and Rohlf (1973). The null hypothesis was accepted for all tests where $p < 0.1$. 
V ANALYSIS OF VERTEBRATE REMAINS

Vertebrate remains are dealt with before invertebrates because a number of species (seals, sea birds and possums) provide good evidence, on the basis of the age of individuals and their known breeding cycle, for determining the season during which sites were occupied. The hypotheses generated from this information will then be tested against the pattern of exploitation observed for the shellfish.

Our discussion of the vertebrate fauna is divided into two sections. The first presents the various animals in the total analytic context of all the Louisa Bay and Maatsuyker Island sites; references to individual sites and excavation units will be made only when that information is considered useful to the discussion. The second part is a detailed dissection of this data, site by site and deposit by deposit, aimed at a fuller interpretation.

THE ANIMALS

Insofar as is possible, we give in this chapter only the common names of the various vertebrate animals; zoological nomenclature was given in Chapter II. It is clearly not possible to retain this aim when two or more species of the same genus are being compared or when additional genera or species are discussed.

Mammals

Brush Wallaby

There are at least nine individuals of this species. Five of the six mandibles which can be analysed are from mature (i.e. with all teeth erupted) individuals, two from quite old individuals. The sixth mandible has only two molars erupted. Two of the four maxillae which can be analysed were also from mature animals. Using data from Kirkpatrick (1965), these two animals would have been between 5 and 6 years old, and 9 and 10 years old, respectively. Some error would be involved in this estimate because Kirkpatrick dealt with Queensland animals, but this would not be significant. The other two maxillae probably both have only two molars erupted and would be approximately 2 years old.

Pademelon

There are at least 19 individuals present in the sample, making only the ringtail possum more numerous. Among the 15 mandibles which can be analysed there are three distinct age groups present: 10 have fully erupted molars; three (possibly four) have either the third molar almost fully erupted, or the fourth molar just starting to erupt; one (possibly two) has the second molar just beginning to erupt. These animals were mainly mature to old animals. It is possible that the presence of discrete age groupings indicates that the animals were being killed at a particular time each year, but to establish this it would be necessary to calculate absolute ages instead of relative ages.

Nothing has been published on the growth and development of this or other Thylogale species, but there are some unpublished data on T. thetis (K. Johnson pers. comm.). It is likely that growth in T. thetis is similar enough to that of T. bilanderi for the purpose of this analysis.

Johnson's data are based on maxillae and cannot be applied directly to the mandibles, so the nine maxillae found at Louisa Bay were analysed, and are compared below with the 14 recovered mandibles. The ages calculated are as follows:

- one at 1 year 3 months, one at 1 year 9 months, two at 2 years 4 months, one at 2 years 6 months, one at 3 years 3 months, two at 4 years, one at 4 years 9 months.

The comparison with the mandibles is as follows. The maxillae over 3 years old have fully erupted teeth and would therefore correspond to the nine mandibles with full eruption. The maxillae aged between 2 and 3 years correspond to the three mandibles with fourth molar starting to erupt. There are no mandibles equivalent to the 1 year 3 months maxilla, and no maxillae equivalent to the two youngest mandibles, which must be somewhere under a year old and are probably pouch young.
There is a single old specimen of this species, represented by a left mandible and a left maxilla.

**Ringtail Possum**

This is the most numerous animal at Louisa Bay with the remains of at least 18 individuals. All of the jaws are from adults except for one juvenile right mandible. In this animal the third molar was only just beginning to erupt.

Hughes *et al.* (1965) note that almost all births in Victoria occur between May and August, with almost half occurring in June. Thomson and Owen (1964) present slightly different data, suggesting that most births occur in July and August. On the basis of a scheme developed by Thomson and Owen which describes the ageing process in this species in relation to the eruption and wear of the upper teeth, all the maxillae from Louisa Bay fall into age class five, i.e. animals which have just reached sexual maturity at just over one year of age. The exception is a single left maxilla from LR 3/3 which is from an old animal, probably about 4 years old.

The mandibles show a similar pattern. All are consistent with age class five, except for one juvenile mandible from LRC 2-2/9 which fits into class three, an animal approximately 7 months old, probably one which is being weaned or has just been weaned. This juvenile must have died in the period September to February, the only time of the year when animals of this age class are present in the population (at least in Victoria, though there may be a slightly different time period in southwest Tasmania).

The fact that the great majority of these animals were in age class five may be partly a reflection of human choice, but even if this is the case, the selection would have to be based on a population in which there were a large number of class five animals. If there were greater numbers present in other age classes, it would in economic terms make no sense to try to select a particular age class. It would in addition not be possible to select a particular age class so accurately if there were large numbers of other age classes present.

The only month which has a great majority of class five individuals in Victoria is July. On the data from Louisa Bay, it seems reasonable to suggest that most ringtail possums were caught around that time, although at least one animal was caught during the summer months (September-February). The other animals are least likely to have been caught in November-December, the months with the lowest proportion of class five animals in the population.

**Brushtail Possum**

Only one specimen of this species was found, in the second lowest level of AC 1.

**Wombat**

The remains include at least five individuals from five sites.

**Brown Bandicoot**

There are at least seven individuals of this species from four sites (LR 3, LRC 2, AC 1 and MAT 1). The greatest numbers are at AC 1, where the species is found mainly in the lowest five spits. Of the 10 mandibles which can be analysed, all are adult except one from AC 1-1/6, a juvenile about 130 days old (based on data for *Perameles nasuta* from Kingsmill 1962).

**Eastern Native Cat**

There are at least five individuals from three sites (AC 1, LRC 2 and LR 3). All of the remains seem to be from mature animals, and two from LRC 2 are from old animals with very worn teeth. Green (1967a) did not observe any examples of severe tooth wear in this species.

**Tiger Cat**

Only one specimen of this species was found.

**Platypus**

There is only a single individual of this species.
Broad-toothed Rat

There is only a single individual of this species, represented by the maxilla of an old animal.

Swamp Rat

There are some problems with the interpretation of the *Rattus* remains. A number of mandibles and some postcranial remains are present on the mainland and on Maatsuyker. However no rat has been recorded living on Maatsuyker. The native *Rattus* of Tasmania is *R. lutreolus* (eastern swamp rat). It has been recorded from Louisa Bay (Green 1967b) and may well be, or have been, on Maatsuyker. The other possibility is one of the introduced *Rattus* species, but these are believed not to be present on Maatsuyker (Milledge and Brothers 1976). This species was observed by Vanderwal to be extremely common at Louisa Bay, along the Louisa River banks and in the low swampy areas. The rodent bones present in the sites are more likely to belong to a native species; if they were to be identified as one of the introduced species, this would suggest they were intrusive in the sites.

Long-tailed Rat

There is a small humerus from LRC 2 which agrees in size with *Pseudomys higginsi*, but there are no mandibles from which the identification can be confirmed. This species is known to occur in the area (Green 1968) and was observed at Louisa Bay by Vanderwal.

Antechinus

There are a number of postcranial remains (one individual) of a large antechinus-like species, and one humerus of a smaller one, both from Maatsuyker Island. One species of antechinus (*Antechinus minimus*) is recorded from Maatsuyker, and the small humerus seems to be of a size appropriate to this species. There is another species of antechinus (*A. swainsonii*) in Tasmania which is somewhat larger than *A. minimus*. This species has not been recorded from the southwest, although on the basis of habitat it could occur there (Green 1972). Wakefield and Warnke (1963:198) note that it 'has never been authentically recorded from any island, either in Bass Strait or elsewhere in Tasmania'. These two facts considered together make it unlikely that *A. swainsonii* occurred on Maatsuyker.

There is some sexual dimorphism in antechinus species, and it is possible that the large and small bones are simply those of male and female. The disparity in size is very great however and this solution seems unlikely.

The above analysis of murids and small dasyurids is unsatisfactory, but a range of reference specimens from the area would be needed to resolve the difficulties.

Fur Seal

Fur seal remains are almost certainly those of the Australian fur seal rather than the New Zealand fur seal, but identification has not been precisely determined. They appear similar to Australian fur seal reference specimens, and there is at present a colony of the species breeding on rocks just off Maatsuyker Island.

Since the pattern of seal exploitation on Maatsuyker Island appears to be different to that seen on the mainland, the samples are discussed separately. Also, the Maatsuyker Island samples from the two excavation squares MAT 1-1A and MAT 1-5 are treated individually.

Based on the number of lower canines (the most numerous element), there are at least 24 individual seals present in MAT 1-5. The other elements analysed give minimum numbers of between approximately 15 and 20. If we divide these remains into those from yearlings and older animals (Fig.13, Tables 14 and 15), based on root length for canines and bone size for other elements, we find that the percentage of yearlings (Table 16) ranges from 38-67%, with an average figure of 60%. For upper and lower canines we can calculate the numbers of males and females (Table 17), the percentages of males being 79% and 76% respectively. The yearlings are approximately equally divided between males and females (upper canines five males, six females; lower canines 14 males, 10 females), but all the older animals are males. However, as will be discussed later, it is apparent from the postcranial remains that a few mature females are present.

The other excavation squares have the same general pattern as MAT 1-5. In total,
Table 14  Metrical (mm) and ordinal data on fur seal mandibles and lower canines

<table>
<thead>
<tr>
<th>Site</th>
<th>Specimen no.</th>
<th>Length</th>
<th>Posterior height</th>
<th>Molar alveolar length</th>
<th>% width</th>
<th>Length</th>
<th>Wear</th>
<th>Eruption</th>
<th>Root length A</th>
<th>Root length B</th>
<th>Root width</th>
<th>Root: Open(O), Closed(C), Closing(C)</th>
<th>Sex</th>
<th>Age (years, months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MANDIBLE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM</td>
<td>1101</td>
<td>103.6</td>
<td>16.1</td>
<td>21.5</td>
<td>38.2</td>
<td>12.0</td>
<td>21.8</td>
<td>0</td>
<td>0</td>
<td>11.8</td>
<td>4.7</td>
<td>12.9</td>
<td>d</td>
<td>12m</td>
</tr>
<tr>
<td>FWV</td>
<td>5953</td>
<td>125.6</td>
<td>19.0</td>
<td>25.9</td>
<td>42.3</td>
<td>12.7</td>
<td>24.0</td>
<td>+</td>
<td>+</td>
<td>18.6</td>
<td>10.0</td>
<td>15.2</td>
<td>d</td>
<td>12m</td>
</tr>
<tr>
<td>FWV</td>
<td>8505</td>
<td>163.7</td>
<td>24.0</td>
<td>32.8</td>
<td>46.5</td>
<td>13.2</td>
<td>18.4</td>
<td>++</td>
<td>+</td>
<td>40.8</td>
<td>30.6</td>
<td>16.4</td>
<td>d</td>
<td>6y 10m</td>
</tr>
<tr>
<td>FWV</td>
<td>5933</td>
<td>100.8</td>
<td>15.0</td>
<td>20.5</td>
<td>34.8</td>
<td>7.4</td>
<td>16.8</td>
<td>0</td>
<td>0</td>
<td>10.0</td>
<td>4.8</td>
<td>7.7</td>
<td>d</td>
<td>6m</td>
</tr>
<tr>
<td>FWV</td>
<td>7585</td>
<td>116.1</td>
<td>15.9</td>
<td>21.2</td>
<td>38.2</td>
<td>7.0</td>
<td>15.7</td>
<td>+</td>
<td>+</td>
<td>19.3</td>
<td>13.3</td>
<td>8.3</td>
<td>d</td>
<td>14m</td>
</tr>
<tr>
<td>FWV</td>
<td>5962</td>
<td>131.3</td>
<td>17.8</td>
<td>24.8</td>
<td>40.2</td>
<td>8.1</td>
<td>15.0</td>
<td>+</td>
<td>+</td>
<td>27.9</td>
<td>21.1</td>
<td>8.7</td>
<td>d</td>
<td>14m</td>
</tr>
<tr>
<td>FWV</td>
<td>8506</td>
<td>128.2</td>
<td>16.8</td>
<td>25.3</td>
<td>41.0</td>
<td>10.3</td>
<td>14.5</td>
<td>++</td>
<td>+</td>
<td>38.6</td>
<td>29.1</td>
<td>8.6</td>
<td>d</td>
<td>14m</td>
</tr>
</tbody>
</table>

A. Reference specimens or yearlings

- **MAT 1-5/2**: 7 L 16.4
- **MAT 1-5/2**: 11 L 16.1
- **MAT 1-5/2**: 13 L 16.1
- **MAT 1-5/2**: 15 L 16.1
- **MAT 1-5/2**: 44 L 16.1
- **MAT 1-5/2**: 45 L 16.1
- **MAT 1-5/2**: 46 L 16.1
- **MAT 1-5/2**: 98 L 16.1
- **MAT 1-5/2**: 99 R 16.1
- **MAT 1-5/2**: 28 R 16.1
- **MAT 1-5/2**: 30 R 16.1
- **MAT 1-5/2**: 35 R 16.1
- **MAT 1-5/2**: 64 R 16.1
- **MAT 1-5/3**: 3 L 16.1
- **MAT 1-5/3**: 16 L 16.1
- **MAT 1-5/3**: 21 L 16.1
- **MAT 1-5/3**: 47 L 16.1
- **MAT 1-5/3**: 49 L 16.1
- **MAT 1-5/3**: 67 L 16.1
- **MAT 1-5/3**: 27 R 16.1
- **MAT 1-5/4**: 5 L 16.1
- **MAT 1-5/4**: 10 L 16.1
- **MAT 1-5/4**: 17 L 16.1
- **MAT 1-5/4**: 22 L 16.1
- **MAT 1-5/4**: 23 L 16.1

B. Root: Open(O), Closed(C), Closing(C)
| MAT 1-5/4  | 50 | L | . . | 11.4  | ~19.6 | ~14.0  | 8.5  | 13.0 | 0 | d | Y |
| MAT 1-5/4  | 51 | R | . . | 6.8  | ~12.5 | . . | 15.5 | 11.3 | 7.4 | 0 | Y |
| MAT 1-5/4  | 53 | R | . . | 6.8  | . . | 14.5  | 10.1 | 8.3 | 0 | ? | Y |
| MAT 1-5/4  | 29 | R | 118.2 | ~18.0 | 21.8 | 37.5 | ~10.3 | . . | + | 19.8 | 12.1 | 13.7 | 0 | d | Y |
| MAT 1-5/4  | 31 | R | . . | 15.8 | 18.3 | 37.4 | . . | . . | . . | . . | . . | . . | . . | . . | . . |
| MAT 1-5/4  | 36 | R | . . | 17.2 | 33.6 | 6.1  | . . | + | 15.9 | 11.7 | 7.0 | 0 | ? | Y |
| MAT 1-5/4  | 38 | R | . . | 17.6 | . . | . . | . . | . . | . . | . . | . . | . . | . . | . . | . . |
| MAT 1-5/4  | 51 | R | . . | 6.8 | ~12.5 | . . | 15.5 | 11.3 | 7.4 | 0 | Y |
| MAT 1-5/4  | 53 | R | . . | 6.8 | . . | 14.5 | 10.1 | 8.3 | 0 | ? | Y |

**Table 14 continued next page**
### Table 14 (cont’d)

<table>
<thead>
<tr>
<th>Site</th>
<th>Specimen no.</th>
<th>Side</th>
<th>Length</th>
<th>Posterior height</th>
<th>Anterior height</th>
<th>Molar alveolar length</th>
<th>Width</th>
<th>Length</th>
<th>Wear</th>
<th>Eruption</th>
<th>Root length A</th>
<th>Root length B</th>
<th>Root width</th>
<th>Root: Open (O), Closed (C), Closing (CG)</th>
<th>Sex</th>
<th>Age (years, months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAT 1-5/4</td>
<td>39</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-5/4</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-5/4</td>
<td>60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-5/5</td>
<td>6</td>
<td>L</td>
<td>17.3</td>
<td>38.9</td>
<td>10.6</td>
<td></td>
<td>+</td>
<td>20.9</td>
<td>15.4</td>
<td>14.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-5/5</td>
<td>42</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>~15.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-5/5</td>
<td>43</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-5/5</td>
<td>62</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-1A/2</td>
<td>263</td>
<td>L</td>
<td>~21.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-1A/2</td>
<td>264</td>
<td>L</td>
<td>24.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-1A/2</td>
<td>249</td>
<td>R</td>
<td>15.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-1A/2</td>
<td>267</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-1A/3</td>
<td>234</td>
<td>R</td>
<td>~15.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>~41.2</td>
<td>&gt;33.3</td>
<td>C (?)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-1A/3</td>
<td>248</td>
<td>R</td>
<td>~13.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>~32.3</td>
<td>&gt;25.9</td>
<td>~11.6</td>
<td>Cg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-1</td>
<td>236</td>
<td>L</td>
<td>~12.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt;36.0</td>
<td>~30.3</td>
<td>&gt;12.2</td>
<td>C (?)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-1</td>
<td>237</td>
<td>L</td>
<td>12.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>35.5</td>
<td>25.2</td>
<td>~12.5</td>
<td>Cg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-1</td>
<td>241</td>
<td>L</td>
<td>8.3</td>
<td>14.6</td>
<td></td>
<td></td>
<td>28.5</td>
<td>21.4</td>
<td>8.2</td>
<td>0 d</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-1</td>
<td>257</td>
<td>L</td>
<td>&gt;137.6</td>
<td>22.8</td>
<td>44.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-1</td>
<td>233</td>
<td>R</td>
<td>~10.7</td>
<td>~17.5</td>
<td></td>
<td></td>
<td>&gt;34.5</td>
<td>7.5</td>
<td>C</td>
<td>d</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-1</td>
<td>235</td>
<td>R</td>
<td>~12.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt;36.0</td>
<td>~30.3</td>
<td>&gt;12.2</td>
<td>C (?)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-1</td>
<td>243</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt;25.8</td>
<td>~20.0</td>
<td>&gt;12.5</td>
<td>Cg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-2</td>
<td>240</td>
<td>L</td>
<td>26.7</td>
<td>31.2</td>
<td>45.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-2</td>
<td>230</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LR 3/6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LR 3/8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LR 1-1/3</td>
<td>254</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LR 1-2/2</td>
<td>232</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LR 1-3/2</td>
<td>265</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Fisheries and Wildlife Service, Victoria
2. Ages estimated from mandible
3. Ages estimated from canine
<table>
<thead>
<tr>
<th>Site</th>
<th>Specimen no.</th>
<th>Side Width</th>
<th>Length</th>
<th>Wear</th>
<th>Eruption</th>
<th>Root Length A</th>
<th>Root Length B</th>
<th>Root Width</th>
<th>Root: Open(C)</th>
<th>Cleared(Cg)</th>
<th>Sex</th>
<th>Age (years, months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAT 1-5/2</td>
<td>FW 5953</td>
<td>L 11.5</td>
<td>22.3</td>
<td>0</td>
<td>+</td>
<td>10.8</td>
<td>10.5</td>
<td>14.8</td>
<td>0</td>
<td>d</td>
<td>12m</td>
<td></td>
</tr>
<tr>
<td>MAT 1-5/2</td>
<td>FW 6337</td>
<td>L 13.6</td>
<td>21.6</td>
<td>+</td>
<td>20.5</td>
<td>20.3</td>
<td>15.2</td>
<td>0</td>
<td>d</td>
<td>2y</td>
<td>11m</td>
<td></td>
</tr>
<tr>
<td>MAT 1-5/3</td>
<td>FW 7503</td>
<td>R 12.0</td>
<td>20.5</td>
<td>+</td>
<td>22.9</td>
<td>19.4</td>
<td>13.2</td>
<td>0</td>
<td>d</td>
<td>3y</td>
<td>1m</td>
<td></td>
</tr>
<tr>
<td>MAT 1-5/2</td>
<td>FW 7555</td>
<td>L 8.2</td>
<td>16.5</td>
<td>0</td>
<td>+</td>
<td>13.7</td>
<td>12.0</td>
<td>9.1</td>
<td>0</td>
<td>d</td>
<td>14m</td>
<td></td>
</tr>
<tr>
<td>MAT 1-5/2</td>
<td>FW 6642</td>
<td>L 9.3</td>
<td>16.5</td>
<td>+</td>
<td>22.9</td>
<td>20.7</td>
<td>8.2</td>
<td>0</td>
<td>d</td>
<td>3y</td>
<td>7m</td>
<td></td>
</tr>
<tr>
<td>MAT 1-5/2</td>
<td>FW 5962</td>
<td>L 9.0</td>
<td>14.4</td>
<td>+</td>
<td>23.2</td>
<td>20.8</td>
<td>8.4</td>
<td>0</td>
<td>d</td>
<td>4y</td>
<td>3m</td>
<td></td>
</tr>
</tbody>
</table>

Table 15 Metrical (mm) and ordinal data on fur seal upper canines

1 Fisheries and Wildlife Service, Victoria | 2 Estimated ages
Fig. 13 Measurements made on fur seal mandibles and canines

<table>
<thead>
<tr>
<th>Site</th>
<th>Pelvis</th>
<th>Femur</th>
<th>Tibia</th>
<th>Humerus</th>
<th>Radius</th>
<th>Ulna</th>
<th>Mandible</th>
<th>Canine</th>
<th>Lower</th>
<th>Upper</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAT 1-5</td>
<td>64</td>
<td>55</td>
<td>53</td>
<td>67</td>
<td>50</td>
<td>39</td>
<td>39</td>
<td>52</td>
<td>38</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>MAT 1-1A</td>
<td>65</td>
<td>50</td>
<td>100</td>
<td>100</td>
<td>75</td>
<td>60</td>
<td>54</td>
<td>67</td>
<td>18</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>MAT 1-1</td>
<td>100</td>
<td>67</td>
<td>0</td>
<td>100</td>
<td>100</td>
<td>60</td>
<td>83</td>
<td>40</td>
<td>28</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>MAT 1-2</td>
<td>100</td>
<td>71</td>
<td>60</td>
<td>75</td>
<td>83</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>71</td>
<td>59</td>
<td></td>
</tr>
</tbody>
</table>

Table 16 Yearling fur seal bones and teeth (shown as a percentage)

<table>
<thead>
<tr>
<th>Total</th>
<th>Yearling</th>
<th>Older</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>MAT 1-1</td>
<td>LC</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>UC</td>
<td>83</td>
</tr>
<tr>
<td>MAT 1-2</td>
<td>LC</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>UC</td>
<td>86</td>
</tr>
<tr>
<td>MAT 1-1A</td>
<td>LC</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>UC</td>
<td>100</td>
</tr>
<tr>
<td>MAT 1-5</td>
<td>LC</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>UC</td>
<td>79</td>
</tr>
<tr>
<td>LR 1</td>
<td>LC</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>UC</td>
<td>100</td>
</tr>
<tr>
<td>LR 3</td>
<td>LC</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>UC</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 17 Sex ratios for fur seal canine teeth (shown as a percentage)
the bones analysed show a percentage of yearlings between 52 and 59% for MAT 1-1, MAT 1-1A and MAT 1-2. The canine teeth are variable, with some squares showing a majority of yearlings, in others a majority of older animals, and these vary also between those from maxilla and mandible. These teeth also show a majority of males over females for both yearlings and older animals, only one older female lower canine being found (in MAT 1-1) and this animal would still have been immature, between 1 and 3 years old. The minimum numbers of individuals in these three squares are considerably lower than for MAT 1-5, being nine individuals in MAT 1-1A, five in MAT 1-1 and four in MAT 1-2, but these come from only 25% of the volume of MAT 1-5.

It is clear from the analysis that these animals were mainly from the non-breeding part of the seal colony, as there are no pups or mature bulls, and few mature females (Fig.19). The yearlings could have been obtained in either part of the colony, but the immature males would only be present in the non-breeding section. The few mature females may be animals caught while returning from feeding at sea, or animals moving out from the breeding area to feed pups.

The possible interpretations are that (a) a breeding colony was present at or near the site where the remains were found; (b) there was a breeding colony on the Needles, as there is at present, and that these non-breeding animals were using this site as a resting area; and (c) the non-breeding section of the colony was being exploited. It seems most likely that animals were being caught in the last two situations.

The nature of these remains helps in understanding the circumstances in which the animals were obtained. Females remain permanently in the area, alternating daily between feeding that year's pups and feeding themselves. Bulls arrive in late October to set up their territories, and females give birth to the young of the previous year's mating between the end of November and mid-December. Mating again takes place approximately a week after birth. Towards the end of December the territorial bulls leave, and by early January only nursing females, pups and a few immatures are left. The large quantities of yearlings and immature males in the deposits can therefore best be accounted for by suggesting that the people exploiting Maatsuyker Island arrived there during November and December.

At Louisa Bay, 12 fur seal bones representing 60% yearlings were recovered from site LR 3, and 25% and 29% respectively from sites LR 1 (nine bones) and LR 2 (six bones). Of the seven canines found, six are from males and one is indeterminate. A single humerus was recovered from site LRC 2.

The low numbers of individuals present in the Louisa Bay sites, and the fact that they seem to be all males, is consistent with their being animals dispersing after the breeding season. The one possible inconsistency is the presence of a very large, fully grown (the root of the canine is closed) male at LR 3. It is possible this is a territorial bull, though it could also be a fully grown bachelor. If the former it is hard to understand what it is doing here, if, as has been postulated, this was a non-breeding area, and breeding animals were not being exploited. However, it will later be argued that LR 3 is a winter site, and as pointed out earlier the territorial bulls disperse in January.

Fletemeyer (1977) presents results of a study on Cape fur seal (same species as the Australian fur seal) remains found in archaeological deposits in the Western Cape area of South Africa. His conclusions were that most of the animals were less than 2 years old, and that all had been killed in the winter when washed ashore during storms. This is a similar pattern to that proposed here for Louisa Bay. Fletemeyer used tooth sections to determine accurately the age of animals and time of death, and a similar study is planned for the Louisa Bay and Maatsuyker Island remains when the reference specimens are available and the technique can be developed.

The postcranial remains were also analysed in some detail (Table 18). On the basis of the minimum numbers of individuals, the expected totals of the six limb bones were calculated and plotted against those actually present. For fur seal on Maatsuyker, an average of 50% of the bones are present (21-66%), while only 18% (15-25%) are present at the three Louisa River sites, and for elephant seal at LR 3 and AC 1 only 11% (10-12%) of these bones are present. If we separate the figures for forelimb and hindlimb there is a considerable excess of hindlimb elements, except in MAT 1-1 and LR 3 where the position is reversed. Leaving out these two, the average ratio of forelimb to hindlimb is 84% for Maatsuyker and 62% for Louisa River. For MAT 1-1 and LR 3 the ratios are 122% and 600% respectively. For elephant seal the proportions of each are approximately equal.

A hypothesis which would explain these figures is as follows. On Maatsuyker the usual procedure was to kill and eat the seal in one place, or at least to cook
and eat it in one place. Occasionally parts of the animal were taken elsewhere, with a tendency to take the forelimbs rather than the rest of the animal. It is possible that some of this meat was taken right off the island, although it may simply have been taken a short distance (MAT 1 may represent an area to which it was taken).

On the mainland the situation was quite different in the sense that the sites being excavated were some distance from the beach. However, the pattern is to some extent the reverse of what might have been expected. We would need to postulate that the heads of the animals were brought back to the sites more often than other parts of the body. Alternatively we could postulate that whole animals were brought to these areas, and that most of the body, particularly the forelimbs, were subsequently removed. For elephant seals the situation is even more difficult to explain because there is little possibility of whole carcasses being moved, so we are back to our original hypothesis, that heads were most often brought back to the site. Perhaps animals were usually killed and eaten on the beaches, but heads were removed for the later extraction and consumption of choice items (e.g. tongue, brain). There are several ethnographic records of seal butchering and these are discussed in Chapter VII.

Finally, two minor points need to be mentioned. Firstly, male seals have penis bones, which increase in size with increasing age, presumably until sexual maturity. Only two reference specimens for fur seals were available, one from a 3-year-old and one from a 7-year-old. Four specimens were found in the Maatsuyker Island excavations, three of which are slightly bigger than the 7-year-old specimen, and the fourth intermediate in size between the 3-year-old and 7-year-old specimens. There is no evidence here for the large number of yearling males. However, the penis bone from the 3-year-old is small, the bone light and spongy and the shape amorphous. Penis bones from younger animals would probably be broken down in the deposit, or would be unrecognizable. The penis bones present do provide confirmation that relatively few older males were present, and that even the oldest ones were not of breeding age.

Our second point is that fur seal postcranial remains present problems in interpretation. It is clear from the canine teeth that there are few if any females older than yearlings, while there are several males in each of the age classes 1-3, 3-4, and 6-7. The available postcranial reference material is limited, consisting of a pup, two yearling males and a 6-year-old female. The excavated postcranial remains are mainly from yearling animals as discussed earlier. However, there are a number of bones in each element which have fused epiphyses and are clearly similar in size to the reference 6-year-old female. The fused epiphyses indicate that these bones are not from young males, so there are several mature females present which are not represented by teeth. Conversely there are few bones which could conceivably represent young males. The absence of the latter is not particularly disturbing since the percentage of these males, as indicated by the teeth, is relatively low anyway, and the lack of bones could be a chance distributional factor. The absence of older female teeth seems inexplicable unless these are weaker and have been broken down, or there is some difference in the way that remains of these were disposed of (e.g. they could have been butchered where they were killed and only joints of meat brought back). Clearly there are two or three older females present in the Maatsuyker remains. The first of the two possibilities is contradicted in MAT 1-4, where there is at least one tooth of a mature female.

Elephant Seal

Remains of this species are found predominantly on the mainland, though an ulna
Table 19  Metrical and ordinal data on elephant seal mandibles (reference specimens are from the National Museum of Victoria)

<table>
<thead>
<tr>
<th>Reference no.</th>
<th>Mandible height (mm)</th>
<th>Sex</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>C7387</td>
<td>27.2</td>
<td>q</td>
<td>'Pup'</td>
</tr>
<tr>
<td>C7386</td>
<td>28.5</td>
<td>d</td>
<td>&lt;2 weeks</td>
</tr>
<tr>
<td>C7393</td>
<td>29.0</td>
<td>d</td>
<td>&lt;11 days</td>
</tr>
<tr>
<td>C7390</td>
<td>30.3</td>
<td>d</td>
<td>1 year</td>
</tr>
<tr>
<td>C7407</td>
<td>45.8</td>
<td>d</td>
<td>3-6 years</td>
</tr>
<tr>
<td>C7474</td>
<td>73.0</td>
<td>d</td>
<td>8 years</td>
</tr>
</tbody>
</table>

Site Estimated age
LR 3/6 ~24.5 - <2 weeks
LR 3/6 26.2 - <2 weeks
LR 3/6 30.7 - ≤1 year
LR 3/6 47.4 - 3-6 years
LR 3/8 ~22.1 - <2 weeks
AC 1/2 ~30.9 - ≤1 year
AC 1/4 29.9 - ≤1 year
AC 1/7 27.6 - <2 weeks
AC 1/8 20.9 - <2 weeks
AC 1/8 28.5 - <2 weeks
AC 1/8 31.8 - ≤1 year
AC 1/9 26.6 - <2 weeks

was recovered on Maatsuyker Island. Based on mandibles, there were at least six animals at AC 1 and four at LR 3 (on stratigraphic grounds, nine elephant seals were recovered from LR 3, see Table 25). However, on the basis of periotic bones, there were also at least six individuals at LR 3 (only three periotics were found at AC 1 and one at LR 2). All of these are approximately the same size except for one considerably larger from an almost complete skull. The mandibles show the same pattern, all seven from AC 1 and four from LR 3 being small, with one large animal from LR 3 (Table 19).

There are eight whole or fragmented canine teeth from LR 3 and five from AC 1, but most of these cannot be assigned to left or right sides or identified as being upper or lower canines. One of those from LR 3 was in place in a mandible, and one other seems to fit a mandible.

Canines from males and females can be distinguished by the relative sizes (Laws 1952, 1953a; Carrick and Ingham 1962; Briggs and Morejohn 1975). At LR 3, two of the canines are from different females, while five are from males, and at AC 1 all canines are from males.

Some estimate of the age of animals can be made from the length of the canine root which grows continuously as the animal gets older. All except four (Table 20) have very short roots, approximately equal in length to those of animals between 1-12 months old. The longest, on a male canine, is approximately equal in length to that of a >3-year-old, the next longest from a male about 19 months old. All the other males are aged 9 months or less, and the two females are approximately 15 months and 8 months old.

Age estimates can also be made on the basis of postcranial bones (Table 21). These show an almost identical pattern to that given by the canines: seven at 1-12 months, one at 1-2 years, two at 2-3 years, one at 4-5 years, two at 6-78 years. The only data which are apparently inconsistent with this are those based on the mandible measurements, because a number of these are equivalent in size to young pups. Of the three age estimates, that from mandibles is likely to be the poorest and therefore to be the one which requires correction. The estimates must be consistent because all of the bones are derived from the same population. Shifting the categories for the mandible estimates, so that the 'pups' would belong in the 1-12 month age group and the others in correspondingly older groups, would produce a good match. The likely explanation for the discrepancy then would seem to be that the Louisa Bay seals had slightly smaller mandibles than do the modern Macquarie Island seals from which the reference specimens came. Although all the age estimates are very approximate, it is absolutely certain that there are no mature (i.e. breeding) elephant seals present among the remains, and it is also clear that no pups are present either.

It seems unlikely that Louisa Bay supported a breeding colony of elephant seals, and even if it had done it is unlikely to have been exploited. Laws (1953b:26) gives some idea of the difficulties involved in obtaining pups for measurement:
### Table 20: Metrical and ordinal data on elephant seal canines (reference specimens are from the National Museum of Victoria)

<table>
<thead>
<tr>
<th>Reference no.</th>
<th>Upper root length (mm)</th>
<th>Lower root length (mm)</th>
<th>Sex</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>C7472</td>
<td>18.9</td>
<td>9.7</td>
<td>d</td>
<td>-</td>
</tr>
<tr>
<td>C7474</td>
<td>-</td>
<td>21.0</td>
<td>d</td>
<td>-</td>
</tr>
<tr>
<td>C7537</td>
<td>9.7</td>
<td>9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>C7404</td>
<td>11.2</td>
<td>10.0</td>
<td>g</td>
<td>-</td>
</tr>
<tr>
<td>C7404</td>
<td>-</td>
<td>d</td>
<td>7*</td>
<td>1 month</td>
</tr>
<tr>
<td>C7404</td>
<td>-</td>
<td>d</td>
<td>36</td>
<td>20 months</td>
</tr>
<tr>
<td>C7404</td>
<td>-</td>
<td>d</td>
<td>54</td>
<td>3+ years</td>
</tr>
<tr>
<td>C7404</td>
<td>-</td>
<td>d</td>
<td>73</td>
<td>6+ years</td>
</tr>
<tr>
<td>C7404</td>
<td>-</td>
<td>g</td>
<td>9</td>
<td>1 month</td>
</tr>
<tr>
<td>C7404</td>
<td>-</td>
<td>g</td>
<td>38</td>
<td>18 months</td>
</tr>
<tr>
<td>C7404</td>
<td>-</td>
<td>g</td>
<td>39</td>
<td>3 years</td>
</tr>
<tr>
<td>C7404</td>
<td>-</td>
<td>g</td>
<td>64</td>
<td>7 years</td>
</tr>
</tbody>
</table>

Site Estimated age
---
LR 3/2 13.7 - d 34.8 19 months
LR 3/6 20.9 - d 55.3 3+ years
LR 3/7 11.1 - g ~33.4 15 months
LR 3/8 8.5 - g ~20.4 8 months
AC 1/1 17.4 - d -
AC 1/6 >16.7 - d ~16.2 7 months
AC 1/8 >21.0 - d ~14.0 6 months
AC 1/9 - - 16.4 5-7 months

* measurements for *Mirounga angustirostris* (Briggs and Morejohn 1975)

---

### Table 21: Metrical and ordinal data on elephant seal postcrania l bones (age estimates based on data from Bryden 1972)

<table>
<thead>
<tr>
<th>Bone</th>
<th>Length (mm)</th>
<th>Circumference (mm)</th>
<th>Estimated age&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femur: AC 1</td>
<td>56.0</td>
<td>79.0</td>
<td>4 months</td>
</tr>
<tr>
<td>AC 1</td>
<td>60.7</td>
<td>82.0</td>
<td>5 months</td>
</tr>
<tr>
<td>LR 3</td>
<td>58.4</td>
<td>81.0</td>
<td>4.5 months</td>
</tr>
<tr>
<td>LR 3</td>
<td>60.5</td>
<td>83.0</td>
<td>6 months</td>
</tr>
<tr>
<td>Humerus: AC 1</td>
<td>106.0</td>
<td>110.0</td>
<td>18 months</td>
</tr>
<tr>
<td>LR 3</td>
<td>93.2</td>
<td>96.0</td>
<td>6 months</td>
</tr>
<tr>
<td>LR 3</td>
<td>-</td>
<td>-</td>
<td>(small)</td>
</tr>
<tr>
<td>Ulna: MAT 1-5</td>
<td>141.8</td>
<td>67.0</td>
<td>36 months</td>
</tr>
<tr>
<td>AC 1</td>
<td>115.0</td>
<td>42.0</td>
<td>1 month</td>
</tr>
<tr>
<td>LR 3</td>
<td>-</td>
<td>46.0</td>
<td>1.5 months</td>
</tr>
<tr>
<td>Scapula: AC 1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>AC 1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LR 3</td>
<td>240.0&lt;sup&gt;2&lt;/sup&gt;</td>
<td>200.0&lt;sup&gt;3&lt;/sup&gt;</td>
<td>36 months</td>
</tr>
<tr>
<td>Radius: LR 3</td>
<td>225.0&lt;sup&gt;2&lt;/sup&gt;</td>
<td>79.0</td>
<td>6+ years</td>
</tr>
<tr>
<td>LR 3</td>
<td>175.0</td>
<td>86.0</td>
<td>6+ years</td>
</tr>
<tr>
<td>AC 1</td>
<td>104.0</td>
<td>50.0</td>
<td>5 years</td>
</tr>
<tr>
<td>Tibia: AC 1</td>
<td>-</td>
<td>-</td>
<td>(small)</td>
</tr>
<tr>
<td>Pelvis: AC 1</td>
<td>-</td>
<td>-</td>
<td>(large)</td>
</tr>
<tr>
<td>AC 1</td>
<td>-</td>
<td>-</td>
<td>(small)</td>
</tr>
<tr>
<td>LR 3</td>
<td>-</td>
<td>-</td>
<td>(small)</td>
</tr>
<tr>
<td>LR 3</td>
<td>-</td>
<td>-</td>
<td>(small)</td>
</tr>
</tbody>
</table>

<sup>1</sup> calculated from circumference
<sup>2</sup> epiphyses fused
<sup>3</sup> width
The routine eventually practiced was for two men to grab the pup to be measured...Meanwhile the two other men distracted the attention of the mother and of the harem bull with sticks or a whip. The older pups are very strong and lively and have to be taken by surprise...chloroform...had little effect in quietening them. Furthermore, they were usually lying among the cows of the harem and, as well as being arduous, the work was dangerous. Four men are much less than the ideal number for handling these animals. Frequently it was not possible to prevent the bull from rushing the tripod, or a particularly maternal cow would follow her pup and interfere with the operation. On one occasion, in an attempt to minimise the interference, the bull and a cow were lassoed, but the cow had to be freed because it was choking, and there was no fixed rock near enough or large enough to provide anchorage for the bull.

Owing to these practical difficulties only seven male and eight female pups were weighed regularly and even to accomplish this meant several hours of strenuous work each weighing day.

Laws (1953b:4) also gives a graphic description of the difficulties of killing the mature animals:

The elephant seal, in common with other species of seal, is very tenacious of life, and must be shot in the head so that the bullet strikes the brain. Initially, soft nosed .303 ammunition was used for killing, but death is not certain unless the bullet is placed through the skull...After the first season's experience a .22 rifle, firing high velocity ammunition, was used and proved most effective except when dealing with very large bulls. In that case .22 bullets did not have enough power to penetrate the heavily ossified skull and a .303 rifle was used...With experience the seal may be killed from almost any position. It is the shock effect of the first shot which is important. If it is wrongly placed, several other shots, each of which would normally be sufficient to kill the animal, are required.

It is possible that a breeding colony was present on the main beach at Louisa Bay, and that immature animals on the fringe of that colony, and those which had moved over to Anchorage Cove, were being killed. The other, more likely, possibility is that these remains represent immature (2-12 months old) animals hauling out during the winter months. These animals could be derived either from a colony at Louisa Bay itself, or, more likely, from a colony somewhere else in the southwest of Tasmania.

The exploitation of immatures during the winter seems the most likely hypothesis because (a) trying to catch and kill immature animals on the fringe of a breeding colony would still involve considerable difficulty and danger; (b) no bones of mature animals were found, so that such animals were apparently not dying (even of natural causes) at the same time as the deposit at LR 3 was being laid down. It may also be significant that so many of the remains of the youngest age group appear to represent animals around 6 months old. Animals of this age could only be killed in winter, and it is tempting to equate the period of exploitation with the hauling out of immatures which occurs between February and September, reaching a peak in April and May (at which time pups born in the previous November would be about 6 months old).

Leopard Seal

A single maxilla and a single radius, from AC 1 and LC 1 respectively, do not belong to either fur or elephant seal, and are most likely leopard seal. Another less likely possibility is sea lion (Neophoca cinerea).

Unidentified Mammal Bones

There are approximately 400 other unidentified bones. Most of these are probably from land mammals, but some are from seals. The majority of these are shaft fragments. These number 232, of which 27 are juvenile and 11 are burnt. The greatest numbers come from LRC 2 (107), LR 1 (42), AC 1 (28), LR 3 (27) and LR 1 (21), other sites having three or less.

There are 178 interesting pieces (i.e. articular ends or odd shaped shafts); of these, 22 are juvenile and six are burnt. Greatest numbers are from LRC 2 (54), LR 3...
(52), LR 1 (35), AC 1 (15), and LR 2 (9), the other sites having four or less.

These figures are negligible, as most of this material would come from species already identified in the deposits. There are no cases of large numbers of one type of bone being present (the greatest number is four of what is probably a tibia of one of the small mammal species).

It should be pointed out that none of the unidentified material would normally be considered in analysis; in fact, postcranial material as such is rarely considered. It is categorised here to indicate that although there are certainly additional individuals, and perhaps species, present at these sites, they are in insignificant proportions.

Reptiles and Fish

Snake

A single small elapid vertebra was found at LR 1, which from its size is most likely to be *Drysalta coronoides*, the white-lipped snake.

Fish

The fish vertebrae have been sorted into six types, based on size and shape. These types may represent individual fish of different sizes, or different species of fish, and some of the types may simply represent different parts of the vertebral column. The distribution of the fish vertebrae is shown in Table 22. Other possible fish bones came from AC 1-1/8, LRC 2-3/1 and MAT 1-1A/2 (one bone in each). Two bones which may be fish spines come from LR 3/9 and LR 3/7. In MAT 1-4/2 and MAT 1-6/2 there are some premaxillae and pharyngeal plates of wrasse (Labridae), so some of the vertebrae may also be from this species.

<table>
<thead>
<tr>
<th>Fish Type</th>
<th>Site</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of vertebrae</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 1-5/2</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1-5/3</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1-1A/2</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LR 1-2/3</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1-1/11</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5*</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3/3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LRC 1/2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* plus other bones from a single fish

Table 22 Distribution of fish remains in various sites (type 1 is largest)

Birds

Mutton-bird

Mutton-bird occurs at four of the Louisa Bay sites (LR 1, LR 2, LRC 1 and LRC 2), and is massively represented on Maatsuyker Island. Many of the long bones were broken before or during deposition, and post-depositionally by being walked on, burrowed into, excavated and packed. All breakage is generally of the same nature, at the weakest part of the bone, or at the point where the shape of the bone concentrates the stress when weight is placed on the bone. Analysis of the ulna shows that the lengths of the broken pieces are similar for both old and fresh breaks.

In two elements, ulna and radius, a number of bones show an additional type of breakage pattern, having lost both (articular) ends. This breakage seems unlikely to have occurred through the simple application of weight stress to the bones such as from the weight of deposit, or by people or animals walking on them. The numbers involved are relatively small, approximately 7% for ulna and 4% for radius. However, the percentages are actually higher than this because these percentages are of total bones, including proximal and distal ends and shafts; and there are a number of bones which have lost either the proximal or distal end, but which have in addition a break in the midpoint. There is, however, no objective way to calculate more realistic proportions.

It is suggested that this breakage is of human origin and has been done for the purpose of extracting marrow from the bones concerned. It is not clear why this should
have been done only with radius and ulna, and not with the similar sized tibia and humerus, but it is possible that the former have more marrow, or it is easier to extract.

As in the analysis of the fur seal remains, that of mutton-birds will be pursued first by examining the Maatsuyker Island square MAT 1-5, then the other Maatsuyker Island squares and the Louisa Bay sites.

A total of 6858 mutton-bird bones from MAT 1-5, excluding vertebrae, ribs and phalanges, was analysed, representing a minimum number of 270 individuals. The greatest number of bones (Fig.14) for any element is 1052 for the humerus, followed by ulna (687), radius (638) and metacarpus (593). These figures are based on all identifiable fragments (including shafts), and minimum numbers probably provide a more realistic comparison. The highest minimum numbers are obtained for humerus (270), ulna (253), metacarpus (244), mandible (197), coracoid (179), carpal (179) and radius (178). It is obvious that, with the exception of the mandible, the six most numerous bones are those of the wing.

A number of these bones are burnt. Elements with the greatest percentages of burnt bones (Fig.14) are metatarsal (14%), femur (7%) and tibia (6%), while the next six highest percentages are all wing bones, ranging from humerus (6%) down to radius (2%). A reasonable hypothesis would seem to be that the relatively low number of leg bones is correlated with the fact that relatively more of them are destroyed by burning. There is, however, no simple correlation between number of bones and percentage burnt. The pattern seen is that eight bones (some of wing bones, skull bones, pelvis and synsacrum) have intermediate numbers and few of these are burnt (less than 3%). Three bones (metacarpus, ulna and humerus) occur in high numbers and relatively more of these are burnt (4–6%). Four bones (sternum, tibia, femur and metatarsus) occur in relatively low or intermediate numbers, but a very high percentage of these are burnt (5–14%). A factor this last group has in common is that they are the bones from the areas of the body with the greatest amount of meat, the leg and the breast. It is unclear why this should relate to their being burnt, unless the birds were dissected before cooking, which seems unlikely, or some of the flesh-stripped bones were disposed of in the cooking fires. It is not possible to be more precise.

The final analytic aim was separation into adults and juveniles, whose bones at Maatsuyker Island are of approximately equal size. Assuming that epiphyseal fusion is complete before 4 years of age, juvenile bones must be from nestlings, because the immatures do not visit the breeding grounds. Since they are close to adult size they are probably from nestlings about to leave the nest rather than from very young birds.

The metatarsus reflects the greatest number of juveniles, 5% of the total number of this element. This represents a minimum number of seven individuals out of the 100 defined on the metatarsus, or out of the 270 greatest minimum number. There are two major problems in determining the significance of the presence of juveniles. First, we can recognise juvenile bones because the epiphyses are not fused, and because there is (apparently) less calcification of the bone, which gives it a rougher, more porous, texture to that of adult bones. These same qualities result in a decreased ability to recognise and identify juvenile bones, and probably result in a poorer survival rate for them. It is unlikely that the bones of very young birds would survive at all. Second, without reference specimens they cannot be correlated with animals of a particular age.

The first problem can be solved partly by checking all the unidentified fragments of 125 unidentified bird fragments, only 12 are from juveniles. This gives a percentage similar to that of the mutton-bird metatarsus, but this covers all species, so that very few of these would be mutton-bird juveniles; even if all 12 were from mutton-bird, the addition of another dozen bones would have almost no effect on the calculation of juvenile percentages. The problem can also be solved partly by a comparison with prion, although the same considerations apply (and may well be more acute because the bones are smaller), a much higher percentage or prion bones are juvenile. There is however no answer to the problem of non-preservation of very young birds, and it should be recognised that these could have been taken as well. One partial indication that they may not have been taken is that there is little if any variation in the size of the juvenile bones, and we would expect to get a few of the stronger bones of smaller chicks surviving. A reasonably complete series of reference animals would go some way toward solving the second problem.

As is the case with the fur seals, the other squares on Maatsuyker Island and sites around Louisa Bay have considerably fewer mutton-birds. There are 22 individuals in MAT 1-1A, 13 in MAT 1-2 and five in MAT 1-1. These numbers are fewer than at MAT 1-5 even when the figures are adjusted to compensate for volume differences. Multi-
Fig. 14  Anatomical position of bones and percentage of burnt bones: mutton-birds and fairy prions
lication by four gives numbers of 88, 52 and 20 respectively per square metre. Even these quantities, however, are much greater than those recovered from the mainland, which total only 49 individuals from four sites.

The frequency of bones varies slightly from site to site, but humerus, tibia and metacarpus are generally among the most numerous. There are consistently few juvenile bones, their percentage of the total ranging from 2-9% (at MAT 1-1). On most sites the percentage of burnt bone is low, ranging from 0-5% (at MAT 1-2). However, two sites have more burnt bone than this, LRC 2 (12%) and MAT 1-1A (6%). The burnt bone in MAT 1-1A is all at the lowest level of that site, where 90% of the total bones are burnt, suggesting a special event with preparation of or disposal of mutton-birds. There seems to be no corresponding concentrations of burnt bone at LRC 2, the percentages in the four trenches ranging from 10-16%. The only relatively high concentration is in excavation level 3 of the LRC 2 extension where 10 of the 31 bones are burnt. Of the most numerous bones at MAT 1A, femur (81%), metacarpus (78%) and metatarsus (71%) have most burnt. At LRC 2 the highest figures are metacarpus (32%), radius (22%) and tibia (20%). There are a number of radius and ulna showing the human breakage pattern in the other Maatsuyker trenches and also in the Louisa Bay sites.

As noted, the number of mutton-birds at the Louisa Bay sites is extremely low, which may result from two factors. The first is that the size of the rookery on Louisa Island may not have been large enough to provide numbers of birds. Secondly, access to the island may have varied in the past; indeed, even today the connecting tombola is often covered by water too deep for walking passage.

The reverse of this must also be considered, that the island in the not too distant past was directly connected to the mainland, in which case mutton-birds would be unlikely colonisers. The absence of snakes may argue against this, and while a small pademelon population resides there today, the tombola is once or twice a year totally free of water which would allow them to depart, or for others to join them. However, apart from the possibility of direct connection, the presence of mutton-birds at Louisa Bay could only be explained by storm-washed birds, or less likely by chance encounters while feeding or resting close inshore. If this is a correct alternative, the presence of juveniles would mean that the birds were obtained in about April when the juveniles began leaving the islands. The other possibility, considered to be equally remote, is that the birds were brought back to the mainland after being killed on Maatsuyker.

**Fairy Prion**

Fairy prions are found at the same sites as mutton-birds, though in far fewer numbers, and the same human breakage pattern is seen. In the following analysis, the Maatsuyker Island square MAT 1-5 is treated separately. There are fewer prion than mutton-bird present. The greatest minimum number, based on the humerus, is 48. This represents only 18% of the number of mutton-birds.

The most numerous bone (Fig.14) is the humerus (159), followed by tibia (131), ulna (101), metacarpal (74), coracoid (49) and metatarsus (48). In terms of minimum numbers the figures are humerus (48), ulna (47), metacarpus (41), tibia (34), synsacrum (31), coracoid (27) and metatarsus (18). As with mutton-bird, the wing bones are in relatively high numbers, but the difference is not so clear cut (tibia high, radius low, carpus very low).

In contrast to mutton-bird, very few prion bones are burnt - one tibia from MAT 1-5/2, and another from MAT 1-5/4. A number of the prion ulnas show the same pattern of breakage (articual ends lost) as was seen in the mutton-bird.

The other difference between the mutton-bird and prion remains is the high percentage of juveniles (10%) in the latter species, suggesting that many of these birds were obtained in late January to early February. The humerus has the highest percentage (17%), and the next highest percentages range from 6-14%, and these are all higher than the highest mutton-bird percentage. In general, the bones with the highest percentage juveniles seem to be the longest and/or strongest bones, which is probably a result of differential preservation.

As with the mutton-bird, there are relatively few remains of prion at other Maatsuyker sites, and six (or 24 if adjusted for volume) at MAT 1-1, five (20) at MAT 1-1A and one (4) at MAT 1-2. In the mainland sites there are 76 birds, about a third as many again than of mutton-birds. The percentage of juveniles ranges from 2% (at LRC 2) to 13% (LR 1), percentage of burnt bone from 2-6% (calculated only for reasonable numbers). The most numerous bones are humerus, ulna, tibia and metacarpus,
and there are a number of examples of the human breakage pattern of ulna and radius at these other sites.

Like mutton-birds, the fairy prions recovered from the Louisa Bay sites probably were obtained from Louisa Island, though the alternate hypotheses must also be kept in mind.

Fairy Penguin

A minimum number of four penguins was recovered from Maatsuyker Island, and five others were recovered from three mainland sites. None of the bones came from immature animals. Low numbers are probably explained by small breeding populations. A colony of 30 pairs on Maatsuyker Island (Milledge and Brothers 1976), and perhaps fewer at Louisa Island (but see White 1980:34), would not be capable of withstanding much exploitation.

Other Penguins

Bones found in LR 3 agree in size with Eudyptes chrysolophus (the royal penguin). Bones from LR 3 and LRC 1 are intermediate in size between the royal and fairy penguins, and may belong to the rock hopper penguin (E. chrysocephalus).

Cormorant

These birds are found at all sites, though in low numbers. All the radiuses and all but one ulna show the human breakage pattern observed in mutton-bird and prion. Bones present in the greatest numbers are tibia, ulna and humerus. There was one juvenile specimen, a synsacrum, and a burnt humerus, both from AC 1.

It is possible that bones from the two species of cormorant, Phalacrocorax carbo and P. fusciceps, may be confused.

Shy Albatross

This bird is found at all but two mainland sites, where there are 18 individuals; a further 10 are from Maatsuyker Island. Of approximately 130 bones (approximately because there are numerous small fragments), 32 are from juveniles and two are burnt. Two ulnas, of approximately 20, have both ends broken off.

The presence of juveniles is puzzling. The individuals cannot be aged, but logically since they are near adult size they should represent animals around 4 months old. However, it is possible that growth is not completed until some time between 6 months and the breeding age in Diomedea cauta, in which case the juveniles observed here may be immatures washed up in storms or visiting the island.

If this is not the case, there are two other possibilities. One is that there was originally a breeding colony (probably a small one) on Maatsuyker itself, and that young birds were being taken from the nest around March. The other more remote possibility is that Maatsuyker was being visited after April, and that young birds from the Mewstone colony were caught when they landed at Maatsuyker.

The same possibilities are available for the young birds found at Louisa Bay. However, it seems unlikely that albatrosses would breed on the mainland; they do not do this anywhere else, and it would be very unusual. If this is a reasonable assumption, then the juveniles on the coast must represent birds which have flown, and have been caught, some time after April. This leaves us with the possibility that the same thing is true for Maatsuyker, with juveniles being caught either in their first year, during winter, or in their second year, during summer. For other reasons the latter seems more likely, but resolution of this problem requires a series of known-age albatross skeletons.

Other Albatrosses

There are four bones from LR 3, of a single individual, which agree in size with the wandering albatross (Diomedea exulans).

A single bone from a small unidentified albatross was recovered from site LRC 2.

Diving Petrel

Only a single bone of this species was found, at LRC 2.

Seagull

The remains of two individual seagulls, probably Larus novaehollandiae, were
found at site LR 3.

Ducks

There are at least two species of ducks present among the remains. A small species is relatively few in number (one bone each from LRC 1, LR 1, LR 2 and LR 3). A large species is more abundant and occurs mainly at LR 3 with fewer numbers from LRC 2, and single bones from LR 1 and AC 1. Bones from the larger species are equivalent in size to the black duck (Anas superciliosa) and the smaller to the grey teal (A. gibberifrons).

Black Swan

There are a number of bones of this species, most of them from LRC 2, where there are at least two individuals. Two bones came from site LR 3, and one each from AC 1 and LRC 1.

Forest Raven

Plentiful remains of at least one raven were found on Maatsuyker Island, while at Louisa Bay a single bone was recovered from site LR 3.

Currawong

There are at least four currawongs represented by remains recovered from site LRC 2, three from AC 1, and two each from LR 2 and LR 3. One bone from LRC 2 is burnt. It is of interest that of the 29 bones, 12 are metatarsals and six are metacarpals. There is only a single humerus, and no radius, ulna, femur or tibia. As has been observed before, these last five bones are usually the most numerous bird bones.

Parrot

A single bone which seems to be from a small parrot was recovered from LRC 2.

Unidentified Bird Bones

There are some 190 bird bones which cannot be identified. This may seem to be a large number but in fact is negligible. To put this into perspective, it is noted that the mutton-birds in MAT 1-5 have on average 25 bones for each individual analysed. The prions have an average 15 bones per individual. The unidentified bones then could come from around 7 to 12 individuals.

In addition there are no cases where there are large numbers of identified bones of a particular element - in any one element there are no more than two individual bones which could come from a single species.

Finally, it is likely that many of these bones come from species already identified, but have some individual variation, or are broken in such a way that identification is uncertain.

Of the 190 bones, over 100 are from relatively small species, 30 are from juveniles and 17 are burnt (these figures are not exclusive of each other). The greatest numbers come from LR 3 (57), LRC 2 (38), LR 1 (37), AC 1 (21) and LR 2 (17), the other sites having less than 10 each.

THE SITES

Analysis is carried out as outlined in Chapter IV. Summary tables are included within this chapter. The raw data have been deposited as open access manuscripts with the Australian Institute of Aboriginal Studies, Canberra.

Louisa River Site 1

The minimum number of individuals recovered from LR 1 was 92, representing nearly 350 kg of animal weight (Table 23). In Tables 23–29 the order of species reflects general habitat from fully marine to fully terrestrial environments. Thus seals appear first, followed by sea birds, water birds, land birds and terrestrial mammals. Figure 15 shows that the animals most commonly procured through time were mutton-birds and fairy prions, with cormorants present mainly in the lower half of the site. In the upper part of the site we have a steadily increasing diversity as
Fig. 15  Louisa River site 1: Concentration bar graphs, vertebrates

Fig. 16  Louisa River site 1: procurement and consumption Heterogeneity and Divergency, vertebrates
shown in both Heterogeneity and Divergency values (Fig. 16). The consumption Heterogeneity/Divergency band, on the other hand, shows an inversion relative to the lower part of the site, caused by the energy contribution of a wombat in the Sandy Soil deposit, and of fur seal in the two topmost deposits. In all three deposits the very commonly procured mutton-birds and priions fade into insignificance because of their small individual weights.

The most probable interpretation is that the people who visited the site in earlier times were exploiting only the immediate coastal environment, in fact restricting themselves to the maritime fringe itself. The absence of seals, however, as well as the relative low total numbers in the sample, suggests either that this part of the dune was visited only by a few people, or that the remains accumulated over a very short time period, or both. In the upper part of the site, there is increasing evidence of more inland exploitation, while the presence of at least four fur seals in the topmost deposits argues for more than casual visits to the area, and perhaps more intensive exploitation by more people.

Although seasonality will be discussed more formally toward the end of this chapter, it is appropriate here to comment that the presence of mutton-bird and prion remains, probably from Louisa Island, argues for summer visits through all deposits at site LR 1. Further comments will also be made on seal exploitation, though it can be said that the remains preserved at LR 1 are probably from animals casually visiting the high energy rocky areas around Louisa Point.

Louisa River Site 2

Table 24 sets out the contents of the site in terms of spits. Because the only real stratigraphic division was between the overlying Dense Shell and the underlying Sandy Soil, minimum numbers were calculated for the site as a whole. Fur seals number four when considering the site as a whole, but five when calculated by spits, of which four are in Dense Shell.

<table>
<thead>
<tr>
<th>Corrections:</th>
<th>Spit 1 MNI</th>
<th>Spit 2 MNI</th>
<th>Spit 3 MNI</th>
<th>Spit 4 MNI</th>
<th>Spit 5 MNI</th>
<th>Total MNI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MNI Mwt</td>
<td>MNI Mwt</td>
<td>MNI Mwt</td>
<td>MNI Mwt</td>
<td>MNI Mwt</td>
<td>MNI Mwt</td>
</tr>
<tr>
<td>Fur seal</td>
<td>- 1 200</td>
<td>- 2 104</td>
<td>- 2 104</td>
<td>- 1 70</td>
<td>- 3 174</td>
<td></td>
</tr>
<tr>
<td>Elephant seal</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>Mutton-bird</td>
<td>1 0.5</td>
<td>1 0.5</td>
<td>2 1.0</td>
<td>4 2.0</td>
<td>3 1.5</td>
<td>9 4.5</td>
</tr>
<tr>
<td>Fairy prion</td>
<td>1 0.1</td>
<td>2 0.2</td>
<td>1 0.1</td>
<td>3 0.3</td>
<td>1 0.1</td>
<td>6 0.6</td>
</tr>
<tr>
<td>Shy albatross</td>
<td>1 3.3</td>
<td>- 1 3.3</td>
<td>4 13.2</td>
<td>1 3.3</td>
<td>5 16.5</td>
<td></td>
</tr>
<tr>
<td>Cormorant</td>
<td>- 1 2.0</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>- 2.0</td>
</tr>
<tr>
<td>Fairy penguin</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>Ringtail possum</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>Pademelon</td>
<td>1 8.5</td>
<td>1 8.5</td>
<td>1 8.5</td>
<td>1 8.5</td>
<td>2 17.0</td>
<td></td>
</tr>
<tr>
<td>Wallaby</td>
<td>1 16</td>
<td>2 32</td>
<td>- -</td>
<td>- -</td>
<td>- 2 32</td>
<td></td>
</tr>
<tr>
<td>Wombat</td>
<td>1 23</td>
<td>1 23</td>
<td>1 23</td>
<td>1 23</td>
<td>1 23</td>
<td></td>
</tr>
<tr>
<td>Bandicoot</td>
<td>1 1.5</td>
<td>1 1.5</td>
<td>- -</td>
<td>- -</td>
<td>- 1.5</td>
<td></td>
</tr>
</tbody>
</table>

Table 24: Louisa River site 2: vertebrate analysis. Minimum numbers of individuals and minimum weights (kg)
Fig. 17  Louisa River site 2:
Concentration bar graphs, vertebrates
The contents of site LR 2 (Fig. 17) are similar to those of LR 1, though the total range is somewhat greater. Mutton-birds and fairy prions are again the most commonly procured animals, but larger animals such as seals, macropods and wombats were also exploited.

Figure 18 shows the various relationships of procurement and consumption. The Heterogeneity/Divergency pattern clearly differs from spit to spit and we therefore suggest that these deposits record multiple occupations. Some confirmation is provided by evidence in the lowermost deposit (spit 5) for several stratified layers (Fig. 6). For our hypothesis to be true, these separate episodes must have followed each other very quickly, as they would otherwise have been separated by windblown sands. Sites LR 1 and LR 2 are both of the same general antiquity, around 3000 years, yet a different wind regime in the area of LR 2 meant a slower depositional rate (see Figs 5 and 6, and Plates 5 and 6 for comparisons of sand overburdens).

In most respects sites LR 1 and LR 2 are similar. They both date from around the same time, they both preserve the same range of animals though the emphasis on resources is different, and the presence of mutton-birds and fairy prions indicates summer occupation. The seals in both sites were almost certainly killed while on the rocks around Louisa Point, and the mutton-birds and prions collected from Louisa Island.

Louisa River Site 3

This site is located on the same dune system as sites LR 1 and LR 2, but it dates only to within the last millennium. The bones recovered represent a total of 55 animals, accounting for 2181 kg of meat (Table 25). This very high weight is due to the presence of elephant seal in the LR 3 deposits. Figure 19 shows a great number of other differences between this and the previous sites, particularly the occurrence of ducks and swans, cormorants, and currawongs; greater representation of some other animals; and, conversely, the absence of mutton-birds, fairy prions, wallabies and wombats.

<table>
<thead>
<tr>
<th>DEPOSIT</th>
<th>Dense Shell</th>
<th>Mussel Shell</th>
<th>Light Shell</th>
<th>Organic Shell</th>
<th>Light Shell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fur seal</td>
<td>1 200</td>
<td>1 2.0</td>
<td>1 70</td>
<td>1 138</td>
<td>1 200</td>
</tr>
<tr>
<td>Elephant seal</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Shy albatross</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Large albatross</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cormorant</td>
<td>1 2.0</td>
<td>1 2.0</td>
<td>1 70</td>
<td>1 138</td>
<td>1 200</td>
</tr>
<tr>
<td>Fairy penguin</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Large penguin</td>
<td>1 3.7</td>
<td>1 3.7</td>
<td>1 70</td>
<td>1 138</td>
<td>1 200</td>
</tr>
<tr>
<td>Intermediate penguin</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Seagull*</td>
<td>2 1.5</td>
<td>2 1.5</td>
<td>2 1.5</td>
<td>2 1.5</td>
<td>2 1.5</td>
</tr>
<tr>
<td>Small duck</td>
<td>1 2.0</td>
<td>1 2.0</td>
<td>1 70</td>
<td>1 138</td>
<td>1 200</td>
</tr>
<tr>
<td>Swan</td>
<td>1 5.0</td>
<td>1 5.0</td>
<td>1 70</td>
<td>1 138</td>
<td>1 200</td>
</tr>
<tr>
<td>Currawong</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Raven*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ringtail possum</td>
<td>1 1.0</td>
<td>1 1.0</td>
<td>1 70</td>
<td>1 138</td>
<td>1 200</td>
</tr>
<tr>
<td>Pademelon</td>
<td>2 17.0</td>
<td>2 17.0</td>
<td>2 1.5</td>
<td>2 1.5</td>
<td>2 1.5</td>
</tr>
<tr>
<td>Bandicoot</td>
<td>1 1.5</td>
<td>1 1.5</td>
<td>1 70</td>
<td>1 138</td>
<td>1 200</td>
</tr>
<tr>
<td>Native cat</td>
<td>1 1.0</td>
<td>1 1.0</td>
<td>1 70</td>
<td>1 138</td>
<td>1 200</td>
</tr>
<tr>
<td>Tiger cat</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Broad-toothed rat</td>
<td>1 0.2</td>
<td>1 0.2</td>
<td>1 70</td>
<td>1 138</td>
<td>1 200</td>
</tr>
<tr>
<td>Rat</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Platypus</td>
<td>1 2.7</td>
<td>1 2.7</td>
<td>1 70</td>
<td>1 138</td>
<td>1 200</td>
</tr>
</tbody>
</table>

* three bird species, raven, seagull and diving petrel (Table 27), were excluded from the analyses. The low numbers of these, and the scavenging habits of the first two species, suggest to us that these are accidental inclusions rather than food remains. In any case their small size, and the fact that each is present in only a single site, means that their exclusion has a negligible effect on the analyses.

Table 25 Louisa River site 3: vertebrate analysis. Minimum numbers of individuals and minimum weights (kg)

Fig. 18 (opp. page) Louisa River site 2: procurement and consumption Heterogeneity and Divergency, vertebrates
The procurement strategies (Fig. 20) vary widely, though the Heterogeneity diversity is high in all but the Mussel Shell deposit. Examination of the bar graphs shows that in relative terms the procurement strategies also vary between deposits. In contrast, procurement diversity at sites LR 1 and LR 2, while varying in intensity, maintained the same Heterogeneity/Divergence relationship from deposit to deposit.

The consumption band is somewhat different, showing that much the same strategies were pursued in all except the Mussel Shell deposit. In the first three deposits most energy, between 90 and 98%, is contributed by seals, particularly elephant seals. Much the same situation exists for the last deposit, Dense Shell, but fur seal is completely absent. While elephant seal is still dominant (84%), pademelons (7%) and ducks and swans (4%) are also important. The aberrant deposit is Mussel Shell, where the Heterogeneity and Divergency values are inverted by the absence of any seal, and where only two individual birds (cormorant and duck), and a possum were recovered. The shellfish analysis also showed this deposit as being different, the remains comprising almost entirely mussel shells.

The absence of mutton-birds and fairy prions suggests that site LR 3 deposits were all laid down in the process of winter occupation. While there were five deposits recognised during excavation, it is possible that the lower three, and of these more probably the lower two, are gradations of a single deposit, caused perhaps by organic leaching. However, no sterile sands apparently separate the deposits, and since the site is in a high energy wind environment this suggests that the whole site may have been deposited in as short a period as a single season.

An examination of the site LR 3 animals (and their habitats) will show that all exploitation could have been immediately coastal. The Louisa River and its associated swamps were heavily used, and the scrub mammals could have been caught near the site. Birds are prominent, elephant seals were most probably killed where they hauled themselves onto the sand, and fur seals on the rocks around Louisa Point. In contrast, hinterland animals such as wallabies and wombats are notably absent. The energy return on the pursuit of these mammals is reasonably high, but that on seals is even higher. The knowledge that elephant seals often hauled themselves onto the beach in winter could have provided a strong motive for visiting this part of Louisa Bay.

---

**Fig. 19** Louisa River site 3: Concentration bar graphs, vertebrates
Fig. 20 Louisa River site 3: procurement and consumption Heterogeneity and Divergency, vertebrates
Louisa River Cave Site 1

Because of the nature of deposits in this site (see Chapter III), spit volumes and therefore concentrations could not be calculated. Similarly no purpose would be served by calculating Heterogeneity and Divergency values for each spit, and no bar graphs were drawn. Table 26 shows that the most commonly occurring animals are mutton-birds (4) and cormorants (2), though there are single individuals of another 10 species.

<table>
<thead>
<tr>
<th>Animal</th>
<th>Spit 1 MNI</th>
<th>Mwt</th>
<th>Spit 2 MNI</th>
<th>Mwt</th>
<th>Spit 3 MNI</th>
<th>Mwt</th>
<th>Total MNI</th>
<th>Mwt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mutton-bird</td>
<td>4</td>
<td>2.0</td>
<td>1</td>
<td>0.5</td>
<td>1</td>
<td>0.5</td>
<td>4</td>
<td>2.0</td>
</tr>
<tr>
<td>Fairy prion</td>
<td>1</td>
<td>0.1</td>
<td>1</td>
<td>0.1</td>
<td>1</td>
<td>0.1</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Shy albatross</td>
<td>1</td>
<td>3.3</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>3.3</td>
<td>1</td>
<td>3.3</td>
</tr>
<tr>
<td>Cormorant</td>
<td>2</td>
<td>4.0</td>
<td>1</td>
<td>2.0</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>4.0</td>
</tr>
<tr>
<td>Intermediate penguin</td>
<td>1</td>
<td>2.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2.0</td>
</tr>
<tr>
<td>Small duck</td>
<td>1</td>
<td>1.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Large duck</td>
<td>1</td>
<td>2.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2.0</td>
</tr>
<tr>
<td>Swan</td>
<td>1</td>
<td>5.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>5.0</td>
</tr>
<tr>
<td>Ringtail possum</td>
<td>1</td>
<td>1.0</td>
<td>1</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>Pademelon</td>
<td>1</td>
<td>8.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>8.5</td>
</tr>
<tr>
<td>Wallaby</td>
<td>1</td>
<td>16</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>Wombat</td>
<td>1</td>
<td>23</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>23</td>
</tr>
</tbody>
</table>

Table 26 Louisa River Cave site 1: vertebrate analysis. Minimum numbers of individuals and minimum weights (kg)

The presence of ringtail possums suggests that this site was partially occupied in winter, and the mutton-birds and fairy prions attest to summer occupation. The nature of the site suggests that it may have been a retreat from bad weather in all seasons (there is a high incidence of gales and storms in this area even in summer). The results of the shellfish analysis, discussed in the following chapter, add weight to this hypothesis.

In addition, LRC 1 is in a very favourable ecotonal situation (Fig.2) and it is unlikely that the same conditions preventing general access to the sea would also hinder terrestrial exploitation. It is possible, moreover, that we here see reflected the roles of men and women, the women obtaining what they can on the beach (including a few storm-tossed mutton-birds and fairy prions), the men perhaps supplying somewhat more food and energy through their hunting activities.

There are other hypotheses to explore, all of which depend on the synchronic occupation of sites LRC 1 and LRC 2 (both caves would have become available at about the same time – see Chapter III). The first is that LRC 1 represents overflow from the occupation of the larger LRC 2 in normal weather conditions, though this does not adequately explain the shellfish data. Another is that the little cave was used by women, the larger by men, but this is considered unlikely if each were consuming their own produce and again does not come to grips with the shellfish problem. A third hypothesis is that the smaller cave is the equivalent of a children's cubby where they have left the remains of shellfish they collected for and by themselves (including a small number of larger shellfish), and of other food perhaps supplied to them by adults in the adjoining 'dining room'. It is tempting to suggest that the presence of a deciduous human molar at this site, probably from a 5-year-old child (A.G. Thorne pers. comm.), lends weight to this hypothesis.

Louisa River Cave Site 2

The range of resources recorded at LRC 2 is impressive (Table 27), consisting of 19 species, six of them occurring in four or more of the six deposits, and another five species in three deposits (Fig.21). The most common are mutton-birds, currawongs, possums and fairy prions, though pademelons, ducks and swans, and cormorants are also common.

In terms of the overall exploitation of the site (Fig.22), procurement strategies appear rather uniform, with fairy prion being the most common animal, followed by mutton-birds and possums. A pinching of the Heterogeneity/Divergency band at the Dense Shell I deposit is a function of both a lower Heterogeneity (only two fairy prions, a currawong and a wallaby are in the deposit) and a higher Divergency, the latter a result of the absence of mutton-birds.
This apparent division in the site, foreshadowed by the procurement diversity band, is confirmed by the consumption band. The two lower deposits are each distinct: in Grey Soil a duck, a possum and a native cat together constitute nearly 70% of food; in Organic Soil the same amount is made up of a pademelon and seven mutton-birds. A single wallaby in Dense Shell I accounts for nearly all food. The upper half of the site, however, reflects a more even distribution of resources, with wallabies and wombats providing the bulk, though a single seal in Dense Shell II is important (accounting for the Divergency bump).

The division we see in the site is possibly the result of disturbances to the cave deposits. We saw in Chapter III that sites LRC 1 and LRC 2 were available for occupation only within the last millennium due to a shift in the river channel. Such a movement, however, might not have resulted in a permanently habitable cave, as seasonally high water might have invaded the area, disturbing or even partially flushing out some of the deposits.

Both cave sites are in a highly favourable ecotonal position. They occur in a
little stand of rainforest bordered by the Louisa River and surrounded by swamps and scrub. On the bluff above is heath and herb country, and the sea is nearby. The range of animals recorded at the site testifies to the resources available to those camping in the cave. It is therefore considered that LRC 2 was occupied not simply because it provided shelter, but also because of its location.

All the deposits contained mutton-birds or prions, and often both, indicating that each period of occupation included a summer component. However the equally wide occurrence of ringtail possums indicates that each defined deposit (but not necessarily each occupation – see Chapter III concerning the stratigraphy) also had a winter component. The cave is located within and adjacent to the preferred habitats of these and other scrub-loving animals, but the mutton-birds and prions were probably collected from Louisa Island, although the possibility cannot be excluded that a more locally accessible rookery, no longer present, was being exploited. The single fur

Fig. 22 Louisa River Cave site 2: procurement and consumption Heterogeneity and Divergency, vertebrates
seal was probably killed on the rocks to the east of the beach. It is surprising that the remains of only one seal were recovered, as LRC 2 was hardly any further away from rocky areas than LR 1 and LR 3. In coming to grips with the problem it will be recalled that in our discussion of LRC 1 we suggested that some of its unusual features may reflect the different roles of men and women in the economy. This argument can be pursued even more strongly here. We suggest that women were responsible for the exploitation of marine resources, and men for the terrestrial. This scenario would involve women collecting all shellfish, possibly storm-beached penguins, most probably the mutton-birds, fairy prions (even if it meant walking to Louisa Island), perhaps the cormorants and albatrosses, and (although this is less likely) the land and river and swamp birds. The men would be the suppliers of mammals from swamp, scrub, heathlands and herblands. If men were hunting in the bush, while women exploited the marine habitats, this could explain the absence of seal remains at this site (since men were probably responsible for hunting these – see Chapter VII). It is possible that seals might not have made use of the rocky area closest to LRC 2, but this is considered unlikely since the environment is similar to those areas on either end of Louisa Bay.

Louisa Creek Site 1

This site produced the remains of three pademelons, one mutton-bird and a bone from a leopard seal. This strongly suggests that the area was exploited on only a very casual basis which, as will be seen, is a conclusion supported by the invertebrate analysis.

Anchorage Cove Site 1

The most distinctive feature of the contents of AC 1 (Table 28) is the lack of mutton-birds and fairy prions. While it is possible that their absence reflects unsuitable rookery locations, other similarities to the winter-occupied site LR 3 make it likely that the negative evidence here also indicates winter exploitation. Only very limited statements can be made about the stratigraphy, because sometimes two, three, and four contiguous spits contain the bones of the same animal. Figure 23 is therefore more a record of bone dispersal than of depositional sequence.

![Fig. 23 Anchorage Cove site 1: Concentration bar graphs, vertebrates](image-url)
Fig. 24  Anchorage Cove site 1: procurement and consumption Heterogeneity and Divergency, vertebrates
Table 28  Anchorage Cove site 1: vertebrate analysis. Minimum numbers of individuals and minimum weights (kg)

Pademelon, elephant seal, possum and currawong bones were distributed in the most random fashion. A test for the degree of this dispersal is seen in Figure 24, where the only major deviation in the procurement band occurs in spits 1 and 10. Similarly, the consumption band shows that spits 3 and 10 are most divergent.

The most meaningful data for AC 1 then is the minimum number of individuals shown in Table 28. The accumulation of these remains, as evidenced by the bone dispersal, must be considered to have been the result of very rapid deposition of midden debris. Protected as the site is from the dominant southwesterly winds, sand aggregation is slow, and we would not expect any visible stratigraphic breaks separating yearly occupation. It is even possible in fact that the deposits could have been deposited during one or two seasons of intensive occupation. This is not at variance with the interpretations made on the invertebrate analyses of the next chapter, where _Noto- halis ruber_ is seen to be the dominant resource, also being very intensively exploited.

It should be noted that the single leopard seal (referred to in the first part of this chapter) has not been included in our discussion, but its capture must have resulted in considerable meat. Body weight for the animal is unavailable.

Maatsuyker Island Site 1

The exploitation of Maatsuyker Island must represent a very special situation because of the harsh and unpredictable southwest Tasmanian weather. *Ipso facto*, the island must have been visited during the summer, and this is borne out by the vertebrate fauna which in part consisted of vast quantities of mutton-birds and fairy prions (Table 29). Other animals, including cormorants, albatrosses, penguins and rats (*Rattus lutreolus*) were also recovered, as well as quantities of fur seals.

Figure 25 shows the diversity of this exploitation in MAT 1-5, the larger of the two squares analysed; MAT 1-5 is four times as large as MAT 1-1A. The most consis-
<table>
<thead>
<tr>
<th></th>
<th>5/2 MNI</th>
<th>5/2 Mwt</th>
<th>5/3 MNI</th>
<th>5/3 Mwt</th>
<th>5/4 MNI</th>
<th>5/4 Mwt</th>
<th>5/5 MNI</th>
<th>5/5 Mwt</th>
<th>5/6 MNI</th>
<th>5/6 Mwt</th>
<th>Square 5 total MNI Mwt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fur seal</td>
<td>10</td>
<td>5520</td>
<td>9</td>
<td>450</td>
<td>10</td>
<td>520</td>
<td>7</td>
<td>346</td>
<td>2</td>
<td>114</td>
<td>24</td>
</tr>
<tr>
<td>Elephant seal</td>
<td>1</td>
<td>200</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Mutton-bird</td>
<td>17</td>
<td>8.5</td>
<td>35</td>
<td>17.5</td>
<td>195</td>
<td>97.5</td>
<td>55</td>
<td>27.5</td>
<td>37</td>
<td>18.5</td>
<td>270</td>
</tr>
<tr>
<td>Fairy prion</td>
<td>14</td>
<td>1.4</td>
<td>21</td>
<td>2.1</td>
<td>21</td>
<td>2.1</td>
<td>3</td>
<td>0.3</td>
<td>1</td>
<td>0.1</td>
<td>48</td>
</tr>
<tr>
<td>Shy albatross</td>
<td>5</td>
<td>16.5</td>
<td>2</td>
<td>6.6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Cormorant</td>
<td>1</td>
<td>2.0</td>
<td>1</td>
<td>2.0</td>
<td>1</td>
<td>2.0</td>
<td>1</td>
<td>2.0</td>
<td>1</td>
<td>2.0</td>
<td>2</td>
</tr>
<tr>
<td>Fairy penguin</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Antechinus*</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Swamp rat</td>
<td>1</td>
<td>0.15</td>
<td>1</td>
<td>0.15</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

* weight not available

<table>
<thead>
<tr>
<th></th>
<th>1A/1 MNI</th>
<th>1A/1 Mwt</th>
<th>1A/2 MNI</th>
<th>1A/2 Mwt</th>
<th>1A/3 MNI</th>
<th>1A/3 Mwt</th>
<th>1A/5 MNI</th>
<th>1A/5 Mwt</th>
<th>1A/SS1 MNI</th>
<th>1A/SS1 Mwt</th>
<th>1A/SS2 MNI</th>
<th>1A/SS2 Mwt</th>
<th>Square 1A total MNI Mwt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fur seal</td>
<td>6</td>
<td>348</td>
<td>5</td>
<td>242</td>
<td>2</td>
<td>104</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>9</td>
</tr>
<tr>
<td>Elephant seal</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mutton-bird</td>
<td>4</td>
<td>2.0</td>
<td>2</td>
<td>1.0</td>
<td>3</td>
<td>1.5</td>
<td>13</td>
<td>6.5</td>
<td>4</td>
<td>2.0</td>
<td>3</td>
<td>1.5</td>
<td>22</td>
</tr>
<tr>
<td>Fairy prion</td>
<td>2</td>
<td>0.2</td>
<td>3</td>
<td>0.3</td>
<td>2</td>
<td>0.2</td>
<td>2</td>
<td>0.2</td>
<td>1</td>
<td>0.1</td>
<td>1</td>
<td>0.1</td>
<td>5</td>
</tr>
<tr>
<td>Shy albatross</td>
<td>2</td>
<td>6.6</td>
<td>1</td>
<td>3.3</td>
<td>2</td>
<td>6.6</td>
<td>1</td>
<td>3.3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Cormorant</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fairy penguin</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.75</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Antechinus*</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

* weight not available

<table>
<thead>
<tr>
<th></th>
<th>Square 1 MNI</th>
<th>Square 1 Mwt</th>
<th>Square 2 MNI</th>
<th>Square 2 Mwt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fur seal</td>
<td>8</td>
<td>380</td>
<td>4</td>
<td>172</td>
</tr>
<tr>
<td>Elephant seal</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mutton-bird</td>
<td>5</td>
<td>2.5</td>
<td>13</td>
<td>6.5</td>
</tr>
<tr>
<td>Fairy prion</td>
<td>6</td>
<td>0.6</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Shy albatross</td>
<td>1</td>
<td>3.3</td>
<td>1</td>
<td>3.3</td>
</tr>
<tr>
<td>Cormorant</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fairy penguin</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Antechinus*</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Swamp rat</td>
<td>1</td>
<td>0.15</td>
<td>1</td>
<td>0.15</td>
</tr>
</tbody>
</table>

* weight not available

Table 29 Maatsuyker Island site 1: vertebrate analysis. Minimum numbers of individuals and minimum weights (kg)
Because of its size, MAT 1-5 is the more useful of the two squares. On the basis of the procurement Heterogeneity/Divergency band (Fig.26), the deposits can be divided into an earlier low-diversity procurement component, and a later high-diversity component. The observed differences are only minor ones however, for the Heterogeneity/Divergency consumption band varies only slightly from one spit to another. Further examination of Figure 26 reveals that seals provide the major source of energy. We suggest that the major reason for coming to Maatsuyker Island was the fur seal, all other animals perhaps being exploited only incidentally. Both spatial and temporal differences within the site (perhaps including that small window provided by MAT 1-1A) can be attributed to the general hunting of seals and the more or less random utilisation of other foods. This pattern is also reflected in the exploitation of invertebrate animals, examined in the next chapter.

Although the depth of deposit does not appear to exceed 30-35 cm, the site
itself is extensive (Plate 14), so that an estimate of accumulation rate cannot reliably be calculated, and there are no source sands to serve as chronological separators. However, it is considered quite likely that within the 500 or so radiocarbon years of its occupation there may well have been years in which planned voyages simply could not take place because of unfavourable weather conditions.

Comparisons Between all Sites

As has been seen in the previous few pages, most sites have a distinctive pattern of faunal exploitation, though internal variation is often present. Some of these
sites, such as LR 2, AC 1 and MAT 1, consist of midden deposits which can be seen as mainly undifferentiated occupation. The following summary is made on the basis of these observations. Table 38 contains the basic data.

The remains of a total of 34 vertebrate animal species are preserved in the sites investigated at Louisa Bay and Maatsuyker Island. In total there are 791 individuals weighing 7383.2 kg. Figure 27, with all diversity values plotted, is a representation of these data; the sites are arranged in order of increasing consumption Heterogeneity.

The width of the Heterogeneity/Divergency procurement band produces a division of the sites into three groups. There is firstly Maatsuyker Island with its unique position of low diversity levels. Sites AC 1 and LR 3 are coherently grouped together, each with high diversity levels. There is thirdly the grouping made by sites LR 1, LR 2, LRC 1 and LRC 2, each with high Heterogeneity values and considerably lower Divergency values. These clusters can be described in terms of seasonality:

1. MAT 1 was clearly occupied during summer for a special purpose.
2. Sites AC 1 and LR 3 were occupied during the winter.
3. The sand dune sites LR 1 and LR 2 were occupied during summer, and the cave sites LRC 1 and LRC 2 include winter components but were mainly occupied during summer.

All sites show relatively uniform consumption strategies with a more or less standard Heterogeneity/Divergency band width, a function of seals being the most productive animals. At MAT 1 92% of all vertebrate food comes from seals. Sites AC 1 and LR 3 show equally low diversity, with seals contributing respectively 92% and 95%. However, seals comprise only 78% of vertebrates at LR 2 (and this percentage is raised by the presence of a single elephant seal, also responsible for the Heterogeneity/Divergency bulge) and this decreases to only 60% at LR 1. The increasing diversity seen at the summer sand dune sites is climaxed at the cave sites where a large range of food was consumed, with wallabies, wombats and pademelons being the major elements.

The significance of the various vertebrate foods and the differences in both procurement and consumption diversity pointed out here will be more fully developed in Chapter VII. For now it can be said that the procurement and consumption strategies reflect both environmental and seasonal factors. Our analysis of invertebrates will complete the picture, after which we will be in a position to attempt a synthesis of the strategies developed for obtaining vertebrate and invertebrate food in this area of southwest Tasmania.
VI ANALYSIS OF THE INVERTEBRATES

Modern invertebrate populations were defined in Chapter II. In this chapter we examine such remains in their archaeological contexts, looking at intra-site and inter-site differences in procurement strategies.

Most of the species were grouped into general categories on the basis of their ecological requirements (see Chapter II), though exceptions were made for very large and/or relatively common species. We will define these categories first, and then examine their occurrence in each of the sites.

As in Chapter V, data summary tables are included, but the raw data are lodged with the Department of Anthropology, Tasmanian Museum and Art Gallery, Hobart.

THE CATEGORIES

Beach

Included are all the beach and sand species. Most species found in archaeological contexts are considered to have been directly exploited, requiring individual acts of collection. The largest of the beach shellfish are *Katelysia rhytiphora* and *Mactra rufescens*, both living in sand or sandy mud. In terms of sheer numbers occurring in the archaeological sites of Louisa Bay, the smaller *Donacilla angueta* and *D. erycinaea* are important, both living in sand exposed at low tide. At most sites this collection habit is relatively unimportant.

Ocean

This category includes mainly small species, though the rare *Cabestana spengleri* (150 mm maximum length), the relatively uncommon *Dioathais textilosa* (75 mm), and the occasionally plentiful *Argobuccinum vexillum* (100 mm) are included. Important, though smaller, shellfish are *Austrooochohlea* (three species), *Cellana solida*, *Notoacmea* (two species), *Patellanax peroni* and *Poneroplax albida*.

A problem with a number of shellfish in this category is that, although present in an archaeological site, their collection may have been unintentional - that is, they may have been attached to the shell of another species which was being intentionally collected. However, even if this is the case, many such species may have been eaten, and cannot therefore be arbitrarily excluded from analysis. Clearly some judgement is called for in this matter, and we have chosen to use size as a criterion for exclusion from analysis. There is a clear division between a species such as *Kellia australis* (probably collected attached to the mussel *Brachidontes australis* (Macpherson and Gabriel 1962:290)), which is only 5 mm long, and a species such as *Hipponyx conicus* (probably collected attached to *Subninella undulata*), which is 20 mm long. We exclude *K. australis* from analysis, but include *H. conicus* and other similar sized species (e.g. *Antisabia foliacea*, *Chiasaomea flammea*, *Clanoulus limbatus*, *Lensieilla vinosa*, *Melarapha* sp. and *Patelloidea latistrigata*). Two species of *Notoaomea* are of a size (12 mm) which suggests they should be excluded, but their constant and rather high frequencies indicate that their presence is not accidental.

*Mytilus planulatus*

Individuals of this mussel species frequently attain lengths of 125 mm, living on exposed rocks. The presence of the whole size range from very large to very small individuals suggests that a mass harvesting technique, scraping entire colonies off rocks, was used.

*Brachidontes rostratus*

This mussel species is smaller than *Mytilus* and somewhat less common in sites, which is perhaps surprising since its ecology is similar. It was also present in a range of sizes.
Subninella undulata

This species (warrener or turbo) is by far the most common of the larger shellfish (50 mm) at all sites excepting Maatsuyker Island. Its habitat range is such that it could have been collected at low tide in water of wading depth, though diving would probably have been more productive. Small numbers are sometimes exposed on rock surfaces at low tide.

Notohaliotis ruber

This very large shellfish (mutton-fish, ear fish, abalone), living in rock crevices, is always found in the infralittoral fringe. Therefore, while it is occasionally possible to reach its preferred habitat by wading, most effective exploitation is in deeper water. In any event, the slightest disturbance causes the animal to increase its very effective grip on the rock surface, and it can be dislodged intact only by levering the foot away from the rock. Pulling by the shell will only result in detachment at the columella, leaving most of the animal still attached. The most effective means for exploiting N. ruber is therefore through total immersion, using both hands and allowing hand and eye co-ordination.

Jasus lalandei

The spiny crayfish inhabits the infralittoral fringe in much the same area as Notohaliotis ruber and Subninella undulata, and similarly is best exploited by diving.

Beach Castups

This is an uncommon category, present at only two sites, the most important species of which is Scaeolidia crassa. The presence of such deep-water shellfish in midden debris most probably reflects opportunistic collecting of specimens cast up by stormy seas.

THE SITES

Louisa River Site 1

Subninella undulata accounted for most of the 8060 shellfish recovered from the LR 1 deposits (Table 30). Only three of the defined categories were present. Figure 28 summarises the relative stratigraphic occurrence of each category. Notohaliotis ruber occurs most uniformly in the various deposits, and most shellfish were recovered equally from the deposits Dense Shell and Sandy Soil.

<table>
<thead>
<tr>
<th>DEPOSIT</th>
<th>Dark</th>
<th>Dense</th>
<th>Sandy</th>
<th>Tan</th>
<th>Grey</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beach</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ocean</td>
<td>77</td>
<td>17</td>
<td>18</td>
<td>10</td>
<td>127</td>
<td></td>
</tr>
<tr>
<td>Mytilus planulatus</td>
<td>-</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Brochidontes rostratus</td>
<td>-</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Subninella undulata</td>
<td>770</td>
<td>1642</td>
<td>613</td>
<td>548</td>
<td>7873</td>
<td></td>
</tr>
<tr>
<td>Notohaliotis ruber</td>
<td>12</td>
<td>27</td>
<td>11</td>
<td>3</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Jasus lalandei</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>787</td>
<td>4404</td>
<td>1670</td>
<td>638</td>
<td>561</td>
<td>8060</td>
</tr>
</tbody>
</table>

Table 30  Louisa River site 1: invertebrate analysis. Minimum numbers of individuals

Figure 29 gives the various Divergency/Heterogeneity values. The procurement component shows uniformly low diversity, with concentration on S. undulata. Slight fluctuations in Heterogeneity vis-a-vis Divergency in Tan Sand and Dense Shell are not considered meaningful because relationships between shellfish categories for the site as a whole are constant. Slight variations result from a few more N. ruber being collected, which increases diversity.

Consumption diversity values reflect a greater diversity of sources. Examination of the bar graphs shows that the overwhelming energy source is S. undulata though N.
"ruber provides a large component. The greatest diversity in energy sources is seen in Tan Sand, and in particular the topmost Dark Organic deposit. There is however little to choose between the relative quantities of either procurement or consumption, and no notable deviations occur in the Heterogeneity/Divergency values, so this locality on the dune was probably visited several times, with a similar range of resources being available each time. *S. undulata* contributed between 80–92% of all earned energy, while *N. ruber* was responsible for between 7 and 20%. Other resources were not very important.

**Louisa River Site 2**

As noted in Chapter III, all shellfish excavated from the site were lost. However, *Subninella undulata* opercula had been counted, as had the remains of *Notohaliotis ruber*, and these results are presented in Table 31. Since many of the data are unavailable, the various operations involving Heterogeneity and Divergency have not been carried out. However, two of the three largest meat producers from the site are recorded, and by manipulating the figures in Table 31 it is seen that between 73 and 79% of consumption derives from *S. undulata*, while the inverse values describe the contribution made by *N. ruber*.

<table>
<thead>
<tr>
<th>Spit 1</th>
<th>Spit 2</th>
<th>Spit 3</th>
<th>Spit 4</th>
<th>Spit 5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Subninella undulata</em></td>
<td>1229</td>
<td>5162</td>
<td>3644</td>
<td>5004</td>
<td>1438</td>
</tr>
<tr>
<td><em>Notohaliotis ruber</em></td>
<td>30</td>
<td>90</td>
<td>78</td>
<td>88</td>
<td>28</td>
</tr>
<tr>
<td>Total</td>
<td>1259</td>
<td>5252</td>
<td>3722</td>
<td>5092</td>
<td>1466</td>
</tr>
</tbody>
</table>

Table 31 Louisa River site 2: invertebrate analysis. Minimum numbers of individuals
Louisa River Site 3

Site LR 3 shows a broad spectrum exploitation of tidal resources. Table 32 lists the depositional occurrence of the various invertebrate categories. Figure 30 shows that the three most common categories in all deposits are Ocean species, *Jasus lalandei* and *Subninella undulata*. All but the Beach species occur in all deposits, and great variability is shown in the relative intensity of exploitation within each deposit.

<table>
<thead>
<tr>
<th>DEPOSIT</th>
<th>Dense Shell</th>
<th>Mussel Shell</th>
<th>Light Sand</th>
<th>Organic Sand</th>
<th>Light Organic Sand</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beach</td>
<td>18</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td></td>
<td>28</td>
</tr>
<tr>
<td>Ocean</td>
<td>342</td>
<td>53</td>
<td>111</td>
<td>162</td>
<td>167</td>
<td>835</td>
</tr>
<tr>
<td><em>Mytilus planulatus</em></td>
<td>574</td>
<td>308</td>
<td>79</td>
<td>94</td>
<td>36</td>
<td>1091</td>
</tr>
<tr>
<td><em>Brachidontes rostratus</em></td>
<td>99</td>
<td>21</td>
<td>16</td>
<td>33</td>
<td>14</td>
<td>183</td>
</tr>
<tr>
<td><em>Subninella undulata</em></td>
<td>4005</td>
<td>258</td>
<td>1135</td>
<td>1897</td>
<td>578</td>
<td>7873</td>
</tr>
<tr>
<td><em>Notohaliotis ruber</em></td>
<td>403</td>
<td>64</td>
<td>309</td>
<td>473</td>
<td>67</td>
<td>1316</td>
</tr>
<tr>
<td><em>Jasus lalandei</em></td>
<td>38</td>
<td>4</td>
<td>20</td>
<td>36</td>
<td>13</td>
<td>111</td>
</tr>
<tr>
<td>Total</td>
<td>5479</td>
<td>709</td>
<td>1675</td>
<td>2699</td>
<td>875</td>
<td>11,437</td>
</tr>
</tbody>
</table>

Table 32 Louisa River site 3: invertebrate analysis. Minimum numbers of individuals.

![Fig. 30 Louisa River site 3: Concentration bar graphs, invertebrates](image)

![Fig. 31 Louisa River site 3: procurement and consumption Heterogeneity and Divergency, invertebrates](image)
category. As the name suggests, the two mussel species were very heavily exploited in the Mussel Shell deposit, and it is suggested that the larger of the two, *Mytilus planulatus*, must have been in especially abundant supply, a hypothesis that will be examined presently. The smaller species, *Brachidontes rostratus*, also appears to be a fairly constant source of food. *Notohaliotis ruber*, *S. undulata* and *J. lalandei* all appear to vary directly one with another, a relationship similar to that seen for *N. ruber* and *S. undulata* in sites LR1 and LR2.

In Figure 31 we can see that the most constant and important species collected is *S. undulata*, accounting in most cases for over 50% of all shellfish. As suggested by the data presented in Figure 30, *M. planulatus* is indeed strongly represented in the Mussel Shell deposit, though in no instance does the frequency of *B. rostratus* reflect an important collecting activity, nor is *J. lalandei* frequently collected. The diversity diagram in most cases shows the same relationship between Heterogeneity and Divergency, that is, the band is quite uniform. For the Mussel Shell deposit there is a definite bump in both diversity values, and a pinching of the procurement band. The cause lies in the very high incidence of *M. planulatus*. The pattern as demonstrated in Figure 30 and as confirmed by Figure 31 strongly suggests that this particular resource is subject to extreme fluctuation which perhaps confirms the hypothesis that it was being mass-harvested. It might be further suggested, though on less firm grounds, that *M. planulatus* was a preferred food when available. Its relative, *B. rostratus*, seems to have been exploited fairly constantly at low levels, and it appears never to have been an important food.

Regarding consumption, it can be seen that some rather dramatic things happen. Firstly, *N. ruber* assumes greatest importance, contributing between 49 and 72% of all the energy derived from invertebrate sources, followed by *S. undulata* (18-34%) and *J. lalandei* (8-19%). Ocean shellfish species appear as a minor source only in the lowest deposit, and *M. planulatus*, despite its frequency in the Mussel Shell deposit, is reduced to only 6% energy value.

Secondly, the highest diversity figures for consumption occur in the lowest deposit. It would be tempting to suggest that at first occupation there was a wider range of resources from which to choose, but, since LR3 is one of the younger sites, this is unlikely. If there was such a wider range, we would expect some evidence of selective exploitation, perhaps based on least energy expenditure, or reflecting food preferences. There is no such evidence, so we interpret such fluctuations as being due to minor and unimportant by-products of collecting methods. Inaccuracies in the methodology might also be responsible, but because all measures are relative this is not considered likely.

A third point of interest is that procurement diversity levels are slightly higher than consumption. While energy came from fewer major sources, procurement strategies involved the exploitation of more major sources.

The fourth, and perhaps most important observation to be made is that the Mussel Shell relative diversity peak has disappeared. Each deposit then has similar sources of earned energy, probably reflecting a conscious and planned procurement strategy optimising energy from available habitats. As pointed out earlier, the relationship of procurement to consumption is not as direct as it seems, for the three dominant sources, *N. ruber*, *S. undulata* and *J. lalandei*, live in the habitat where most energy expenditure is needed for collection. Nevertheless, on balance it would seem that certain priorities were maintained. It may well be that most of the minor habitat sources were exploited only inadvertently in the process of satisfying the major procurement priority.

Finally, the uniformity of both the procurement and the consumption bands allow us to strengthen our earlier interpretation (Chapter V) that the various deposits were laid down under much the same conditions, probably over a short period of time.

Louisa River Cave Site 1

It will be recalled that because of depositional problems only a small part of the cave was excavated, so the sample is small. The site did, however, have some unique features which made its analysis of interest. Firstly, it was a very small cave made relatively weatherproof by the small entrance. Secondly, it was noted during excavation that a large proportion of very small shellfish was represented: 1412 of 1756 individual remains representing 48 species (Tables 2, 3, 4, 33).

The small size of the trench and the problems encountered in excavation of the site made full analysis, as for vertebrates, seem a not very worthwhile exercise. Our comments are therefore derived merely from examination of Table 33. It has
Table 33  Louisa River Cave site 1: invertebrate analysis. Minimum numbers of individuals

previously been suggested that the cave was a refuge from severe weather conditions, and, as a corollary, that the people who sheltered there had to collect their food opportunistically.

There are two lines of supporting evidence. Firstly, there is a much higher than normal frequency of deep-water shellfish (which most probably were cast up by storm waves). Secondly, there are extremely high numbers of shellfish from habitats accessible at low tide even when high seas would normally preclude diving for more energy-rich foods. These contrasting examples illustrate the lack of a standard collecting strategy. While it may be possible that the sample, by virtue of its small size, is not representative of the cave's occupation, the interpretation seems reasonable, is internally consistent with the data, and is a good fit with the size of the cave and its small entrance. Alternatives were discussed in Chapter V.

Louisa River Cave Site 2

The range of species in the Beach and Ocean categories found at LRC 2 is about the same as that for LRC 1, but they account for only 541 of the 19,284 invertebrate remains (Table 34).

Figure 32 reveals marked differences in the representation of species. Noto-
haliotis ruber is the most frequently encountered, followed by the two mussel species, and Beach species. The greatest numbers are in the upper part of the site, a pattern also seen in our analysis of the vertebrate fauna.

Figure 33 shows an attenuated version of this pattern, with a major bump in the procurement band at the Dense Shell I locus, and with general diversity levels lower in the underlying two deposits than in the overlying three. However, the differences are thought to be more apparent than real, for reasons discussed in Chapter V.

The procurement strategy involved large quantities of mussels, and it is interesting to note (as is the case at LR 3) that Mytilus planulatus in every instance more plentiful than Brachidontes rostratus, a somewhat different picture than that presented in Figure 32 where the stratigraphic representation of each species was identical. It is tempting to suggest that the former were selected over the latter, perhaps for reasons of size or taste, but in the absence of comparative growth studies (e.g. Craig and Hallam 1963), it is difficult to rule out ecological reasons for the different representations.

The consumption of resources section of Figure 33 shows a reasonably uniform relationship between Heterogeneity and Divergency, with the greatest, though slight, variation occurring in the deposit Dense Shell I. This is a variation of degree, not
Fig. 32 Loisua River Cave site 2: Concentration bar graphs, invertebrates

Fig. 33 Loisua River Cave site 2: procurement and consumption Heterogeneity and Divergency, invertebrates

of kind, for there are no inversions in the bar graph record. In all deposits Notohalioitis ruber is the greatest energy contributor, between 48 and 78%, followed by Subrinella undulata at between 9 and 38%. Despite the heavy exploitation of the two mussel species, their combined energy contribution amounts to between only 7 and 15%. Jasus lalandei is important only in the Last Occupation deposit.

The broad Heterogeneity and Divergency pattern shows that levels of procurement diversity are consistently higher by a good margin than those of consumption, meaning that more habitats were regularly exploited, but at the same time energy was obtained from fewer sources. Dense Shell I in particular shows this pattern, with a general exploitation of a number of habitats and species but very heavy reliance on N. ruber as an energy source.

The occupation of LRC 2 seems to differ from that of LR 3: more Beach and Ocean species were collected at LRC 2, but despite this the Ocean habitat is more important at LR 3; except for a single deposit, mussels are not commonly exploited at LR 3; and J. lalandei is not common in the LRC 2 deposits. In addition, there are much more marked procurement and consumption diversity levels at LRC 2, and more variability in these levels from one deposit to another. Despite such differences, however, consumption patterns are in general similar, with heavy reliance on N. ruber and S. undulata. The overall character of the LRC 2 occupation (and of LR 3) suggests a planned and controlled procurement strategy. We conclude that the major differences between LRC 2 and LR 3 reflect the exploitation of different areas, respectively the western (Central Cliffs) and eastern (Eastern Cliffs) sides of Louisa Bay beach.
Louisa Creek Site 1

This site is adjacent to the same series of rocky embayments as are the cave sites at the western end. As might be expected, very much the same range of Ocean and Beach species are represented (Table 35). The most common species are Subinrella undulata and Notohaliotis ruber (Fig.34), both of which are very important at the other sites discussed. The distribution of species is erratic. Beach species occur most frequently in Stained Sand, while all others are more strongly represented in the Mussel deposit. N. ruber and S. undulata, however, are also important in the Shell deposit.

<table>
<thead>
<tr>
<th>DEPOSIT</th>
<th>Sandy Soil</th>
<th>Mussel</th>
<th>Shell</th>
<th>Stained Sand</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beach</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>253</td>
<td>261</td>
</tr>
<tr>
<td>Ocean</td>
<td>39</td>
<td>148</td>
<td>13</td>
<td>127</td>
<td>327</td>
</tr>
<tr>
<td>Mytilus planulatus</td>
<td>2</td>
<td>23</td>
<td>1</td>
<td>8</td>
<td>34</td>
</tr>
<tr>
<td>Brachidontes rostratus</td>
<td>243</td>
<td>2772</td>
<td>29</td>
<td>11</td>
<td>3055</td>
</tr>
<tr>
<td>Suboinella undulata</td>
<td>147</td>
<td>140</td>
<td>56</td>
<td>132</td>
<td>475</td>
</tr>
<tr>
<td>Notohaliotis ruber</td>
<td>9</td>
<td>16</td>
<td>11</td>
<td>5</td>
<td>41</td>
</tr>
<tr>
<td>Jasus lalandei</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Beach Castups</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>Total</td>
<td>442</td>
<td>3103</td>
<td>112</td>
<td>581</td>
<td>4238</td>
</tr>
</tbody>
</table>

Table 35 Louisa Creek site 1: invertebrate analysis. Minimum numbers of individuals

Fig. 34 Louisa Creek site 1: Concentration bar graphs, invertebrates

The LC 1 deposits present a most confused picture for both procurement and consumption (Fig.35). No two of the four deposits contain the same species even in reasonably similar proportions, except that the most recent, Mussel and Sandy Soil, both have Brachidontes rostratus in large proportions. The highest Heterogeneity and Divergency values for both procurement and consumption are in the Stained Sand deposit, where the Beach species, Ocean species and S. undulata are heavily collected. Jasus lalandei is the heaviest contributor toward total energy, followed by S. undulata, N. ruber and Beach species. The lowest Heterogeneity value for consumption is the Shell deposit where N. ruber is most important. The lowest Divergency value is in the Mussel deposit but this deposit also has a high Heterogeneity value. All of these characteristics emphasise the extreme range of exploitation. In this connection, too, it should be noted that consumption is in no two deposits even remotely similar.

The evidence suggests that there was no basic procurement strategy at LC 1, and that people exploited habitats on an ad hoc basis. Despite this, however, half the deposit contains large quantities of high procurement/consumption ratio foods, those which yield most energy for least effort, such as J. lalandei in Stained Sand and N. ruber in Shell. In the latter deposit S. undulata and N. ruber are important, while in the Mussel deposit B. rostratus is most strongly represented in terms of both procurement and consumption, probably reflecting a time when the mussel was particularly abundant. We interpret the evidence as indicative of only casual visits to the site, with people exploiting a range of resources in more or less random ways. Perhaps experience had shown this particular location to be deficient in the range and quality of desired resources, but nevertheless worth visiting from time to time.

Anchorage Cove Site 1

Compared with most sites in Louisa Bay, AC 1 is relatively impoverished in
numbers of species present, though in total numbers of individuals (Table 36) AC 1 ranks third to LRC 2 and LR 2.

Occurrence of species through the spits is graphed in Figure 36 where it is seen that *Mytilus planulatus* and *Jasus lalandei* are only occasionally present in the various spits. Frequently represented are Ocean species, *Notohaliotis ruber* and *Subninella undulata*, all of which have similar values. *Brachidontes rostratus* and Beach species are occasionally strongly represented, though in different parts of the deposit.

Procurement diversity is reasonably uniform as seen in Figure 37 where in each spit *S. undulata* is the most frequent species. *N. ruber* is also well represented though at a lower frequency in the upper half of the site. Ocean species are present in most spits but never in great numbers. Diversity levels (Heterogeneity and Divergence) are generally low and reasonably uniform from one spit to another, except for
Fig. 36  Anchorage Cove site 1: Concentration bar graphs, invertebrates

Fig. 37  Anchorage Cove site 1: procurement and consumption Heterogeneity and Divergency, invertebrates
the lowest (spit 10) where they are high. The anomalous nature of this spit is a reflection of the relatively large numbers of *J. lalandei* and of Beach species.

The high proportion (75%) of *J. lalandei* in spit 10 also produces an aberrant situation in consumption, with *N. ruber* accounting for only 20%. The positions of Heterogeneity and Divergency are also reversed. In spits 9 to 6 *N. ruber* contributes between 47 and 59% energy, followed by *S. undulata* with between 33 and 44%. In the top five spits the situation is reversed, *S. undulata* representing between 52 and 75% of all energy resources, and *N. ruber* providing between 24 and 41%. Aside from its abundance in spit 10, *J. lalandei* is present only in spits 9, 8 and 1, contributing respectively 17%, 11% and 8%. Comparison of diversity levels reveals that, apart from spit 10, the relationship of procurement and consumption Divergency and Heterogeneity values is much the same from spit to spit. Unlike sites LR 3 and LRC 2 however, the diversity levels of procurement are consistently lower than those of consumption, meaning that energy was derived from more sources but collected from fewer habitats. The exact nature of these relationships can be seen in the bar graphs of Figure 37.

The evidence from site AC 1 strongly suggests that a procurement strategy was well developed. It is considered likely that the AC 1 midden was rapidly deposited, and what we are seeing in Figure 37 is a manifestation of very slow and perhaps relatively insignificant changes in habitat exploitation. The shift from *N. ruber* to *S. undulata* as the dominant energy source could be the result of heavy local predation over a short period of time. We may be witnessing the gradual attrition of the most valued energy sources, first *J. lalandei*, then *N. ruber*. This interpretation is very attractive as an explanation of the apparent irregularity of spit 10, though it is also possible that the smaller sample of that spit is a skewing factor. But the volume corrected spit 10 values shown in Figure 36 do not appear out of place, so this factor is not considered to be a particularly likely source of error. Heavy local predation remains the most satisfactory explanation for the observed phenomena.

Maatsuyker Island Site 1

Little can be done with the Maatsuyker Island sample since there is such a restricted range of species: a limpet (*Patellana peroni*), a chiton (*Pomeroplaax albida*), *Notohaliotis ruber* and *Jasus lalandei*. As pointed out earlier, the primary focus of subsistence activity at Maatsuyker Island is the seal colony. Nevertheless, the shellfish debris represents a respectable amount of food, with *N. ruber* frequently appearing in some deposits, and *J. lalandei* being occasionally present. The Maatsuyker Island shellfish remains are therefore included in the following summary of shellfish exploitation at the Louisa Bay and Maatsuyker Island sites.

**COMPARISONS AND CONCLUSIONS**

This final section develops a comprehensive view of those invertebrates exploited at the various sites of Louisa Bay and Maatsuyker Island. Each animal category will be looked at, then the total range of exploitation will be compared, site by site. Conclusions will be presented at various points while discussing the inter-category and intersite comparisons.

Figure 38 illustrates the transformation of the relevant data presented in Table 37. Looking first at the general procurement pattern, it is no surprise to see the lack of Heterogeneity/Divergency conformation, which amplifies the impression gained earlier, that the range and intensity of exploitation varied from site to site. Though the sites are ordered on the basis of increasing consumption Heterogeneity

<table>
<thead>
<tr>
<th></th>
<th>LR 1</th>
<th>LR 2</th>
<th>LR 3</th>
<th>LR 4</th>
<th>LC 1</th>
<th>AC 1</th>
<th>MAT 1</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beach</td>
<td>-</td>
<td></td>
<td>28</td>
<td>835</td>
<td>48</td>
<td>261</td>
<td>45</td>
<td>1217</td>
</tr>
<tr>
<td>Ocean</td>
<td>127</td>
<td></td>
<td>835</td>
<td>466</td>
<td>493</td>
<td>327</td>
<td>460</td>
<td>161</td>
</tr>
<tr>
<td><em>Mytilus</em> planulatus</td>
<td>-</td>
<td>1091</td>
<td>9231</td>
<td>34</td>
<td>10</td>
<td>18</td>
<td>24</td>
<td>430</td>
</tr>
<tr>
<td><em>Brachidontes rostratus</em></td>
<td>-</td>
<td>183</td>
<td>3493</td>
<td>3055</td>
<td>293</td>
<td>7024</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Subniliella undulata</em></td>
<td>7873</td>
<td>16,477</td>
<td>7873</td>
<td>299</td>
<td>4607</td>
<td>475</td>
<td>11,655</td>
<td>49,259</td>
</tr>
<tr>
<td><em>Notohaliotis ruber</em></td>
<td>60</td>
<td>314</td>
<td>1316</td>
<td>24</td>
<td>1377</td>
<td>41</td>
<td>671</td>
<td>4102</td>
</tr>
<tr>
<td><em>Jasus lalandei</em></td>
<td>-</td>
<td>111</td>
<td>21</td>
<td>35</td>
<td>18</td>
<td>47</td>
<td>12</td>
<td>244</td>
</tr>
<tr>
<td>Beach Castups</td>
<td>-</td>
<td>-</td>
<td>112</td>
<td>-</td>
<td>27</td>
<td>-</td>
<td>139</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8060</td>
<td>16,791</td>
<td>11,437</td>
<td>1756</td>
<td>19,284</td>
<td>4238</td>
<td>13,181</td>
<td>472</td>
</tr>
</tbody>
</table>

Table 37 All sites: invertebrate analysis
Fig. 38 All Louisa Bay sites and Maatsuyker Island: procurement and consumption Heterogeneity and Divergency, invertebrates

values, a simple manipulation of procurement Divergency produces the ranking LR 1, AC 1, MAT 1, LC 1, LR 3, LRC 1 and LRC 2. While there are no obvious correlations between the ranking and procurement strategies as previously defined for each site, there is some suggestion that location might be important. Firstly, those sites with high Heterogeneity values - LC 1, LR 3, LRC 1 and LRC 2 - are located at either end of Louisa Beach, contiguous to the rocky embayments of the Central Cliffs, or to Louisa Island and the extensive rock platform adjacent to the Eastern Cliffs. The special natures of LRC 1 and LC 1 may have led to an artificial inflation of Heterogeneity, deriving from the opportunistic collecting behaviour of LRC 1 inhabitants and the casual collecting at LC 1, but this does not explain the high Heterogeneity for the more typical LR 3 and LRC 2.

Sites LR 1 and LR 2 are also located at the eastern end of Louisa Beach and perhaps should have the same characteristics. However LR 2 is not included in this part of the analysis for reasons given earlier, and LR 1 has some odd features which will be discussed below. It is possible that this end of the beach is less productive, since there are only 24 species at LR 3 (11 fewer than at LC 1 and 17 fewer than at LRC 2). Despite the presence of 22 species at AC 1, dependence on few species, particularly Subuminella undulata, gives a low Heterogeneity value which might reflect preferences in collecting behaviour, or perhaps a well-developed collecting strategy. These themes will be developed below.

The computation of Heterogeneity values on weighted shellfish figures produces the results seen in Figure 38, where the order of presentation is from lowest Heterogeneity (greatest energy per category in relation to fewest species) to highest (least energy per category in relation to most species). Site MAT 1 is predictably at the lower end of the scale, as is LR 1. Those sites which can be interpreted as most typically defining exploitation of Louisa Bay's resources - AC 1, LR 3 and LRC 2 - are closely clustered, and in a separate higher cluster are the atypical sites LRC 1 and LC 1 reflecting energy acquired from a variety of sources.
The computation of Divergence values for the variety of sites serves as a standard for the total energy resources of Louisa Bay and Maatsuyker Island. On this evidence MAT 1 and LR 1 are both distinct when compared with all other sites (Fig. 38). The bar graphs show that the shellfish contribution to total energy at MAT 1 is extremely high for Notohaliotis ruber, though, as shown in the previous chapter, the summer exploitation of seals was the main reason for occupation. Site LR 1 shows a dependence mainly on Subminella undulata.

Extremely interesting is the block containing the sites AC 1, LR 3 and LRC 2, thus confirming that these sites typify occupation at Louisa Bay. What appears to be reflected at each site is a procurement strategy optimising energy return for energy expenditure. N. ruber and S. undulata are important sources of energy at all three, and particularly at AC 1 and LR 3 the exploitation of upper sublittoral habitats is strongly indicated by the presence of both species. At site LRC 2 the strong representation of Mytilus planulatus is unlikely to represent much labour if the suggested collection technique of rock scraping is accepted, so even here exploitation of the sublittoral returns the most energy. As we have concluded in our analysis of the vertebrate fauna, AC 1 and LR 3 are winter-occupied sites. The invertebrate analysis supports this conclusion, for at both sites there is a well-developed procurement strategy aimed at high energy return. The analysis of site LRC 2 shellfish leads to only slightly more equivocal conclusions, but this is perhaps attributable to the cave having been occupied during both summer and winter. As was argued in the previous chapter, the people living from time to time at LRC 2 used mainly terrestrial resources.

Sites LRC 1 and LC 1 also form a block, reflecting low intensity energy return from a number of sources, but this similarity is misleading. At site LRC 1 procurement activities are focused on Beach and Ocean habitats with fewer S. undulata and Beach Castup species. While energy returns still lie in J. lalandei, N. ruber and S. undulata, their more or less equal contributions are at variance with the evidence from other sites. While this might be interpreted to mean that the intensive collection of J. lalandei, for instance, represents a much better return for energy spent, the nature of the site leads to the suggestion that collection was more ad hoc than purposive. Moreover, it is logical that in systematically exploiting the sublittoral, most time (= energy) would be devoted to collecting that which was most common. This is in fact the case at the more typical sites, so the opportunistic nature of the procurement activities reflected at site LRC 1 is again strongly suggested. Site LC 1 is somewhat different. The vast differences between deposits are not shown in Figure 38, but they were discussed earlier in reference to Table 35 and Figure 34. In the absence of evidence suggesting retreat from harsh weather, it is suggested that local resources were exploited on a casual basis.

So the general picture of shellfish collecting is of people moving from one area to another, visiting well-known and productive localities - LR 3, LRC 2, AC 1 - from time to time. We know from our analysis of the vertebrate remains that two of these sites were occupied during the winter, and that LRC 2 has a winter component. The data from some sites, like LC 1 and LRC 1, suggest casual exploitation and retreat from more than ordinarily harsh weather conditions. Maatsuyker Island must logically have been exploited in summer, and the vertebrate data are in agreement. Sites LR 1 and LR 2 present some problems in interpretation, but it is clear from the vertebrate evidence that these are also summer-occupied sites. We can now turn our attention to the reconstruction of these seasonal activities.
In the last three chapters we have examined the types of sites present at Louisa Bay, the range of resources available and representation of those resources in the archaeological record. To recapitulate, the people of Louisa Bay had available to them, and used, a wide variety of food resources. The most important ones, among the vertebrates, were fur and elephant seals, pademelons and wallabies, possums, muttonbirds, fairy prions and albatrosses. Among invertebrates, the most important species were abalone, warrener and crayfish.

In order to consider the total resources available to the Needwonne, we need to establish a method for comparing the contributions of the invertebrate and vertebrate species. For vertebrates, as explained in Chapter IV, total body weights were used to calculate consumption figures, while dried body weights were used for the invertebrates.

For *Notohaliotis ruber*, live body weight is a little over twice dry body weight (mean = 30 gm). However, we also need to take into account shell weight (since the weight of the skeleton is part of the body weight of the vertebrates), and caloric and protein values (which are higher for vertebrates than invertebrates). To allow for these factors, invertebrate dry body weights were multiplied by three, so that by using the summary Table 38, Tables 39 and 40 may be generated. It will be noted that sample sizes for sites LC 1 and LRC 1 are very small; the percentages of invertebrates and vertebrates in these sites are therefore considered to be of little value in comparisons with other sites.

From our knowledge of the breeding behaviour of the vertebrate species, coupled with our analysis of the individual ages of the animals recovered, we have postulated that some sites were occupied only (or mainly) during summer (LR 1, LR 2 and MAT 1), some only during winter (AC 1, LR 3) and some all year round (LRC 1, LRC 2). Differences in invertebrate exploitation support the suggested pattern.

In this chapter we combine all of this evidence in order to examine the economic strategy which the Needwonne employed to enable them to live year round in the rigorous conditions of Louisa Bay and southwest Tasmania. As an aid to our interpretation we rely heavily on the journals of George Augustus Robinson, as edited by Plomley (1966). Although the impact of colonisation had severely disrupted Tasmanian behavioural patterns (notable were the effects of disease, murder, sheep farming, the kidnapping of women and the introduction of dogs and firearms; see Jones 1971 for a detailed discussion), and Robinson's trip itself imposed artificial patterns (see Horton 1979 for some discussion), the Aboriginal Tasmanians accompanying Robinson still had to eat, and their methods of obtaining food are recorded in some detail. In addition, Robinson records stories which were told to him about the way things were done before colonisation. We believe that, used with caution, Robinson's journals are a valuable aid to interpretation, while at the same time recognising the difficulties and dangers of ethnographic analogy (e.g. Chang 1967; Yellen 1977:1-12).

In the midsummer of 1830, Robinson ascended 'a steep and lofty mountain, the greatest in altitude of any...[I]...had yet travelled over' (6.2.30:116). It was from this vantage point at the top of the Ironbound Range that Robinson first saw Louisa Bay. He was unimpressed. In summing up Robinson's feelings about the area, Plomley (1966:125) commented:

> The whole extent of country from Recherche Bay to Port Davey was dreary and cheerless and altogether inhospitable. Game had been very scarce - only two kangaroo were seen and these on the first days - and the rivers were barren both of scale fish and shellfish.

Robinson's view, though, may have been based more on his circumstances than on reality, for the schooner supplying his party had run aground at Louisa Bay, and until repairs could be effected three weeks later, supplies had to be carried overland to Port Davey. In a note which appears to have been at least partially based on Robinson's comment, Plomley (1966:969) observes that there is in general less food available on the west and southwest coasts and that people must therefore occupy more coast. This is only partially true. The coastal strip, as Jones (1974:325) points out, is much narrower in the southwest and west, so that a greater length of coastline is needed to support a given population than in other parts of Tasmania. The Jones' model of population density, however, implicitly assumes a fixed proportion of resources for a given
<table>
<thead>
<tr>
<th>Occupation</th>
<th>Caves</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LRC 1</td>
<td>MAT 1</td>
</tr>
<tr>
<td></td>
<td>MN</td>
<td>Mwt</td>
</tr>
<tr>
<td>Fur seal</td>
<td>4</td>
<td>208</td>
</tr>
<tr>
<td>Elephant seal</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total seals</td>
<td>4</td>
<td>208</td>
</tr>
<tr>
<td>Mutton-bird</td>
<td>27</td>
<td>13.5</td>
</tr>
<tr>
<td>Fairy prion</td>
<td>42</td>
<td>4.2</td>
</tr>
<tr>
<td>Albatross</td>
<td>7</td>
<td>23.1</td>
</tr>
<tr>
<td>Cormorant</td>
<td>4</td>
<td>8.0</td>
</tr>
<tr>
<td>Penguins</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ducks</td>
<td>2</td>
<td>3.5</td>
</tr>
<tr>
<td>Swan</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Currawong</td>
<td>-</td>
<td>2.0</td>
</tr>
<tr>
<td>Total birds</td>
<td>82</td>
<td>52.3</td>
</tr>
</tbody>
</table>

**Table 38** Louisa Bay and Maatsuyker Island fauna. Minimum numbers of individuals and minimum weights (kg)
length of coastline. This is not the case at Louisa Bay, where Maatsuyker Island and the others in the group provide extra resources of seals and sea birds for the area. As we have seen, these extra resources are available not only during the summer, but throughout the year as seals come ashore to rest on the mainland outside the breeding season. We will consider the implications of these extra resources later, but first we will examine in detail the way in which resources were used in both summer and winter.

THE SUMMER ECONOMY

Maritime and Island Resources

In assessing the faunal contributions to the summer diet, we begin with a quote from Jones (1978:36) concerning adaptation to winter conditions:

for the Tasmanians, winter was the stress period, when they fanned out into small groups along the west coastline and lived on those resources which were still available if less rich in absolute terms than during the summer.

Jones' primary evidence for this statement comes from Robinson (14.6.33:736) who recorded that the people at Low Rocky Point lived mainly on shellfish during the winter. We will return to a consideration of Robinson's statement later; we wish to examine here, on the basis of the archaeological evidence from Louisa Bay, the proposition that shellfish (i.e. invertebrates) were more important during winter than during summer.

It is clear from a comparison of the purely winter-occupied sites (LR 3 and AC 1) and the purely summer-occupied ones (LR 1, LR 2) that invertebrates form a much higher component of the diet in the latter than the former (we will consider the two extreme cases of invertebrate representation, MAT 1 and LRC 2, later). At Louisa Bay it therefore seems clear that invertebrates were far more important as a summer resource than as a winter one.

The strong representation of shellfish, particularly in the summer diet of the people who visited Louisa Bay, brings into sharper focus the precise role of women in Aboriginal Tasmanian society, and of shellfish as an important coastal resource. It is clear from the descriptions of contemporary observers like Labillardiere (1800) and Robinson (1966) that women were responsible for providing sea food. Men, it is related, stayed warm by the fires eating the choicest morsels (Labillardiere 1800:53), the women coming 'out of the water only to bring their husbands the fruit of their fishing; and they frequently returned to dive again almost immediately, till they had procured a stock sufficiently abundant for subsisting their families' (Labillardiere 1800:52). A graphic description of abalone collecting is given by Labillardiere (1800:51) who described a scene consisting of 10 men, 14 women and 24 children around seven fires:
we had only a faint idea of the trouble that the women are at to procure the food necessary for the subsistence of their family: presently they each took a basket, and were followed by their daughters who did the same; they then went to the rocks projecting into the sea, and then ventured to the bottom of the water in search of lobsters and other shellfish...in the midst of sea-weeds of a great length...and shewed us that it was no difficult matter for them to remain under water twice as long as our most expert divers.

It is considered likely that Labillardiere’s description relates to the saltwater crayfish (*Jasus lalandei*); his description becomes equivocal, however, as he says that ‘they distributed the claws of them to the men and the children, reserving for themselves the body’ (1800:53). Crayfish do not have claws and the best meat is in the tail; either the description is wrong or the women were accorded rights not often rewarded. The latter is considered most unlikely (cf. Bowdler 1976).

While on Bruny Island in the spring of 1829, Robinson (28.9.29:79) records that:

The females are in general very adept swimmers and are enabled to procure a surprising quantity of shellfish upon the single immersion in the water. [They] plunge into the deep with a basket of their own manufacture (made of plaited grass with surprising neatness and ingenuity), which they invariably fill ere they rise again. This basket is slung over the left shoulder so as to hang under the left arm; a chisel stick is held in the right hand or between the teeth.

The chisel stick referred to by Robinson is described by Labillardiere (1800:46):

We saw some of these savages employed in cutting into the shape of a spatula, and polishing with a shell, some small pieces of wood, destined for detaching from the rocks ear-shells (abalone) and limpets.

The women in southwest Tasmania 'stand on the rocks in rather an obscene position and chant a song and then plunge into the water' (Robinson 24.3.30:135).

The less arduous shellfishing pursuits also fell to the women. Labillardiere (1800:39) describes 19 people:

they were...seated round three small fires, making their meal on muscles [sic] as fast as they were dressed on the embers. Some women went, from time to time, to detach these shell-fish from the neighbouring rocks, and did not come back till they had filled their baskets with them.

Finally, another quotation from Robinson (28.9.29:79):

Wooraddy [from Bruny Island] is very dejected and frequently takes occasion to bewail his single state. He urges me repeatedly to send a messenger for the female fugitives and is very anxious for their return. An aborigine of this colony without a female partner is a poor dejected being. When arrived at the years of maturity his tantamount object is a wife who can provide himself and family with shellfish, and as animal sustenance must at certain periods become scarce even where game is most prolific, that is the only food to which under such an emergency they can resort.

This quote from Robinson supports the earlier one used by Jones, both stressing the emergency nature of shellfish, although this latter quote does not suggest that such emergencies were winter phenomena. On the other hand, the archaeological evidence from Louisa Bay suggests that Robinson, and Jones, are wrong. Shellfish were of little importance at any time of the year but were least important in winter, the time when maximum stress might be expected. Further archaeological support for the hypothesis comes from site LRC 2 where there is evidence for both summer (mutton-birds and prions) and winter exploitation (possums) of the site, and where the highest percentage of invertebrates is found. While Maatsuyker Island might be seen to contradict this, it is emphasised that the main reason for going there was seals.

Fur seals were largely a summer resource. For Maatsuyker Island we have already determined that most seals were probably killed in November and December, and furthermore that the animals were part of the non-breeding colony; indeed, attempts at exploiting the breeding part of the colony would be hazardous because of the territorially aggressive bulls. Seals at all times, however, appear to have been dangerous prey; the following passage of seal stories told to Robinson is illustrative:

Wooraddy said that the natives of the De Witts or Coxes Bight, i.e. the Needwonne, subsisted in a great measure on the seal, of which they
were very fond. Said that the blacks was frequently attacked by the seal, that on one occasion a seal flew at a black man and caught him by the cheek and pulled him off the rock into the water and dived down with him. The seal however let go his hold and the man came up and his life was saved. At another time a seal flew at a black man when he was about to strike him and bit on the arm and broke his arm. At another time a seal bit a man on the leg; another on the thigh. Plenty of blacks had been attacked by them [15.12.31:554].

Trugernanna (from southeast Tasmania) also relates that the Needwonne were at risk:

a seal caught a black by the thigh and they both fell over the rock into the water and the seal carried the man down. He however came up but was ever after lame [8.6.34:883].

It is clear from these accounts that men were being attacked and were therefore probably the hunters, but it is not stated whether they were after a lone seal in amongst coastal rock or many seals on an offshore island colony. In two of the related instances the men were dragged into deep water but this could happen where coastal fringe rock is normally adjacent to deep water. It could be that men appear in these stories because they are attempting to take bulls, or perhaps trying to separate calves from females. It is noteworthy that women do not feature in these stories, so it is possible that women’s role in sealing was somewhat different, perhaps such as described by Kelly in his 1816 narrative. This takes place at George Rocks in northeastern Tasmania, and the situation is similar to that seen at Louisa Bay, where a seal colony occurs on an offshore island:

We gave the Women Each a Club that We had used to Kill Seals" with they went to the Waters Edge and Wet themselves" all over their head and Body as they Said to Prevent the Seals from Smeling them as they Walked along the Rocks they Were Verry Cautious not to go to Windward of them as they Said a Seal Would sooner Belive his Nose than his Eyes" When a Man or Woman Came Near him, the Six Women Walked into The Water two and two and Swam to three Rocks about 50 yards from the Shore Each Rock, had about 9 or 10 Seals on it they were all Laying apparently asleep, Two Women went to Each Rock with their Clubs in hand Each of them Crept Slowly Close up to their Seal and Lay Down with their Club alongside them [they lay for about an hour imitating the seals' behaviour and] all of a Sudden the Women aRose" up on their seats their Clubs up at arms Length - Each Struck a Seal on the Nose Which Killed him, and in an Instant they all Jumped up as if by Magic and Killed one More Each [Kelly 1921:177].

In this passage there are several points of interest: that the seals were killed by women, on the rocks offshore, and that the technique was extremely effective, with six women killing 12 seals, which probably provided more than 100 kg of meat, in just over one hour. Since the seals were on offshore rocks, they were clearly separate from the breeding colony and so are likely to have been immature. They could also have included females resting after feeding, but these normally return at once to their pups to feed them. The fact that the seals were each killed with a single blow also suggests that they may have been young animals.

With regard to the participation of women in the event, while Kelly may not have wanted to take men with him (a number of incidents earlier in his voyage reveals just how wary he was of Tasmanian men), it is clear that the women were skilled at killing seals. He says earlier:

The Natives asked if we Would Bring over more Seals Tomorrow Briggs told them they were getting Scarcce and Shy of Being Caught Tolo" told Briggs We had Better take Some Women over to the Island to assist in Catching Seals" at Which they Were Verry Dexterous [Kelly 1921:176].

Plomley (1966:36) comments on this incident:

Although the women killed seals when enslaved by the sealers of the straits, they were also the hunters of kangaroo there. It seems possible that in the natural state it was the men who hunted the seal since it was they who used the spears and waddles in the tribe.

Hiatt (1967:208), on the other hand, suggests that the sealers may have taught women to kill seals in the manner described by Kelly.
It is clearly impossible to know what the real situation was, but Plomley's view seems simplistic. The women whom Kelly observed were not sealers' women, but members of a tribe, and the whole atmosphere of the incident suggests that Tolo saw nothing unusual in the women catching seals - in fact it was his suggestion. Hiatt's proposal is deficient for the same reason, and also because the method described seems a highly unlikely one for European sealers to employ. Kelly had obviously seen nothing like it before. Norman (1946:103) quotes an article in the Hobart Town Gazette of 1826 which describes what was probably the normal procedure for sealers:

Four or five men then surround them and crowd them to a centre, and one or two get into the throng with their clubs and a scene of slaughter ensues.

Kelly's own methods were even more direct, 'there was a good Number of Seals' up on the Rocks' we Stormed them, and Killed, twenty', a technique leading to the seals becoming 'Scarce and Shy of Being Caught' (Kelly 1921:176), so the women's method became the only practical one.

While the evidence is equivocal, there might have been some dichotomy in hunting methods whereby the men hunted the larger animals, the women dealing with the smaller. Or perhaps in Tasmania's southwest men did all the seal hunting, in contrast to the northeast, though this seems unlikely. Thus we might see the mature fur seals at sites LR 1 and LR 2 as mainly having been killed by men, the yearlings perhaps by women, while at Maatsuyker Island most seals were killed by women. The single seal represented at LRC 2 was a young animal, and since only the humerus was recovered, it may well have been brought back as a 'cut' from Maatsuyker, though even if shore-captured would be well within the limits of our hypothesis.

Little is known of seal butchering patterns, as only two observations are available. One is of 'flitches' being cut from a beached seal at Louisa Bay (Robinson 10.2.30:118), but Kelly's somewhat earlier description (1921:178) is more informative:

the Women then Commenced - Cooking their Supper Each Cut a Shoulder off a young Seal Weighing three or four pounds and threw them on the fire When they were about Half Done they Commenced Devouring them and Rubing the oil on thair Skin Saying they had a Glorious Meal.

Later Kelly (1921:179) describes how:

the Women [were] Employed Roasting a Large Number of Seals - Flippers and Shoulders Ready to take over with them they informed us that if We gave them Some Seals for the trouble they had been at in Catching them the Chief Tolo would not Let them Keep them but if the Shoulders and flippers Were Roasted they Might Keep them and do as they pleased with them so the Ladies were Determined to have a good Stock of fresh Meat to take home with them.

When they returned to the beach, Tolo was:

Verry Much pleased to See the Boat Loaded with Dead Seals, we threw them out of the Boat Tolo ordered them to be put in a Heap on the Beach, he also ordered the Six Women to take their Roasted flippers and Shoulders into the Bush [1921:179].

Though the overwhelming reason for venturing out to Maatsuyker Island must have been for the seals, the remains of various sea birds are also preserved at MAT 1. The most common are mutton-birds and the smaller prions. Mutton-birds, arriving in September to mate, do not lay their eggs until about 20 November. From that time until late April to early May when the young leave the nest, both sexes remain in their rookeries, though by the end of January the two parents are away during the day. A low percentage of juvenile birds indicates that there was some exploitation of fledglings about to leave the nest in April but that mostly they were taken earlier.

Prions appear in August but the peak of egg laying occurs at the beginning of November. Adult birds remain with the eggs until late November, but from then until late February when the fledglings depart they are absent during the day. Thus, the best time for obtaining the adults is during November, while the high percentage of juveniles would suggest that they were obtained in late January to early February. Prions and mutton-birds may have been collected from different localities, as Milledge and Brothers (1976) note that prions prefer steep slopes.

Thus our scenario for the exploitation of Maatsuyker Island is guided by Table 41, where it can be seen that the availability of resources is concentrated in
November and December when seals and mutton-birds and their eggs are most accessible. The shorter period during which priors are available may help to explain why they are not so abundant in the deposits, but they are considerably smaller and may not have been as much sought after. Similarly the higher representation of juvenile priors might be a measure of their value and availability late in the season when seals are beginning to be less common. Juvenile mutton-birds become important when the priors have completely left the island, and most of the seals have also gone.

The seasonality of seals is not mentioned in the ethnographic literature, but several references to mutton-birds support the Maatsuyker Island data. Robinson saw eggs being collected on 20 November (20.11.30:280) and Kelly saw them being collected in January (1881:10). Robinson saw young birds being collected on 16 March (16.3.31:323).

If our reconstruction is accurate, then the resource schedule demanded that people be on the island when the seas were still highly unpredictable, as flat seas do not normally occur until late January or early February. This attests to the seamanship of these people (Jones 1976; Vanderwal 1978a, 1978b) and probably also to a heavy casualty rate (Robinson 21.9.29:76, 15.7.31:379), though probably not the numbers reported in 1831: 'Many hundred natives have been lost on those occasions'. The watercraft used are well described in the literature (see Jones 1976:240-3 for a summary), constructed of three to five bark bundles tied together, and propelled by long poles (spears?) and sometimes by women swimming alongside. Wooraddy told Robinson (15.7.31:378-9) that the southern peoples - naming the Needwonne as one group - were particularly adept at sea faring:

Their catamarans was large, the size of a whale boat, carrying seven or eight people, their dogs and spears. The men sit in front and the women behind.

Fires were also carried on clay beds (Jones 1976:243), so the arduous process of creating new fires could be avoided (Volger 1973 but see Plomley 1966:11-12; Hatt 1968:211; Jones 1974:197). Such craft were reported in the vicinity of Maatsuyker Island (in a letter from Roberts to Bonwick 1870:51; Robinson 15.7.31:379); in both instances seals were specifically mentioned. Maatsuyker was probably near or at the extreme range of both navigational ability and buoyancy (Jones 1976; Vanderwal 1978b). Robinson (15.7.31:379) records also that Maatsuyker Island was visited by the Bruny Island people, and that sealing was also carried out at Eddystone Rock. This seems impossible to us because of the distance of the Rock from South Cape (32 km) and Bruny Island (48 km). Because of westerly winds and unfavourable currents, it is unlikely that the Bruny Island people sailed directly to Maatsuyker (Vanderwal 1978b). If visited, it was probably from some point on the mainland within the home ground of one of the southwestern groups.

Some note should also be made of Big Witch (Lord 1927), an island known on the nautical charts as De Witt. It was certainly visited, as Flinders (1801:3) noted that the grass had been burnt, and, in a letter sent to Bonwick, Roberts recorded that a canoe had travelled 'across to Witch Island in the midst of a storm' (Bonwick 1870:51). The attractions of the island could only be birds (there are no seal colonies), and archaeological sites are unknown (Vanderwal 1978b:19). It could well be that visits to the island were made only in mid to late summer when minimum risk was involved, as the potential rewards were not great.

Turning our attention once again to the mainland sites, we can see from Table 38 that the ratio of fairy priors to mutton-birds at sites LR 1 and LRC 2 is about 1.5:1, the reverse of that at MAT 1. However, the proportion of juveniles for both species varies between 2 and 10%, suggesting that Louisa Island (or another local resource) was visited at various times throughout the summer, and that these figures probably represent the relative availability of the two birds. Sites LR 2 and LRC 1 have only a few individuals of each species.

Penguins (Robinson 4.11.30:267, 24.7.32:635) do not figure prominently in
resource exploitation and contribute little to the total economy. Albatrosses, on the other hand, are large birds and appear everywhere except LRC and LC though they are most numerous at sites LR 1, LR 2 and LR 3. Robinson, while on Albatross Island in northwest Tasmania, relates the following story, which illustrates that these large birds and their eggs were eaten when available:

When those birds are sitting on their eggs, i.e. hatching, they will not stir, but bite your legs if you pass near them. Some that I found sitting on their eggs I could not force to leave them. On observing Trugeranna I called her. She had got several eggs. I told her to take them but not kill the bird...We both tried to push it from its nest but it fought with us both...Wooraddy was busy looking for eggs and knocking down the birds with a club. He was most assiduous in his endeavours to obtain those birds and though a strong athletic man it was not a little amusing to see him scrambling over the rugged surface with his enormous load [7.10.32: 664-5].

At Louisa Bay it would seem most likely that such birds were caught individually when on land, while at Maatsuyker Island there may at one time have been a rookery.

Terrestrial and Riverine Resources

Apart from the marine resources, the only significant animals present at the summer sites LR 1 and LR 2 are the pademelon, wallaby and wombat. The men clearly hunted these animals (Robinson 28.3.30:140, 12.7.31:376, 26.11.31:531). Weapons used in the chase were spears and a club (waddy). Robinson refers several times to the manufacture of spears, which appear to have been made of tea-tree (e.g. 20.9.34:899). Flaked stone appears to have been used for fashioning (12.7.31:376) and sharpening them (19.10.31:486, 22.10.31:488, 14.6.33:736). Waxing lyrical, Robinson (27.7.30: 190) describes the several uses of such stone and of spear-making:

Here the aborigines are provided with those rude and shapeless utensils of nature resorted to by these unfettered beings for the several purposes of dissecating food, affording relief to the afflicted body, modelling the destructive weapon, stripping the forest animal of its fur...

In making their spears, the natives begin by making the point. They then take off the bark, after which they hold it over the fire and then straighten it by placing it between their teeth and bending it. After that they black it over. They sing all the time they are at work [27.9.30:220].

Thus, we see tools and flakes of stone - some of which were perhaps similar to those discussed in Appendix 1 - being used in the manufacture of weapons. The processes Robinson describes are illustrated by Dutterea (1835). The blackening may be incidental to curing the wood in smoke, or to being rubbed with wood charcoal. Spears, once made, were well looked after: 'In the evening they scrape and clean the spear, but seldom straighten them before morning' (Robinson 14.6.33:736).

From Robinson's narrative there apparently were two different types of spear, one nearly 5 m long used primarily for fighting (10.10.30:245, 7.11.30:268) and a shorter hunting variety (7.11.30:268). Robinson records a throw of 73 m in the northwest (27.1.34:839) and on Flinders Island 3 years later a throw of 91 m was noted (Pломлеу 1966:914).

Somewhat less is known of the waddy, or club, except that it apparently was made of she-oak, about 45 cm long and around 4 cm in diameter (Robinson 1.5.29:58). It too was fashioned and sharpened with flaked stone (2.2.30:113). The waddy appears to have been a throwing weapon: 'They are remarkably dextrous in using this missile and seldom fail to hit their object' (1.5.29:58, see also 28.11.31:533 and 24.12.31:564), but was also used as a hand club (18.8.31:404-5). Dutterea (1836), in a sketch similar to those noted above, illustrates the use of such a club on a wallaby.

It is uncertain whether the scrub-loving pademelons were hunted by men (though it is likely that they were) for it is not mentioned. Wombat and wallaby hunting, however, is often recorded. The wombat appears to have been one of the staple diet items during Robinson's trips and is often mentioned. On one occasion he was told that wombats are frequently hunted by torch light:

Each person takes with him a stick and beats the bush as they proceed.
When they discover their game they strike him with a spear or waddy. One said he sometimes got hold by the tail and then struck with his waddy [21.5.30:162].

Later on the southwest coast:

Whilst the women were fishing the male aborigines went to hunt for badger or wombat...The natives returned in a short time with several animals of this description which served us an excellent repast. I directed my servant to make a stew of the hind quarter of this animal and which is excellent food, especially with onions, potatoes, pepper and salt. The female is the best, especially the young. The wombat abounds in the moors, i.e. heathy mountainous country [12.5.33:719-20].

And a few days later:

This country abounds with wombat or badger and the path or track of this animal is everywhere to be met with, and whenever the wild 'natives discovered a track of one of those animals they burst forth into an extravagance of wild joy and evinced a savage eagerness to go in pursuit of the game [23.5.33:728].

Macropods are mentioned by Robinson even more frequently. He was reasonably consistent in his identification, using the name kangaroo to refer to the brush wallaby and the term boomer kangaroo (sometimes forester or bush) to refer to the grey kangaroo. He occasionally uses the term wallaby, and where he does it may refer to the pademelon. Several quotations considered together illustrate Robinson's taxonomy: 'The inland natives have their hunting grounds for the different species of game, i.e. boomer, forester, wallaby, kangaroo' (13.8.31:398); at Cape Grim 'There are no boomer or forest kangaroo at this part of the island' (16.7.32:632); near Cradle Mountain:

Towards evening the natives returned having caught a few kangaroo and wallaby...said that the boomer kangaroo at Moleside Creek are not native of that country, but first came from the boomer country on the north side between the Forth and Mersey Rivers. These are the only boomer known to exist to the westward of Launceston Road [13.7.34:900].

There are some indications of confusion however; one example is his description of 'kangaroos' being abundant on Hunter Island, this almost certainly means pademelons (Hope 1973). Another example is the use of three different terms for grey kangaroos, to the extent of presenting them as alternative species as in one of the quotes above.

There are few days when Robinson does not record kangaroos (i.e. Macropus rufogriseus) being caught, there are many descriptions of their being abundant, and they were very much a staple food item during Robinson's travels. Three particular observations describe methods of capture. At Cape Grim a trap-like affair is described:

Today my natives discovered a stake in one of the native pathways. They brought it to me. It was very sharp. The part that went into the ground was burnt to prevent it decaying. It projected about two feet out of the ground and was intended to wound kangaroo [7.4.34:875].

At another time:

This evening Woorady entertained us with a relation of the exploits of his and neighbouring nations in hunting and their predatory wars. Said that the men have frequently hunted the kangaroo unassisted by dogs or spears and have followed them into the water and pulled out the animals by the tail. Said that some of his nation have run and caught the kangaroo by the tails, that the fathers would not let the young men eat much at a time on purpose that they might the better run the kangaroos [15.12.31:554].

Robinson comments on this:

It may appear incredible to some persons for natives to hunt down kangaroo without the use of weapons or dogs, but to those accustomed to the habits and customs of these people it is not so. The kangaroo is a timid animal and though swift it can by no means keep up its pace long, but soon wearies. This may arise from its form, it only being able to use the hind legs in propelling itself forward; and hence it is driven from one position to another till at length it
becomes exhausted, when they rush upon and seize the prey [15.12.31: 554-5].

Again at Cape Grim, Robinson summarises these methods:

They spear the kangaroo, tire them out, run them in the rivers and lagoons and then lay hold of their tail. Sometimes one man goes and makes a noise and starts the game, when the rest, who are in advance and concealed, spear them. I have frequently seen their hunt [19.6.32: 618].

It is impossible to assess the proportion of vegetable foods to other resources, though it is thought to be relatively low (see Lee 1968:43; McCartney 1975:282), and the components can only be inferred from the documentary evidence:

Their resources are indeed prolific when hunger craves and there is a variety of unknown herbs or roots or plants to which they fly when hunger compels or when animal food is scarce [Robinson 11.7.29:66-67].

Of direct relevance for southwest Tasmania are several references by Robinson, some while he was at the Louisa River:

Discovered a variety of berries which the natives eat, among which were the native currant [Leucopogon sp.], of white colour and pleasant flavour...as well as a small red berry [Coprosma hirtella]?...There was also the pigface [Carpobractus rossii]...and a native plum [8.2.30:117].

Two days later (10.2.30:118) he recorded 'a wild fruit resembling a greengage [Solanum laciniatum]' and also bulbous roots (4.3.30:124) which may have belonged to the Orchidaceae. Comprehensive lists of other vegetable food, including such staples as the grass tree (Xanthorea australis), bracken fern (Pteridium esculentum) and tree fern (Dicksonia antarctica) are recorded by Maiden (1889), Jones (1971:91-95) and Cane et al. (1979).

THE WINTER ECONOMY

Maritime Resources

The most productive invertebrate habitats are exploited very heavily at the winter-occupied sites. Both AC 1 and LR 3 contain large quantities of abalone, warrener and crayfish.

On this evidence alone, women would seem to have contributed a great deal to the winter economy, yet in terms of total subsistence the invertebrate components (Table 40) at these two sites are lowest at Louisa Bay, 8.8% (LR 3) and 10.2% (AC 1). The overwhelming mass comes from another maritime resource, seals. Most energy comes from elephant seals, obtained after having hauled themselves out onto the Louisa River and Anchorage Cove beaches. These animals were probably killed by groups of people, most probably men with spears and waddies, acting in concert (recall the discussion in Chapter V on elephant seals and the effort required to kill them). The fur seals recorded, like those at the summer-occupied sites, were probably resting on the rocks at either end of Louisa Bay, and in the terms of the model earlier constructed for the killing of larger seals, were likewise obtained by the men's spears and clubs.

Robinson records two incidents which relate to killing beached seals. On the northwest coast he observed:

met a native girl coming up bawling out that there was Toperer or sea devil, a species of seal called by Captain Cook, Leopard Oil Seal from its being spotted like a leopard...down at the beach. I saw the beast coming in: it was as large as a sperm calf and crawled up the beach a few feet clear of the wash of the surf and lifted up its jaw and smelt. The natives were all mustered ready to attack it, but it immediately turned and got back into the sea and went away. The natives were so much chagrined and disappointed at the escape of this animal that they quarreled among themselves. They are exceedingly fond both of this fish and also of seal [18.10.32:670].

The other incident, as it happens, was at Louisa Bay where the natives were more
successful:

observed a large seal on the beach which the natives killed and cut up in flitches. Their appearance was very ludicrous, some having long strips dangling over their shoulders, others with it fastened behind their backs and some dragging it along the ground [10.2.30:118].

Plomley (1966:697) thinks that this Louisa Bay reference was also to a leopard seal, because Robinson refers back to this at the end of his description of the 1832 event. However it seems clear that the earlier incident involved a large fur seal (less likely an elephant seal). Robinson's terminology, 'this fish and also of seal', and also the fact that he goes into considerable detail in the later incident about the appearance of the animal, suggest strongly that he had not previously seen one.

The only marine birds represented in any numbers in these winter sites are penguins, perhaps caught when they came ashore to moult.

Terrestrial and Riverine Resources

While pademelon, wallaby and wombat are present in the winter sites as well as the summer ones, their importance in terms of numbers is far less. There is, however, a far greater range of species in winter than in summer, including ringtail possums, bandicoots, native cats, tiger cats, platypuses, potoos, brushtail possums, various rats, ducks and swans, cormorants, and currawongs. It could be suggested that many of these species were collected by women, the men's role in winter being largely restricted to seeking and killing beached seals.

Possum hunting seems definitely to have been a women's occupation, the method used apparently being constant all over Tasmania (e.g. Robinson 26.7.30:190, 3.9.30:208, 1.7.31:368):

Some of the women ascended a tree in quest of the opossum by means of the grass rope. This is a dangerous way of climbing trees and is effected first by bruising the bark with a stone so as to form a notch. In this they place their foot and then, embracing the tree with the grass rope and at the same time laying hold of the ends in each hand, they proceed to ascend, shifting the rope by a jerk and notching the bark for their feet as they advance [Robinson 24.7.31:386, 388].

Smaller animals were also caught and eaten, often by women (Robinson 25.11.31:531). These may have included the bandicoot and native cat, though the only witness to the former is Robinson's narrative where he:

Observed the chief track a bandicoot, and having come to a small hillock of ground he pressed it with his foot, and when the animal moved he thrust in his hand and pulled him out [28.8.31:413].

Regarding the latter, 'the natives frequently kill [and eat, Robinson 24.11.31:529] native cats when in the act of eating their prey' (6.6.30:170).

Land, river and swamp birds do not comprise a large part of the diet at Louisa Bay, but they are significant. (Robinson reports a great fondness for these: 1.7.29:66, 25.3.31:330.) The least common are the land birds, consisting of currawongs and parrots. Currawongs are not mentioned by Robinson, but he does mention crows and crow traps while in the west:

Saw on a point of rock a trap which the natives had constructed to catch crows, made...with a hole in the top. All the natives along this coast and south make or construct these machines and catch ducks, crows, etc. Crows are numerous on the coast and feed principally on kelp, and follow the native hunters in quest of offal. The native huts are mostly covered with feathers on the inside of magpies, cockatoos, crows, and feathers of different feathered animals which they catch or kill with waddies [18.5.33:722].

Slightly further north Robinson observed:

In walking along the coast saw numerous places where the natives had made traps to catch crows...; hence persons passing along the coast may see sticks projecting from rocks. The natives erect a kind of hut with grass under which they lay concealed. In front on a rock they place some fish, fastened by stone, and when the crows come to
feed they do nothing more than put out their hand and pull them in.

As Plomley (1966:813) notes, these two traps were clearly different. The first one apparently operated on the principle of a cray pot with birds hopping down through an upper opening (presumably the trap was baited) but then being unable to fly out (because the outstretched wings would be too wide for the opening). The second one was essentially a hide. Water birds are also mentioned in the southwest: 'Swans and ducks were very plentiful and we saw some pelicans. This is a great resort for the Port Davey natives' (Robinson 5.3.30:124). While on the southeast coast the following year, Robinson (8.1.31:310) relates the killing of five swans and two ducks with stones, which he comments elsewhere were thrown by the men 'with great dexterity' (26.11.31:531). Ducks were trapped in a blind in the manner described for crows: 'They adopt the same plan for catching ducks except they bait with worms!' (Robinson 12.7.33:752, see also 20.5.33:714). It is possible that nesting birds were obtained while tending the eggs and returning to feed the young. Eggs almost certainly formed a part of the Louisa Bay diet - 'The natives all round the island frequent the rivers in the eggig season and take the eggs' (Robinson 16.9.30:212) - and were probably available for several months each year, during spring and summer (Hiatt 1967:126). For instance, swan's eggs were reported by Robinson as available in July, September and October (28.7.31:390, 2.9.31:418, 15-16.9.30:212, 20.10.30:254).

It is somewhat difficult to understand why the broad-toothed rat is not more commonly seen in the sites as it is said to share the same habitat as *Rattus lutreolus* (Chapter II). Perhaps they simply are not abundant, or they were not a preferred food.

The presence of the tiger cat, on the other hand, is odd because it would not be expected in the kinds of habitats seen around Louisa Bay; it is more at home in heavily treed areas. It is a somewhat more ferocious creature than the native cat, and might be harder to catch and kill. This was probably done in a similar way to hunting native cats. Its presence at LR 3 may be the result of a chance encounter.

The platypus definitely occurs in the area, having been seen in the Louisa River. Hiatt (1967:115) could find no ethnographic record of the Tasmanians having eaten platypus. Her assertion probably arises from the fact that the only record of consumption is from a 'gossip' entry made by Robinson (7.12.31:544): 'Umarrah and the women of the Big River tribe said they eat the platypus'. However, the rest of Robinson's evidence is capable of a different interpretation. Robinson records four encounters with this animal. The first was at Recherche Bay where a platypus was caught (1.2.30:113). The following year he states:

on the banks of this river the natives discovered several platypus burrows. In fact the ground for yards was excavated by them, and above thirty yards from the water...The natives commenced searching for one of them by digging away the ground with a stick, and succeeded in digging it out [7.12.31:543].

Three years after that (21.6.34:888): 'The natives said they saw several platypus in the river but could not catch them'. And finally, another platypus was caught (15.7.34:902); only a month after there is a record of the people having tried to catch them. While the animal may not have been a favourite food, the people with Robinson did know how to catch them, and in fact appear to have actively sought them. The platypus at site LR 3, however, is the first archaeological record of Aboriginal Tasmanian consumption of the animal.

The potoroo is a probable resident of the area (Vanderwal 1975) since it prefers damp environments in lowland scrub but is shy, strictly nocturnal and very fast when disturbed. Robinson (19.9.30:214) refers to a kangaroo rat but it is considered likely the animal was in fact a bettong (*Bettonia curticollis*). Another animal represented in the AC 1 deposit is the brushtail possum which is said not to live in the area (Chapter II), but which is common in many other parts of Tasmania. Though Robinson often does not distinguish between the two possum species, there are two references specifically to brushtails. The first record (2.6.30:168) is at the mouth of Macquarie Harbour where he observes black and red possums - old animals have a reddish tinge (Green 1973). The second is inland of the north coast (15.7.34:903). The tiger cat, broad-toothed rat, potoroo and brushtail possum remains may all have found their way into the AC 1 site as a result of chance encounters.
SYNTHESIS

On 13 January 1802, Peron summarised his impression of southwest Tasmania while lying under the Big Witch:

The sea all this time was stormy and rough; the winds blew violently and in squalls from the S.W.; the temperature was cold; the sky thick; and long clouds of vapour gathered round the grey sides of the woods and mountains. This fog was succeeded by heavy rains, hail, and hoar frost; innumerable flights of boobies, goelands [seagulls], cormorants, swallows...flew from the neighbouring rocks and encircled our ships, mingling their piercing cries with the noise of the angry waves;...in a word, every thing seemed to unite in giving a sort of solemnity to our arrival off these shores, and all proclaimed that we touched the extreme boundaries of the southern world [Peron 1975:171].

Almost exactly 28 years later and at nearly the same place, Robinson (9.2.30:118) echoed that wintry summer scene: 'Strong winds from the south west, with heavy rain and hail at times. At the De Witts [Louisa Bay]. Engaged in writing journal'. It would appear, then, that the rather sturdy west coast hut, so often seen by Robinson from west of the Ironbound Range and including all of the west coast, is a direct adaptation to the climate (Plomley 1966:229). Illustrative is an entry in Robinson's journal relating his encounter with some people at Low Rocky Point who were:

in one of those secure and warm habitations so ingeniously constructed by the aborigines of those parts and which are so well adapted for the bleak and inclement winters peculiar to the western coast of VDL [20.5.33:724].

They were earlier described:

These huts are differently constructed from that of the Brune people [Bruny Island and adjacent mainland]. They are in the form of a semi-circular dome and are very commodious and quite weather-proof ...Some of these huts are from 10 to 12 feet in diameter and eight feet in height. The door or entrance is a small hole 14 inches wide by two feet high, and their aperture is made to answer the threefold purpose of door, window and chimney. I entered several and found them to be very comfortable dwellings. [They]...are constructed by first placing a long stick in the ground and bending it over and forcing the other end into the ground at the distance required for the width of the hut. Other sticks are then stuck in the ground and bent over as the first, intersecting each other, and this is continued until they have a sufficient quantity to support the weight of thatch that is to be put on. After this frame or skeleton of a hut is completed they put on the thatch, which consists of long grass...The whole when completed has a very neat appearance. Some of these huts are tied with the bark of the tea-tree and are remarkable warm [5.4.30:144].

Some huts appear to have been partially subterranean:

The holes made in the ground for habitations are remarkable. These holes are concave, about 10, 12 and 20 feet wide and three or four and five feet deep, and a large heap of shells beside them [9.3.34: 858; see also 4.9.33:790 and Plomley 1966:818].

No such remains were found at Louisa Bay, but the rapid landscape destruction by wind and sea might have eliminated most of them. Or perhaps the huts were flimsier here, though this does not seem likely, as in other parts of the southwest and west of Tasmania they were clearly important (Ranson 1978). The time of their occupation appears to be an indication of seasonally changing movement patterns, as for example: 'at Low Rocky Point...during the winter...remaining chiefly in their huts' (Robinson 14.6.33:736). We also note Plomley's (1966:125) summary of Robinson's impressions of March 1830 in the area of our immediate interest:
he had obtained definite information about the occurrence of aborigines in the region: he had not seen a single one although he had travelled in the native tracks, but had come across upwards of a hundred of their huts. He had come to the conclusion that the only natives frequenting the region were those of the Port Davey tribe and he believed them to have their 'local residences' at Low Rocky Point or Point Hibbs.

As Plomley (1966:226) later comments, Robinson at that time had little idea about tribal areas, but the important point is that the Tasmanian huts were empty because the population was dispersed.

The winter saw a retreat, probably to known areas of productivity where perhaps several families congregated. On the west coast Robinson often commented on such 'villages'. While in the Bathurst Range to the west of Cox Bight he 'Ascended a lofty hill and took a survey of the country. Saw numerous native huts - this appeared to be a place of rendezvous for them' (21.2.30:122). We have already seen that those huts were unoccupied in the summer. Later on when the summer weather is beginning to deteriorate, Robinson comments:

Their villages, or favourite places of resort, are selected by them as affording them shelter from the blast of the tempest, and having an abundant supply of water and fuel [2.4.30:192].

The ethnographic pattern, then, seems to be that during winter the people congregate in shelter, while in summer they spread out to exploit particular resources. The most extreme expression of the latter at Louisa Bay is the exploitation of Maatsuyker Island.

The economic side of these differential activities in summer and winter can be summarised as follows:

Winter. A great number of vertebrate species (but fewer animals than in summer) were being collected, including substantial numbers of terrestrial mammals, freshwater and terrestrial birds, and seals. By contrast, invertebrates were relatively unimportant. Most energy was derived from seals.

Summer. Fewer numbers of vertebrate species were collected, though sea birds are widely represented. While still relatively unimportant, more shellfish were collected in the summer. Most energy came from seals, but there were also substantial contributions from terrestrial mammals and invertebrates.

The two specialised sites, LRC 2 and MAT 1, provide some interesting contrasts:

LRC 2. A wide range of vertebrate species were collected, with particular emphasis on sea birds and terrestrial mammals. Shellfish were important. Most energy came from terrestrial mammals and invertebrates.

MAT 1. Large numbers of sea birds and small numbers of seals were collected. Almost all energy derived from seals.

The earlier model for the west coast of Tasmania (Jones 1978:36) was one of seasonal stress. It was built primarily on Robinson's statement that:

The wild natives at Low Rocky Point had no spears with them, they not having occasion for them during the winter at least but seldom, remaining chiefly in their huts on the sea coast living on [shell]fish [14.6.33:736].

As noted at the beginning of this chapter however, the Robinson testimony must be used selectively and with caution. In this particular case, comments of three years earlier at the same time of year and in the same general area contradict his claim about spears. In two entries dated 23 May 1830, he notes 'twenty natives...had spears with them' (23.5.30:163), and 'the natives...had plenty of spears' (23.5.30:164), and a week later he encountered three men, each having a spear (1.6.30:166). Implicit to Robinson's statement 'they not having occasion for them during the winter at least but seldom' is the scarcity of game, yet in the three weeks preceding there are references to six wombats, one kangaroo (10.5.33:718); 10 wombats, one kangaroo (11.5.33:718); and six wombats (11.6.33:734), all of which were captured by the people in Robinson's party.

Although winter may well have been a period of greater stress, we think that this difference has been exaggerated. This is particularly the case for the Needwonne, whose access to beached seals throughout the winter must have considerably lessened
the impact of this season on the economy.

We have also shown that Robinson was wrong in his assertion that shellfish were mainly of importance during winter. On consideration this hypothesis was never likely. We see shellfish as a relatively constant source of food during both summer and winter, but collection must be governed by availability, and this availability will be considerably less during the winter when storms lash the west coast of Tasmania. In a similar sense, while shellfish are a renewable resource, this renewing takes time. For example, all of the *Mytilus* could be removed quite quickly from an area, but this would provide very little total meat and the species would take a long time to recolonise. For a people bound to an area by the need to find shelter during winter, reliance on shellfish as a staple diet would seem to be a suicidal economic strategy.

We have discussed economic strategy for Louisa Bay as if all of the sites were being occupied simultaneously. This of course was not the case, and we must now consider the changes which have occurred in the area. These changes are based on the premise that the Louisa Bay and Maatsuyker Island site samples fairly reflect the regional coastal archaeology of southwest Tasmania, though of course this cannot be assessed in the absence of comparable investigations in other parts of the area.

Vanderwal (1978a, 1978b) pointed out that occupation of Louisa Bay had not occurred until around 3000 BP, and suggested that this was an indication that the population of Tasmania was expanding and adapting to new conditions. The model we put forward to illustrate this expansion is gradualist in nature, the earliest expression of movement into the area being provided by the sand dune sites LR 1 and LR 2. It would appear that Louisa Bay was visited at first only during the summer by people who exploited shellfish, rock-resting seals, birds breeding on Louisa Island and wallabies and wombats from the bush. It may be that the somewhat later occupation of LC 1 is of a similar nature. Around 1000 years ago we have the first example of a dual economy, winter and summer activities preserved in the LRC 2 deposits. From that time until the present, the economy was fully diversified, supporting - and allowing - permanent occupation. This was achieved by the use of particular sites for specialised purposes, sites like AC 1 and LR 3, to tap the seals which were available during winter, and most notably, Maatsuyker Island to make use of the rich seal and muttonbird harvest of the summer. It is tempting to suggest that the latter strategy was not possible until boats were developed or sufficiently improved to make the hazardous voyage. This fully integrated economy did not complete its evolution until around 500 BP. It is another clear sign that adaptation was continuing, at least in southwest Tasmania, into quite recent times.
Lourandos (1968) has developed a model for the economic activities of the Aboriginal Tasmanians which involves two different economic strategies, one on the south coast of Tasmania and another in the northwest based on Jones' work at Rocky Cape and West Point. More recently, Bowdler (1979:418) has seen the exploitation of Hunter Island as forming part of the northwestern strategy. The differences between the two strategies are summarised in Table 42. For both areas Jones (1978) suggests that until about 3500 years ago, fish had formed an important part of the winter diet.

In order to see how the Louisa Bay economy fits this model, we must subject the data from the key sites to the same analysis as we have carried out in the previous chapters. We have used the same animal weights as for Louisa Bay, but it is noted that some of these are different from those applied by other authors; Jones and Bowdler, for example, allocate 50 kg to each seal. Fish have been allocated a body weight of 500 gm per individual (following Bowdler 1979:412).

<table>
<thead>
<tr>
<th>东南</th>
<th>西北</th>
</tr>
</thead>
<tbody>
<tr>
<td>冬季</td>
<td>生活在海岸，贝壳鱼提供所有或大部分能量</td>
</tr>
<tr>
<td>夏季</td>
<td>生活在内陆，巨兽提供大部分能量</td>
</tr>
<tr>
<td>移动人口</td>
<td>移动人口可以是半定居的，在适合的条件下，如探索海豹繁殖群</td>
</tr>
</tbody>
</table>

表42 东南和西北塔斯马尼亚人的利用模式比较

**Rocky Cape**

In a number of articles Jones has described his work at Rocky Cape in the northwest of Tasmania, with perhaps the most comprehensive accounts appearing in 1966, 1968 and 1978. The full report of Rocky Cape is contained in Jones' PhD thesis (1971) and it is from here that the faunal data (Table 43) have been extracted. Jones considers that units 7 to 1 in the South and North Caves form a more or less continuous sequence of occupation. That sequence can further be divided so as to form two major (analytical) epochs, the earliest of which has fish (units 7-4), but the latest has no fish (units 3-1) except for one incidental specimen in unit 1 at the top of the sequence. We examined the Rocky Cape record in these terms, computing Heterogeneity values for the two epochs and comparing the results with the Louisa Bay data. Attention is drawn specifically to the summations of the earlier units 7-4 on the one hand, and on the other the later units 3-1 (upper part of Fig.39). Heterogeneity values were calculated. As discussed earlier (Chapter IV), procurement is a simple statement on species availability (local habitats) whereas consumption values are considered to reflect subsistence strategy. Because we are not comparing habitats, but rather strategies, our discussion will centre around the latter measure. The Heterogeneity values are very similar for the two analytical units, 0.53 for the earlier (with fish, units 7-4, Table 43), and 0.48 for the latter (units 3-1, Table 43). We can interpret this to mean that the vertebrate fauna subsistence strategies were more or less equally diversified. This situation is somewhat altered, however, if we remove fish from the calculations for the earlier deposits, obtaining a Heterogeneity value of 0.42 (diversity is considerably reduced). It is therefore evident that fish did contribute substantially to the diet, by our calculations something like 10% of all vertebrate food, and if only the South Cave deposits are considered, nearly 15%. This is no mean contribution. Bowdler's (1979:415) estimate of 23.4% for the South Cave deposits is even higher (since she used different meat weights for other species to those used here), which led her to say that 'The reduction in fish numbers does little damage to the overall protein yield from vertebrates' (1979:420). On the contrary, it would seem that the loss of a quarter, by Bowdler's calculations, of the
<table>
<thead>
<tr>
<th></th>
<th>Spit 1</th>
<th>Spit 2</th>
<th>Spit 3</th>
<th>Spit 4-3</th>
<th>Spit 4</th>
<th>Spit 5</th>
<th>Spit 6</th>
<th>Spit 7</th>
<th>Total 4-7</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MNI</td>
<td>Mwt</td>
<td>MNI</td>
<td>Mwt</td>
<td>MNI</td>
<td>Mwi</td>
<td>MNI</td>
<td>Mwi</td>
<td>MNI</td>
<td>Mwi</td>
</tr>
<tr>
<td>Fur seal</td>
<td>2</td>
<td>68</td>
<td>1</td>
<td>34</td>
<td>2</td>
<td>68</td>
<td>5</td>
<td>170</td>
<td>3</td>
<td>102</td>
</tr>
<tr>
<td>Elephant seal</td>
<td>2</td>
<td>400</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>400</td>
<td>4</td>
<td>800</td>
<td>2</td>
<td>400</td>
</tr>
<tr>
<td>Total seals</td>
<td>4</td>
<td>468</td>
<td>1</td>
<td>34</td>
<td>4</td>
<td>468</td>
<td>9</td>
<td>970</td>
<td>5</td>
<td>502</td>
</tr>
<tr>
<td>Cormorant</td>
<td>8</td>
<td>16.0</td>
<td>1</td>
<td>2.0</td>
<td>3</td>
<td>6</td>
<td>12</td>
<td>24</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Mutton-bird</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>Fairy penguin</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>0.75</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>0.75</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Total birds</td>
<td>8</td>
<td>16.0</td>
<td>2</td>
<td>2.75</td>
<td>3</td>
<td>6</td>
<td>13</td>
<td>24.75</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Wallaby</td>
<td>5</td>
<td>80</td>
<td>2</td>
<td>32</td>
<td>4</td>
<td>64</td>
<td>11</td>
<td>176</td>
<td>2</td>
<td>32</td>
</tr>
<tr>
<td>Pademelon</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>8.5</td>
</tr>
<tr>
<td>Potoroo</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>Brushtail possum</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>3.8</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Ringtail possum</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>3.8</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Wombat</td>
<td>2</td>
<td>46</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>46</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Bandicoot</td>
<td>5</td>
<td>7.5</td>
<td>2</td>
<td>3.0</td>
<td>1</td>
<td>1.5</td>
<td>8</td>
<td>12</td>
<td>1</td>
<td>4.6</td>
</tr>
<tr>
<td>Native cat</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>3.5</td>
<td>1</td>
<td>3.5</td>
<td>-</td>
<td>1.5</td>
</tr>
<tr>
<td>Swamp rat</td>
<td>1</td>
<td>0.15</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>0.15</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>Water rat</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>0.15</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>Long-tailed rat</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>0.15</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>Total mammals</td>
<td>14</td>
<td>134.65</td>
<td>4</td>
<td>35.0</td>
<td>6</td>
<td>69</td>
<td>24</td>
<td>238.65</td>
<td>2</td>
<td>32</td>
</tr>
<tr>
<td>Fish</td>
<td>1</td>
<td>0.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>0.5</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>619.15</td>
<td>7</td>
<td>71.75</td>
<td>13</td>
<td>543</td>
<td>47</td>
<td>1233.9</td>
<td>22</td>
<td>543</td>
</tr>
</tbody>
</table>

Table 43 Rocky Cape vertebrate fauna. Minimum numbers of individuals and minimum weights (kg).
Data adapted from Jones 1971: Table 34. Spits 1-4, North Cave; Spits 5-7, South Cave.
food from the Tasmanian diet, if unreplaced, could have been a severe blow to the economy. Jones (1978:44) is perhaps right, then, when he says that this prohibition constricted the ecological universe. An alternative interpretation is given below.

Jones (1978:45) also says that it was not a case of a less effective hunting strategy being replaced by one that was more effective, but this is more or less how Allen (1979) sees the situation, although he concentrates on the energy equation itself, arguing that returns were considerably less than investment. While perhaps attractive as a partial solution, the energy expenditure may not have been very great if the Tasmanians were using nets as Bowdler suggests (1979:297-300). Her argument basically is that the size range of fish from the Rocky Cape sites is constant enough to suggest that they were being netted. She goes on to suggest that the bone point, while multi-functional, may well have been used primarily as a netting needle. The uniformity in fish size, however, may well simply reflect that of the dominant age

Fig. 39 Rocky Cape: procurement and consumption Heterogeneity and Divergency, vertebrates
group in the population. Furthermore, the presence of bone points later than fish at Rocky Cape, and the presence of a single bone point at Louisa Bay (Vanderwal 1978a and Appendix 7) does not add weight to the netting needle idea.

Hence, the Tasmanian fish problem still remains unsolved. Although Jones (1978: 44) maintains that a cultural decision was made to cease fishing, this suggestion is not very useful because it is not accompanied by an archaeologically testable hypothesis. Allen’s hypothesis has a certain attraction, but the basic premise of fish costing too much is in some doubt. Bowdler attempts to show that the fish contribution was insignificant to the Tasmanian diet, but a food weight reduction of between 10% or 15% and 23% is hardly insignificant. The explanation for the loss of fish may be important, but even more importantly it emerges that fish did contribute substantially to the overall economy, and it is to the vertebrate economy that we now return.

The Rocky Cape vertebrate sample was divided into large mammals (wallaby, wombat and pademelon), small mammals, seals, fish and birds, and these data were treated in a manner similar to those from Louisa Bay (Fig. 39). It can clearly be seen that procurement remains relatively constant whether or not deposits contain fish. Thus in units 3, 2 and 1 there is a massive Heterogeneity/Divergency inversion (the inversion actually occurs between units 5 and 4, but the configurations of the nominated groups of units remain essentially the same) where fish are not present, but within each configuration much the same Heterogeneity/Divergency relationship is maintained. The higher diversity in unit 4 is caused by a reduction in the frequency of fish.

The consumption configuration is also fairly constant, but anomalies occur in units 5 and 2. In unit 5 an inversion in the Heterogeneity/Divergency ratio is caused by a decrease in seal meat contribution and a consequent heavier representation of fish. Bowdler explains the different character of this unit as indicating that it represents a phase recording use of this part of the site as a manufacturing area (Bowdler 1979:410; but see Jones 1966:2-3) and for this reason excludes it from her discussion of the Rocky Cape data (Bowdler 1979:420). We prefer however to include the data and to consider explanations after analysis rather than before.

The unit 2 anomaly is different, for while diversity is higher, the same configuration vis-a-vis Heterogeneity and Divergency is maintained. So the only major discrepancy is in unit 5, and we may with some confidence generalise that most food came from seals, up to 92% in one unit and seldom falling below about 75%. Inspection of Table 43 shows that there is little or no difference in the earlier and later exploitation of seals at Rocky Cape. In earlier Rocky Cape times, we have already recorded that fish contributed 10% of the vertebrate diet source. Their loss in later times must be compensated for by greater concentration on other sources. Birds increase from less than 1% in earlier times to 2% later, leaving mammals as the main donor to the deficit by almost doubling their earlier 10% contribution to the vertebrate diet.

Turning now to Figure 40 we can see some of the specifics involved in these changes through time. As will be recalled, this graph describes the internal relationships of categories in terms of quantity per unit volume. The fish contribution of course decreases, but while there is an apparent massive increase in birds it should be remembered that there are only 19 birds in the total sample. Similarly, the anomalies seen in units 5 and 2 (Fig. 39) are caused by the very low seal numbers. This low seal representation may be a sampling artefact, but we think it reflects a real scarcity of seals in the area in prehistoric times, given that a minimum number of only 25 seals is represented at Rocky Cape. The distribution of mammals, however, is consistent with the pattern observed earlier, small mammals showing a slight increase in the upper deposits, large mammals a somewhat greater increase. It should

Fig. 40 Rocky Cape: Concentration bar graphs, vertebrates
also be mentioned that while the bone points continue later, their distribution through time in general matches that of fish.

Jones (1971:541-2) makes four significant points concerning the vertebrate record at Rocky Cape, which we summarise as:

1. Seals become less important through time.
2. Fish were not present in the upper part of the sequence.
3. Marsupials and birds become important in the upper part of the sequence.
4. The sequence saw three important breaks, between units 2 and 3 marking the increase in birds and marsupials, between units 3 and 5 featuring the disappearance of fish, and between 6 and 7 heralding the decline in seal.

Bowdler (1979:419-20) takes Jones to task on his first interpretation, suggesting that there was in fact an increase in the importance of seals, which has implications for Jones' fourth point. Our findings, however, suggest equal importance in early and late times. We do not dispute the facts of Jones' second point, that fish were unrepresented in the Upper Rocky Cape record, so our summary of the Rocky Cape vertebrate fauna becomes:

1. Seals are equally important in both early Rocky Cape and late Rocky Cape.
2. Fish do not appear in the upper deposits.
3. Marsupials are an important element in early Rocky Cape but large mammals especially become more important in late Rocky Cape. Birds were an inconsequential item in the diet.
4. The only important economic break in the Rocky Cape sequence is that separating early occupation from late, marked by the disappearance of fish and the increase in terrestrial mammals.

Thus, in reference to Jones' claim that the absence of fish from the later Rocky Cape record represents a net loss in food value, and that it 'was not a case of one food being replaced by another' (Jones 1978:45), we can now argue that indeed fish were replaced by larger terrestrial mammals. This may well be associated with the mid-Holocene appearance of open habitats (Macphail 1979) exploited by larger mammals, in turn sought by the Tasmanians in a more efficient procurement strategy.

To determine more clearly the extent of this replacement, and for comparison with Louisa Bay, we need to assess the total meat component of the diet. This involves knowing the shellfish contribution, but this is difficult because shellfish data from Rocky Cape were not fully quantified. The enclosed chamber at Rocky Cape South was analysed for its surface shellfish content (Jones 1971:570-84); based on this and on Coleman's estimate of shellfish contribution at West Point (Coleman 1966; Jones 1966), Jones' estimate at Rocky Cape is 50% or more. In view of the detailed analysis of the Louisa Bay shellfish, this figure is clearly too high, and its use would result in greatly underplaying the role of vertebrates in the diet.

In comparing the vertebrate contribution at Louisa Bay and Rocky Cape we have taken the seemingly arbitrary step of applying the Louisa Bay invertebrate percentages to Rocky Cape. However, justification for this lies in the fact that both Rocky Cape and the Louisa Bay sites lie adjacent to similar marine rock platforms which are unlikely to be very different. We have used both summer and winter shellfish percentages for these calculations, though probably the winter figure is most appropriate; Jones suggests that Rocky Cape was a winter occupation site and the absence of nesting sea-bird remains, or evidence of a seal breeding colony, support this interpretation.

Table 44 shows the comparison between Rocky Cape and Louisa Bay. It will be seen that the seal contribution to the diet is somewhat lower at Rocky Cape than at Louisa Bay (this however is the maximum percentage for seal at Rocky Cape; if the shellfish percentage is any higher the seal percentage would be correspondingly lower). The late Rocky Cape figures for terrestrial mammals are correspondingly somewhat higher than for Louisa Bay, the increase in their representation from the early levels compensating for the loss of fish from the diet. This difference between proportions of marine and terrestrial mammals at the two sites may be a function of seals being more common in southwest Tasmania, if the ethnographic record is any guide. Similarly the more extensive heathland of the northwest may well support a more abundant terrestrial fauna than the mixed heathland/herbland of the southwest. In both areas the contribution of birds to the total diet is equally negligible, an observation
Having established the nature of the differences in exploitation between the mainland Louisa Bay and Rocky Cape sites, we can now turn our attention to the way in which Hunter Island was exploited. For this, we examine the Holocene archaeological record as discussed by Bowdler (1979).

HUNTER ISLAND

Bowdler excavated five sites on Hunter Island and the contents of four of these are recorded in Table 45. The fifth site, the Rookery Rockshelter, was not included because much of the bone contained therein could not with any certainty be attributed to the activities of man (Bowdler 1979:325). The same problem arises with some of the Cave Bay Cave deposits, so that included in Table 45 are only those animals most likely to have been eaten by man and found in definite archaeological and part-archaeological contexts (Bowdler 1979:159-60; see also various references to the possibilities for non-human deposition, pp.107-87). All those animals occurring in the non-archaeological parts of the middens are excluded. In addition there are a number of other uncertainties which include unknown weights for some species (diving petrel, gull) and unknown numbers for others (all three seal species). However, these should not unduly affect the general conclusions of the analysis presented here.

Diversity calculations have been made for each stratigraphic deposit within each site. These are as usual in terms of the minimum numbers of individuals on the one hand and the total animal weights on the other. In order to compensate for small sample sizes in the construction of the vertical bar graph and Heterogeneity/Diversity analysis, all the Mutton Bird Midden deposits and the lower two of the Stockyard Site were combined. Unfortunately, combining the Mutton Bird Midden deposits masks the absence of mutton-birds in the upper layers of this site.

Classes of animals used in the analysis were mutton-birds, swans and ducks, all other birds, pademelons (and five wallabies from the Cave Bay Cave Lower Midden), and other mammals. Seals were excluded because minimum numbers of individuals have not yet been calculated for these sites. The results of the analysis are presented in Figure 41; the sites are arranged from highest consumption Heterogeneity value to lowest. This analysis reveals a great diversity in procurement strategies for these sites, and we must now look at possible explanations for the variability.

Although procurement diversities vary widely on Hunter Island, this is not true of consumption Heterogeneity, which has a very narrow range (0.19-0.55). These values fall far short of the figure for all resources combined (0.88). Our interpretation of this pattern is that the people responsible for the various deposits were in each locality focusing on different resources and exploiting them differentially. It is also clear that most energy is derived from pademelons, with a variety of species occurring in second place. In other words, pademelons form a staple for the people who are exploiting the varied resources of Hunter Island at special purpose sites.

The contribution of shellfish to the Hunter Island economy is more difficult to assess than at Rocky Cape. We felt unable to apply the Louisa Bay data because of the clearly different nature of the economy and environment on Hunter Island. Bowdler analysed four shellfish samples, two from the Mutton Bird Midden and two from the Cave Bay Cave middens. Computations (Table 46) are based on the shellfish data presented in Chapters VI and VII. Bowdler examined all the Cave Bay Cave shellfish, so the totals shown are derived from actual counts of shellfish. The dense Mutton Bird Midden deposits were sampled by removing five 10 x 10 x 10 cm solid blocks.

Table 44 Comparisons of Louisa Bay and Rocky Cape subsistence patterns. Known winter and all-season shellfish percentages at Louisa Bay are applied to Early Rocky Cape and Late Rocky Cape faunal data supported by Gaughwin's (1978) analysis of mutton-birds and other sea birds in southern Australian archaeological contexts.

<table>
<thead>
<tr>
<th></th>
<th>Louisa Bay</th>
<th>Maatsuyker Island</th>
<th>Early Rocky Cape</th>
<th>Late Rocky Cape</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Winter</td>
<td>All seasons</td>
<td>Winter</td>
<td>All seasons</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Seals</td>
<td>86</td>
<td>72</td>
<td>79</td>
<td>71</td>
</tr>
<tr>
<td>Mammals</td>
<td>4</td>
<td>10</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Birds</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Invertebrates</td>
<td>8</td>
<td>14</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Fish</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

113
<table>
<thead>
<tr>
<th>Stockyard Site</th>
<th>Upper Midden</th>
<th>Lower Midden</th>
<th>Brown Sand</th>
<th>Little Duck Bay</th>
<th>Upper Midden</th>
<th>Lower Midden</th>
<th>Brown Sand</th>
<th>Cave Bay Cave</th>
<th>Total</th>
</tr>
</thead>
</table>
| Elephant seal  | - - - -       | - - - -      | - - - -    | - - - -        | 1? 200       | - - - -      | - - - -    | - - - -       | 1? 200+
| Leopard seal   | - - - -       | - - - -      | - - - -    | - - - -        | 1? 200+      | - - - -      | - - - -    | - - - -       | 1? 200+
| Fairy penguin  | 2 1.5         | - - - -      | - - - -    | - - - -        | 4 3.0        | - - - -      | 1 0.75     | - - - -       | 1 0.75+
| Albatross      | - - - -       | - - - -      | - - - -    | - - - -        | 1 8.0        | - - - -      | - - - -    | - - - -       | 3 6.9+
| Mutton-bird    | - - 8 4.0     | - - - -      | - - - -    | - - - -        | 7 3.5        | - - - -      | 3 1.5 4 2.0 | 5 2.5 27 13.5 | 54 27.0
| Diving petrel  | 1 1          | - - - -      | - - - -    | - - - -        | - - - -      | - - - -      | - - - -    | - - - -       | 1 -    |
| Pelican        | 1 4.0 1 4.0   | - - - -      | - - - -    | - - - -        | 1 2.0        | 1 2.0       | - - - -    | - - - -       | 1 2.0 - 4 8.0 |
| Cormorant      | 1 2.0 1 5.0   | - - - -      | - - - -    | - - - -        | - - - -      | - - - -      | - - - -    | - - - -       | 1 -    |
| Black swan     | - - - -       | - - - -      | - - - -    | - - - -        | - - - -      | - - - -      | - - - -    | - - - -       | 1 2.0 6 12.0 |
| Duck           | 1 2.0         | - - - -      | - - - -    | - - - -        | 1 2.0        | 1 2.0       | - - - -    | - - - -       | 5 - 2    |
| Gull 1         | 1 0.75        | - - - -      | 1 0.75     | - - - -        | 3 2.25       | - - - -      | - - - -    | - - - -       | 1 -    |
| Currawong      | 1 0.3         | - - - -      | - - - -    | - - - -        | - - - -      | - - - -      | - - - -    | - - - -       | 1 0.3 |
| Raven 2        | 1 0.75        | - - - -      | 1 0.75     | - - - -        | - - - -      | - - - -      | - - - -    | - - - -       | 5 3.7 |
| Total birds    | 7 10.55       | 12 13+       | 1 0.75     | 17 20.75       | 1 2.0 4 2.25  | 4 2.0       | - - - -    | - - - -       | 16 14.15 37 31.25 |
| Wallaby        | - - - -       | - - - -      | - - - -    | - - - -        | - - - -      | - - - -      | - - - -    | - - - -       | 5 80 |
| Pademelon      | 7 59.5        | 3 25.5       | - - - -    | 8 68           | 1 8.5 1 8.5 1 8.5 | - - - -    | - - - -    | - - - -       | 4 34.0 11 93.5 |
| Potoroo        | 2 2.0         | 3 3.0        | - - - -    | 1 1.0          | 1 1.0 - -    | - - - -      | - - - -    | - - - -       | 1 1.0 |
| Bandicoot      | 2 3.0         | - - 1 1.5    | - - - -    | 15 22.5        | 1 1.5 1 1.5 1 - | - - - -    | - - - -    | - - - -       | 4 6.0 2 3.0 |
| Swamp rat      | 3 0.45        | - - 2 0.3    | - - - -    | 89 13.35       | - - - -      | 2 0.3       | - - - -    | - - - -       | 2 0.3 |
| Broad-toothed rat | - - - -    | - - - -      | - - - -    | 1 0.2          | - - - -      | 1 0.2       | - - - -    | - - - -       | - - - |
| Total mammals  | 14 64.95      | 6 28.5 3 1.8 | 114 105.05 | 3 11.0 2 10.0 4 9.0 | 9 41.0       | 18 176.5    | - - - -    | - - - -       | 173 447.8 |
| Total          | 22 109.5      | 18 41.4+ 4 2.55 | 134 559.8 | 4 13 6 12.25 8 11 | 25 55.15 55 207.75 | 276 1012.5 |

1 weight not available
2 an estimated weight of 0.75 kg is used for purposes of analysis, as the animal's occurrence at two sites and three depositional environments suggests it was hunted

Table 45 Hunter Island vertebrate fauna. Minimum numbers of individuals and minimum weights (kg). Data adapted from Bowdler 1979:114, 135, 159-60, 304, 311, 317
Fig. 41 Hunter Island: procurement and consumption Heterogeneity and Divergency, vertebrates

Table 46 Shellfish contributions to the faunal diet at Cave Bay Cave and the Mutton Bird Midden (numerical data are from Bowdler 1979:206, 217, 315, 318-19)
Computations here are based on extrapolations from these samples to the total volume of the excavation. In this table we can see that the shellfish contributions in the Lower and Upper Cave Bay Cave middens were negligible (0.003% and 4.5%). Conversely, at the Mutton Bird Midden, shellfish formed 99% of the diet and vertebrates were only incidental. The model for short-term visits and narrow spectrum exploitation at each site is therefore supported by these data.

Bowdler sees Hunter Island as being exploited in summer, as part of the northwest regional economic strategy. While we see this as being generally true, and indeed would equate it with the summer pattern at Louisa Bay, there is some indication of exploitation outside of summer.

Mutton-birds do not occur in the upper deposits of the Stockyard Site and Mutton Bird Midden, dated to between 800 and 400 BP, but are found earlier at both sites. Their disappearance is explained by Bowdler (1979:334) as being due to a shift in the location of the rookery site, perhaps caused by the collapse of the site in a hard westerly as a result of undermining. However mutton-birds are very site specific and it is hard to imagine a site being abandoned for such a reason. Bowdler does not refer to an example of this having been observed, and we also know of none. A more plausible hypothesis is that visits to the site in more recent times occurred before the arrival of mutton-bird adults or after the departure of the chicks.

Bowdler (1979:418) says:

The differences between Cave Bay Cave, Rocky Cape South, Rocky Cape North and Sisters Creek, are interpreted as representing seasonally scheduled aspects of an overall economic strategy of a single society. That is, each site is a component in an overall strategy; indeed, other components may await discovery.

While we agree with this statement in general terms, it is suggested here that the same statement could be applied to Hunter Island itself, and that each site on the island is part of an overall strategy for the exploitation of the island.

OTHER NORTHWEST TASMANIAN SITES

Jones excavated a number of other sites in Tasmania's northwest but they remain to be reported fully. Only a brief description of the fauna from Sisters Creek, thought to have been occupied about midway through the Rocky Cape record, is available (Jones 1966:6). Jones reports that there are more small mammals and fewer seals than at Rocky Cape, but none of these data are quantified.

The massive West Point midden is only slightly better reported. Jones has variously estimated up to about 50% meat value for shellfish (1971:585) and as low as 25% in a recent and perhaps more accurate estimate (1978:37). The large numbers of elephant seal remains are seen to contribute between 80% of the non-shellfish diet (1966:7) and 65% of all meat (1978:37). In the most recent estimate the remaining 10% comes from birds and mammals. These figures, however, are at best approximations and cannot be directly compared with the other sites. It is somewhat surprising, though, that the people occupying a site interpreted to represent exploitation of an elephant seal breeding colony were dependent on seals for only 65% of their meat when it has been calculated that at Rocky Cape, where seals are interpreted to have been only casually butchered, their contribution was 79%. Another factor, however, might be that a breeding population, including the immatures, protected its own only too well (see the discussion on elephant seals in Chapter V), and that the major periods for taking animals were during the initial days of congregation and after the colony had dispersed. Only a detailed analysis of the remains will allow further interpretation.

SOUTHEAST TASMANIA

The two sites excavated in this area by Lourandos (1970) were Little Swanport and Crown Lagoon, and it was from these that he developed his model of summer dispersed/winter concentrated on coast, summer exploitation of terrestrial fauna/ winter exploitation of shellfish.

It is not possible to apply the same analytic techniques used at Louisa Bay to these sites because of the nature of the remains, for Crown Lagoon had only isolated kangaroo teeth and Little Swanport had small quantities of bone which, although partially identified, have not been analysed for minimum number determination.
A very approximate calculation can, however, be made for Little Swanport. The site contained some 20 identified vertebrate remains (the total of 60 given by Lourandos includes remains identified only to size, not species). If we treat these as being minimum numbers, and calculate total body weight accordingly, we obtain a figure of approximately 250 kg. This is probably a considerable overestimate since a number of fragments may be derived from single individuals, but it gives us an idea of the order of magnitude.

Total oyster shell excavated weighed 17,727 kg, and using the ratio of 5:1 for shell weight:meat weight (Bailey 1975), these would have offered some 3545 kg of meat. Total mussel shell excavated is 4836 kg, which using an estimated weight ratio of 3:1 gives 1612 kg of meat.

For the total site, then, we have figures of: oyster 66%, mussel 29%, total shellfish 95%, vertebrates 5%. Although these figures are clearly gross approximations, it is apparent that Little Swanport is indeed a site at which almost all energy was derived from shellfish. This pattern is confirmed at other sites along the banks of the Derwent Estuary (Vanderwal 1977b; Gaffney 1978; Stockton and Wallace 1979). The most intensively sampled is Shag Bay (Vanderwal 1977b) where 99% of all shellfish were mussels, and no animal bone was recovered.

SUMMARY AND CONCLUSIONS

Louisa Bay contains a large number of sites which we have characterised as representing summer occupation (LR 1, LR 2, MAT 1), winter occupation (AC 1, LR 3) and year-round occupation (LRC 1, LRC 2). The subsistence pattern for this area is clearly divided on a seasonal basis. In summer there are short-term camps, used when visiting the seal and mutton-bird colonies at Maatsuyker, hunting terrestrial mammals and collecting shellfish. Winter saw the establishment of longer term camps, where elephant and fur seals, coming ashore to rest, formed the most important contribution to the diet. There was a marked reduction in shellfish collecting, and mammals were less important in terms of their diet contribution, although a greater variety were collected in this season than during summer.

It is in winter, when the population is more sedentary, and probably formed into larger groups, that much of the Tasmanian ceremonial life may have been carried out (Horton 1979), perhaps in many ways similar to those of other temperate hunter-gatherers such as the Ainu (Coon 1971:377; Watanabe 1972:677), the Northwest Coast Indians of North America (Coon 1971:383), the Maidu of the central California coast (Coon 1971:386) and the Yahgan of Tierra del Fuego (Coon 1971:406). Shawcross (1967) makes a similar observation for the high latitude Maori, who share many of their economic patterns with pure hunter-gatherers (see for example a number of papers in Anderson 1979).

In terms of the overall pattern for Tasmania, Louisa Bay clearly is similar to the sites in the northwest and not to those of the southeast. We believe that, considering the northwest as a whole, sites such as West Point and Hunter Island will be found to be similar to the summer pattern at Louisa Bay, while Rocky Cape fits the winter pattern.

The southeastern pattern is quite different, as Lourandos (1968) has pointed out. The differences are a reflection of three factors:

1. In the southeast there is access to the hinterland with its kangaroo populations, in the southwest there is not.
2. By way of compensation, in the southwest there is access to breeding colonies of seals; for Louisa Bay, Maatsuyker Island is the hinterland.
3. In the southeast there is access to the larger oyster and mussel populations of the estuaries and these provided a reliable and accessible winter resource which was not available in the southwest. At Louisa Bay, the arrival of seals provide an accessible winter resource, but their unpredictable beaching habits made it necessary occasionally to seek greater numbers of land mammals.

We have been able to support these and other interpretations throughout this study with the aid of our explicitly quantitative approach. The main thrust of our work, however, has been directed toward the creation of a tableau describing subsistence economy in southwest Tasmania, as well as a re-evaluation of economic prehistory in northwest and southeast Tasmania, against which future archaeological work may be compared.
A total of 7608 pieces of flaked stone was recovered from all sites, consisting of cherts, rhyolites, a single piece of volcanic tuff, quartzites, and a massive amount of quartz (there were 7365 pieces of quartz, weighing over 58 kg). This appendix is concerned with the analysis of the material, first discussing those quartz pieces on which no secondary flake removal could be detected, followed by a short section on exotic flakes and cores. The appendix concludes with consideration of stone which has been retouched and use worn.

Stone was found at all excavated sites, though only a single chert flake, four cores, one flake, 14 fragments and five pebbles were recovered from LRC 1, and 38 fragments and three pebbles from site LC 1; these two sites are therefore excluded from this analysis on the grounds that the samples are far too small to be meaningful.

In the other sites, analysis consisted of counting the number of pieces in each category and weighing the total to the nearest gram; this information is shown on the relevant tables. Concentration of artefacts is shown in the same manner as discussed in Chapter IV. Since only four analytic categories were involved, the use of diversity measures was considered inappropriate.

QUARTZ ARTEFACTS

 Quartz artefacts are notoriously difficult to analyse with any degree of sophistication because the unpredictable flaking characteristics and the refractivity of the stone combine effectively to obscure the record of artefact manufacture and use (see Dickinson 1977 for some of the qualities of quartz, and Sullivan 1973 for recent attempts at analysis). An examination of the southwest Tasmanian sample revealed that it is no exception, so it was decided to divide the collection into four broad categories in an effort to derive some information. These categories are cores, flakes, fragments and pebbles. The following list presents the criteria for definition:

1. **Cores.** This category was defined by the general chunkiness of the stone, and its relatively large size and faceted appearance, often with pebble cortex visible at some point on the surface.

2. **Flakes.** Inclusion in this category required that the piece be relatively flat and have at least one sharp edge. All were considered to have been possible tools, but clear evidence of usage was not observed on any piece.

3. **Fragments.** These were pieces of stone which were irregular, having no sharp edges.

4. **Pebbles.** This category contained unfractured pieces of stone which were weathered and rounded.

While sorting the stone into these categories, each piece was carefully examined, including, where appropriate, microscopic examination. The 28 pieces which showed signs of manufacture and/or use are described later in this appendix. The immediate concern here is the 7337 remaining pieces. None exhibits traces of a bipolar flaking technique (White 1968; Vanderwal 1977a; Kamminga 1978:25-29), which is itself unusual for a predominantly quartz industry.

ANALYSIS

Louisa River Site 1

Of the 1246 quartz pieces, 62 occur in the three lower units (Table 47). These small numbers, and the fact that flakes are the most common artefact, support the suggestion that the lowest deposits represent very sparse occupation. Much more intense artefactual deposition is seen in the topmost deposits (Fig.42), with fragments being by far the most predominant refuse, a fact which presumably reflects greater flaking activity, consistent with more intensive occupation (Vanderwal
1978a). These data and conclusions are consistent with those of analyses presented in Chapters V and VI.

![Fig. 42 Louisa River site 1: Concentration bar graphs, quartz](image)

**Table 47** Louisa River site 1: quartz artefacts

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Cores nos wt(gm)</th>
<th>Flakes nos wt(gm)</th>
<th>Fragments nos wt(gm)</th>
<th>Pebbles nos wt(gm)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark Organic</td>
<td>71 2811</td>
<td>151 1015</td>
<td>554 1634</td>
<td>6 268</td>
<td>782</td>
</tr>
<tr>
<td>Dense Shell</td>
<td>46 1628</td>
<td>107 457</td>
<td>242 745</td>
<td>7 396</td>
<td>402</td>
</tr>
<tr>
<td>Sandy Soil</td>
<td>2 50</td>
<td>9 52</td>
<td>7 46</td>
<td>-</td>
<td>18</td>
</tr>
<tr>
<td>Tan Sand</td>
<td>3 46</td>
<td>25 68</td>
<td>10 7</td>
<td>-</td>
<td>38</td>
</tr>
<tr>
<td>Grey Sand</td>
<td>3 43</td>
<td>-</td>
<td>3 1</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>125 292</td>
<td>816</td>
<td>13</td>
<td>1246</td>
<td></td>
</tr>
</tbody>
</table>

**Louisa River Site 2**

Even in gross terms, LR 2 contained more stone (Table 48) than did LR 1, and since the excavated portion of LR 2 is half the area and less than half the depth of LR 1, intensity of deposition is at least four times greater.

Internally, site LR 2 exhibits only minimal change, though there is a general increase through time in the frequencies of artefacts, particularly in the flakes anddebitage.

There is little stratigraphic differentiation (Fig.43) and the deposits appear to represent a more or less continuous laying down of debris, with little or no difference even between the sandier spit 5 and the overlying Dense Shell midden.

![Fig. 43 Louisa River site 2: Concentration bar graphs, quartz](image)

**Table 48** Louisa River site 2: quartz artefacts

<table>
<thead>
<tr>
<th>Spit</th>
<th>Cores nos wt(gm)</th>
<th>Flakes nos wt(gm)</th>
<th>Fragments nos wt(gm)</th>
<th>Pebbles nos wt(gm)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23 2020</td>
<td>79 452</td>
<td>312 1455</td>
<td>8 619</td>
<td>422</td>
</tr>
<tr>
<td>2</td>
<td>40 1436</td>
<td>61 327</td>
<td>252 1253</td>
<td>1 159</td>
<td>354</td>
</tr>
<tr>
<td>3</td>
<td>21 802</td>
<td>29 128</td>
<td>182 1107</td>
<td>6 607</td>
<td>238</td>
</tr>
<tr>
<td>4</td>
<td>49 1607</td>
<td>42 220</td>
<td>129 745</td>
<td>4 211</td>
<td>224</td>
</tr>
<tr>
<td>5</td>
<td>38 1148</td>
<td>60 418</td>
<td>126 593</td>
<td>12 724</td>
<td>236</td>
</tr>
<tr>
<td>Total</td>
<td>171</td>
<td>271</td>
<td>1001</td>
<td>31</td>
<td>1474</td>
</tr>
</tbody>
</table>
Louisa River Site 3

Like site LR1, LR3 consists of a series of quite separate depositional epochs, but there is a more uniform distribution of artefacts (as seen in Table 49) between the top and bottom of LR3. Within each deposit much the same relative proportions between the various quartz categories is seen (Fig. 44).

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Cores nos</th>
<th>Cores wt(gm)</th>
<th>Flakes nos</th>
<th>Flakes wt(gm)</th>
<th>Fragments nos</th>
<th>Fragments wt(gm)</th>
<th>Pebbles nos</th>
<th>Pebbles wt(gm)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dense Shell</td>
<td>13</td>
<td>461</td>
<td>32</td>
<td>212</td>
<td>171</td>
<td>635</td>
<td>6</td>
<td>440</td>
<td>222</td>
</tr>
<tr>
<td>Mussel Shell</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>9</td>
<td>13</td>
<td>74</td>
<td>1</td>
<td>83</td>
<td>16</td>
</tr>
<tr>
<td>Light Sand</td>
<td>7</td>
<td>210</td>
<td>17</td>
<td>79</td>
<td>53</td>
<td>252</td>
<td>2</td>
<td>128</td>
<td>79</td>
</tr>
<tr>
<td>Organic Sand</td>
<td>25</td>
<td>817</td>
<td>38</td>
<td>304</td>
<td>60</td>
<td>188</td>
<td>-</td>
<td>-</td>
<td>123</td>
</tr>
<tr>
<td>Light Organic Sand</td>
<td>11</td>
<td>266</td>
<td>21</td>
<td>148</td>
<td>128</td>
<td>447</td>
<td>-</td>
<td>-</td>
<td>160</td>
</tr>
<tr>
<td>Total</td>
<td>56</td>
<td>110</td>
<td>425</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>600</td>
</tr>
</tbody>
</table>

Table 49 Louisa River site 3: quartz artefacts

Fig. 44 Louisa River site 3: Concentration bar graphs, quartz

Louisa River Cave Site 2

No quartz artefacts were recovered from LRC1 and only 125 from LRC2 (Table 50). Their distribution in LRC2 is extremely discontinuous (Fig. 45), with cores, pebbles anddebitage often being unrepresented in some deposits. The variation between the LRC2 deposits may reflect differences in behaviour. At first, flakes may have been brought to the cave; Dense Shell I may represent an episode of quartz flaking in the cave, while the later presence of more flakes than debitage suggests very limited flaking, perhaps for specific purposes, but with only a small amount of stone being introduced to the site.

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Cores nos</th>
<th>Cores wt(gm)</th>
<th>Flakes nos</th>
<th>Flakes wt(gm)</th>
<th>Fragments nos</th>
<th>Fragments wt(gm)</th>
<th>Pebbles nos</th>
<th>Pebbles wt(gm)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last Occupation</td>
<td>2</td>
<td>120</td>
<td>16</td>
<td>97</td>
<td>8</td>
<td>31</td>
<td>-</td>
<td>-</td>
<td>26</td>
</tr>
<tr>
<td>Dense Shell II</td>
<td>5</td>
<td>781</td>
<td>6</td>
<td>43</td>
<td>5</td>
<td>41</td>
<td>-</td>
<td>-</td>
<td>16</td>
</tr>
<tr>
<td>Brown Soil</td>
<td>1</td>
<td>105</td>
<td>9</td>
<td>189</td>
<td>2</td>
<td>6</td>
<td>-</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>Dense Shell I</td>
<td>1</td>
<td>34</td>
<td>1</td>
<td>2</td>
<td>55</td>
<td>22</td>
<td>-</td>
<td>-</td>
<td>57</td>
</tr>
<tr>
<td>Organic Soil</td>
<td>-</td>
<td>-</td>
<td>12</td>
<td>45</td>
<td>1</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>13</td>
</tr>
<tr>
<td>Grey Soil</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>50</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
<td>45</td>
<td>70</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>125</td>
</tr>
</tbody>
</table>

Table 50 Louisa River Cave site 2: quartz artefacts

Fig. 45 Louisa River Cave site 2: Concentration bar graphs, quartz
Anchorage Cove Site 1

LR 2 and AC 1 resemble one another in that they are both dense midden deposits, and about the same amount of deposit was removed from both. However, three times as much stone was recovered from LR 2 (compare Tables 51 and 48). While there is variation in the frequency of quartz through the course of occupation, there appears to be no general trend, except that flakes become relatively more frequent toward the top of the deposit (Fig.46).

![Table 51 Anchorage Cove site 1: quartz artefacts](image)

Maatsuyker Island Site 1

More stone, both in gross and relative terms, was deposited in the excavated portions of MAT 1 than in any other site. Since no two of the squares here dealt with are contiguous, and there was little visible stratigraphy, each square is treated separately.

There were twice as many quartz artefacts recovered from square 4 than from either squares 5 or 6 (Table 52). This, however, appears to be a local variation with little meaning. Apart from pebbles, all other categories show similar patterns, increasing in frequency to the second level (spit), then rather dramatically decreasing at the top. The latter may be due to the difficulty in distinguishing the last occupation from subsequent soil deposition. Pebbles appear to be randomly distributed in each square. Examination of Table 52 and Figure 47 shows that there is practically no internal variation from spit to spit within each square.

Comparisons among all Sites

Table 53 summarises data from all sites and shows that there is little difference in the relative frequencies of artefacts from one site to another. In an attempt to define more closely the nature of flakes, since these are inferred to be the desired products, some values of $\chi^2$ were calculated for the sizes of flakes (weight divided by numbers). No significant differences in contiguous sizes were seen, so those flakes recovered from sites AC 1 and MAT 1 seem to be respectively the largest and
smallest of a continuum. The nature of the debris, and the consequently broadly defined classes, do not allow more rigorous testing or additional interpretation.

<table>
<thead>
<tr>
<th></th>
<th>Cores nos wt (gm)</th>
<th>Flakes nos wt (gm)</th>
<th>Fragments nos wt (gm)</th>
<th>Pebbles nos wt (gm)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Square 4/1</td>
<td>28 562</td>
<td>27 105</td>
<td>108 254</td>
<td>10 115</td>
<td>173</td>
</tr>
<tr>
<td>4/2</td>
<td>36 986</td>
<td>150 549</td>
<td>589 1265</td>
<td>35 358</td>
<td>810</td>
</tr>
<tr>
<td>4/3</td>
<td>24 602</td>
<td>57 328</td>
<td>416 1218</td>
<td>1 38</td>
<td>498</td>
</tr>
<tr>
<td>4/4</td>
<td>11 318</td>
<td>37 181</td>
<td>173 462</td>
<td>1 36</td>
<td>222</td>
</tr>
<tr>
<td>4/5</td>
<td>3 101</td>
<td>4 7</td>
<td>30 168</td>
<td>- -</td>
<td>37</td>
</tr>
<tr>
<td>Total</td>
<td>102 275</td>
<td>1316</td>
<td>47 1740</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|      |                   |                    |                       |                     |       |
| Square 5/2 | 3 48              | 20 127             | 3 8                   | - -                 | 26    |
| 5/3   | 34 1246          | 76 482             | 281 1151              | - -                 | 391   |
| 5/4   | 21 690           | 36 262             | 190 1044              | - -                 | 247   |
| 5/5   | 22 745           | 45 211             | 37 228                | 1 8                 | 105   |
| 5/6   | 11 225           | 15 73              | 38 88                 | 1 40                | 65    |
| Total | 91 192           | 549                | 2 834                 |                     |       |

|      |                   |                    |                       |                     |       |
| Square 6/1 | 3 105             | 6 42               | 8 32                  | - -                 | 17    |
| 6/2   | 38 659           | 57 250             | 174 643               | 4 62                | 273   |
| 6/3   | 17 283           | 87 350             | 118 402               | - -                 | 222   |
| 6/4   | 21 550           | 48 274             | 155 696               | 3 158               | 227   |
| 6/5   | 11 239           | 40 188             | 86 248                | - -                 | 137   |
| Total | 90 238           | 541                | 7 876                 |                     |       |

Table 52 Maatsuyker Island site 1: quartz artefacts

Fig. 47 Maatsuyker Island site 1: Concentration bar graphs, quartz

<table>
<thead>
<tr>
<th></th>
<th>Cores nos wt (gm)</th>
<th>Flakes nos wt (gm)</th>
<th>Fragments nos wt (gm)</th>
<th>Pebbles nos wt (gm)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LR 1</td>
<td>125 4575</td>
<td>292 1606</td>
<td>816 2448</td>
<td>13 664</td>
<td>1246</td>
</tr>
<tr>
<td>LR 2</td>
<td>171 7011</td>
<td>271 1545</td>
<td>1001 5205</td>
<td>31 2399</td>
<td>1474</td>
</tr>
<tr>
<td>LR 3</td>
<td>56 1753</td>
<td>110 748</td>
<td>425 1615</td>
<td>9 651</td>
<td>600</td>
</tr>
<tr>
<td>LRC 2</td>
<td>9 1040</td>
<td>45 387</td>
<td>70 98</td>
<td>1 50</td>
<td>125</td>
</tr>
<tr>
<td>AC 1</td>
<td>54 3326</td>
<td>113 1051</td>
<td>248 1662</td>
<td>27 1091</td>
<td>442</td>
</tr>
<tr>
<td>MAT 1</td>
<td>283 7358</td>
<td>705 3454</td>
<td>2406 7940</td>
<td>56 818</td>
<td>3450</td>
</tr>
<tr>
<td>Total</td>
<td>698 1536</td>
<td>4966</td>
<td>137 7337</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 53 All sites: quartz artefacts
EXOTIC STONE

Stone other than quartz was only rarely recovered from the sites. Such exotic material (see Sutherland 1972 for known Tasmanian sources) does not often occur in southwest Tasmania (see Chapter II). Exotics are therefore thought to have been passed from hand to hand (Hiatt 1968; Jones 1974; Vanderwal 1978b), a proportion eventually becoming incorporated into the archaeological deposits. This section describes only that exotic stone which has not been altered secondarily; reference is made to Table 54 (mainland sites) and Table 55 (Maatsuyker Island).

<table>
<thead>
<tr>
<th>Site</th>
<th>Deposit</th>
<th>Chert flakes (nos wt(gm))</th>
<th>Chert cores (nos wt(gm))</th>
<th>Other stone (nos wt(gm))</th>
</tr>
</thead>
<tbody>
<tr>
<td>LR 1</td>
<td>Dark Organic</td>
<td>21 167</td>
<td>3 56</td>
<td>- -</td>
</tr>
<tr>
<td></td>
<td>Dense Shell</td>
<td>27 53</td>
<td>- -</td>
<td>1(^1) 21</td>
</tr>
<tr>
<td></td>
<td>Sandy Soil</td>
<td>16 32</td>
<td>1 30</td>
<td>- -</td>
</tr>
<tr>
<td></td>
<td>Tan Sand</td>
<td>1 1</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td></td>
<td>Grey Sand</td>
<td>2 2</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>LR 2</td>
<td>Dense Shell</td>
<td>12 32</td>
<td>1 35</td>
<td>- -</td>
</tr>
<tr>
<td></td>
<td>Sandy Soil</td>
<td>12 37</td>
<td>1 20</td>
<td>- -</td>
</tr>
<tr>
<td>LR 3</td>
<td>Dense Shell</td>
<td>3 15</td>
<td>- -</td>
<td>1(^2) 5</td>
</tr>
<tr>
<td></td>
<td>Light Sand</td>
<td>1 11</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td></td>
<td>Light Organic Sand</td>
<td>- -</td>
<td>- -</td>
<td>1(^3) 10</td>
</tr>
<tr>
<td>LRC 1</td>
<td></td>
<td>1 5</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>LRC 2</td>
<td>Dense Shell</td>
<td>2 8</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td></td>
<td>Brown Soil</td>
<td>2 4</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td></td>
<td>Dense Shell I</td>
<td>1 1</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>AC 1</td>
<td></td>
<td>14 41</td>
<td>- -</td>
<td>4(^4) 83</td>
</tr>
</tbody>
</table>

\(^1\) rhyolite, \(^2\) quartzite, \(^3\) volcanic tuff, \(^4\) vein quartz

Table 54 Louisa River site 1, Louisa River site 2, Louisa River site 3, Louisa River Cave site 1, Louisa River Cave site 2 and Anchorage Cove site 1: exotic stone

Louisa River Site 1

Chert, being a considerably more tractable stone than quartz, can be flaked much more finely, and this appears to be reflected in the size range in all but one (Dark Organic) of the LR 1 deposits. Four chert cores and a rhyolite flake complete the exotics inventory for the site.

Louisa River Site 2

The site is here divided into the two units (Sandy Soil and Dense Shell) used in previous analyses. The same number of chert flakes occurred in each. Average weight of flakes is about 3 gm, which is not at variance with those from site LR 1. Two cores were recovered.

Louisa River Site 3

A much smaller number of flakes (four only) were recovered from the site, and though they were somewhat larger than those from the other sand dune sites, a \(\chi^2\) calculation for a contingency table - involving LR 1, LR 2, LR 3, number of flakes and weight of flakes - showed that there was no size difference (3.33, 3 df).

Two other larger flakes, one of quartzite and the other of volcanic tuff, were also recovered.

Louisa River Cave Site 2

Only five flakes were recovered. Their size range is consistent with those from other sites.

Anchorage Cove Site 1

Fourteen chert flakes (average weight 2.93 gm) and four large pieces of vein
quartz were recovered. This is the only site at which the latter was found, but no recognisable tools were manufactured from it. The chert flakes are unremarkable.

Maatsuyker Island Site 1

MAT 1 is notable for its number and range of exotic flaked stone artefacts. There are 27 chert flakes, weighing 133 gm, 39 quartzite flakes weighing 211 gm, and 11 flakes of red quartzite weighing 109 gm. There is obviously no significant difference between the chert and quartzite, suggesting that the two stones are equally tractable (and therefore desirable?). A $\chi^2$ evaluation for the red quartzite does not allow a significance within acceptable limits (3.67, 1 df).

The quartzites (white and red) are not present in Louisa Bay sites, with the single exception of a flake from LR 3 (Table 54). There is unlikely to be a source on the island and a search did not reveal one. Such stone must almost certainly have been brought from other mainland areas, perhaps to the east where Sutherland (1972) has recorded a number of quarries.

<table>
<thead>
<tr>
<th>Square</th>
<th>Cherts</th>
<th>Quartzites</th>
<th>Red quartzites</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>nos wt(gm)</td>
<td>nos wt(gm)</td>
<td>nos wt(gm)</td>
</tr>
<tr>
<td>1</td>
<td>3 6</td>
<td>1 8</td>
<td>3 31</td>
</tr>
<tr>
<td>1A/2</td>
<td>2 23</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1A/3</td>
<td>-</td>
<td>1 5</td>
<td>-</td>
</tr>
<tr>
<td>1A/5</td>
<td>-</td>
<td>1 1</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>2 18</td>
<td>3 12</td>
<td>2 20</td>
</tr>
<tr>
<td>4/1</td>
<td>1 1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4/2</td>
<td>6 23</td>
<td>8 26</td>
<td>2 14</td>
</tr>
<tr>
<td>4/3</td>
<td>-</td>
<td>3 6</td>
<td>1 5</td>
</tr>
<tr>
<td>4/4</td>
<td>1 2</td>
<td>4 55</td>
<td>1 18</td>
</tr>
<tr>
<td>4/5</td>
<td>-</td>
<td>2 8</td>
<td>-</td>
</tr>
<tr>
<td>5/2</td>
<td>1 3</td>
<td>2 6</td>
<td>1 15</td>
</tr>
<tr>
<td>5/3</td>
<td>1 3</td>
<td>3 18</td>
<td>-</td>
</tr>
<tr>
<td>5/4</td>
<td>-</td>
<td>2 5</td>
<td>-</td>
</tr>
<tr>
<td>5/5</td>
<td>1 5</td>
<td>4 27</td>
<td>-</td>
</tr>
<tr>
<td>5/6</td>
<td>4 15</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6/2</td>
<td>-</td>
<td>1 10</td>
<td>-</td>
</tr>
<tr>
<td>6/3</td>
<td>3 6</td>
<td>1 9</td>
<td>1 6</td>
</tr>
<tr>
<td>6/4</td>
<td>1 25</td>
<td>1 2</td>
<td>-</td>
</tr>
<tr>
<td>6/5</td>
<td>1 3</td>
<td>2 13</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 55 Maatsuyker Island site 1: exotic stone

STONE ALTERED SECONDARILY

Those flakes which exhibited the removal of small flakes from edges (use is inferred but not demonstrated) and those which were thought to have been altered to form specific tools are discussed in this section. Seventy-one altered pieces are recorded from the Louisa Bay sites and Maatsuyker Island, distributed as seen in Table 56. Stone used includes quartz (31), chert (25), quartzite (14) and rhyolitic tuff (1). Observations made on quartz, due to difficulties in detecting flake removal, are somewhat problematical. Measurements taken were length, width, height, weight, the length of alteration and, in the case of scrapers, angle of retouch.

<table>
<thead>
<tr>
<th>Site</th>
<th>Flakes</th>
<th>Scrapers</th>
<th>Notched artefacts</th>
<th>Nosed artefacts</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>LR 1</td>
<td>10</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>14</td>
</tr>
<tr>
<td>LR 2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>7</td>
</tr>
<tr>
<td>LR 3</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>LRC 2</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>AC 1</td>
<td>6</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>9</td>
</tr>
<tr>
<td>MAT 1</td>
<td>17</td>
<td>13</td>
<td>3</td>
<td>6</td>
<td>39</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>22</td>
<td>7</td>
<td>6</td>
<td>71</td>
</tr>
</tbody>
</table>

Table 56 All sites: secondarily altered artefacts
Louisa River Site 1

Table 57 shows only two pieces of altered quartz, a scraper and a flake. The remainder are made of chert. It is noteworthy that in the upper part of the deposit (Dark Organic and Dense Shell) all chert artefacts are characterised only by use alterations, while only half are so defined in the lower part, the remainder being tools. This is not considered to be a significant distribution (Fisher Exact Probability Test = 0.34). On the other hand, a 2 x 2 contingency table involving quartz flakes in the upper and lower part of the site (Table 47), and the chert flakes, demonstrate a significant distribution ($\chi^2 = 14.84, 1$ df; $p = 0.001$).

Although people continued to bring chert to the site with them in the later period of site use, this was much less common than before. The difference, then, might simply be that later deposits reflect the use of locally abundant quartz, and of chert traded into the area. The observed distribution supports an interpretation of Chapter VIII where it was suggested that site LR 1 saw seasonally itinerant visitors (from areas of locally abundant chert).

The two scrapers in the sample are inferred to be for general woodworking (Gould et al. 1971; Kamminga 1978; Hayden 1979:124).

Table 57 Louisa River site 1: secondarily worked stone and stone with use-wear

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Square/ Spit</th>
<th>Material</th>
<th>Description</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Height (mm)</th>
<th>Weight (gm)</th>
<th>Length alteration (mm)</th>
<th>Scraper angle (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark Organic</td>
<td>4/1</td>
<td>Quartz</td>
<td>Scraper</td>
<td>63</td>
<td>35</td>
<td>13</td>
<td>32</td>
<td>21</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>3/1</td>
<td>Chert</td>
<td>Use-wear</td>
<td>21</td>
<td>7</td>
<td>6</td>
<td>1</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>Dense Shell</td>
<td>1/4</td>
<td>Quartz</td>
<td>Use-wear</td>
<td>22</td>
<td>18</td>
<td>7</td>
<td>4</td>
<td>9</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2/3</td>
<td>Chert</td>
<td>Use-wear</td>
<td>21</td>
<td>16</td>
<td>6</td>
<td>2</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>3/2</td>
<td>Chert</td>
<td>Use-wear</td>
<td>20</td>
<td>10</td>
<td>5</td>
<td>2</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>3/2</td>
<td>Chert</td>
<td>Use-wear</td>
<td>15</td>
<td>12</td>
<td>2</td>
<td>1</td>
<td>15</td>
<td>-</td>
</tr>
<tr>
<td>Sandy Soil</td>
<td>1/6</td>
<td>Chert</td>
<td>Use-wear</td>
<td>32</td>
<td>23</td>
<td>7</td>
<td>7</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>1/7</td>
<td>Chert</td>
<td>Notch on core</td>
<td>44</td>
<td>29</td>
<td>23</td>
<td>30</td>
<td>9</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2/4</td>
<td>Chert</td>
<td>Low scraper</td>
<td>17</td>
<td>10</td>
<td>3</td>
<td>1</td>
<td>13</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2/4</td>
<td>Chert</td>
<td>Use-wear</td>
<td>30</td>
<td>28</td>
<td>7</td>
<td>5</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>Tan Sand</td>
<td>1/11</td>
<td>Chert</td>
<td>Scraper</td>
<td>41</td>
<td>25</td>
<td>8</td>
<td>8</td>
<td>41</td>
<td>60</td>
</tr>
</tbody>
</table>

Table 58 shows that there are three quartz artefacts and four chert artefacts. There appear to be no distribution anomalies. The two scrapers display edge angles similar to those at LR 1. The remainder of the assemblage consists of a notched quartz core and a notched flake.

Louisa River Site 3

A single chert scraper was recovered (Table 58).

<table>
<thead>
<tr>
<th>Site</th>
<th>Deposit</th>
<th>Material</th>
<th>Description</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Height (mm)</th>
<th>Weight (gm)</th>
<th>Length alteration (mm)</th>
<th>Scraper angle (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LR 2/4</td>
<td>Dense Shell</td>
<td>Quartz</td>
<td>Notch on core</td>
<td>48</td>
<td>45</td>
<td>23</td>
<td>54</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Dense Shell</td>
<td>Quartz</td>
<td>Use-wear</td>
<td>34</td>
<td>18</td>
<td>8</td>
<td>6</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Dense Shell</td>
<td>Chert</td>
<td>Notch on flake</td>
<td>26</td>
<td>20</td>
<td>11</td>
<td>4</td>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Dense Shell</td>
<td>Chert</td>
<td>Use-wear</td>
<td>23</td>
<td>18</td>
<td>4</td>
<td>2</td>
<td>19</td>
<td>65</td>
</tr>
<tr>
<td>5</td>
<td>Sandy Soil</td>
<td>Quartz</td>
<td>Scraper</td>
<td>32</td>
<td>25</td>
<td>9</td>
<td>10</td>
<td>17</td>
<td>65</td>
</tr>
<tr>
<td>5</td>
<td>Sandy Soil</td>
<td>Chert</td>
<td>Scraper</td>
<td>25</td>
<td>19</td>
<td>4</td>
<td>2</td>
<td>23</td>
<td>65</td>
</tr>
<tr>
<td>LR 3/9</td>
<td>Light Organic</td>
<td>Chert</td>
<td>Scraper</td>
<td>38</td>
<td>34</td>
<td>9</td>
<td>14</td>
<td>23</td>
<td>45</td>
</tr>
<tr>
<td>LRC 2-1/5A</td>
<td>Brown Soil</td>
<td>Chert</td>
<td>Notch on flake</td>
<td>18</td>
<td>8</td>
<td>2</td>
<td>2</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>AC 1/2</td>
<td>-</td>
<td>Quartz</td>
<td>Use-wear</td>
<td>48</td>
<td>26</td>
<td>5</td>
<td>11</td>
<td>18</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
<td>Chert</td>
<td>Use-wear</td>
<td>27</td>
<td>21</td>
<td>7</td>
<td>4</td>
<td>27</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
<td>Chert</td>
<td>Use-wear</td>
<td>27</td>
<td>18</td>
<td>6</td>
<td>4</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>-</td>
<td>Quartz</td>
<td>Scraper</td>
<td>38</td>
<td>34</td>
<td>18</td>
<td>18</td>
<td>37</td>
<td>75</td>
</tr>
<tr>
<td>7</td>
<td>-</td>
<td>Chert</td>
<td>Use-wear</td>
<td>25</td>
<td>13</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>-</td>
<td>Chert</td>
<td>Scraper</td>
<td>59</td>
<td>54</td>
<td>13</td>
<td>36</td>
<td>47</td>
<td>65</td>
</tr>
<tr>
<td>9</td>
<td>-</td>
<td>Quartz</td>
<td>Scraper</td>
<td>51</td>
<td>44</td>
<td>14</td>
<td>31</td>
<td>16</td>
<td>65</td>
</tr>
</tbody>
</table>

Table 58 Louisa River site 2, Louisa River site 3, Louisa River Cave site 2 and Anchorage Cove site 1: secondarily worked stone and stone with use-wear
Louisa River Cave Site 2

A single notched chert flake was recovered from the deposit (Table 58).

Anchorage Cove Site 1

Altered artefacts were very evenly distributed through the site (Table 58). They consisted of two quartz scrapers, a quartz flake with two areas of small flake removal, three chert flakes and a chert scraper with the additional removal of small edge flakes. The three scrapers are similar to those at other sites.

Maatsuyker Island Site 1

More than half of all altered stone was recovered from MAT 1 (Table 56). Quartzite and quartz tools (Table 59) far outnumber chert tools. Comparison of the quartzite and recognisable quartz tools on a 2 x 3 contingency table (combining noded and notched artefacts) demonstrates no significant difference ($\chi^2 = 0.03$). Likewise, comparison of chert and quartzite flakes (Table 60) results in an insignificant $\chi^2$ distribution (3.14). It is therefore likely that chert and quartzite are comparable in their flaking characteristics (and desirability?). Although many tools were probably unrecognisable, thus biasing the sample, it seems likely that proportionately fewer quartz pieces were selected simply because the flaking responses of the stone were so unpredictable.

<table>
<thead>
<tr>
<th>Square/Spit</th>
<th>Material</th>
<th>Description</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Height (mm)</th>
<th>Weight (gm)</th>
<th>Length alteration (mm)</th>
<th>Scraper angle (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Chert</td>
<td>Scraper</td>
<td>36</td>
<td>31</td>
<td>9</td>
<td>9</td>
<td>53</td>
<td>48</td>
</tr>
<tr>
<td>1 Quartzt</td>
<td>Scraper</td>
<td></td>
<td>36</td>
<td>26</td>
<td>10</td>
<td>12</td>
<td>39</td>
<td>45</td>
</tr>
<tr>
<td>1 Quartzz</td>
<td>Use-wear</td>
<td></td>
<td>26</td>
<td>16</td>
<td>7</td>
<td>3</td>
<td>17</td>
<td>-</td>
</tr>
<tr>
<td>1 Quartzz</td>
<td>Use-wear</td>
<td></td>
<td>38</td>
<td>23</td>
<td>24</td>
<td>18</td>
<td>23</td>
<td>-</td>
</tr>
<tr>
<td>2 Quartzz</td>
<td>Use-wear</td>
<td></td>
<td>36</td>
<td>18</td>
<td>10</td>
<td>4</td>
<td>16</td>
<td>-</td>
</tr>
<tr>
<td>4/1 Quartzz</td>
<td>Nosed artefact</td>
<td></td>
<td>51</td>
<td>35</td>
<td>25</td>
<td>40</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4/2 Chert</td>
<td>Notched artefact</td>
<td></td>
<td>42</td>
<td>38</td>
<td>33</td>
<td>51</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4/2 Quartzz</td>
<td>Use-wear</td>
<td></td>
<td>33</td>
<td>20</td>
<td>10</td>
<td>8</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>4/2 Quartzz</td>
<td>Use-wear</td>
<td></td>
<td>34</td>
<td>17</td>
<td>9</td>
<td>7</td>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td>4/2 Quartzz</td>
<td>Use-wear</td>
<td></td>
<td>32</td>
<td>22</td>
<td>7</td>
<td>7</td>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td>4/2 Quartzz</td>
<td>Use-wear</td>
<td></td>
<td>33</td>
<td>23</td>
<td>16</td>
<td>12</td>
<td>34</td>
<td>52</td>
</tr>
<tr>
<td>4/3 Quartzz</td>
<td>Nosed artefact</td>
<td></td>
<td>29</td>
<td>23</td>
<td>26</td>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4/3 Quartzz</td>
<td>Double scraper</td>
<td></td>
<td>24</td>
<td>18</td>
<td>8</td>
<td>4</td>
<td>13</td>
<td>64</td>
</tr>
<tr>
<td>4/4 Quartzz</td>
<td>Scraper</td>
<td></td>
<td>34</td>
<td>25</td>
<td>12</td>
<td>12</td>
<td>20</td>
<td>75</td>
</tr>
<tr>
<td>4/5 Quartzz</td>
<td>Scraper</td>
<td></td>
<td>50</td>
<td>41</td>
<td>11</td>
<td>28</td>
<td>38</td>
<td>52</td>
</tr>
<tr>
<td>4/5 Quartzz</td>
<td>Scraper</td>
<td></td>
<td>52</td>
<td>34</td>
<td>11</td>
<td>24</td>
<td>23</td>
<td>59</td>
</tr>
<tr>
<td>4/5 Quartzz</td>
<td>Use-wear</td>
<td></td>
<td>35</td>
<td>20</td>
<td>6</td>
<td>4</td>
<td>30</td>
<td>-</td>
</tr>
<tr>
<td>4/5 Quartzz</td>
<td>Use-wear</td>
<td></td>
<td>23</td>
<td>19</td>
<td>5</td>
<td>3</td>
<td>19</td>
<td>-</td>
</tr>
<tr>
<td>4/5 Quartzz</td>
<td>Use-wear</td>
<td></td>
<td>18</td>
<td>12</td>
<td>7</td>
<td>2</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>5/3 Quartzz</td>
<td>Use-wear</td>
<td></td>
<td>31</td>
<td>16</td>
<td>11</td>
<td>7</td>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td>5/3 Quartzz</td>
<td>Notched flake</td>
<td></td>
<td>29</td>
<td>21</td>
<td>11</td>
<td>6</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>5/3 Quartzz</td>
<td>Notched core</td>
<td></td>
<td>43</td>
<td>43</td>
<td>33</td>
<td>55</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>5/4 Quartzz</td>
<td>Use-wear</td>
<td></td>
<td>28</td>
<td>23</td>
<td>7</td>
<td>4</td>
<td>28</td>
<td>-</td>
</tr>
<tr>
<td>5/5 Quartzz</td>
<td>Scraper</td>
<td></td>
<td>31</td>
<td>26</td>
<td>8</td>
<td>10</td>
<td>28</td>
<td>65</td>
</tr>
<tr>
<td>5/5 Quartzz</td>
<td>Use-wear</td>
<td></td>
<td>56</td>
<td>29</td>
<td>14</td>
<td>20</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>5/6 Quartzz</td>
<td>Use-wear</td>
<td></td>
<td>44</td>
<td>29</td>
<td>8</td>
<td>10</td>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td>6/2 Quartzz</td>
<td>Use-wear</td>
<td></td>
<td>30</td>
<td>24</td>
<td>17</td>
<td>13</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>6/2 Quartzz</td>
<td>Scraper</td>
<td></td>
<td>34</td>
<td>21</td>
<td>19</td>
<td>11</td>
<td>14</td>
<td>68</td>
</tr>
<tr>
<td>6/3 Quartzz</td>
<td>Scraper</td>
<td></td>
<td>29</td>
<td>19</td>
<td>11</td>
<td>9</td>
<td>14</td>
<td>82</td>
</tr>
<tr>
<td>6/3 Quartzz</td>
<td>Scraper</td>
<td></td>
<td>42</td>
<td>30</td>
<td>6</td>
<td>17</td>
<td>15</td>
<td>43</td>
</tr>
<tr>
<td>6/3 Quartzz</td>
<td>Nosed artefact</td>
<td></td>
<td>23</td>
<td>14</td>
<td>11</td>
<td>3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6/3 Quartzz</td>
<td>Scraper</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6/4 Quartzz</td>
<td>Nosed artefact</td>
<td></td>
<td>40</td>
<td>20</td>
<td>13</td>
<td>9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6/4 Quartzz</td>
<td>Use-wear</td>
<td></td>
<td>26</td>
<td>21</td>
<td>12</td>
<td>5</td>
<td>18</td>
<td>-</td>
</tr>
<tr>
<td>6/4 Quartzz</td>
<td>Use-wear</td>
<td></td>
<td>36</td>
<td>33</td>
<td>20</td>
<td>19</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6/4 Quartzz</td>
<td>Use-wear</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>26</td>
</tr>
</tbody>
</table>

Table 59 Maatsuyker Island site 1: secondarily worked stone and stone with use-wear
Table 60 Maatsuyker Island site 1: secondarily altered artefacts

<table>
<thead>
<tr>
<th></th>
<th>Chert</th>
<th>Quartzite</th>
<th>Quartz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use-wear</td>
<td>-</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Scraper</td>
<td>1</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Nosed artefact</td>
<td>-</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Notched artefact</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

DESCRIPTIVE ANALYSIS OF SECONDARILY ALTERED ARTEFACTS

The names (scraper, flake, etc.) used above were of necessity fairly general, and were idealised concepts rather than descriptions. It is the aim of this section to produce some more meaningful statements about the functional appearance of these artefacts. One of the limitations, however, is that the basic descriptive categories, as already defined, must be utilised as the control points. Therefore, in the following presentation, the appearance of flakes, scrapers and their edges, sizes of nosed artefacts, and the sizes of notches on flakes and cores are the relevant elements of analysis. The data derive from Tables 57-59.

Alteration Defined by Small Flake Removal

Although several different variables on every stone artefact were measured, only those considered most crucial were analysed. Height usually simply indicates whether a piece of stone is a flake or a core. Likewise, the weight of the artefact reflects not only height, but also the length and width of the object, and both the latter are recorded. The independent measures of value are length, width and length of altered edge.

Because of the small samples, and because assumptions could not be made about the samples being part of a normal distribution, certain non-parametric statistics were used in the analysis. These were the Mann-Whitney U test and Spearman's rank correlation coefficient, both of which are described by Siegel (1956). The resultant test values have been converted to z for ease of reference and to obtain significance levels. Those sites for which samples are considered adequate are LR 1, LR 2, AC 1 and MAT 1, though LR 2 (n = 3) is almost certainly borderline.

Table 61 presents correlations between the lengths and widths of altered stone. As can be seen, correlations are reasonably high - but note the negative value for the low n LR 2 - and most probability levels (except for LR 2) are such that it is reasonably certain those correlations are significant. Flakes generally conform to a particular relationship between the length and the width of the artefact. It cannot necessarily be inferred however that this reflects cultural values. The shape is more likely to represent an optimum one for fingers to manipulate.

<table>
<thead>
<tr>
<th>Site</th>
<th>r</th>
<th>z</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>LR 1</td>
<td>0.75</td>
<td>2.25</td>
<td>0.0122</td>
</tr>
<tr>
<td>LR 2</td>
<td>-0.25</td>
<td>0.35</td>
<td>0.3632</td>
</tr>
<tr>
<td>AC 1</td>
<td>0.85</td>
<td>1.70</td>
<td>0.0446</td>
</tr>
<tr>
<td>MAT 1</td>
<td>0.73</td>
<td>2.91</td>
<td>0.0019</td>
</tr>
</tbody>
</table>

Table 61 Spearman rank correlation analysis: utilised flakes, length with width

Similar correlations were calculated for the relationship between the length of the artefact and the length of that part of it from which flakes have been removed. Reference to Table 62 will show that values for r are not very high; in addition, only the coefficient for MAT 1 has a reasonably high probability of not being due to chance. It seems most likely, as might be expected, that the length of alteration on such flakes is not very closely related to length of the artefact; rather, the length of that alteration probably varies most closely with the type of job and intensity of use, as well as with the amount of usable edge.

<table>
<thead>
<tr>
<th>Site</th>
<th>r</th>
<th>z</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>LR 1</td>
<td>0.68</td>
<td>2.04</td>
<td>0.0207</td>
</tr>
<tr>
<td>LR 2</td>
<td>-0.50</td>
<td>0.71</td>
<td>0.2387</td>
</tr>
<tr>
<td>AC 1</td>
<td>0.71</td>
<td>1.60</td>
<td>0.0548</td>
</tr>
<tr>
<td>MAT 1</td>
<td>0.58</td>
<td>2.31</td>
<td>0.0104</td>
</tr>
</tbody>
</table>

Table 62 Spearman rank correlation analysis: flakes, length with length of use-wear
Having ascertained that length probably varies significantly and proportionately with width, and that the amount of alteration varies independently, it remains to be determined whether there are any significant differences between sites. The length means for the various sites are: LR 1 = 23.9 mm; LR 2 = 31.7 mm; AC 1 = 37.2 mm; and MAT 1 = 32.9 mm. With this range, it was felt that significant differences might be present, but the Mann-Whitney U test suggests that the site samples could all derive from the same population.

Scrapers

Scrapers, stones retouched so that a more or less blunt face with a steep angle relative to the longitudinal axis is formed, were found on every site except LRC 2. Even then, however, the total sample numbered only 20. The sample was split into two analytic units consisting of scrapers from MAT 1 and those from elsewhere.

The mainland scrapers were first divided into quartz and chert varieties, calculated and the probabilities of significance obtained. While the results were interesting, with a quartz length/width correlation of 0.80, the sample of four did not allow a high enough probability of significance (0.0832), and correlations were very low for the other variables. The chert results were also interesting: between all variables a correlation of 1.00 was achieved, but again low n would allow a significant level of only 0.0418, which is high enough to warrant suspicion but not to reject the null hypothesis. The samples were therefore combined, with results as shown in Table 63: length and width is most strongly correlated, though width and height and length and height are also significantly associated. Calculations for the Mann-Whitney U test, however, show no significant relationships.

<table>
<thead>
<tr>
<th></th>
<th>r</th>
<th>z</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length/width</td>
<td>0.89</td>
<td>2.52</td>
<td>0.0059</td>
</tr>
<tr>
<td>Width/height</td>
<td>0.88</td>
<td>2.50</td>
<td>0.0062</td>
</tr>
<tr>
<td>Length/height</td>
<td>0.78</td>
<td>2.19</td>
<td>0.0143</td>
</tr>
</tbody>
</table>

Table 63 Spearman rank correlation analysis: scrapers, length with width and height, sites Louisa River site 1, Louisa River site 2, Louisa River site 3, and Anchorage Cove site 1

The MAT 1 sample was similarly divided into kinds of stone—quartz, chert and quartzite. Only a single chert scraper is represented, though there are five each of quartz and quartzite. The statistical results were much as for the mainland, though the highest correlation was this time for quartz length versus width (1.00), but with an inadequate significance level of 0.0228. The mean sizes for the quartz are 32.8 mm long, 22.0 mm wide and 11.4 mm high; for quartzite, 42.8 mm, 31.4 mm and 11.4 mm, respectively. Like the mainland samples, however, the Mann-Whitney U test suggests that the null hypothesis be accepted.

All MAT 1 scrapers were then combined, with correlation results as shown on Table 64. The strongest correlation is seen between length and width (0.94); z and p are well within the null hypothesis rejection range. The other variables, however, were very weakly correlated and could not be accepted as significant.

Similarly, there appears to be no size variation between the mainland scrapers and MAT 1; all possible combinations, tested by the Mann-Whitney U test, were insignificant. Considered as a group, the length and width of all scrapers are strongly correlated (height is an independent variable), perhaps, like the flakes examined earlier, a function of optimum ease in handling the tool.

The average length of the scrapers, then, is 39.0 mm, width is 28.6 mm and height 10.8 mm. Interestingly, the Mann-Whitney U test suggests a significant difference between the lengths of flakes (mean = 30.8 mm) and of scrapers (z = 3.94; p = 0.0001).

Scraper retouch angles were discussed in the last section. In reiteration, all but the LR 3 specimen in the mainland sample measured above 60° while six of the 13 MAT 1 scrapers measured less than 60°. There were no significant correlations between angle of retouch and size of tool.

<table>
<thead>
<tr>
<th></th>
<th>r</th>
<th>z</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length/width</td>
<td>0.94</td>
<td>2.98</td>
<td>0.0014</td>
</tr>
<tr>
<td>Width/height</td>
<td>0.53</td>
<td>1.68</td>
<td>0.0465</td>
</tr>
<tr>
<td>Length/height</td>
<td>0.31</td>
<td>0.98</td>
<td>0.1635</td>
</tr>
</tbody>
</table>

Table 64 Spearman rank correlation analysis: scrapers, length with width and height, Maatsuyker Island site 1
Notched Artefacts

This category of tool was classified on the basis of a notch made in a flake or a core. There were only 10 such artefacts, one at LR 1 (core), two from LR 2 (one core), a single notch on a flake from LRC 2, and three at MAT 1 (two on cores, one with a double notch). Their sizes did not differ significantly from the scrapers, and the only other attribute was the diameter of the notch. These ranged from 6-10 mm, with a mean of 8.3 mm.

Nosed Artefacts

These five artefacts, all from MAT 1 and distinguished by the more or less uniform removal of flakes from a convex edge, were separated from the flake category on the grounds of being nosed. They were made either on chunky flakes or on cores and their average height is 19 mm. Indeed, the other dimensions are similarly larger than scrapers: 35.8 mm long as against 32.8 mm for scrapers, and 25.0 mm wide as against 22.9 mm for scrapers, but statistical testing (Mann-Whitney U test) suggests that they probably belong to the same population.

Other Stone Artefacts

A single pointed flake from MAT 1 has use alteration consistent with piercing experiments carried out with similar stone, although such an identification of function is not positive (J. Kamminga pers. comm.). There were only two quartz pebbles with hammer marking, one from Maatsuyker Island and the other from the Dense Shell deposit of site LR 1.

SUMMARY AND INTERPRETATION

The analysis of stone artefacts recovered from the excavated sites at Louisa Bay and on Maatsuyker Island (see Table 65 for a summary) revealed that the industry involved was a simple and relatively uniform one, differing little or not at all through time or across space. The majority of recovered stone was a very poor quality quartz, flaked and fractured in a haphazard manner, apparently not involving the bipolar technique for quartz flaking.

<table>
<thead>
<tr>
<th>Site</th>
<th>Quartz tools</th>
<th>Quartzite flakes &amp; cores</th>
<th>Quartzite tools</th>
<th>Chert flakes &amp; cores</th>
<th>Chert tools</th>
<th>Rhyolite</th>
<th>Volcanic tuff</th>
<th>Vein quartz</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>LR 1</td>
<td>1246</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>71</td>
<td>12</td>
<td>1</td>
<td>-</td>
<td>1332</td>
</tr>
<tr>
<td>LR 2</td>
<td>1474</td>
<td>3</td>
<td>0</td>
<td>26</td>
<td>4</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1507</td>
</tr>
<tr>
<td>LR 3</td>
<td>600</td>
<td>-</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>607</td>
</tr>
<tr>
<td>LRC 1</td>
<td>42</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>LRC 2</td>
<td>42</td>
<td>-</td>
<td>-</td>
<td>125</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>131</td>
</tr>
<tr>
<td>AC 1</td>
<td>442</td>
<td>3</td>
<td>-</td>
<td>14</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>4</td>
<td>467</td>
</tr>
<tr>
<td>MAT 1</td>
<td>3450</td>
<td>20</td>
<td>50</td>
<td>27</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>3563</td>
</tr>
<tr>
<td>Total</td>
<td>7337</td>
<td>28</td>
<td>51</td>
<td>13</td>
<td>148</td>
<td>24</td>
<td>2</td>
<td>1</td>
<td>7608</td>
</tr>
</tbody>
</table>

Table 65 Summary of altered stone

Chert and other exotic stones were brought to the various sites, the majority to Maatsuyker Island, where exotic quartzites were also relatively plentiful in the site.

Analysis of the secondarily altered stone was undertaken on four classes of artefacts called flakes, scrapers, notched artefacts and nosed artefacts. Statistical analysis revealed that no distinctions could be made between assemblages of flakes at different sites, though a close correlation was found to exist between length and width of the populations, separately and together.

Scrapers, likewise, were statistically indistinguishable from one site to another, and there was, similarly, a close correlation between length and width. The single difference appearing out of the analysis was that nearly half the 13 Maatsuyker Island scrapers exhibited retouch angles of less than 60°, the remainder of greater than 60°. Only one of nine such scrapers on the mainland had a retouch angle of less than 60°. While there may be a functional reason for the observed distribution, perhaps connected with butchering seals or the manufacture of other tools required for killing seals, its precise nature cannot be defined. Scrapers at all sites were found to be larger than flakes.
Notched artefacts were found to be the same size as scrapers, and the notch size averaged 8.3 mm. Nosed artefacts are also the same size as scrapers, but unlike all other classes are restricted to Maatsuyker Island and may be associated with sealing activities.

A possible piercing tool was recovered from Maatsuyker Island, and two quartz hammerstones, one from Maatsuyker Island and the other from LR 1, complete the inventory.

The most impressive part of the stone industry from Louisa Bay and Maatsuyker Island is the immensity of the quartz assemblage. The products sought were probably sharp-edged flakes - instant tools useful for general cutting of soft materials like fur and flesh. The intensity of that use, however, must remain an unknown factor in the absence of means to identify that alteration on most quartz edges (13 probable cases were so identified out of a potential 1531 flakes). It is perhaps arguable, even, that such edges were preferred to those in chert: out of 156 chert flakes, on which alteration is easily detected, only 14 exhibit any form of secondary alteration that might be consistent with use. On Maatsuyker Island it would appear that quartzite might have been considered chert's equivalent, as six out of 50 quartzite flakes exhibit alteration, compared with one chert flake out of 27 ($\chi^2 = 1.25$).

The picture developed for other kinds of artefacts is somewhat different, though of course those quartz pieces exhibiting alteration consistent with scrapers, as the main category, may be only a portion of those that were in fact similarly altered but undetectably so. On the other hand, imagination coupled with lighting effects could have led to the identification of alteration when in fact there was none. The important point here, however, is that on the mainland seven such tools were made on chert while on Maatsuyker Island quartzite appears to have been preferred. However one looks at these data, though, the number of formal tools is extremely low. Only two classes might be interpreted to have been used for special purposes, the scrapers (20) reflecting woodworking, and notches (7) whose size could probably only mean the maintenance of spear tips, but only a fraction of these artefacts exhibit any evidence of ever having been used (J. Kaminga pers. comm.).

The overwhelming impression, then, is of a people whose stone artefactual requirements were met by flaking quantities of quartz, out of which were selected suitable sharp flakes which were used for generalised cutting and slicing activities.
APPENDIX 2

A recent prehistoric bone point from Louisa River site 1

Johan Kamminga

A bone point dating to less than 4000 BP was recovered from LR 1, from within the Grey Sand deposit of Figure 5 (Vanderwal 1978a). This tool is similar to much more ancient ones from the Tasmanian and island sites excavated by Bowdler (1974) and Jones (1966:3).

The point is made from a macropod fibula (specifically a wallaby), ground on its distal end. Its length is 145 mm and it has a diameter of 7.5 mm at mid-section, narrowing to 2 mm immediately before the apex of the ground tip (Fig. 48). Examination at relatively low magnification (x4–x50) with a stereo-microscope revealed a number of features that could be attributed to the method of manufacture and to the deposition environment. Obvious evidence of general dehydration occurs in the form of seven major shrinkage cracks, one 30 mm long, running longitudinally along the shaft of the fibula. These are accompanied by numerous, very fine hairline cracks. The articular surface at the proximal end of the fibula has suffered surface degradation, almost certainly a result of natural depositional processes.

Definite traces of grinding, intended to shape the tip, are only barely detectable. These traces consist of two small areas near the tip which have aligned broad but short striae. The bone point is lightly polished for most of its length. More intense polish appears on the tip and for approximately 35 mm of the length of the distal portion of the shaft. Longitudinal striations are observable within the area of intense polish. These striations, however, are not recognisably patterned and are of varied lengths and widths. The light polish may well be the result of general handling of the bone point or other accumulated non-use contact situations with soft materials.

There is very little information available on the nature of use-wear on bone. The fact that bone polishes quite readily in many different contact situations frustrates any attempt at a specific functional ascription of this particular artefact. Overall size is also as yet of no real diagnostic value. Ethnographic sources indicate that in Australia bone points were used for a wide range of activities, including peeling vegetables, hollowing out earring tubes, picking the bark off water vessels, boring holes in wood, piercing bark, picking the kernels from nuts, awling dry marsupial skins and arming spears (Roth 1904:25).

The bone point under examination could have served any number of purposes from awling skin to adorning the person, and no particular functional ascription can be forwarded.

Fig. 48  Bone point from Louisa River site 1
Allen, H. 1979 Left out in the cold: why the Tasmanians stopped eating fish. The Artefact 4:1-10


Bonwick, J. 1870 On the origins of the Tasmanians geologically considered. Journal of the Ethnographic Society 2:121-130


Cane, S., J. Stockton and A. Vallance 1979 A note on the diet of the Tasmanian Aborigines. Australian Archaeology 9:77-81


Coleman, E. 1966 An analysis of small samples from the West Point shell midden. Unpublished BA(Hons) thesis. Sydney: University of Sydney


Coon, C.S. 1971 The hunting peoples. Pelican


Dutterreau, B. 1835 Aborigines Making and Straightening Spears. [Etching plate, Ballarat Fine Art Gallery]
Dutertreau, B. 1836 Wild Native taking a Kangaroo, His Dog having caught it, he runs to kill it with his Waddy. [Etching plate, Ballarat Fine Art Gallery]


Egloff, B. 1979 Recent prehistory in southeast Papua. Canberra: Australian National University, Research School of Pacific Studies, Department of Prehistory, Terra Australis 4

Flemmeyer, J.R. 1977 Age determination in the teeth of the Cape fur seal and its bearing on the seasonal mobility hypothesis proposed for the Western Cape, South Africa. South African Archaeological Bulletin 32:146-149

Flinders, M. 1801 Observations on the coast of Van Diemen's Land, on Bass's Strait and its islands, and on part of the coasts of New South Wales. London: Nichol


Green, R.H. 1967a Notes on the devil (Sarcophilus harrisii) and the quoll (Dasyurus viverrinus) in northeastern Tasmania. Records of the Queen Victoria Museum, Launceston 27

Green, R.H. 1967b The murids and small dasyurids in Tasmania, Parts 1 and 2. Records of the Queen Victoria Museum, Launceston 28

Green, R.H. 1968 The murids and small dasyurids in Tasmania, Parts 3 and 4. Records of the Queen Victoria Museum, Launceston 32

Green, R.H. 1972 The murids and small dasyurids in Tasmania, Parts 5, 6 and 7. Records of the Queen Victoria Museum, Launceston 46

Green, R.H. 1973 The mammals of Tasmania. Launceston: the author


Guiler, E. 1954 The intertidal zonation at two places in southern Tasmania. Papers and Proceedings of the Royal Society of Tasmania 88:105-199


Hayden, B. 1979 Palaeolithic reflections: lithic technology and ethnographic excavations among Australian Aborigines. Canberra: Australian Institute of Aboriginal Studies
Heinsohn, G.E. 1968 Habitat requirements and reproductive potential of the macropod marsupial Potorous tridactylus in Tasmania. Mammalia 32:30-43


Jones, R. 1966 A speculative archaeological sequence for northwest Tasmania. Records of the Queen Victoria Museum, Launceston 25

Jones, R. 1968 The geographical background to the arrival of man in Australia and Tasmania. Archaeology and Physical Anthropology in Oceania 3:186-215


Kelly, J. 1921 The first discovery of Port Davey and Macquarie Harbour. Papers and proceedings of the Royal Society of Tasmania, pp.160-181


Macphail, M. 1978 Climatic changes in the evolution of the south-west wildsace. In Gee and Fenton 1978:81-83


Maiden, J.H. 1889 *The useful native plants of Australia*. Turner and Henderson for the Technological Museum of New South Wales

Meehan, B. 1977a Hunters by the seashore. *Journal of Human Evolution* 6:363-370


Norman, L. 1946 *Sea wolves and bandits*. Hobart: Walsh and Sons

Nunez, M. 1978 *Climate*. In Gee and Fenton 1978:67-69

Peron, F. 1975 *A voyage of discovery to the southern hemisphere, performed by the order of the Emperor Napoleon during the years 1801, 1802, 1803 and 1804*. Melbourne: Facsimile copy, March Walsh


Ranson, D. 1978 A preliminary examination of prehistoric coastal settlement at Nelson Bay, west coast of Tasmania. *Australian Archaeology* 8:149-158

Robinson, G.A. see Plomley 1966


Sullivan, K.M. 1973 The archaeology of Mangat and some of the problems of analysing a quartz industry. Unpublished BA(Hons) thesis. Sydney: University of Sydney

Sutherland, F.L. 1972 The classification, distribution, analysis and sources of materials in flaked stone implements of Tasmanian Aborigines. *Records of the Queen Victoria Museum, Launceston* 42


Warneke, R.M. 1968 The fur seal. In Wildlife in southeastern Australia. ABC Radio Science


White, J.P. 1968 Fabricators, outils écaillés or scalar cores? Mankind 6:658-666


