The Warruwi Pond enigma: Pre-European aquaculture in Arnhem Land?

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A thesis submitted for the degree of Doctor of Philosophy of the Australian National University

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Declaration

I hereby declare that the work herein, now submitted as a thesis for the degree of Doctor of Philosophy, is the result of my own investigations and all references to ideas and work of other researchers have been specifically acknowledged. I hereby certify that the work embodied in this thesis has not already been accepted in substance for any other degree and is not currently being submitted in candidature for any other degree.

Signed

Graeme Dobson
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Abstract

This project sets out with two principle aims:

1. Determine the origins and uses of a stone pond-like structure near South Goulburn Island, west Arnhem Land, Northern Territory, Australia

2. Describe the methods and origins of traditional Yolgnu pearl cultivation in north east Arnhem Land

It also seeks to determine if comparative aquaculture and marine wild stock management techniques, taken together with historical and archaeological sources, can be used to identify early foreign activity in Arnhem Land, Northern Territory of Australia.

There is one known pre-European example of aquaculture in Arnhem Land—Indigenous pearl cultivation by Yolgnu, the Indigenous clans of northeast Arnhem Land. There is also a large hitherto undescribed stone walled, clay lined pond in the low intertidal area in Mardbulk Bay off the community of Warruwi on South Goulburn Island in west Arnhem Land (the Warruwi pond) which was potentially used for either aquaculture or wild marine stock management. Local clans do not claim this structure nor are they aware of its origins or uses.

The Warruwi Pond is described in this thesis and that description used to compare it with structures used in four possible scenarios for the pond’s use. These were a ceremonial ground, a wild stock management tool, a fish trap and aquaculture. It is also compared to similar structures with known uses in the region. Two linked activities are identified as possible uses for the Warruwi pond, holding live sea cucumbers prior to processing and as a spawning enhancement device (where a single species is heavily stocked in a confined area and induced to breed, the proximity of individuals maximises breeding success).

East Arnhem Land pearl cultivation is also described and compared to known modern and historic techniques to determine the origins of the Arnhem Land method. It is probable that the pearl industry, both wild harvested and cultured, was introduced to the Yolgnu as they had no significant use for pearls other than to trade with foreigners and were, therefore, unlikely to have learned the technique themselves.

Comparisons of the Warruwi pond and structures associated with pearl cultivation determined that the two were probably not linked, leading to the conclusion that two or more distinct groups of foreign people were active in Arnhem Land in pre-
European times. Identifying these people (albeit tentatively) required a detailed examination of the history of the region, of sea cucumber cultivation, trade and consumption, and pearl trade and cultivation. Evidence in each of these topics is sparse for the most part, so use is made of several disparate sources and observations.

Using aquaculture and marine wild stock management as central themes, this thesis draws together a range of sources to determine which were the most likely foreign groups active in pre-European north Australia, and proposes hypotheses on when they came, how long they stayed, what they did there and why they departed.

This thesis adds two more significant pieces of evidence for foreign activity in north Australia prior to the mid-18th C, but given the scant and often controversial nature of other evidence the conclusions of this research remain tentative and provisional. Further research is suggested into several enigmatic artefacts identified in the course of this study which may serve to reinforce or undermine these conclusions.
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Chapter 1

Introduction

Aims

This project had two principle aims:

1. Determine the origins and uses of a stone pond-like structure near Warruwi, South Goulburn Island, west Arnhem Land, Northern Territory, Australia.

2. Describe the methods and origins of traditional Yolngu pearl cultivation in north east Arnhem Land.

The problem

The main problem encountered in achieving the first aim lay in determining what possible uses the pond could have had and who had the technology and opportunity to have built it—which was not simply a question of ‘Indigenous or introduced?’, but ‘Indigenous or which group of foreigners built/introduced it?’.

The structure and location of this pond, henceforth called the “Warruwi Pond”, strongly suggest there was some form of marine cultivation being conducted there in pre-European times, but, although there are examples of Indigenous aquaculture from around Australia (Ross, 1996; Barham et al, 2004; Builth, 2005), there was no known tradition for the cultivation of either marine or fresh water species on the north coast of Arnhem Land. Nor are there any histories—oral or otherwise—that could be interpreted as describing aquaculture, the closest that were uncovered were stories of a tradition of pearl cultivation in northeast Arnhem Land (Trudgeon, 2000; Danatunga, per com, 2011) and statements by two elders:

“We used to grow fish and clams and oysters. Trap fish, collect little clams and [pearl] oysters and put them in ponds [smaller and more irregularly shaped enclosures] to grow up.” (Per Com, Anon, 2004).

And:

“Collect big clams and oysters, put them together in a pond and pretty soon there are lots of little ones around.” (Per Com, Gali, 2004).

Both these examples were from east Arnhem Land, several hundred kilometres from the Warruwi pond in the west of Arnhem Land.

A similar problem was encountered in achieving the second aim—proving the veracity of traditional pearl cultivation and determining who had the technology to
cultivate pearls and the opportunity to introduce it to Arnhem Land, Indigenous Yolgnu or an unknown group of foreigners. If the technology were imported there were a number of candidates, the most likely being the Chinese who had developed pearl cultivation at a very early period (Kunz & Stevenson, 1908; Jackson, 1917; Donkin, 1998; Gungwu, 2003; Hall, 2006). The Chinese had been trading spices from the Malukus since at least the 6th C (Ellen, 2003; Gungwu, 2003) and visited the Malukus at least as early as the 15th C when a ‘treasure fleet’ visited the region in search of ‘useful and valuable goods’—including pearls (McMillan, 2001)—and in 1603 Australia appeared on a Chinese map. But that doesn’t mean they visited it, the map may have been compiled using second hand information, nor that they imported technology. All it says is that they had pearl cultivation technology and the opportunity to introduce it.

Once Indigenous pearl cultivation was proven it became one of determining if it were linked to the Warruwi Pond and therefore related back to the first problem ‘determine the origins and uses of a stone pond-like structure near South Goulburn Island, west Arnhem Land, Northern Territory, Australia’ (the Warruwi Pond).

Background

This project had its genesis in the early 2000s when I was working with Indigenous communities in north Australia. At the time I was teaching aquaculture on behalf of the Northern Territory University (now Charles Darwin University) and working with Aboriginal Traditional Owners in coastal Arnhem Land to research appropriate forms of aquaculture to suit its unique physical and social environment. One day a colleague who had just returned from teaching at Warruwi on South Goulburn Island, asked me:

“What do you make of that fish trap in front of Warruwi? I can’t see how it could work. ”

The ‘fish trap’, as it was commonly referred to, appeared from the beach to be a semi-circular pile of stones (Fig 1.1) about 200m offshore in Mardbulk Bay, in front of the community of Warruwi, on South Goulburn Island in west Arnhem Land.
The Warruwi structure—a semi-circular pile of stones when seen from the beach

Shortly afterward I had occasion to visit the Northern Territory (NT) lands office to check some aerial photos, and while there I looked for photos of Warruwi and Mardbulk Bay. By happy coincidence I found a photo (Fig 1.2) that had been taken at a low tide when the structure was visible and I was somewhat surprised to see an almost perfect circle where the ‘fish trap’ stood. Seen from above it was anything but a random pile of stones and clearly warranted further investigation.
I took the image to the local Traditional Owners and asked them what it was, and received the rather surprising answer:

"Don’t know, it’s not ours. Balanda (Europeans) call it a fish trap, but we’ve never seen it used."

The stones are so low in the intertidal zone that they’re covered with water on all but spring low tides, so when I next visited Warruwi on a spring tide I obtained permission from the Traditional Owners (TOs) concerned to investigate it, then waded through the thigh-deep mud that clogs the bay to make a quick and cautious inspection (quick because the low tide did not extend far beyond the structure, and careful because at least three saltwater crocodiles were known to frequent the bay).

The structure formed an almost perfectly circular, strongly constructed stone wall 1.2 – 1.5m high enclosing a pond ~40m in diameter. I paced out approximate measurements, noted the uniform stone sizes and dug an exploratory hole through the mud to the bottom of the wall to estimate the wall height. When I dug the hole at the wall I found some clay, so I dug another toward the centre of the structure and discovered a heterogeneous layer of clay and small stones. The clay layer was only about 15cm thick.
and did not appear natural. Indeed it seemed that the pond had been waterproofed as a part of its construction.

At this point I agreed with my colleague—that while the structure was definitely man-made, I could not see how it might function as a fish trap because the wall described an intact circle, leaving neither an entrance nor a catchment area, features normally associated with fish traps (Bowen & Rowland, 1999; Walters, 1885; Best, 1977; Marshall, 1986; Slack-Smith, 2001). As it stands, the structure would only catch fish unlucky enough to be caught in the circle at spring low tide (about 1/3 of the tidal cycles). Unless there were some unique local fishing technique employed, such as nets or baits, or there had been significant alteration of the structure over time it appeared very unlikely that it had operated as a fish trap.

It does, however, closely resemble an aquaculture pond in all respects except its location low in the intertidal zone where the wall is overtopped by water most of the time, which means that it could not be used to hold anything that could swim. The structure now began to be referred to simply as the ‘Warruwi pond’.

When I discussed it further with the Aboriginal elders some said that they thought it had been built by Makassans to hold trepang (sea cucumbers), but they were not sure. The term ‘Makassan’ was first used by Campbell Macknight to refer to Indonesian fishermen originating from the south Sulawesi city of Makassar who frequented Arnhem Land in the 18th and 19th Cs (Macknight, 1976; Baker, 1987) in search of valuable trepang which they exported to China. The reference by the elders to ‘trepang’ is slightly misleading in this context. Trepang are actually the boiled, dried and preserved body walls of a variety of species of sea cucumbers (holothurian spp), a delicacy much sought after by the Chinese, but it is a distinction that is seldom made by traditional people, Aboriginal or Malukun, throughout the region.

As to how the pond was built, one old man, Tommy Gagaraba, said that he had heard that:

“Makassans made everyone line up across the sand and pass rocks down the line to make the wall. It was very hard work.”

Unfortunately Tommy could not say where he had got this information, other than he was told the story when he was young.
Finally Bunug, then the Warruwi Council Chairman of the local Aboriginal resident community, asked me to find out what it was—and then to tell them.

On my next trip around Arnhem Land I took the aerial photo of the pond with me and asked TOs across the region if they knew of anything similar. I thought that perhaps they were a reasonably common, but unrecorded, phenomena and their builders and uses would be quickly explained. It turned out that no one had seen such a structure, but the image led to discussions about traditional aquaculture-like practices that I had never heard of before. Many of these practices trod a fine line between wild harvesting, stock management and aquaculture, which is to be expected with people who live so close to the natural cycles of the sea, but some activities, such as gathering clams and oysters and concentrating them in small ponds to improve spawning success (Various Elders, Per Com, 2005), certainly appeared to be at least proto-aquacultural in intent.

Only one technique, pearl cultivation (Trudgen, 2000; Dunutunga, Per Com, 2005) previously described among the Yolgnu from east Arnhem Land, did not involve increasing the availability of food species. This was intriguing in a hunter-gatherer society as, although at least one Yolgnu clan—the Warramiri—includes both pearls and pearl shell as totems (Mcintosh, 2005), many do not place any particular value on either other than using shell to decorate some sacred objects and some larger pearls in fashioning amulets and for magic (Berndt & Berndt, 1954; Dunutunga, Per Com, 2005). I was told that pearls were used for trade with Makassans, which meant that the stimulus to learn how to cultivate pearls must have been the opportunity for trade.

So now I had a large stone pond with unknown (but by their own admission probably not Indigenous) builders and uses, and an aquaculture practice that produced a product that the growers had no use for except as foreign trade goods. Both were linked to visiting Makassans. Together they appeared to provide enough evidence to propose a hypothesis that Indigenous and/or Makassan activity on Australia’s Arnhem Land coast in pre-European times included aquaculture or something approaching it.

Aquaculture was not the only subject I heard about in the course of my six or seven years of travels among the Yolgnu in east Arnhem Land. They also spoke of the Bayinia small, ‘white’ or pale skinned people who visited them before the Makassans arrived. I later also heard about another group of early visitors who were referred to as the Whale Hunters or Wurramala (Mcintosh, 1995b). This information presented the possibility that it may have been other foreign visitors to the shores who were responsible
for the Warruwi pond and the Yolgnu pearl cultivation techniques. It also raised the possibility that they may be identified through technology transfer, that is to say matching structures and techniques in Arnhem Land with structures and techniques found elsewhere.

The rationale for this thesis thus rests with one large, well-preserved circular stone-walled pond half buried in glutinous mud a couple of hundred metres off a remote shore, and a collection of Aboriginal stories about pearls and visitors.

The problem was three-fold:

- Who built the Warruwi pond?
- Why?
- Were the pond and the Yolgnu stories of pearl production and visitors connected?

Research for this project required a cross-disciplinary approach involving a combination of marine science (aquaculture), anthropology, archaeology and history, with possibly the dominant discipline being aquaculture. I was able to bring to the study much of the necessary aquaculture knowledge and experience, as well as cross-cultural skills courtesy of my previous study and work experience. Since obtaining a Master’s Degree in aquaculture and marine ecology by research conducted in an Aboriginal homeland on Sunday Island in north Western Australia, I have worked extensively and closely with coastal Aboriginal groups in Arnhem Land and fishermen in east Indonesia and have become familiar with the physical environments, cultures and the aquaculture techniques central to this thesis. This practical experience and prior knowledge stood me in excellent stead to carry out the varied multi-disciplined research required to complete this project.

In the course of my research I have conducted fieldwork on South Goulburn Island where I measured and took core samples from the Warruwi pond, excavated a small section of the pond wall and, with the help of the local Indigenous Sea Rangers, searched the nearby mainland coast for similar ponds. Other fieldwork in Arnhem Land included aerial surveys of the Arnhem Land coast at spring low tides to look for other extant examples of intertidal stone ponds, and research into and replication of Indigenous pearl cultivation techniques. I also searched aerial photos at the Northern Territory Department of Lands and satellite imagery of both Northern Territory and east Indonesian inshore waters. I visited Indonesia on several occasions to research regional history in Makassar,
Ternate, Tidore, Ambon, Aru Islands, Kei Islands and the Tanimbar Islands and to conduct ground searches for ponds similar to the Warruwi example.

It soon became apparent, however, that coastal searches by any means could only reveal a fraction of the number of ponds that may exist. The coastal interface, particularly in Arnhem Land, between terrestrial and marine environments is dynamic with regular localised sand movement, both above and below the low tide mark, leading to localised erosion or accumulation (personal observation). This can be exceptionally severe during the wet season, especially when a cyclone or severe tropical storm brings about a tidal surge, with elevated water levels that are caused by low atmospheric pressure coinciding with a high tide driven by strong on-shore winds (Australian Bureau of Meteorology, Darwin, Per Com, 2005).

Dune movement also occurs in the dry season when strong and consistent winds shift beach sands more slowly than, but just as surely, as cyclones. Sand movement is exacerbated when fires destroy beach vegetation that would otherwise consolidate the sand. Sand and silt brought to the sea from flood runoff can alter the marine environment by smothering reefs and infilling bays and channels. Mangroves trap silt and in so doing create environments suitable for more mangrove growth, which in turn traps more silt, and so on. This natural progression of the mangrove zone can be quite rapid and is capable of covering large features both onshore and in the immediate offshore zone, including archaeological artefacts such as man-made stone ponds. Conversely, sand and silt movement can expose artefacts previously buried.

Inshore waters not subject to high siltation usually support rapidly growing coral reefs. These corals overgrow any exposed substrate, including artefacts, and quickly render them almost unrecognisable. A direct hit from a cyclone will often break up reefs leaving a jumble of upturned and dead corals, which in turn rapidly overgrown by new corals. In such cases any artefacts that formed the reef's original substrate would likely be unrecognisable and hidden forever.

In keeping with the multi-disciplinary nature of the thesis, my literature search covered a wide range of subjects, including aquaculture, marine ecology, history, anthropology and archaeology—in many cases topics related only by their relevance to this thesis. In some aspects of the study there is an apparent dearth of modern references, so where the topic does not depend on up-to-date scientific research (for example on the
history of pearls) I have used publications up to a century or more old. I have also referred to the writings of several chroniclers in the region, including Earl, Searcy, Foelsche, Forrest, King, Kolff, Idriess, Harney and Whittington, whose writings present first-hand observations spanning more than a century and a half.

Reference is often made throughout the thesis to personal communications (Per Com) with a wide range of informants across both the Northern Territory and Indonesia. There are also instances where data or information has been obtained through my personal observations outside of the specific research required for the thesis, for example in the course of my work prior to, or concurrent with the thesis research.

An Antipodean Mediterranean

A map of the Arafura and Banda Seas is reminiscent of a map of the Mediterranean—heavily populated and lush, productive lands to the north separated by a few hundred kilometres of sea from a sparsely populated, comparatively arid and unproductive land to the south. On this basis I have approached this thesis from the viewpoint that the north coast of the Northern Territory of Australia is geographically and historically a part of SE Asia, albeit a peripheral part (Fig 1.3), and the history and people of Arnhem Land were integrated with that region right up until the opening of the 20th C.

Like the North African littoral, the arid interior to the south of Arnhem Land forms a far more effective barrier than the sea to the north. There are two diametrically opposite ways to look at a map (Bennet, 2001):

- The ‘Continental’ (European) attitude where seas form a barrier
- The ‘Island/Archipelagic’ (SE Asia and Pacific) attitude that seas are roads that connect
The early British settlers in the Northern Territory, particularly those at Port Essington, understood the Island interpretation and would have viewed any idea that north Australia was somehow separate from the region as ridiculous, especially as they depended on ports a couple of days sail to the north for their fresh fruit and vegetables (Cameron, 1999). They even went to great trouble to try and entice entrepreneurs from those ports to settle in Port Essington to create an Australian-based Asian trading centre to rival Singapore and compete directly with the Dutch in the far SE Asian region (Cameron, 1999).

In modern times we have become used to the Continental view that Australia is a distinct entity that is irrevocably divided by sea from SE Asia. This is a distinction that was fostered throughout the 20th C to emphasis Australia as a white, Anglo-Saxon bastion in an Asian hemisphere. Attitudes have changed a great deal but the impression of isolation, both historic and modern, still pervades both public and political thinking.

Today Arnhem Land is a remote, impoverished piece of Aboriginal-owned land occupying about 79,900 ha of the north-east part of the Northern Territory of Australia (Fig 1.4). It was officially established in Australian law on 16th of April 1931 on the recommendation of the 1929 Bleakly report (Dewar, 1992). Permanent Aboriginal settlements on the north coast came about when missionaries arrived and established
mission stations in the early 20th C. These gave rise to the eight communities (Fig 1.4) that are now scattered along the coast. The coastal Indigenous communities of Minjilang (on Croker Island), Warruwi (on Goulburn Island), Maningrida, Milingimbi, Galiwin'ku (on Eleho Island) and Yirrkala are more or less evenly distributed along the north coast, and the community of Numbulwar is near the south border on the east (Gulf of Carpentaria) coast. With the exception of Maningrida, these communities are situated on the sites of missions established in the first half of the 20th C. Only three communities—Gunbalunya, Ramingining and Ngukurr—are located away from the coast. The Aboriginal-owned Cobourg peninsula (including Gurig National Park), Groote Eylandt and the Tiwi Islands lie outside Arnhem Land.

The nearest major population centre to Arnhem Land is Darwin, the capital of the Northern Territory of Australia. The uranium-mining town of Jabiru and Kakadu National Park lie on the west border, the bauxite-mining town of Nhulunbuy on the Gove peninsular is within east Arnhem Land and the manganese-mining town of Alyangula is on Groote Eylandt in the Gulf of Carpentaria off the east coast.
The Arnhem Land coast forms the south limit of the Arafura Sea, which is bound in the east by Papua New Guinea, in the north by the Tanimbar and Aru island groups and the Banda Sea, and on the west by the Timor Sea (Fig 1.5). It runs west to east for 500km, approximately between the latitudes of 10° to 13°S and 129° to 137°E, before turning sharply sou' sou' west for about 250km to the Roper River at about 15°S.

Figure 1.5  The Arafura and Banda Seas region (Map by ANU CartoGIS CAP)

The closest land to the north of Arnhem Land is the Tanimbar Islands (Fig 1.5) which lie approximately 350km north of the Cobourg Peninsular, and the Kalepom Peninsular in West Papua approximately 300km to the nor' nor'east of the Wessel Islands. To the north of the Tanimbar and Aru Islands lies the Banda and Seram Seas with a large number of islands, including Banda, Ambon and Seram. To the west of the Banda Sea lies the city of Makassar on the island of Sulawesi.

In contemporary times eleven Indigenous language groups (Northern Land Council, Per Com, various) occupy the north coast and islands of Arnhem Land (Fig 1.6),
however it is highly likely that some of these were not present on the coast a few hundred years ago, only moving in to fill vacancies left by groups driven to extinction in the 18th – 19th Cs or earlier (Earl, 1842 in Cameron, 1999). Each group has its own distinct language, history and customs, although some customs and ceremonies are common to all. There is some evidence that disease, warfare and possibly slavery (Earl, 1842 in Cameron, 1999; Russell, 2004) caused considerable disruption to Aboriginal society in the Tiwi Islands, Cobourg peninsular and west Arnhem Land before the mid-19th C. It is certain, however, that the 20th C saw major dislocation to, and fracturing of, Indigenous culture and society caused by physical assault from pastoralists, cultural assault from missionaries and assault on families and self-esteem from successive government policies (Trudgen, 2000).

**Figure 1.6** Indigenous language groups of coastal Arnhem Land (source: Northern Land Council)

There is currently a revival of traditional life that has seen a resurgence of Indigenous languages and customs, and the reoccupation of traditional land (Trudgen, 2000), but no resurgence in traditions can bring back Arnhem Land’s integration into the
region or the wealth, both cultural and material, that integration brought. Nor can it wholly reverse the social malaise that resulted from its integration into Australia.

The introduction of competing spheres of colonialism, Islam and Christianity have all served to influence the interpretation of history in the region by emphasising some aspects and downplaying, or ignoring, others. This makes interpreting regional history a fraught task. For example, the Makassans, the last foreign visitors to Australia's north coast before the advent of British rule, were expelled by an act of the South Australian Parliament in 1905 (Macknight, 1976; NT Archives Ref No 15236) after at least 150 years presence on the coast. They were then virtually forgotten until the mid-20\(^{th}\) C, and even today are seldom mentioned despite the role they played in north Australia's history.

Most events pertaining to the pre-European and pre-Islam period are, at best, poorly recorded and open to interpretation and question. It is to these records, however, that we must look when trying to decipher the enigma of the Warruwi pond.

Fortunately the poorly preserved, feeble threads of history pertaining to the region are in stark contrast to the physical preservation of the Warruwi pond. While disastrous for the Indigenous economy, isolation both ensured the preservation of the Warruwi pond from the attentions of the curious and the ravages of development, such as dredging or clearing for boating lanes. It also limited the number of candidates for building and using it to those who came before the turn of the 20\(^{th}\) C. Over the past century few outsiders have visited the Goulburn Islands, partly because their remoteness makes them both difficult and expensive to reach, but also for most of the 20\(^{th}\) C the islands were 'off limits' to outsiders. In the first half of the 20\(^{th}\) C Warruwi was the site of a mission station, which was established in 1916 (Lamilami, 1974) and went to extraordinary lengths to 'protect' its flock from outside influences (NT Archives 1374/15236; Dewar, 1992). In the mid-1970s Warruwi went through a transition from mission to government control and the Goulburn Islands became a part of the Arnhem Land Aboriginal reserve for which all visitors required a permit and a good reason to visit.

Being able to describe the Warruwi pond in the knowledge that it is very near its original condition enabled an informed comparison to be made, using current knowledge of several possible regional activities (ceremony, fish trapping, managing wild marine stocks and aquaculture), with various structures associated with each activity. This
process of comparison narrowed the options for the pond’s use, which in turn narrowed the options for its builders and even allowed an estimate for the pond’s approximate age.

In addition to the enigma posed by the Warruwi pond there were also questions posed by pearl cultivation in east Arnhem Land, such as determining how it originated, if it was linked to the pond and if the two represented two separate activities and two or more distinct examples of foreign involvement. This could be resolved only by comparing Arnhem Land pearl cultivation techniques with known modern and historic pearl cultivation methods, and comparing any structures that may have been used anywhere in pearl farming with the Warruwi pond. The outcome of these comparisons not only indicates if the Warruwi pond is linked to pearls, it also gives an indication of the possible origin of Arnhem Land pearl cultivation and who may have introduced it (with foreign trade the only significant use for pearls, it is unlikely that Yolgnu devised it themselves).

The plethora of comparatively sophisticated states and small political domains scattered through the islands a few hundred kilometres to the north provide many candidates for people who may have been active on the Arnhem Land coast in the distant past and therefore may have been linked to both (or either) the Warruwi pond and pearl cultivation. Historically Arnhem Land was Australia’s focus of activity and international trade—in fact it was at the forefront of Australian human history and development from the arrival of the first Indigenous people (Coutts, 1979; Lape, 2000; Allen & O’Connell, 2008) up until the British settlement of Sydney. And there is evidence that foreign activity on the north coast steadily increased in the centuries leading up to British settlement in the north.

To date the only proven pre-British, non-European visitors to Australian coasts were the Makassans whose huge fishing and trading fleets employed crew from all parts of east Indonesia and beyond. These fleets are known to have visited the Arnhem Land coast annually for at least 150 years (Macknight, 1969, 1976; Berndt, 1954, 1988; Baker, 1987; Berndt & Berndt, 1952, 1988; Spillett, 1983, 1988, 1996; Clarke, 2000), during which time local Aboriginal men and women were able to take ship with these Makassans and, through their experiences with foreigners at home and abroad, gain a degree of sophistication well beyond anything available to their southern cousins (Harney, 1946; Lamilami, 1974; Macknight, 1976: Trudgeon, 2000; Sharp, 2002; Ganter, 2006).
There appears to be several pieces of evidence of pre-Makassan arrivals in Arnhem Land—a rock painting in west Arnhem Land dating to between 1568 and 1625 (Tacon et al., 2010); a 15th–16th C sherd of stoneware (Bulbeck & Rowley, 2001); a cache of 12th–14th C coins (Mcintosh, 2012, Bulbeck & Rowley, 2001); several samples of charcoal dated to the 12th–17th C (MacKnight, 1976) and several references to foreigners from the north in Indigenous oral history. The provenance of all these artefacts remains under debate to varying degrees, and the oral history attracts considerable scepticism.

In this thesis there are several issues to be resolved before it can be established if there was any form of pre-European aquaculture in Arnhem Land. Initially two problems presented themselves—alleged pearl cultivation in northeast Arnhem Land and the provenance of the Warruwi pond in west Arnhem Land.

Pearl cultivation proved much the easier to resolve, a simple matter of asking Yolgnu about it, being shown the technique and verifying that it was scientifically feasible, then trawling through history to determine if the technique originated with Yolgnu or was introduced, and if so by whom and when.

The Warruwi pond presented the greater problem. It is a large physical structure of unknown use and origin, without apparent precedence in Australia and with virtually no associated local knowledge or datable material. The first task was to describe the pond and its environs in detail to give concrete data that could be compared to other structures, essentially making the Warruwi pond the *holotype*. This data was then used to first determine the pond’s likely use from four options—ceremonial, trapping fish, wild stock management and aquaculture—by comparing the pond’s attributes with those necessary for each of those functions.

Once the possible uses had been narrowed down, the pond’s attributes were once again used, together with its environment and Warruwi’s history, to further narrow the options. This was essentially a process of discarding the impossible, then the improbable to reach the possible and finally the probable.

With a probable use and a *holotype* in hand, the wider region was searched for similar ponds. Examples were found that verified the probable use of the Warruwi pond and identified their builders. A review of regional history demonstrated that it was
possible for the builders of the regional ponds to build and operate the Warruwi pond (and probably several others).

Finally, a review of the scant archaeological evidence and Yolgnu oral history (Allen & O'Connell, 2008; Berndt & Berndt, 1954; Clarke, 2000; Cole, 1979, 1980; Coutts, 1979; Dewar, 1992; Earl, 1846; Foelsche, 1881; King, 1827; Lamilami, 1974; Lape, 2000; Macknight, 1969; McMillan, 2001; Russell, 2004; Searcy, 1912; Tacon et al., 2010; Tommy Gagaraba and Billy Nawaloinba (per com)) allowed an estimate of approximate dates for building the pond and the commencement of pearl cultivation in Arnhem Land, and to draw conclusions as to the existence of pre-European aquaculture in Arnhem Land.

Chapter outline

Chapter 2  Stone ponds in the region

This chapter presents the survey methods employed to identify pond-like structures in the region and the results of those surveys. This is followed by a detailed description of the Warruwi pond, a definition of the diagnostic features to be employed to determine if other structures in the region are likely to have similar origins to the Warruwi structure and a review of possible construction methods.

Chapter 3  The Goulburn Islands and Arnhem Land

A description will be given of the general environmental conditions in Arnhem Land with particular reference to the Goulburn Islands and their immediate environs; especially the environmental and ecological conditions pertinent to the Warruwi pond. The history of the Goulburn Islands and the adjacent mainland will be presented together with a description of known foreign activity on the Goulburn Islands and in the region.

Chapter 4  Possible uses for the Warruwi pond

Given its location and construction, there are four possible uses for the Warruwi pond that present themselves: a ceremonial ground, a fish trap, a marine wild stock management tool, or an aquaculture pond. This chapter will explore each of these options in detail to draw a conclusion as to the pond’s probable use.
Chapter 5  History of the Arafura region

This is an examination of the relevant history of Arnhem Land and the region using all available historic sources—written, oral and archaeological—with especial emphasis on the development of regional trade nodes and international trade links, the products of the region and the history of involvement by foreign explorers and traders.

Chapter 6  Sea cucumber cultivation and the trepang trade

Trepang (dried sea cucumber) is a regionally important product and one that is historically and prominently linked to Arnhem Land. This chapter will describe the biology and reproduction of sea cucumbers, the history of the trepang fishery and fishing techniques, and the history of the trade including the pivotally important history of trepang in China. It will also describe the history of, and the techniques associated with, sea cucumber cultivation.

Chapter 7  Pearls—history, trade and cultivation

Like trepang, pearls are of specific interest to this thesis because of their traditional cultivation by Yolgnu and their historic links to foreign trade. In this chapter the biology of pearl oysters is described together with pearl formation processes. A review of historic pearl use, trade and, as far as they are known, historic cultivation methods will also be presented. A traditional Yolgnu pearl cultivation technique is described and compared to historic cultivation methods to determine the probability of the Yolgnu devising pearl cultivation themselves or if their technique originated in either of the historic centres of pearl production, China or the Middle East.

Chapter 8  The case for pre-European and pre-Makassan introduction of aquaculture into Arnhem Land

Finally this discussion will pull together the relevant facts and information presented in the previous chapters, evaluate the value of and the weight which may be attached to each to reach a conclusion as to the probable origins and uses of the Warruwi pond and the origins of Yolgnu pearl cultivation. There is also a recommendation for further associated research.
Chapter 2

Stone ponds in the region

The discovery of the pond in Marbalk Bay at Warruwi on South Goulburn Island in west Arnhem Land started an extensive survey and enquiry process to try to answer the challenge posed by Warruwi elder Bunug to:

"Find out what it was—and then tell them".

This simple request became the primary aim of the thesis.

There ensued a series of surveys across Arnhem Land and east Indonesia (Fig 2.1) aimed at identifying other, similar structures in the region and determining who built them, and why. Gathering this information was a vital step toward the primary aim of determining the origins and uses of the Warruwi stone pond South Goulburn Island.

![Map of north Australia and east Indonesia](Image)

**Figure 2.1** Areas surveyed in north Australia and east Indonesia (Map by ANU CartoGIS CAP)
Survey methods

Initially these surveys, both in Arnhem Land and Indonesia, were informal and conducted where and when opportunity presented itself in the course of my work. At the time I was employed first by the Northern Territory University (now Charles Darwin University) to identify potential aquaculture species and teach aquaculture techniques to people in Indigenous Arnhem Land communities and homelands, and later by ANU and Ausaid for similar work in Eastern Indonesia. During this period I was covered by various ethics approvals obtained through my work.

The length and extreme remoteness of the Arnhem Land coast made extensive untargeted ground surveys prohibitively expensive and, in many sites, physically virtually impossible, so searches for ponds and similar structures were carried out by personal observations made from air, boat and on land, and by questioning Traditional Owners in coastal communities and homelands (out-stations).

Most of this early survey work was conducted before I commenced this PhD program and, as it was not a priority at the time, no records of interviews or interviewees were kept hence it may be that information gathered at this time may be better regarded as either 'personal observation' or 'prior knowledge'. Later interviews and interviewees were recorded and are presented here.

My work at the time involved a great deal of low-level flying over coasts between communities and interaction with Traditional Owners, providing me with excellent opportunities to acquaint myself with both the coast and gather local information. Where I did not adequately cover stretches of coast, such as that between Blue Mud Bay, the English Company and Wessel Islands as far as Elcho Island, I chartered aircraft to over-fly them, but I was often in contact with Traditional Owners from these areas.

A similarly informal scenario initially existed in Indonesia where I was engaged in similar work to that in Arnhem Land. As we worked, my Indonesian technicians, Pradina Purwati and Baskara Muliputra, and myself looked out for ponds similar to that at Warruwi and asked local people if they knew anything about them. Also similar to the situation in Arnhem Land, interviews were informal and fishers were questioned as and when opportunities presented themselves and records and names of the numerous negative responses were not kept.
After completing both the Northern Territory and Indonesian contracts I conducted ground surveys in the north Maluku Islands (Tidore, Ternate and Halmahera) and south Sulawesi in the vicinity of Makassar, specifically looking for stone pond-like structures. Two attempts to conduct ground surveys in the south Maluku Islands (especially the Tanimbar, Aru and Kei Islands) had mixed success. The first was initially aborted because civil unrest made access impossible. However some time after I had returned to Australia Baskara was able to carry out a limited survey when he visited the Kei and Aru Islands with Semy Rumahenga from the Lembaga Ilmu Pengetahuan Indonesia (LIPI) office in Ambon.

The second attempt by Semy Rumahenga and myself covered Tanimbar Island, but it was also aborted shortly after reaching Tual in the Kei Islands because of injury to myself. No further attempts could be made due to time and funding restrictions.

Finally an inspection was made of coastal waters off Arnhem Land and the south Maluku using Google Earth satellite imagery.

Survey Results

Intertidal stone pond-like structures appear to be a feature, albeit a comparatively rare one, of the region (Fig 2.2). Four of these structures were located and confirmed off the coast of Arnhem Land by ground and aerial surveys. One was seen in Blue Mud Bay on the Gulf of Carpentaria, one at Warruwi on South Goulburn Island, one in an inlet among the mangroves on Cobourg Peninsula’s west coast and one at the mouth of King River on the northwest Arnhem Land coast south of the Goulburn Islands. There were two located in Indonesia’s south Malukun Islands on the north shores of the Arafura Sea, one near the village of Selmona in the Aru Islands and one near the village of Alma Kota on the Tanimbar Island. Two large three-sided structures, made from stone and net or mesh, were seen near Makassar in south Sulawesi.
Searches of the coasts of Arnhem Land and the archipelago between Tanimbar and Aru Islands on the north side of the Arafura Sea using Google Earth satellite imagery revealed a number of potential pond structures, both round and square. All are in remote locations and all except one appear to be permanently submerged and could not be ground-truthed with available resources.

The only structure located with Google Earth that could be ground-truthed (albeit only partially) was located near the village of Arma Kota in northeast Tanimbar. In 2012 we (the author with interpreter, Semy Rumahenga) met with Arma Kota village heads, brothers Yunus Batkor and Dominggus Bakior Ubawa, and K.P Impoawa, and, after showing them a print-out of the satellite image (Fig 2.3), asked if they knew who built it and what it was used for. Yunus Batkor answered,
“We did, about ten years ago. But it is broken by a storm now. It’s used to store trepang for market. We also put a net on top of the wall and use it to store lobsters for market.”

Figure 2.3 Pond near Arma Kota, northeast Tanimbar (7°25’34.34’S 131°41’14.98’E) (Photos Google Earth)

Unfortunately they were reluctant to allow us to visit their pond, stressing that it was not yet repaired and inaccessible due to very high tides and rough water. Given its recent origins ground inspection did not seem to be a major issue.
The Arma Kota pond notwithstanding, Google Earth satellite imagery proved to be an erratic tool that, while revealing several potential pond-like structures in waters off Aru and Tanimbar Islands (two of which are shown in Fig 2.4) and one in Blue Mud Bay (Fig 2.5), it did not show any of the known ponds (including both the Warruwi and Selmona ones) due to either cloud cover or high tides and turbid water at the time the satellite passed over.

Figure 2.4  Sunken structures off Pulau Leer, east of Aru (Photos Google Earth)

A: 6°11'56.36"S; 134°51'38.20"E  
B: 6°13'42.01"S; 134°51'25.86"E
Aerial surveys in Arnhem Land revealed three ponds in addition to the Warruwi structure. One (Fig 2.6) is located not far from the site of the square pond seen in the satellite image of the north coast of Blue Mud Bay (Fig 2.5). The structure was confirmed during a later flight, but could not be verified by a ground survey as access proved extremely difficult and more expensive than would have been justified at the time.
In west Arnhem Land two further round, pond-like structures were located on or near the Cobourg Peninsula to the west of the Goulburn Islands (Fig 2.7), one at the mouth of the King River and one in an inlet on the west of the peninsula. There were also a few mentions by Traditional Owners of remnants of stone walls in mangroves and sheltered bays of the Cobourg Peninsula that they describe as bits of old fish traps. No similar fish traps are used in the area today, nor have they been in recorded or oral history, but it can’t be ruled out that stone fish traps were used in the past. An extensive future research program will be needed to locate and identify these relics.

There does not appear to be any knowledge among the Traditional Owners of any pond-like structures east of King River; however this does not necessarily mean that they are not there, buried under sand, mud, mangrove or coral; or broken to the point of being unrecognisable by cyclone-driven storm seas. If they exist only time and chance may uncover them, but most will probably never be found. And if the Traditional Owners know of such structures there is no guarantee that they will tell.
The structure on the west coast of the Cobourg Peninsula was seen from a scheduled commercial small aircraft, but was not photographed. Like the Blue Mud Bay structure, this pond is in a very remote and inaccessible place and has not been visited.

The King River structure was reported by Jim Gorey, then CEO of Warruwi community, and subsequently sighted and photographed from a small plane (Fig 2.8). This pond was buried in sand by a cyclone in 2005 and could not be located by a ground search in 2008. This was a good demonstration of the highly dynamic nature of the Arnhem Land coast—another storm may well uncover it again in the future.
Ground surveys revealed no further ponds in Arnhem Land, but two structures were located near Makassar in Sulawesi and one in the Aru Islands in east Maluku.

The first of the south Sulawesi structures is located in the vicinity of the city of Makassar. It is constructed with low stone walls (Fig 2.9) on three sides, each of which was estimated to be between 50 and 70m long and topped with a mesh fence. The sides extended onto the beach, which formed the fourth side to the square. The owner said that it had been built within the past 50 years and was used to grow out trepang.
The second structure is located ~100km north of Makassar on the west coast of Sulawesi. This structure (Fig 2.10) has a single stone sea wall topped by a fine mesh fence. A mesh fence extended from each end of the wall to the beach, which, like the other Makassan pond, formed the fourth side. The pond was also estimated to be between 50 and 70m on each side.
The owner of this structure was not present, but Herman, a nearby trepang dealer, explained that it had only been built about ten years ago.

“It’s used to store small trepang,” he said. “About this size [indicated his thumb]. They are put in there live direct from the boats, when there are enough they are boiled and sold in Makassar.”

The Makassan style of pond, three sides enclosed and backing onto a beach, is identical to one described by Spillett that, he said, was located at South Goulburn Island:

At the south end of the sandbar in front of Mission Beach there is a three sided square, made of rocks, with the fourth side the sandbar. It is a fish trap made by the Makassans to trap fish but also to keep the trepang in (Spillett, 1996, p 11).

The location Spillett gives for this structure matches that of the existing Warruwi pond (although there is no sand bar there today), but his description does not. There are two possible explanations for this discrepancy;

1. Spillett was told about the pond but never saw it. He assumed that it was Makassan and his description is merely an extrapolation of structures he had seen in Sulawesi. If this were the case, he may also have been extrapolated its uses from those Sulawesi structures

2. The pond he described was a different one to the one exposed in the bay today. Spillett’s pond may still be there, buried beneath the mud somewhere in front of Warruwi, or long since destroyed by storms

If the latter explanation is correct it may indicate two waves of fisher/builders, each with a distinct style of pond.

The Aru Island structure (Fig 2.11) is at the village of Selmona. It was located by Baskara Muliputra and Semy Rumahenga, who photographed it, assessed the substrate under it and took basic measurements. The pond is square, ~20m a side and encompasses ~400m². The walls are made from local stone (beach-rock) and are about 1.2m thick at the base and 1.2m high. Approximately 400mm of the wall is buried in mud. Beneath the mud the wall sits on a solid rock base that forms the natural substrate that extends across the pond. The wall was not excavated to investigate its construction, but superficially the construction appears to be very similar to that of the Warruwi structure. This structure also
resembles the Warruwi structure in its location near the low spring tide level where it is covered by water most of the time.

Figure 2.11  Stone-walled pond-like structure at Selmona in the Aru Islands (Photos courtesy of Baskara Mauliputra and Google Earth)

The structure itself appears to be old, but how old is unknown as the villagers do not know who built it, when it was built or what its original use was. They did say that it had been used to hold live pearl oysters for sale to Chinese pearl farmers (Baskara Muliputra, Per Com), but this trade declined rapidly with the advent of modern pearl oyster hatcheries.
Today this pond has a mesh enclosure built within it that is used to hold sea cucumbers that have been harvested from the wild. The mesh enclosure is modern, but its situation within the pond is interesting. In its current condition the pond’s wall would be useless to contain trepang due to the amount of mud in and on it (the mud level is considerably higher inside than outside the wall), but building the modern enclosure inside its walls may be recognition of a tradition that this was the pond’s original use.

Given that there are a number of pond-like structures in the region there was a need for specific criteria to enable structures to be classified as either similar to the Warruwi pond, and therefore likely to have a common cultural origin, or dissimilar and therefore likely to have originated with a different culture. The Warruwi pond will be regarded as the holotype (reference specimen) and the description below used to establish those criteria.

The pond at Selmona in the Aru Islands is very similar to the first pond recorded at Warruwi—some 600km away. Because of its accessibility and good state of preservation the Warruwi pond, was the only one to be researched and recorded in detail.

**Warruwi pond description**

This well-preserved and accessible stone pond (Fig 2.12) is located at the bottom of the inter-tidal zone in Mardbulk Bay, near the community of Warruwi on South Goulburn Island in west Arnhem Land.
Figure 2.12  Warruwi pond in Mardbulk Bay (11°38’ 59.07” S; 133°23’ 37.72” E)

The pond has not been used for any purpose in living memory, nor is its original use known. The following description will enable comparisons with other structures—such as fish traps and various aquaculture ponds—and enable an informed assessment of its possible original purpose.

The stone wall creates an enclosure constructed from laterite rocks (Fig 2.13) atop a layer of clay and adjacent to a laterite rock outcrop, which forms a part of the wall.
The pond is generally circular and averages about 40m in diameter. Only about 20m of the north east part of the circle (Fig 2.14) does not describe an arc because this section utilises a natural laterite outcrop. The outcrop is topped with large rocks that, because they would have been difficult to move and appear to fulfil no practical function, may have been left over from the construction process or been weathered out of the natural rock since the pond was constructed.
The southwest quarter of the pond wall is about 200mm lower than the east and north sections. This can be clearly seen when the pond is viewed from the shore on the right tide (Fig 2.15).
The northeast section (on the natural rock) is higher than the constructed east and southeast sections (Fig 2.16) which are close to uniform in height and width – the effect is as if the structure had been tilted several hundred millimetres on a northwest – southeast axis. This variation in height may be due to either an irregularity in construction or to the wall sinking unevenly into the substrate.
Given the regularity in construction in other respects it seems more likely that unevenness in substrate consistency (becoming softer the further from the rock outcrop) allowing uneven settling is the more likely explanation.

Determining the pond's position (level) in the inter-tidal zone was done by noting exposure (Fig. 2.17) at known tide levels (Fig. 2.18). Based on full year tide charts for 2009 (Mobilegeographics, 2011), the top of the highest part of the wall would be exposed on 545 of the 728 (75%) tidal cycles that occurred in that year; the lowest part of the wall would be exposed on 358 (49%) tidal cycles; and the substrate surface as it is today would be exposed on 92 (12%) tidal cycles. When it was silt-free the clay base layer would have been exposed when tides fell below 0.3m, this occurred only 21 times in 2009 or 3% of tide cycles. The lowest recorded tide in 2009 was 0.18m on 29th October.

Figure 2.17 A. The southwest section of the stone wall one hour after a 1.18m low tide (tide level ~1.1m). Only isolated rocks can be seen projecting above the water along the southwest quarter, but the northeast part (B) was not submerged until forty minutes later (level ~1.3m)
Figure 2.18  A: Tide chart for North Goulburn Island for 10/07/2009 (closest available data)

B: Pond exposure at varying tide levels

Dimensions, materials and construction:

Survey methods

Because the natural turbidity of the water in Mardbulk Bay normally reduces visibility to less than a metre, where possible work was done on low spring tides when the pond was at least partially exposed (about one hour per tide). When the substrate was disturbed visibility was reduced to zero, so all wall components and other material within the wall and pond were lifted out of the water for measuring and identification. To
minimise damage to the structure only a small excavation was made in the east wall of the pond (Fig 2.19) and on completion of work all rocks were returned to their original position.

Measurements were made with a tape measure, but wall heights and widths are estimates as the base of the wall could only be detected by touch. Similarly, the depth of the clay layer (and hence the depth of the original pond) was also an estimate. Ten core samples were taken from the substrate, eight inside the pond and two outside (Fig 2.20).

Figure 2.19  Core sample and excavation locations

Cores were made by driving 1m lengths of sharpened 50mm PVC pipe (Fig 2.20) into the substrate. Before being withdrawn, caps were placed on the top of each pipe to create a vacuum and hold the sample in the pipe when it was withdrawn (Fig 2.21). After they were withdrawn the bases were also capped, then the caps removed from the tops to allow overlying water to be decanted off—in several cases much of the light sand / silt overlaying the clay flowed out with the water and this layer remained intact only where it
was held together with sea grass. The top caps were replaced and the pipes taken to shore where they were cut in half lengthwise with a small angle grinder to expose the sample (Fig 2.22). Very little sand was recovered from below the clay.

**Figure 2.20** Sharpened 50mm PVC pipes cut to 1m lengths

**Figure 2.21** Pipes were driven into the substrate as deeply as possible before being capped and removed
Figure 2.22  Core sample exposed after pipe was cut in half

Pond Dimensions

- Diameter north – south (centre wall to centre wall): 39m
- Diameter east – west (centre wall to centre wall): 44m
- Pond area (average diameter 41m): 1,320m²
- Circumference: 132m
- Wall height (north): ~1.5m
- Wall height (south): ~1.2m
- Wall thickness (at base): ~1.5m
- Thickness of clay base: ~200mm
- Variations in wall height: +300mm on north side

Construction materials

The wall is constructed of graduated sizes of laterite stones, larger stones (300 – 400mm diameter) on the outer surfaces and inside them 100 – 200mm stones graduating
down to <100mm toward the wall’s centre (Fig 2.23). An artificial conglomerate (Tickell, S., Per Com, 2006) of clay and small stones appears to have been laid as a waterproof base inside the pond and in the interior of the wall. This base overlies a substrate of sand and small shell fragments.

Figure 2.23 Excavated wall profile, large rocks (at left) decreasing in size to small closely knit stones to a core of clay

The inside of the wall has three distinct layers of non-laterite material:

a) Sand, small shells and shell fragments. This is similar to the surrounding overlay material.

b) A glutinous, fine dark silt layer without apparent inclusions (Fig 2.24). This silt is consistent with a terrestrial origin and would have been deposited by flooding events. The sheltered conditions inside the wall prevented mixing with the sand / shell deposits. Once disturbed, this silt remained in suspension for >1 hour, indicating a very fine consistency.

c) Discontinuous clay mixed with small stones similar to that found inside the pond. This layer appears broken and has many intrusions from the overlying fine silt.
Figure 2.24  Glutinous, fine dark silt layer without apparent inclusions from inside the wall

Core samples (Figs 2.25 – 2.29) show the pond floor has a consistent layer of mixed clay and small stones approximately 200mm thick overlaying a substrate of sand and shell fragments and overlaid by a mix of mud, sand small shells and shell fragments.
In all cases the substrate below the clay became liquid and drained out of the pipe as it was withdrawn. In several cases a portion of the clay was also lost, however enough was recovered in each case to demonstrate that the clay formed a continuous layer (Fig 2.26).
Figure 2.26  Core samples from across the north – south transect. All show a clay layer

Despite several samples being truncated to some degree, the only sample that was unusable was No 4 (Fig 2.27)—this sample was mostly lost, but what was recovered had several small shells and sticks which probably indicates that the core went through a crab, mantis shrimp or other crustacean’s lair.
Two samples (1 and 6) were taken outside the pond wall. While each of these samples contained what looked to be laterite or clay debris they appeared to be more homogenous than samples from within the enclosure (Fig 2.28).

The mix of clay and small stones (Fig 2.29) is not natural (Tickell, S., Per Com, 2006) and is therefore a man-made artefact.
Despite its heterogeneous nature (or perhaps because of it) the clay substrate remains a barrier to water and burrowing sandfish (but not crustaceans).
Together, the wall and substrate profiles (Fig 2.30) present a picture of a complex and strong structure that appears to have originally been intended to either retain at least some water when the tide receded around it, or to prevent burrowing animals escaping—or both.

Figure 2.30  Pond profile.  

A Profile section east – west

B Profile section south – north

On the inside of the wall clay appears to be moulded up against and between the stones. This moulding and the broken nature of the clay within the wall itself may be a deliberate part of the construction or, more likely, the result of the wall sinking (Fig 2.31) and the clay substrate being displaced by its weight and forced up between the stones within the wall.
Figure 2.31  Pond wall profile:  

A  As it may have appeared when constructed  

B  As it is in 2011  

Summary  

The pond is circular with a circumference of 132m and a diameter of 41m, encloses an area of 1,320m² and is located near the bottom of the inter-tidal zone. The pond’s wall is constructed using laterite stones graduated in size from 300 – 400mm diameter on the outside, down to <100mm toward a central clay core. The wall (as it stands today) has an
average height of ~1.35m, although the original height was likely to have been close to today’s 1.5m maximum and a thickness at the base of ~1.5m. Inside the pond the base is lined with an impervious clay base ~200mm thick. This layer may serve to waterproof the pond or deter burrowing animals, or both.

**Diagnostic features**

The size of the pond can be dismissed as a diagnostic feature because size may simply depend on the resources and area available to the builders and their particular requirements. For example a pond built to grow trout may be anything from <100 to >10,000m², depending on the farmer’s resources and needs, but they will all grow trout. Similarly a fish trap may be anything from a weir a few meters long to a complex system involving hundreds of meters of interlinked walls, depending on the topography and the resources available to the builder—but they all catch fish.

The pond’s shape, provided it is regular, can also be dismissed as a diagnostic feature because shape may be dependent on topography, builder’s preference or the structure’s age. It is worth noting that a curved wall, such as that seen in a round pond, is stronger and more capable of resisting storms, heavy seas and strong currents than a straight one. Currents will also be different inside a round structure than a square one as corners interrupt water flow. A round structure also requires less material (and labour) to enclose the same area as a square. It could be argued that these advantages mean that round ponds evolved from square ones, however it must be noted that at least one square structure (at Arma Kota) is new and that most modern aquaculture ponds are square. Without considerably more extensive and detailed surveys the question of which came first will not be resolved—in the end shape may depend on a number of factors such as the degree of exposure the pond has to strong currents or heavy seas, or on no more than fashion or builder’s preference at the time.

More important as a diagnostic feature is the regularity of shape, whether square or round, as this indicates that the structure has been deliberately built to take account of specific conditions rather than simply utilising random natural features (such as rock outcrops). An irregular structure built using natural features may be able to approximate required conditions but seldom produce them exactly.
A regular shape is also stronger, easier to waterproof and more economical to build, especially when a sophisticated construction method, such as that of the Warruwi pond, is used. The wall’s construction—regularity of height, thickness and stone size—is also important as it suggests a common design. Also important is that the wall fully encloses an area low in the intertidal zone, indicating a common purpose.

Possibly the most interesting feature is the presence of an impervious layer forming the substrate within the pond. This layer prevents both the loss of water and resists many burrowing animals (in a similar way to the lining in a modern pond). Unfortunately, while the other features can be assessed from images, the substrate can only be checked by digging through any overlying mud. As this is only possible with a ground survey and is therefore not practical in many circumstances, this can only be used as a final confirming feature when all others are present (and where circumstances permit).

Diagnostic features that will classify a structure as likely to have a similar origin and purpose to the Warruwi holotype are, therefore:

1. Fully enclosed by a stone wall of regular height and thickness that is constructed with regular sized stones
2. Location low in the intertidal zone
3. Regular shape
4. Has a substrate composed of some sort of impervious layer providing some water holding capacity and resistance to burrowing animals

Possible pond construction methods

The actual construction of the Warruwi pond would have taken a considerable effort. Each metre of wall has an approximate volume of 1.2m³ (the wall in cross section being a parabola with a base of ~1.5m and a height of ~1.2m). The circumference of the pond is 132m, 20m of which is natural rock, making the manufactured section of the wall ~112m long. A Darwin stonemason (Finlay’s Stonemasonry. Per Com, 2006) states that 1m³ of the laterite rocks that he supplies for landscaping (similar in size range to those used in the wall’s construction) weigh 1.8 tonnes, meaning that the constructed wall contains ~240 tonnes of rock.
There are several ways that these rocks could have been transported to the site. The first is that they may have been transported from the nearby island. Local Traditional Owner Tommy Gagaraba (Per Com) described the pond’s construction method thus:

“The Makassans made everyone line up across the sand and pass rocks down the line to make the wall. It was very hard work.”

Prior to the late 20th C this would have been a logical method to use if there was sufficient labour available, but if this story means that the rocks were passed from the island to the site there are three practical and logistical reasons to doubt it:

1. Many of the stones are heavy (5 – 10kg) and even fit, strong men would have had trouble continuously passing these weights along a line for very long.

2. Available labour. Today the pond is located at least 250m from the nearest access point. Although it was probably closer at the time, a direct route would have been through dense mangroves and been virtually impossible. The cliffs to the south are higher and appear to have eroded less, therefore the distance from them to the pond has probably not increased as much as it has to the foreshore to the west. Assuming the practical distance at the time to have been 200m and an effective human chain to have links no more than 2m apart, it would require a labour force of 100 to move the stones from the nearest shore.

These points by no means prove that this was not the way the pond was constructed—there are examples of comparatively small people carrying heavy weights, including carrying them several metres before passing them to another link in a human chain—but given the difficult, muddy substrate underfoot it would have been difficult in this situation. Also, the site is accessible only on low tide, so the window for such a chain would be very tight. Organising and motivating this number of nomadic hunter/gatherers for such a tight schedule would have been no mean feat, especially as it is unlikely to have been completed in one tide cycle so would have to have been repeated at least once, probably several times.

Other ways the pond may have been constructed are:

1. A much smaller chain could have been formed to pass rocks from a quarry site near or on the shore (most of the shoreline around Goulburn Island is composed of laterite rock) to a boat that then transported them to the pond site and dumped them overboard ready for construction when the tide permitted.
2. The natural reef that now forms the north east wall, which was more exposed and therefore more extensively available than it is today, was mined to obtain the material to build the rest of the wall. The rocks would have been passed from hand to hand from the mine site on the reef to the construction site, no more than 40m.

Of the above options, mining the reef is the most logical and Tommy Gagaraba’s story is therefore probably of short lines, not long ones stretching back to the shore. The pond may well have been built on this site primarily to take advantage of the source of building material.

The pond’s current condition is a product of a combination of the history of the Goulburn Islands and local environmental conditions, so it is appropriate at this point to present a description of that environment and a précis of the local history.
Chapter 3
The Goulburn Islands and Arnhem Land

**Arnhem Land**

The isolation imposed on Arnhem Land by both remoteness and legislation (Northern Land Council, per com. 2015) precluded most development and has generally preserved its physical environment as it was a hundred years ago, which is essentially as it has been for millennia. Arnhem Land is a unique environment, distinct from other lands that fringe the Arafura Sea in its ethnology, geology, faunal, floral and marine assemblages and microclimate. By most standards Arnhem Land is a harsher place than its neighbours and, compared to the islands to the north, Arnhem Land presents an uninviting prospect for settlement.

The coastline has long stretches of sandy beach interspersed with extensive, complex mangrove forests (mangals) and occasional low cliffs (personal observation). The immediate hinterland is generally flat and is characterised by:

- Open eucalypt woodland on skeletal infertile laterite soils
- Extensive fertile floodplains that are typically dry between June and December and flooded between January and May
- Patches of jungle or monsoon vine forest
- Large, mangrove-lined tidally influenced river systems.

Behind the immediate littoral area lies an extensive sandstone escarpment (the Arnhem Land Escarpment) backed by highly eroded and generally extremely rugged country. In east Arnhem Land a highly eroded range of ironstone hills terminate in the English Company and Wessel Island groups.

The Arnhem Land climate is wet/dry tropical (Anon, Australian Bureau of Meteorology, Darwin, Per Com, 2005), with northwest winds bringing wet monsoons (wet season) between December and April and southeast winds bringing dry monsoons (dry season) between May and September. The period from October to early December (commonly known as the ‘build up’) is categorised by increasing temperatures and humidity, with long periods of calm weather punctuated by often-severe electrical storms.
During the dry season humidity levels are low but variable across Arnhem Land. Humidity tends to remain higher in eastern coastal regions that are subject to winds off the Gulf of Carpentaria, but the central – west of the north coast receives winds from the dry interior of the continent so tends to have lower humidity levels. Humidity remains universally high throughout the wet season.

Coastal air temperatures typically range between 15° – 32°C during the dry season and 22° – 35°C during the wet (Anon, Australian Bureau of Meteorology, Darwin, Per Com, 2005). Extremes of temperature (35°C+) are normally only experienced during the ‘build up’ period on the coast.

The coast has an average annual rainfall of between 1,200 and 1,600mm. Virtually all rainfall occurs between January and April with February being the wettest month. During this period strong land runoff carries heavy silt loads to inshore waters, especially near river outlets, and reduces visibility in the water to near zero.

Normally at least one tropical cyclone is experienced somewhere along the coast during the wet season. These are often destructive with very high winds, strong surf and heavy localised flooding. Cyclones can impact very heavily on shore-lines (Anon, Australian Bureau of Meteorology, Darwin, Per Com, 2005) where they cross.

Very little rain falls on the north coast from May to October but showers brought by winds travelling across the Gulf of Carpentaria are not uncommon in east Arnhem Land at this time. During the dry season most rivers cease to run and surface water evaporates, leaving most of the land and vegetation, with the exception of mangals and monsoonal rainforests, extremely dry. Fires are very common during the dry season and in many cases local Aborigines set ‘cool’ fires in the early part of the season to ‘clean up the country’ (Bunug, Traditional Owner, Warruwi Per Com. 2005) but fires late in the dry are often started by lightning strike and can be intense and destructive.

The regular fire regime has resulted in many native species, both plant and animal, becoming fire-adapted. The native marsupial fauna in Arnhem Land is diverse but all are small (wallabies are the largest). Bird life is abundant, very diverse and includes species such as parrots, which were (and still are) considered valuable in international trade (Birdlife International, 2015; Gungwu, 2003; Ellen, 2003). Reptiles are also abundant and venomous snakes and saltwater crocodiles constitute considerable threats to human
activity. Saltwater crocodiles (*Crocodylus porosus*) in particular are the major predators in and immediately adjacent to coastal waters and rivers.

The annual flooding of the plains carries a great deal of accumulated nutrients into nearby coastal waters, providing the basis for the inshore food chain and nurturing the extensive coastal mangals that provide valuable habitat for both terrestrial and marine species, as well as stabilising the foreshore (Dewar, 1992). Arnhem Land marine waters are a natural transition zone where marine fauna is abundant and diverse (Veron, 2004). In many respects it is typical of the Arafura Sea region with many species in common with both Papua and the Indonesian Islands. There are, however, Arnhem Land species that are also found on either or both the east and west coasts of Australia but not seen further north (for example the box jellyfish, *Chironex fleckeri*), and some species are found in the north of the Arafura Sea that are not found in Arnhem Land (Veron, 2004).

Marine conditions make these waters very productive. Water temperatures typically range between 25°C in May – June and 32°C in November – December (Anon, Australian Bureau of Meteorology, Darwin, Per Com, 2005). The sea remains shallow (<30m) for a considerable distance off shore and is rich in marine life. Well-defined seasonal fluctuations in environmental parameters, such as increases in water temperature, stimulate mass spawning of most inshore species during the ‘build up’, and during November – December the waters are often discoloured and turbid with clouds of spawned eggs and sperm. The spawning of most species is co-ordinated with full or new moons and spring tides (Ellis, 1998; Counihan, 2001; Setyono, 2004), which can reach ranges of between four – five metres. Benthic and sessile species (eg corals) spawned at this time will settle out and colonise any freshly exposed or new substrate made available by monsoonal storms.

There were considerable commercial attractions in Arnhem Land for people seeking tradable commodities (particularly marine products) and willing to brave the dangers. The inshore waters harbour a number of valuable marine species, principally sea cucumbers—especially *Holothuria scabra* and *H. nobilis*. Some of these species, such as *H. nobilis*, fetched such a high price (Walter, S. & Campbell, S., 1916) that they were fished into local extinction (Australian Government Department of the Environment, Water, Heritage and the Arts, 2007). Other important species include pearl oyster (*Pinctata maxima*) and hawksbill turtle (*Eretmochelys imbricata*), both of which played an important role in the pre-colonial Arnhem Land economy. There were also species of
Arnham Land timber known to have been of economic importance to visitors, principally sandalwood (Santalum spp) and cypress pine (Callitris intratropica) (Macknight, 1976; Russell, 2004)—cypress yields one of the few timbers that is resistant to termites and was harvested as a valuable export product by Makassans (Macknight, 1976; Russell, 2004).

But Arnham Land also boasts a wider range of dangerous species than most other places that make accessing most resources hazardous. On land there is a wide range of venomous snakes, arachnids and insects; and the inshore waters harbour a number of species dangerous to humans, including sharks, stingrays, scorpion fish and several species of poisonous jellyfish. Changing temperatures and fluctuating inshore salinity levels make the build-up and wet season periods of increased danger. The poisonous box jellyfish (Chironex fleckeri) appears in large numbers at the start of October and remain throughout the wet season. The threat from saltwater crocodiles (Crocodylus porosus) also increases during this time as the males—stimulated by storms and rising temperatures to mate and nest—are aggressively territorial in rivers, estuaries and inshore waters.

Natural food and habitat availability is highly seasonal and seasonal drought, the shrinking and expanding flood-plains and available green food either concentrate or disperse species. Food would have been difficult for any visitor unfamiliar with the land to produce. The generally impoverished skeletal soils precluded most agriculture and meant that the coastal people, like all Indigenous Australians, pursued a hunter-gatherer culture (Meehan, B. 1977). They had no permanent settlements but were nomadic within fixed clan estates—even today settlements, both Indigenous and European, are only possible with the considerable input of food and other resources from more productive regions. The sometimes extensive flood-plains that line the lower reaches of the rivers have generally fertile soils, but seasonal fluctuations between long periods of inundation and waterlogged soil and dry, hard, and often cracking soil makes them unsuitable for most perennials (Dewar, 1992).

The Aboriginal people on the coast had a seasonally variable wild food supply that was adequate to their needs available to them from land and sea, which they defended with considerable vigour. Any settlers on the coast would have faced strong resistance had they tried to access these resources in any quantity, especially on the fertile plains where the local people obtained much of their food, and any attempt to usurp them would have inevitably led to conflict (Dewar, 1992; Trudgeon, 2000). In all likelihood settlers
would have been faced with a choice of importing their needs, negotiating agreement to use some of the land to grow crops, or face prolonged conflict.

But the riches of Arnhem Land and the opportunity to profit from an existing coastal Aboriginal exchange mechanism (Thomson, 1949) outweighed these problems and reaching Arnhem Land would have presented few difficulties for experienced sailors, even in small fishing prau, and their voyages both ways would have been assisted by tides, currents and prevailing winds. During the dry season currents sweep down from the north past the islands of Seram, Ambon, Aru, Kei and along the coast of Papua New Guinea before turning west at the Torres Strait and then north again off the north Arnhem Land coast. In the wet season (October/November to March/April) these currents run anti-clockwise (Fig 3.1) which brings them from the Tanimbar Island region down to the Cobourg Peninsula and Goulburn Island (Atlas of Pilot Charts Indian ocean NVPUB. 109 4th edition), often bringing flotsam and sometimes lost fishermen with them (personal observation). They were also known to bring ‘spirit canoes’ from the Fly River region in PNG (Berndt & Berndt, 1988).

Wind direction is also highly seasonal and predictable. During the dry season winds are predominantly strongly from the southeast quarter (Anon, Australian Bureau of Meteorology, Darwin, Per Com, 2005). Wet season winds blow from the northwest, although for the most part these are characteristically not consistently strong. During the build-up winds fluctuate with storm activity, but tend toward the northeast. Unlike the drawn-out build up, the transition from wet to dry season is often abrupt as dry southeast winds push up from the interior. Apart from minor local variations, wind patterns are generally consistent across Arnhem Land.
Goulburn Islands

The Goulburn Islands (Fig 3.2) are located at 11°28' – 42'S and 133°20' – 30'E. There are three main islands, North Goulburn Island (36km²), South Gulburn Island (78km²) and the smaller, uninhabited Sims Island. North and South Goulburn islands, like the adjacent mainland, are flat and low lying (maximum elevation ~15m). South Goulburn Island is separated from Ross Point on the east base of Cobourg Peninsula by the 3km-wide Macquarie Strait (Anon, Australian Bureau of Meteorology, Darwin, Per Com, 2005).

The sea surrounding the islands is mostly shallow (<10m) with many sand banks and reefs, but there are a number of trenches up to 60m deep, notably between North and South Goulburn, and Sims and South Goulburn. These, combined with the narrow channels between the islands and the islands and mainland, create strong and dangerous currents.
The Goulburn Islands’ climate and ecosystem are largely the same as the rest of the north Arnhem Land coast, although the ecosystems have been significantly modified by the introduction of feral animals. The marine ecosystems are also similar to those off the mainland, except that, with the exception of Mardbulk Bay (Fig 3.3), the islands’ waters are not directly affected by large amounts of wet season run-off and silt deposition and are therefore comparatively clear (personal observation).
The north coast of South Goulburn (facing North Goulburn), and the short east coast have narrow inshore rocky/coral reefs, sandy beaches and an extensive dune system extending inland several hundred metres (personal observation). The northwest coast is a long sand beach backed by a single high, grassy and stable dune. Behind and alongside this dune lies a seasonally large body of fresh water that drains toward the southeast into vine forest and mangals. The west and south coasts and the portion of the east coast south of Mardbulk Bay (Fig 3.4) feature stretches of narrow sand beach interrupted by cliffs and headlands, backing directly onto wooded, flat laterite hinterland. The seabed drops steeply into channels from most of the northwest, south and southeast coasts.
The east coast of the island outside Mardbulk Bay is enclosed by a shallow submerged reef system forming a shallow sandy lagoon of approximately 40km². Based on national 2009 tide charts, the maximum tidal range here is 2.7m, peaking at a high of 2.9m and a low of 0.2m. The lowest tide is 0.1m and the maximum high tide is 2.9m, but these do not occur together. The southeast coast is exposed to strong dry season southeast winds resulting in a high degree of mixing of sand and silt. During this season the water is seldom clear, maximum visibility never exceeds 5m and is often no more than 1–2m.

The east coast of South Goulburn Island north of Mardbulk Bay is largely low lying with extensive vine and mangrove forests backing sandy beaches. In the wet season this portion of the coast is sheltered and water visibility is increased considerably. The inshore water along this coast is shallow (2–3m) and has extensive high quality seagrass meadows. On the south side of Mardbulk Bay the shoreline descends from steep, high (~8m) cliffs to narrow beaches on the west side (outside Warruwi township). As the shore continues around the bay to the north and east it passes through discrete stands of mangroves and low laterite cliffs to sand beaches again at McPherson Point (otherwise known as Mungaroooda or Wighu).
There is a small stand of mature mangroves at the foot of the cliffs immediately to the east of Warruwi, according to local elders this is a remnant population from a once extensive stand. At the base of the cliff behind these mangroves and below the overlying laterite is an exposed lens of clay.

**History of Goulburn Islands and the adjacent mainland**

Today Warruwi is a quiet community of about 400 people (West Arnhem Regional Council, 2015) that, like most ex-mission settlements, is home to a considerable mix of language groups living alongside the traditional owners, the Maung. This mix can largely be attributed to the activities of the Methodist mission that brought people onto the islands from a fairly large area of the adjacent mainland. Many of these people, or their descendants and their families, remained after the mission closed and others have since come to join them (Lamilami, 1974).

Maung history over the last two or three centuries has been heavily influenced by outside agents such as the missionaries and the Makassans, and available (albeit tenuous) evidence also allows speculation that there may have also been strong influences from larger language groups from inland (Davis, 1988; Earl, 1846) and early European explorers.

During the life of the British settlement at Port Essington on the Cobourg peninsula (1838 – 1845), one of the colonists, George W. Earl (Earl, 1846) reported considerable movement of different language groups in west Arnhem Land, with some small groups being pushed out of their territory by more powerful inland groups. A weakening of the coastal people through diseases, such as smallpox (Foelsche, 1881; Russell, 2004) or venereal disease, may have brought this about. Foelsche (1881) records that there was a smallpox epidemic in west Arnhem Land some time before 1864 that was so bad and so many died they could not be buried, and Goulburn Islanders were known to have suffered from such a high incidence of venereal disease (Berndt & Berndt, 1954) that many of the women were rendered infertile.

The first recorded European contact was in 1818 when Phillip Parker King landed on South Goulburn Island and named the group after Henry Goulburn, the then British Under Secretary of State for the Colonies. King was given a very hostile greeting by the Aboriginal inhabitants of the islands and left fairly hastily with an understandably poor
impression of the people and the place (King, 1827; Cole, 1979, 1980). There is no record that they had a similar hostility toward Makassans so their reaction to King cannot be simply ascribed to a reaction to foreigners, but rather suggests a previous unpleasant experience of Europeans. Slaving stories are lent weight by the Indonesian name for the Tiwi Islands—Palau Amba or Slave Island (Macknight, 1969; McMillan, 2001).

Evidence for European visitation to Maung land in the mid-18th C was found in rock paintings in a shelter in the Wellington Range on the mainland just south of the Goulburn Islands. Among the paintings are depictions of prau (tradition fishing boats which will be described later in this chapter), tall ships with rigging shown in detail but without sails (suggesting that they were depicted at anchor) and a man wearing a hat with hands on his hips (Tacon et al, 2010).

One of the tall ship paintings was dated by carbon dating beeswax that had been used in making beeswax designs over and under the ship picture. The wax was calibrated to calendar ages using Calib 6.0 and IntCal09, and median ages were calculated using OxCal 4.1 and IntCal09 (Tacon et al, 2010). Wax taken from under the tall ship painting indicated that it can be no older than the early 1500s to mid-1600s (median ages of 1568 and 1625) and samples from over the picture suggest that the latest it could have been painted was between 1664 and 1813 (median ages of 1765 – 1767) (Tacon et al, 2010, p 4). This means that there was at least one European ship in the Goulburn Islands area at least 50 years before King and, if it was anchored, Europeans probably came ashore.

The figure in a hat with hands on hips (a typical pose in which Europeans were depicted) was dated using the wax method to between 1600 and 1808 (81.1% probability; median 1772). There is a possibility that the image depicts an Aboriginal man mimicking a European (Tacon et al, 2010), but the juxtaposition of the picture with the tall ship strongly suggests that the figure is a European. There are a number of European candidates as the artist’s subject—Dutch navigators had been sporadically exploring the north Australian coast for around two centuries before King, and one of these may have made a landing. Or perhaps an unrecorded Portuguese seafarer found his way that far south, or maybe British, French or Spanish.

There is also the possibility that the hat the figure is wearing may indicate that the figure is a Portuguese Topass, an influential group of Portuguese-native ancestry (Mestizo) who were very active in the area from as early as the 17th C. Topasses wore broad
brimmed black hats, similar to that depicted, as a symbol of their status and attachment to Europe—the name Topass may even be derived from the Hindi word *topi*, meaning hat (Meitzner-Yoder, 2011).

There were persistent reports of Portuguese slavers being active on the nearby Tiwi Islands, just to the west of the Cobourg Peninsula, in the 17th C (Searcy, 1909; McIntyre, 1987; Berndt & Berndt, 1988; McMillan, 2001; Russell, 2004). These reports seem to have originated with Major Campbell, commander of Fort Dundas in 1826, who claimed the Tiwi Islanders’ hostile reaction to outsiders was the result of slave raids by ‘Malays’ (Searcy, 1912). King also claimed that Portuguese Timorese (Topasses) were slave gathering in north Australia before 1818.

Any slaves collected in north Australia would have been taken to the Portuguese strongholds of Timor and Ende on the island of Flores—especially Ende, which was a major focus of the slave trade and may have been operating as a slave market for the region (Sutherland in Reid, 1983, p 273).

If Topasses were slaving in Maung territory in the mid-18th C it would account for King’s hostile reception, which was similar to that given foreigners in the Tiwi Islands, and may also offer an alternative explanation for the apparent weakening of west Arnhem Land coastal groups as described by Earl.

There is also the issue of the hostility to outsiders not being maintained in the Goulburn Islands as it apparently was on the Tiwi Islands. This may be explained if the people who had suffered at the hands of outsiders came to be in the minority at some point between King’s visit in 1818 and Earl’s observation in the 1840s, and the majority of the new population had no reason for hostility. They may have actually been attracted to the coast by the trade and other opportunities offered by visiting Makassans (Clarke, 2000) and therefore have welcomed the outsiders.

There is no direct evidence that the west Arnhem Land people of today are relative newcomers, but there is some circumstantial evidence. The people that now occupy west Arnhem Land appear to have a good (although sometimes somewhat superficial) knowledge of the sea, but limited spiritual connection to it when compared to the people in east Arnhem Land (Davis, 1988; Trudgeon, 2000; personal observation, 1998 – 2005). This suggests a limited time of occupation and agrees with statements in the Port Essington records that the original tribes had been replaced.
Apart from seasonally visiting Makassans, a few government officials, Japanese (and other) pearlers, the odd adventurer and an old Scottish trepang fisherman, the islands were left largely alone after King's landing until the arrival of the Reverend Watson in 1916. Watson had an immediate and overwhelming impact on Maung. The site he chose (whether by accident or design will never be known, but perhaps because there was already a well there) was directly over an important ceremonial ground. This sacrilege caused such distress that the elders abandoned not only the site but also the ceremonies associated with it (Lamilami, 1974; Dewar, 1992). Lamilami records:

This man, Mr Watson, looked all around the island. Then he chose the site for the Mission station. This was the place that was the main ceremonial and ritual ground for all the people. Those from the mainland, too, used to come over to this place for their ceremonies. Many tribes used to come and hold their sacred rituals on this sacred ground on Goulburn Island. Today there's an airstrip there. And it broke the hearts of the people. They knew this had been the sacred ground for many, many years. Their people way back had held this ground as a sacred ground. But as you know, things are changing all the time.

Some of the people thought of making a new ceremonial ground, but the old people were against it. They wanted one that was laid down by their grandfathers or their great-great-grandfathers. Their ancestors. So if they wanted to have ceremonies then, they had to go to the mainland (Lamilami, 1974, p 90).

If the previous suggestion that the people of the Island were comparative newcomers is correct, these ceremonies were either comparatively recent in origin or were inherited—at least in part—from the previous occupants.

From its beginnings the mission instituted a harshly disciplinarian regime that strongly discouraged traditional culture, to the point where children were actively alienated from their elders (Lamilami, 1974; Dewar, 1992), so it is not surprising that stories and traditions vanished. The result of these mission policies was the near destruction of the local Indigenous culture.

The condition of Mardbulk Bay today is a direct result of the mission's activity on the island. The mission introduced cattle, horses (which still infest South Goulburn) and goats (which still infest North Goulburn) that degraded the land and trampled waterways, causing considerable erosion. The missionaries also cleared a low-lying area behind the
mission for horticulture (Bunug, Traditional Owner, Warruwi. Per Com. 2005). Once cleared, this soil was easily washed into the waterways and out to the bay by heavy wet season rains. The impact of the mission on both the terrestrial and marine environments continues to be felt to the present day (personal observation).

Traditional Owners (Tommy Gagaraba and Billy Nawaloinba, among others) describe a quite different environment in Mardbulk Bay in their childhood in the 1950s and 60s to that of today, and that, in turn, appears to have been quite different to the environment described to them by their parents and grandparents. The changes to the bay can be tracked through time using information gleaned from elders and the few artefacts that were recovered from the pond.

According to the elders before the mission was established the bay was fringed with mangroves that backed on to a narrow sand and shell beach with a gentle slope up to the land (Fig 3.5).

Figure 3.5 Mardbulk Bay in the early 20th C, before the establishment of the mission (as described by Maung Elders)

To the front of the mangroves (eastward) was a spit or bar composed of sand and a laterite rock outcrop backing a lagoon bounded to seaward by a fringing reef, the sand and rock substrates (ie the absence of mobile mud) ensured that the water remained comparatively clear. This information is confirmed by the discovery of giant clam-shells (Tridacnea squamosa, Willan, 2007) (Fig 3.6)
When one of these shells (Wk 20297) was carbon dated (as per Stuiver & Polach, 1977. Radiocarbon 19, 355-363) it showed a $93.3 \pm 0.3\%$ date of $561 \pm 29$ BP (1417 – 1475), but when the ‘marine reservoir’ is taken into account the probable date is recalculated (Fig 3.7) to between the mid-18th C to the present day (Fiona Petchey, University of Waikato Radiocarbon Dating Laboratory, 2007).

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**Figure 3.6** Giant clam-shells (*Tridacnea squamosa*) found in the Warruwi pond showing severe erosion and degradation of the shell

**Figure 3.7** Calibrated dates for clam-shell wk 20297 (Waikato Radiocarbon Dating Laboratory, 2007)
The shells are all severely degraded by the action of marine invertebrates, indicating that they had been exposed to clean seawater for some time before being buried where they were stained by anoxic mud before being re-exposed. Based on its degree of encrustation and damage, Dr Richard Willan, Senior Curator of Molluses, Northern Territory Museum & Arts Gallery, estimated the age of one of the shells (NT. Sample Registration: NT Record No. P43006) from the pond, which showed the same degree of degradation and encrustation with marine worms to sample wk 20297, to be 80 to 100 years.

When the clams were alive the pond must have had to be mud free for them to survive, but even so it would not have been a natural habitat for them because of the clay or laterite substrate. This, and the uniform large size of the shells, strongly suggests that the clams were brought from nearby reefs and stored there, probably as food.

The age of the shells fits with the presence of four Torres Strait Islander ‘lay missionaries’—Yoram, Kapiu, Matasia and Sam Doy, along with Yoram and Matasia’s wives Rosie and Taita—who were brought to the mission in the early 20th C to assist the missionaries and to crew the mission’s lugger (Kadiba. 1998, p 106). These people, known locally as Baduans, would have been accustomed to maintaining traditional clam ‘gardens’ in their home islands. Torres Strait clam gardens are areas delineated by stone markers to denote ownership (Barham et al, 2004) and stocked with wild harvested clams for later use. It is probable that the lay missionaries brought this tradition with them and they may have opportunistically utilised the existing enclosure in a similar way and the shells are artefacts left by them.

According to the older people on the island, Watson ordered the removal of the mangroves from Mardbulk Bay in front of the mission to provide easier access for the mission lugger and fishing boats, and probably to reduce insects such as mosquitoes and midges. Whatever the advantages to the mission in the day, the removal of the protective screen of mangroves had a considerable impact on the environment of the bay and a picture of its probable evolution can be built from the stories of the older people and evidence from datable artefacts.

The mangroves formed a protective screen and their removal promoted rapid erosion of the beach and soft laterite cliffs by tides and waves driven by strong dry season winds and wet season cyclones. Once the mangroves were removed the residual mud that
they had bound up was scoured out by the same currents and storms that eroded the foreshore, presumably taking with it the remnant mangrove stumps and roots and leaving behind a hard packed substrate of laterite pebbles, shell grit and sand, similar to that found today at the north end of the beach. This type of substrate is unsuitable for mangroves and they were unable to recolonise quickly.

In this scenario the bay’s profile in front of Warruwi (Fig 3.8) up until the mid-20th C was probably a gentle slope from the land to a sand/shell-grit beach that extended out to a rock bar before descending into a sandy lagoon as far as the fringing reef.

![Figure 3.8](image)

**Figure 3.8** Mardbulk Bay in the 1950-60’s (as described by Maung Elders)

The silt-free nature of the environment during this period is described by the elders and confirmed by species that require clean water, such as corals and autochthonous (settle and grow in situ) bivalve mollusc shells, still attached to rocks in the wall and now buried in the mud. One of the mussel shells (*Saccostrea cucullata*, Willan, 2007) was carbon dated (as per Stuiver & Polach, 1977. Radiocarbon 19, 355-363). This showed the shell (Wk 20298) to be modern (98.5 ± 0.9% probability to be grown 122 ± 77 BP). When the ‘marine reservoir’ is taken into account the probable date is recalculated to the mid 20th C (Fiona Petchey, University of Waikato Radiocarbon Dating Laboratory, 2007). These species are still found in abundance in clear water on reefs a few hundred metres further out to sea.

Today the substrate mix varies throughout the bay from almost pure mud to clean shell and there are extensive, if somewhat degraded, seagrass meadows that provide grazing for turtle, dugong and nursery grounds for several marine species, including sea cucumbers. The margin adjacent to Warruwi has been considerably eroded over the years, a process largely stopped in last couple of decades by the Council reinforcing the shores with large boulders. An extensive fresh-water lagoon system lies to the north west of Mardbulk Bay and drains into it in the wet season. During peak rainfall, especially severe
events such as cyclones, land run-off carries considerable silt into the bay and the fresh water flow can be such that it temporarily alters the salinity of the shallow water in the bay. This runoff has led to the area between the shore and the rock spit filling with a deep, glutinous mix of sand, mud and shell (Fig 3.9).

Figure 3.9 Mardbulk Bay today

One of those severe events, probably one of the cyclones that went through the area in the 50s and 60s, carried a terrestrial fern root (identified at the NT Government Herbarium at Palmerston, NT) well out into the bay. This root (Fig 3.10), which was found at the interface between the clay base of the pond and the overlying mud, was carbon dated using the same method as for the previous mussel and clam shell and (Wk 15566) returned a modern date (108.0 ± 0.5).

Figure 3.10 Fern root in silt

After taking the marine reservoir effect into account, carbon dating places the fern root in the mid-20th C (Fiona Petchey, University of Waikato Radiocarbon Dating Laboratory, 2007). Its position at the clay mud interface makes it probable that the fern
root records a major erosion event that killed the mussel shells and corals (whose skeletons are still attached to rocks just above the clay substrate) by smothering them in mud.

In summary, based on all available evidence, the likely scenario for the evolution of Mardbulk Bay over the past century would be:

- Mangroves are removed. Storm-driven seas and a lack of protective mangroves resulted in erosion and the steep bank and residual beach seen in front of Warruwi today.
- Shifting currents brought about by these changes enabled the deposition of material from both shoreline and inland erosion into the inner bay.
- Enough suitable substrate, derived from silt runoff from the nearby degraded streams and wetlands, built up in the inner bay to enable some mangroves to take root and start (or restart) the natural aging process of the bay.
- Mangroves trapped more sediment for more mangroves to colonise, which slowly and subtly altered water flow, reduced scouring and allow ongoing silt deposition.

Siltation and mangrove regeneration are natural estuarine aging processes (Mehengal & Abdalla, 2014) which, if left undisturbed, will probably continue until a wide mangrove screen once more protects the inner bay—there is currently a healthy stand of mangroves in the southwest corner of the bay. The process is not characterised by smooth transition, but rather a trending fluctuation of conditions. Tommy Gagaraba said that silt levels have been deeper in the past and once completely covered rocky features in the inner bay, including the stone pond (Per Com., 2005). Certainly the depth of mud in the bay has varied slightly over the past ten years (personal observation) and appears to have been significantly disturbed by a storm at least once when the giant clam-shells in the southwest sector of the pond were exposed.

The storing of clams in the pond in the early mission days means that the pond was in existence at the beginning of the 20th C, but its size and sophisticated construction mean that it is highly unlikely that it was originally constructed to simply store clams, which do not need to be covered with water all the time, nor do they burrow or escape. There is, however, a suggestion that it may have once been linked to the trepang industry (Traditional Owners Tommy Gagaraba & Bunug, Per Com., 2005).
The trepang industry had been conducted in Arnhem Land, first by Indonesian (Makassan) fishermen and later by Europeans, for at least a century before the mission was established (Earl, 1846; Whittington, 1905; Searcy, 1911; Berndt & Berndt, 1954; Lamilami 1974; Macknight, 1976). Very early in its tenure Reverand Watson took over the local trepang fishery that was formerly operated by a Scotsman, McPherson, from his camp at Wighu (McPherson Point). McPherson was alive when Watson first came to look at the island but died before the mission was established (Kadiba, 1998), so it is probable that Watson learned about the fishery and richness of the trepang fishing grounds around the islands and nearby mainland from him. He realised the local Aboriginals were skilled in the industry and saw an opportunity for a financially self-sustaining mission station. According to Kadiba (1998) the mission continued to harvest trepang into the 1920s, when Watson was replaced, then turned instead to more traditional mission activities in horticulture and farming with all their ensuing environmental impacts. Baker (1987, p 17) says, however, that a patrol officer, Colin Bednall, saw ‘about thirty natives gathering trepang’ in the 1930s.

Watson was aggressive in his approach to the business and aroused considerable ire amongst other fishermen when he obtained exclusive fishing rights from the government, with ‘the rights to remove all trespassers’ from an area within a five-mile radius of the mission (NT Archives 1374/15236; Dewar, 1992). Enforcement of this order would have reduced the chance of the mission’s day-to-day activities being observed, which leaves open the remote possibility that the pond was built by Watson as a part of his operation.

There are, however, no records of him building it—a construction of that size and complexity would surely have been reported in the mission records. Also, Watson learned how to process and market trepang either from McPherson or other trepang fishermen at the time and there is no indication that any of them were using the pond.

The existence of the pond in the early mission days, therefore, places its origins in the pre-mission era when there was very little recorded information that relate directly to the Goulburn Islands, just a few observations from the occasional British official and rock paintings left by nearby Indigenous inhabitants. The Goulburn Islands were, however, known to have been frequented by Makassan trepang fishermen well before the advent of the mission.
Makassans in west Arnhem Land

Every year from about December until April or May, Makassan fleets from the south Sulawesi kingdom of Makassar could be found on the Arnhem Land coast. They began coming some time before the first European settlement in Australia and continued right up until 1905 when the South Australian Government, which assumed control of the Northern Territory in the late 19th C, barred them from its waters. They came in search of a range of products, including pearls and pearl shell, turtle shell and timber—but their main target appears to have been trepang.

In the context of this thesis the term ‘Makassan’ defines a particular group by their port of origin rather than an ethnic identity. The term was first introduced by Ronald and Catherine Berndt (1954) and later used by Campbell Macknight who defined ‘Makassan’ as:

Any person who came in the annual fleet of prau to the Northern Territory (Macknight, 1976, Pp 1 – 2)

Makassan visits to Arnhem Land were concurrent with, and may have preceded European exploration of the north Australian coast. However, even an approximate date for their first arrival is a matter of considerable conjecture and debate which will be reviewed and discussed in later chapters. They represent an overlap between the prehistoric and the historic periods of Australian history and our knowledge of their activities in Arnhem Land comes from the archaeology they left behind, Aboriginal oral histories and written records kept by British colonists in north Australia, first at Port Essington and later in Darwin.

The first the British knew of Makassans in Australia was in February 1804 when Captain Mathew Flinders encountered a Makassan fleet near Cape Wilberforce in east Arnhem Land while he was exploring and charting the north coast. He left a good description of this encounter:

Under the nearest island was perceived a canoe full of men; and in a sort of roadstead, at the south end of the same island, there were six vessels covered over like hulks, as if laid up for the bad season. Our conjectures were various as to who these people could be, and what their business here; but we had little doubt of their being the same, whose traces we had been found so abundantly in the gulf. I had inclined to the opinion that these traces had been left by Chinese, and the report of
the natives in Caledon Bay that they had firearms, strengthened the supposition; and combining this with the appearance of the vessels, I set them down for piratical Ladrones who secreted themselves here from pursuit, and issued out as the season permitted, or prey invited them. (Flannery, 2000, p 203).

Flinders’ initial suspicions indicate that the north coast was strongly suspected of being a pirate haven, but his fears regarding this particular group were soon laid to rest when he met the fleet’s captains and learnt that the prau belonged to fishermen from Makassar:

The chief of the six prows [sic] was a short, elderly man, named Pobassoo; he said there were upon the coast, in different divisions, sixty prows, and that Salloo was the commander-in-chief. (Flannery, 2000, p 204).

This was elaborated on in subsequent interviews:

According to Pobassoo from whom my information was principally obtained, sixty prows belonging to the Rajah of Boni [Bone, probably crewed by Bugis] and carrying one thousand men, had left Makassar with the north west monsoon, two months before, upon an expedition to this coast; and the fleet was then lying in different places to the westward, five or six together, Pobassoo’s division being the foremost. These prows seemed to be about twenty-five tons, and to have twenty or twenty-five men in each...... (Flannery, 2000, Pp 204 – 5).

Flinders also learned that Pobassoo had made six or seven voyages to Arnhem Land in the past twenty years and that he was one of the first, which would put his first voyage in about 1780 – 85. What Flinders did not realise was that he had encountered a thriving international trade, Australia’s first, which linked the Indigenous Australians of the north coast with the wider world.

As previously stated, the ‘Makassan’ fishermen were by no means all ethnic Makassan and men from across the region—from as far as Aru, Papua, Arnhem Land and even Chinese (Ganter, 2006)—often joined the fleet. Some of them were able to travel extensively by first joining a Makassan prau on their homeward journey to travel to Makassar or one of the other international entrepots, on their route, then joining ship’s crews to ports further afield.

Two stories show just how far a man from Arnhem Land could travel when he took ship with the Makassans. The first was recounted by Edward Robinson, a British tax
collector and adventurer who was in Blue Mud Bay in 1875 looking for gold when he met a Yolgnu man who had just returned from Singapore (Ganter, 2006). This must have been a somewhat surreal experience for Robinson—a naked savage able to recount international events that he was not aware of himself.

The second story was told to Bill Harney by Yamboka, a very old man who had first travelled to Makassar by 1865. Harney related Yamboka’s story thus:

He rambled on of the things he saw as he travelled with the traders from Makassar: the chase after huge fish with harpoons where the sea was cold and as hard as stone, and how, muffled up, they would go ashore to kill and skin the fish covered in soft hair (seals). He told of pirates from the unknown isle of “Jipangue”, of timber junks with birds painted on their sterns—the phoenix of the Chinese. The young people laughed at his tales, and pointed to his head, as though he were mad… (Harney, 1946, p 133)

These stories demonstrate a level of world knowledge and sophistication available to the Indigenous people of the region, including Arnhem Land, which went unsuspected or unacknowledged by the new colonials.

The prau they travelled in were sturdy, purpose-built vessels (Fig 3.11), but they were not good at pointing high into the wind so they made use of the seasonal winds, travelling east on the north-west winds of the early monsoon (about December) and returning to Makassar on the south-east winds of the dry season in April or May.
The journey from Makassar to Arnhem Land took them between 10 and 15 days (Baker, 1987, p 6) and covered about 1600 km each way by the most direct route (Fig 3.12), eastward to the east tip of the island of Timor, then south east to the Cobourg Peninsula and on to disperse along the coast.
Searcy, a British tax collector charged with collecting duty from the Makassans, had frequent and intimate contact with the prau and left a detailed description of them which is worth presenting here in its entirety:

The proas [sic] are most peculiar-looking concerns, and present a most clumsy appearance. The hull is of wood, and the top, sides, deck, roof, and yards are made of bamboo, the sails of matting, and many of the ropes and hawsers of plaited cane. They are steered by two rudders, one on each side of the stem. Some of them carry iron anchors, others wooden ones with heavy stones lashed to them. Often when the anchor is let go, a man is sent down to see that it is properly fixed in good holding ground. The mast is very peculiar, being formed of wood or bamboo, having two stays, so that in appearance it resembles a lengthy trident, the spaces between the masts and the stays being fitted with wooden steps, on which the sailors stand to hoist and roll up the sail, which unrolls again by a simple contrivance like a window blind. The orthodox way of getting on board is over the bow, that being close to the water’s edge, the stern being away up in the air. You
then climb a beam, and step across an opening to the deck in front of the captain’s cabin, which is situated on one side of the bows, a similar one on the opposite side for the second in command. The deck is of split bamboo, worked together with wire or fibre, and can be rolled up at pleasure. The entrance to the cabins is about 2 feet by 2 feet 6 inches (~50 x 63 cm). Of course, to enter or leave you must go on your hands and knees. Inside there is room for a man to sit or lie down. The entrance is about 2 feet by 2 feet 6 inches (~50 x 63 cm). Of course, to enter or leave you must go on your hands and knees. Inside there is room for a man to sit or lie down. The stem, which is high up, has several small rooms, or holes, like a great pigeon-house, and in these and on top of the cargo the crew live, the galley being a large iron pan with a quantity of sand in it on which to light the fire. The proas have a sort of bow sprit rigged out, and sometimes carry two or three head sails. On top of the houses they carry plenty of spare bamboos and rattans, which they get at the island of Kissa, near Timor, on the way down. The proas visiting the coast varied from ten to thirteen tons measurement (Searcy, 1907, pp 24 – 25).

Prau were obviously far from comfortable, especially for their crews that varied in size from an average of about 25 up to 50 or more (Macknight, 1976), but the dangers they faced were of more concern than comfort. On the outward voyage in the early monsoon, tropical storms and cyclones were regular and prau were often blown off course and wrecks were common. And on the way home in the fine weather of the early dry they had to run the gauntlet of pirates that lay in wait for them in the narrow straits near Timor (Macknight, 1976). The prau were generally able to defend themselves, usually with ancient brass cannon. Searcy wrote:

On board all the proas were a number of very ancient cannon, which seemed to be much prized by the Malays, and which, I imagine, were regarded as heirlooms, having apparently been handed down from father to son (Searcy, 1907, p 25)

The guns were also used in altercations with the Arnhem Land people where a number of incidents (and some outright massacres perpetrated by both sides) occurred (Searcy, 1911; Whittington, 1905). Without firearms the outsiders were helpless, as shown by an incident recounted by Whittington. A small prau was wrecked and the crew of six asked to be taken to Bowen Straits, but they were killed on the way and their possessions stolen. Interestingly, according to Searcy, this was apparently not a Makassan prau:

The wrecked proa [sic], a small one—was not one of the regular visitors, but a stranger as far as we could make out from the Aru Islands and had evidently been
blown down. I expect the dialect the Malay used was somewhat different from that to which our coast natives were accustomed, hence the difficulty they had in making themselves understood; but by their mentioning ‘Tingha’ showed they had gained some knowledge of the [English] camp at Bowen Straits. Wandy Bay [the main instigator] was afterward executed at Malay Bay, in the presence of as many of the natives as could be rounded up (Whittington, 1905, p 42).

When the Makassan fleet arrived it split up and individual prau or groups of prau tended to return to the same sites that they had occupied in previous years where they based their fishing operations and processed their catch (Fig 3.13). These sites are usually marked by lines of stone fireplaces (stone lines) for cooking trepang placed at right angles to the shore for easy access (Baker, 1987), pottery shards from broken or discarded containers and bowls, evidence of fire pits where smoke houses were constructed to process the trepang, sometimes graves and often tamarind trees—tamarind fruit was used in cooking and trees grew from discarded seeds.

Figure 3.13  A typical Makassan camp near Port Essington in the mid-19th C
During one of his tax collecting trips Searcy (1911, p 162) described the Mungarooda camp thus:

... the tableau as seen from the smoke houses was well worth studying, and one could hardly realise that the picture was an Australian one. The scenically effective smoke houses of bamboo matting and palm leaves; the gaudily-apparelled Malays [Makassans], their black teeth showing as they laughed; their red lips; the great knife or chopper hanging at the waist of each; the natives in a state of nature, some working under Malay direction; the quaint-looking craft at anchor in the offing, and further away the big sailed dredging canoes ploughing through the blue water! (Searcy, 1911, p 162).

There appear to have been two major Makassan sites within the Maung clan territory (Fig 3.14).

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**Figure 3.14** Sites of Makassan camps and rock paintings within Maung clan territory

In the Goulburn Islands the Makassans made their camp and processing site at Mungarooda (Wighu or McPherson Point) on the northeast tip of Mardbulk Bay. This site
offered an easily defended campsite with ample fresh water and a sheltered anchorage inside a fringing reef. Today the original site, which is marked by potsherds and the remains of six stone lines, is located on a sand bar adjacent to the point and is only exposed at low tide (Baker, 1987). On the sand-spit nearby there are two Makassan graves (personal observation) and a number of possible smoke houses (Macknight, 1969), but no stone lines. This was the site of a post-Makassan trepang camp owned by McPherson, who gave the point its English name, and it is likely that his activities destroyed much of the evidence of Makassan activity.

The presence of mature tamarind trees and an old well in Warruwi township suggests that there may have also been a campsite located there. However, the fact that Warruwi is located on an old ceremonial ground argues against such a camp as it would have provoked conflict. It may be that the camp predated the ceremony ground and an immigrant language group brought the ceremony to the island and forced the Makassans to relocate to Mungarooda, or it could be that the tamarind trees simply grew from the leftovers of a fisherman’s lunch. There is also some uncertainty about the well; it may have been dug by the mission in the early 20th C or the mission may have simply enlarged a pre-existing one as claimed by some of the Traditional Owners (Bunug, Tommy Gagaraba and Billy Nawaloinba, Per Com, 2005). Ultimately the presence of a mangrove fringe inside the bay in pre-European times argues against a Makassan camp because it would have been difficult to land canoes without clearing a path. Such sites are rare and tend only to occur where there is no sandy beach available (Baker, 1987), but in this case mangrove-free Mungarooda was nearby and that would probably have been the first choice. If there had been a camp-site at Warruwi the mission would certainly have obliterated almost all signs of it.

The largest Makassan camp in the area appears to have been at Anuru Bay on the mainland just south of South Goulburn Island. In the early 1970s Macknight investigated this camp and recorded a grave containing two skeletons—one laid at right angles to, and cutting through the other, ‘no fewer than twenty-one stone lines’ in various states of preservation, and he recovered 17kg of potsherds from the surface (Macknight, 1976) that he estimated to be about 1 – 2% of the total potsherds buried beneath the sand. This means the total amount of broken pots, most of them relatively small and delicate, must have been upward of 1.7 tonne and therefore this must have been a large camp that had been in use for many years, but how old is debatable.
Two samples of charcoal (ANU 316 & 240) Macknight took from the stone lines number 7 & 17 for carbon dating returned very old dates of between 400 and 800 years BP (Fig 3.15). The charcoal was from mangrove wood which, when calibrated for marine reserve effect, gave an earliest date of between 1004 and 1280 AD (Macknight, 1976).

<table>
<thead>
<tr>
<th>Location</th>
<th>Number</th>
<th>Radiocarbon date (BP)</th>
<th>Marine reservoir calibrated date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anuru Bay</td>
<td>ANU - 316</td>
<td>500 ± 75</td>
<td>1280 - 1615</td>
</tr>
<tr>
<td>Stone line 7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anuru Bay</td>
<td>ANU - 240</td>
<td>740 ± 70</td>
<td>1160 - 1390</td>
</tr>
<tr>
<td>Stone line 17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lyaba Stone line 13</td>
<td>ANU - 241</td>
<td>780 ± 75</td>
<td>1038 - 1386</td>
</tr>
<tr>
<td>Lyaba Stone line 8</td>
<td>ANU - 317</td>
<td>430 ± 70</td>
<td>1331 - 1640</td>
</tr>
<tr>
<td>Entrance Island</td>
<td>ANU - 242</td>
<td>830 ± 80</td>
<td>1004 - 1280</td>
</tr>
</tbody>
</table>

Figure 3.15  Macknight's radiocarbon dates for charcoal from Makassan stone lines.

The early age of these dates, along with a third sample from Anuru Bay, one from Entrance Island and two from Lyaba on Groote Eylandt, led Macknight to dismiss them as being probably erroneous. To test their reliability he dated wood from old mangrove stumps (cut by a metal axe so presumed felled by Makassans) and a sample of fresh mangrove leaves. The leaves gave a modern date, but the stumps returned an age of 400 years. On the basis that mangrove stumps could not survive for 400 years he concluded that an unknown factor had caused an aberration.

Clarke (2000) rejects this conclusion and points out that there is no evidence to back the assertion that wood will not survive in a marine environment for 400 years or longer. If the wood is exposed to marine worm, insect activity or fungal invasion it will break down quickly, but if the stumps had been buried in anoxic mud they would almost
certainly survive for 400 years and longer. Warruwi's Mardbulk Bay provides ample evidence of the dynamism of Arnhem Land's coastal environment, especially when disturbed by the removal of mangrove cover (personal observation). After Macknight's mangroves had been cut their stumps could well have been buried in mud—in the same way that Mardbulk Bay filled with mud—and re-exposed centuries later by an event such as a cyclone. There is, therefore, no grounds to doubt the 400-year date on the test samples on the grounds that wood could not have survived that long.

There may also be a factor known as 'old wood' (Clarke, 2000) where it has been shown that charcoal derived from old trees can give a date from some time during the tree's life span rather than the time it was burnt. Little work has been done on aging individual mangrove trees in north Australia, but like most tropical species mangroves are not thought to be particularly long-lived. It's not known what species the charcoal was derived from, but *Rhizophora species* are the most common large species on the coast (Mangrove, 2015) Studies in a comparative environment on coastal Kenya (Verheyden, 2004) showed that a large mature specimen of a recently fallen *Rhizophora mucronata* (a species related to Australian *Rhizophora*) with a height of 12m and a diameter of 28·6cm was only 89 years old.

Based on this data it is unlikely that mangrove trees in Arnhem live longer than 100 years, therefore any error introduced by 'old wood' could be no more than 100 years.

A third possibility has been suggested by Macknight (Per Com, 2013) to explain his early date, that the Makassan stone lines had been built on the sites of old Aboriginal cooking fires and charcoal from these cooking fires had become mixed with that from the Makassan's fires.

It seems reasonable that one or two stone lines may have been built over old Aboriginal cooking sites (the sites are on beaches so very unlikely for charcoal to result from wild-fire) and old charcoal was accidentally sampled, but for the same circumstances and error to be repeated at five sites is less likely. Nevertheless, the fact remains that radiocarbon dating can give a probable range of dates for a fire being lit, but it cannot say who lit it.

To date the earliest solid evidence for Makassans in west Arnhem Land was found in a rock painting at Djulirri in the Wellington Range, just inland from Anuru Bay, also in Maung clan territory. There are two pictures of a prau (identified from their distinctive
‘tripod’ masts), along with the previously mentioned tall ships and hat-wearing figure. As with one of the European ships, the prau were dated using beeswax that had been used to make designs over the paintings. The age of the wax over one prau was determined (89.9% probability) to be between 1644 and 1802 with a median date of 1777. The other prau, however, proved to be considerably older. The minimum age, as determined by beeswax overlying it, was determined to be between 1517 and 1664 (99.7% probability) with a median date of 1577 (Tacon et al, 2010). This means that there is a 99.7% probability that Makassans (or at least someone from the Indonesian archipelago) visited west Arnhem Land before 1664, and they were close enough and stayed long enough for an Aboriginal artist to be able to make a detailed picture of their prau.

**Dating the Warruwi pond**

Tommy’s story about the pond’s construction and the story of the Makassans using the Warruwi pond to store trepang are the only pieces of information about the pond that have survived to modern times. Aside from these two snippets, history does not appear to make any mention of anyone—Aboriginal, Makassan or European—building or using the pond at any time for any purpose. Nor does it give any clues as to when the pond was built other than in ‘old times’, but, given that the pond seems to have no modern relevance to the local people, it is perhaps surprising that this much has survived.

On the evidence so far, it would seem that the pond was in existence when Europeans arrived on the Goulburn Islands so therefore it was, built by either the Aboriginal residents, Makassans or some other as-yet unknown group—but given the dearth of information history alone cannot tell us which. The only option left open to determine the pond’s probable provenance is to examine the physical and cultural attributes of known structures in the region that are used for each possible function and comparing them to the Warruwi pond description.
Chapter 4

Possible uses for the Warruwi pond

Given its location and construction, four possible uses for the Warruwi pond present themselves: a ceremonial ground, a fish trap, a (marine) wild stock management tool, or for aquaculture.

Ceremonial use appears the easiest to rule in or out as the Maung Elders should have that information, but this is not necessarily the case as some traditions appear to have been lost on the Goulburn Islands and knowledge beyond the start of the mission in the early 20th C may be limited. A second opinion (so to speak) on its possible use can be obtained from the pond itself as the nature of its structure will give an indication of the possibility that it was once a ceremonial ground.

Differentiating between the other three options is more problematic. The lines between definitions of these activities are often grey and structures built for each purpose often similar.

This chapter will explore each of these options in order to determine which is the most likely function of the Warruwi pond and which may, in turn, help identify the most likely builders.

Option 1: Ceremony

Given its size, shape and location it is possible that the structure was built and once used for ceremonial purposes. Lamilami states that there was a ceremonial ground located on the Warruwi site immediately adjacent to the pond.

They [the old people] wanted one that was laid down by their grandfathers or their great-great-grandfathers. Their ancestors. So if they wanted to have ceremonies then, they had to go to the mainland (Lamilami, 1974, p 90).

He does not say what ceremony was performed there other than that it was the main ceremonial and ritual ground where the Maung and other (mainland) language groups gathered (Lamilami, 1974), but all Traditional Owners unanimously deny that the pond was linked to these ceremonies (Warruwui Traditional Owners Bunug, Tommy
Gagaraba and Billy Nawaloinba, Per Com, 2005). Nevertheless, there is a strong tradition among the North Territory tribes of fertility cults that use circles of various sizes and elaborations (Berndt, R., 1974) and several (eg the Laragia and the Daly River tribes) built circular stone structures to represent a womb (Berndt, R., 1974) that was used in initiation ceremonies. The fact that Warruwi pond is built in water does not necessarily rule it out as a ceremonial ground—initiation ceremonies were once carried out in shallow water near Milingimbi in the Crocodile Islands, a couple of hundred kilometres east of the Goulburn Islands (Berndt, R., 1974), although there is no indication that structures were involved.

Assuming that the Warruwi pond could have been a ritual structure, one figure emerges as a possible initiator and subject for ceremonies carried out in it—the fertility figure Waramurunggoindju who came to Goulburn Island from Wongatdjara (Indonesia) (Foelsche, 1881; Berndt, R., 1974; Swain, T., 1993). Given that she not only came from the sea but appears to have been strongly linked to both marine and fresh water, it would seem reasonable to site a ceremonial ground dedicated to her on the shore or in inshore waters.

Linking a circular feature to water is not unique and in at least one case in Arnhem Land one is linked to marine matters through artwork. On a rock shelf projecting into the sea at Wurrawurrawoi in Dalywoi Bay, just south of Yirrkala on the north east tip of Arnhem Land there is a gallery of stone pictures (Fig 4.1) depicting Makassan—or Indonesian—objects or structures, such as prau and trepang-processing fire places (stone lines) (Macknight & Gray, 1969). Set among these obviously foreign objects is a five metre diameter depiction of a stone circle (Macknight & Gray, 1969).
The circle is broken by a one metre (partially blocked) gap on the east side and there is a small pile of stones in a more or less central position (Fig 4.2).

Figure 4.1 The Warrawurrawoi gallery site (from Macknight & Gray, 1969)

Figure 4.2 Wurrurrwurrawoi gallery depicting a circular stone enclosure with a one metre opening (from Macknight & Gray, 1969).
The gallery was first pointed out to Messrs Evans and Gray during a sacred site survey in the 1960s, but they were told at the time that, while clearly a cultural feature, it had no ‘sacred significance’ (Macknight & Gray, 1969) and the circle represented a fish trap of a type used by a man named Djul-djul from the Wessel Islands (Macknight & Gray, 1969)—descendants of his were said to still live on Elcho Island, so it can be assumed that Djul-djul was an historic figure.

This particular feature clearly links a circular structure similar to the Warruwi pond to a marine setting—and, interestingly, to foreign objects. Ritual stone circles appear not to be unusual in the region; for instance, in Tanimbar there is a tradition of ritual stone boats (didalan or natar) where, in pre-Christian days, the villagers gathered to discuss matters of community importance, worship the old gods and to make sacrifices. While some of these ‘boats’ were in the true shape of a boat, many were stylised as a stone circle with an altar (sacrificial stone) and a wooden post inside the bow on the seaward side and stone seats toward the stern (McKinnon, 1991, Pp 68 – 70). Similar stone structures are found in several other east Indonesian islands, so it is possible that the Wurrawurrawoi gallery image depicts something seen while the artist was travelling and the pile of stones inside the circle may have represented the altar.

Grouping the circle with prau and stone lines suggests that it was not a depiction of a sacred feature (unless prau and stone lines had assumed religious overtones in the area) but rather a ‘postcard’ to show the people at home what was across the water—either in Indonesia, Wessel Island or the Goulburn Islands. Or it may have been included in an instructive list of items of economic importance to north east Arnhem Land, but in either case it does not appear likely that it depicted a ceremonial structure.

Then there is the physical evidence from the pond itself. The Warruwi pond’s construction method—the thickness of the wall, the use of size-graded rocks and the clay base—are details unlikely to be needed in a ceremonial structure and argue against it being constructed for ritual purposes. Like the Wurrawurrawoi depiction, the Warruwi structure is more likely to have had an economic purpose, such as a tool for wild stock management, a fish trap or aquaculture. The lines between these activities can be blurred, especially at the lower technology level, so determining the likely function of the Warruwi pond will require a detailed description of each.
Because the Warruwi pond was first described as a ‘fish trap’, it is appropriate to begin with fish traps.

Option 2 Fish traps

Fish traps are common throughout the world (Bowen & Rowland, 1999) and today variations, ranging from habitat traps to weirs, are still used by many societies. All traps involve a degree of construction, ranging from the very simple (strategically placed stones) to the very complex, and may use a variety of materials from organic (woven grass or creepers, brushwood or timber) to stone, or a combination of both. Traps intended for modern commercial fishing often use metals and/or plastics (Slack-Smith, 2001).

Regardless of design or material, most fish traps are built for the sole purpose of increasing the supply of a target species to the owner for either food or commerce. The exception is the comparatively modern use of traps to sample fish stocks for scientific research—often to provide guidelines for stock management policies (Johannes, 1978; Kushlan, 2001; FAO Tech paper, 2005).

Trapping, whether traditional or modern, is accomplished in three ways:

- By creating a habitat—a substrate suitable for shellfish (eg oysters) or attractive to other species (eg lobsters, eels) to settle in or on—that makes a prey more accessible than it would be in its natural habitats. The trap is visited or recovered periodically and animals that have taken up residence are harvested before the trap is reset. The simplest example of this is a pile of rocks to attract oyster settlement, but quite complex habitats are often built to attract species ranging from tropical lobsters to eels (Best, 1977; Marshall, 1986; Slack-Smith, 2001).

- By luring prey into the trap with bait, the prey enters the trap to get the food and is then prevented from leaving. Examples of this type of trap are crab traps, lobster pots or eel baskets (Best, 1977; Marshall, 1986).

- By creating a barrier or weir that directs fish or other targeted species into a ‘pen’ (Best, 1977; Marshall, 1986; Bowen & Rowland, 1999).

The structure and design of the Warruwi pond makes it unlikely to have been built as a ‘habitat’ trap. The pond itself does not provide any more (or less) of a habitat than the
surrounding mud flats, although the rocks do attract oyster settlement. The closely spaced stones that form the pond wall provide insufficient spaces to be a suitable habitat for all but the smallest animals, which would not provide a sufficient return to the builder to compensate for his work. If it was intended to provide a substrate for mollusc settlement (eg oysters) a simple row or scatter of rocks would have been as (if not more) efficient.

Nor is it likely to have been a baited trap, although Walters reported that in some cases (in Queensland at least) stone traps were baited to increase the catch and cites Campbell (1978) as saying:

... a well-tended and carefully baited fish trap would secure huge catches (Walters, 1885, pp 39).

There appears to be limited literature on this type of trap, but we can assume that in such a trap the bait would be set in an enclosure at low tide, then the fish are attracted by the bait and swim over the wall at high tide where they are trapped when the tide falls below the top of the wall as they eat.

Although one can imagine the Warruwi pond being used in this way (albeit somewhat inefficiently because its position is so low in the intertidal zone that there would always be ample time for the fish to enter, eat all the bait and leave again before the tide fell sufficiently to trap them) there is the same argument against it being used as a baited trap as against it being a habitat trap or a ceremonial structure—the sophistication of the structure is far beyond what would be needed.

This leaves a weir type trap option. Weir style fish traps are defined by Bowen & Rowland as:

A trap is any structure having a length and shape that creates a holding area (known as a pen) or comprising at least two walls joined at an angle. A weir is a fence or wall that seals natural conduits of water, such as creeks, streams, coves and so forth (Bowen & Rowland, 1999, p 2).

Weir traps range from simple walls that block a water flow to complex structures that guide fish into a holding area from which they cannot escape. All weir traps necessarily have one thing in common—they all have a catchment from which fish are funnelled into a trap by an enclosing wall. The catchment may be a river upstream from a wall, a natural embayment that can be blocked off by a wall, or it may be created by building walls to join up natural outcrops, or by building a wall to encompass an intertidal
area. Walls are built at an angle to the receding tide so that as the tide goes out fish can only follow them in one direction—into the trap (or pen). Generally speaking the larger the catchment the more efficient the trap.

Bowen & Rowland go on to say that:

Fish traps (weirs) are mostly found in the inter-tidal zone where they make use of fluctuating water levels. The walls must be low enough for aquatic fauna to swim in at high tide, but high enough that some are marooned at low tide (Bowen & Rowland, 1999, p 2).

In other words if a weir trap is to function properly (or at all) it must be completely submerged at high tide to allow fish unimpaired access to the intertidal zone (Fig 4.3).

![Weir trap vertical profile](image1)

**A: Weir trap vertical profile**

![Weir trap from above](image2)

**B: Weir trap from above**

*Figure 4.3* Weir trap in profile: 

- Indicates fish moving in with the tide
- Indicates fish moving out on the ebb tide

Clear water for fish to swim over at high tide

Low tide

High tide

Stone wall

Shoreline

Pen /Catchment

Low tide mark

High tide mark
Many species of fish follow the tide in to forage then go out with the ebb tide, so the trap must become exposed on the ebbing tide in time to prevent foraging fish swimming back over it. To do this the height of the wall should be set at about mid-tide level or above. Nor should the trap hold water except in the very end (the pen)—if it forms a lagoon in which the fish could disperse and hide they would be as difficult to catch as if they were in open water. The wall needs to be made of rocks large enough to allow the free flow of water, but small enough that they do not leave spaces large enough for fish of an edible size to escape. Fish and crabs are often trapped between the stones in the walls of stone weir traps as they try to escape and are picked up at low tide (Bowen & Rowland, 1999). In traps where fish are directed into a pen they are caught at low tide by hook and line, spearing or poisoning.

Weir traps fall into three basic types (Aara, 2002):

1) ‘V’ shaped. These are placed in the intertidal zone with the open end of the V facing the shore and the sharp end toward the waves (Fig 4.4). The ‘V’ shape disperses the wave’s power and strengthens the structure.

![Diagram of 'V' shaped weir trap](image)

**Figure 4.4** ‘V’ shaped weir trap → Indicate movement of fish with ebbing tide
2) ‘U’ shaped. Similar to the V shape but semicircular with the arms of the ‘U’ facing the shore (Fig 4.5). The rounded shape gives the trap better strength to withstand wave action by transferring it horizontally into the arms of the ‘U’ in a similar way that an arch transfers vertical weight.

![Figure 4.5 ‘U’ shaped weir trap](image)

Figure 4.5 ‘U’ shaped weir trap → Indicate movement of fish with ebbing tide

3) Maze. A series of walls to direct fish into a single pen or a series of pens (Fig 4.6). These are generally used in low energy sites where the inherent weakness of a straight wall is not so important.

![Figure 4.6 ‘Maze’ type weir trap](image)

Figure 4.6 ‘Maze’ type weir trap → Indicate movement of fish with ebbing tide
There are a number of Aboriginal stone weir traps that are still being used and maintained in Australia, such as the ‘U’ shaped example in north Western Australian shown in Fig 4.7.

Figure 4.7  A ‘U’ shaped trap at Nangoona, Western Australia, on an incoming tide (Smith, 1997)

The basic trap design was sometimes enhanced by combining the stone foundation with an organic component—a brushwood or net barrier—that could be placed across a gap left in the structure. This type of trap is said to have been used at Momington and other islands in the Gulf of Carpentaria (Bowen & Rowland, 1999) where the traps were left open so fish could pass in and out, but when needed the gap (or gate) was closed and the fish trapped. The description of using a combination of materials to make traps in the Gulf agrees with descriptions by Yolgnu Elders (Various Elders, Per Com, 2004) where ponds were created by sealing gaps between natural outcrops with brushwood to make a composite wall high enough to prevent trapped fish escaping on subsequent high tides.

In the Maluku Islands a variety of fish traps are employed, from small hand-held woven traps (in Seram Laut dari) (Ellen, 2003) to semi-permanent traps made from wood or bamboo fencing (in Seram Laut weam or sero in Ambonese Malay) (Ellen,
2003), and at least two types of permanent stone weir traps. The first of these (in Seram Laut *dabangat*) consists of a simple stone wall built in the intertidal zone parallel to the shore. Fish or prawns are trapped by a net that is run seaward and parallel to the wall then drawn in toward it trapping the fish between stones and net (Ellen, 2003).

The second type of trap—a *lutur* (Seram Laut) or *sero batu* (Ambonese) (Ellen, 2003)—is more complex. This variation of the ‘V’ shape weir has two ‘wings’—stone walls up to one metre high extending from the shore at an angle down the intertidal zone forming an arrow pointing out to sea. But the tip of the ‘V’ is not closed, instead a round, stone walled pond is built on the end (personal observation) so that fish are funnelled down into it (Fig 4.8). In some cases a modified natural reef pool is used instead of building a circular pen (Ellen, 2003), but the effect is the same. Fish may be passively trapped just by tidal action or driven into the pen and the entrance blocked by canoes (Ellen, 2003, p 49).

![Figure 4.8](image_url) 

*Figure 4.8*  
Fish traps on inshore reefs on Tanimbar Island (source Google Earth 2012)

This style of trap is often linked to its neighbour, forming a zig zag pattern across the reef that is clearly visible on Google Earth (Fig 4.8). *Lutur* or *sero batu* are widely
used throughout the region and examples are seen from Seram to Tanimbar. An excellent example of this type of trap is located on the reef at the end of the airport runway at Soumlaki on Tanimbar Island and can be clearly seen from the right-hand side of departing planes.

This type of trap requires a considerable investment in time and resources, especially as they need frequent renovation after monsoonal wave damage. They can be owned either individually or communally, may be over one hundred years old and are treated as ‘a kind of hereditary wealth with symbolic as well as practical utility’ (Ellen, 2003, p 49). Ellen also says that there are few being built today, which may be the result of better technologies available for catching fish, or a reflection on the depletion of inshore fisheries making the investment no longer viable.

In Australia there is some debate about the efficiency of Aboriginal weir style fish traps for increasing food supply (Walters, 1985; Smith, 1997; Bowen & Rowland, 1999; Aara, 2002). Bowen & Rowland make the following comments regarding weir traps:

1) [They were used by] people who were looking for certainty of return or variety to their diet, or both
2) Trapping may be just one way among many of getting food
3) Trapping is only effective at times of the year when aquatic fauna are there to catch (Bowen & Rowland, 1999, p 34).

Building a fish trap alters the environment and may provide a resource where none existed before—if a fish is uncatchable it is not a resource, but a trap may enable it to be caught and thereby turn it into a resource, possibly an abundant one (Walters, 1985, p 41). This alters the local human population dynamics and enables a greater number of people to live in an area than would otherwise be possible. Bowen & Rowland go on to observe that a trap at One Arm Point near King Sound in Western Australia:

... provided a return that barely differed from the one obtained by active foraging (Bowen & Rowland, 1999, p 34)

This statement appears at odds with other observations—and with the assumption that building and maintaining a weir fish trap involves considerable labour. If they do require a lot of labour, yet produce little more food than could be obtained by normal spear or line fishing then they would be uneconomical to build. This observation is
particularly relevant to the Warruwi pond, which would have required considerable time and labour to construct.

The conundrum may be resolved by Bowen & Rowland’s statement ‘Trapping is only effective at times of the year when aquatic fauna are there to catch.’ If a large number of people gathered temporarily—eg for ceremony—and needed to be fed for a short time, it could be achieved by timing the gathering to coincide with an abundance (or run) of a particular seasonal species. For the rest of the year the observation that the traps ‘provided a return that barely differed from the one obtained by active foraging’ would hold true.

Walters (1985, p 41) cites Meehan when describing ‘small groups of people in Arnhem Land travelling to harvest fish from traps and creating dinner time camps beside the traps’. But, contrary to Walters (1985) and Meehan (1982) who maintained stone fish traps were common in Arnhem Land, during my research for this thesis and in the course of earlier work conducting field marine research and aquaculture training in coastal communities I have located only three intertidal stone fish traps in Arnhem Land waters—although it is by no means impossible that there are others buried in mud, hidden in mangroves or incorporated into coral reefs, or simply not yet identified. The lack of stone traps in Arnhem Land was subsequently verified by Meehan (Per Com, 2010), who modified her earlier statement by stating that Arnhem Land people traditionally constructed organic weir traps from branches and brushwood (this was verified by various elders at various times). It is possible that the Yolgnu custom of constructing fish traps by linking rock outcrops with organic material to create barriers was mistaken for stone walled traps.

Two of the traps I located, one at Yirrkala and one at Millingimbi, were built at the instigation of missionaries. The third, a ‘U’ shaped structure on Wessel Island, was originally reported to me by Brian Koennecke, a fisherman who had been operating in the area, who described it as a porous stone wall that allowed water and small fish to pass through but trapped larger fish (Koennecke, Per Com., 2012). Seen from Google Earth (Fig 4.9), it appears to be ‘U’ shaped, approximately 40 – 50m in diameter with a large catchment area formed by the bay to its north. Taken together with the reported porous nature of the wall this would appear to clearly identify it as a fish trap.
Unlike Yirrkala and Millingimbi, the Wessel Island structure could not have been built for a mission as the nearest establishment was at Galiwinku on Elcho Island, about 80km to the south. Nor is it likely that it was built by any other European because Wessel Island is very remote, seasonally short of water, inhospitable and, to the best of my knowledge, the only Europeans ever to occupy it for any length of time were a few soldiers during WWII.

Figure 4.9 The weir fish trap on Wessel Island, Arnhem Land

11°25' 55. 88' S: 136°31' 04.61” E (source Google Earth 2012)
But if the Wessel Islanders were surrounded by cultures that built fish traps from organic matter, why did they alone use stones? Bowen & Rowland (1999) attribute the use of organic material instead of rock to a combination of tidal range and a shortage of stone suitable for building. The tidal range experienced in Arnhem Land is comparatively slight and organic traps are more likely to survive there than in the strong tidal currents in north Western Australia where extensive stone weirs exist. In Arnhem Land there is also an abundance of easily available suitable organic material—often not so easily obtained in the north-west.

I have concluded that available construction material is more likely to be the determining factor in a trap’s construction. At sites such as Nangoona, Western Australia (Fig 4.7) there are adequate suitable free rocks and boulders available in the intertidal zone to enable the construction of extensive weirs, but this is not the case in most parts of Arnhem Land. As observed by Bowen & Rowland, the dominant rock formation in Arnhem Land is laterite (coffee rock) that occurs in large masses. Laterite is a soft ferruginous conglomerate rock that is laid down in beds and suitable amounts of loose usable sized boulders are seldom readily available—and, despite its softness, with the tools available to the Aborigines the large beds would not be easy to break up into enough usable sized rocks to build even a simple structure (this holds true for the Goulburn Islands and considerable effort would have been needed to mine enough stone for the Warruwi pond). The Wessel Islands are, however, an outlier of the remains of an ironstone range and suitable building stone is available, but the comparative aridity of the island meant there was not a large amount of suitable organic material.

It is not known if there was once a ceremonial ground near the Wessel Island structure, but it is a matter of history that large ceremonies were held at Warruwi, so it is possible that the Warruwi pond was built as a fish trap to feed the assembled masses. But without a catchment area of any sort where fish could be concentrated and channelled into a pen by an outgoing tide, it is not a weir type trap—and without a catchment it is difficult to imagine how it could have worked.

There are, however, two known examples of Aboriginal stone traps in south Queensland that appear, from the limited descriptions available in the literature, to also lack any form of catchment. The first, a stone pond described by Bowen & Rowland (1999, p 15) at Tallebudgera Creek in south east Queensland, is, like the Warruwi pond, also an enigma. It is oval shaped, 100m long by 30m wide and built of stone, but they say
that the structure was either eroded or not designed to harvest fish—presumably because, being oval-shaped, it has no catchment.

The other example, however, gives an eye-witness account of its use. Walters cites a description by Stockton of an enclosed stone trap at Toorbul Point in Moreton Bay, south Queensland. Stockton described this structure as:

...a most puzzling feature... A continuous wall made of local rock, enclosing an area approximately 70m x 35m, with no visible traces of iron or cement. The walls appear to have been built by piling the stones together (Walters, 1985, p 39).

The use of this structure by an Aboriginal woman, Mrs Birt, (apparently a Traditional Owner) in the early 20th C was described to Walters by Professor Bruce Rigsby from the University of Queensland:

During the mullet and tailor seasons, if a shoal was close in, Mrs Birt would row out, trailing a bunch of Bribie pine, torulosa she oak and vanilla lilly, this she maintained was necessary to attract the porpoises, very doubtful, but occasionally they would follow the dinghy and frighten a portion of the shoal into the trap. This exercise had to be performed on a falling tide; when it fully receded there would still be a couple of feet in the trap, with the tops of the rocks just awash. The fish were then easily caught with either scoop or cast nets....

The natives purpose of siting this trap in an oyster area was obviously to hold up bream and flathead between tides, both feed on young culture; with a seasonal school or two of mullet & tailor—with porpoise assistance—as a bonus (Walters, 1985, pp 44 – 45)

I am uncertain what to make of these descriptions. It is difficult to know why schools of fish would choose to feed inside the trap in preference to the (presumably) equally productive surrounding rocks and substrate. Walters (1985, pp 42 – 43) points out that fish remains excavated from nine sites around Moreton Bay clearly show a much higher density, and therefore much higher catch rates, then at Toorbul Point and concludes that the higher catch rates are the result of using the ‘fish trap’. This may have been the case, but the higher density of fish remains could be equally as well explained by a large number of people fishing in the vicinity and bringing their catch to a central location for large gatherings.
Like the Warruwi pond, it is difficult to see how an enclosed structure without a catchment of any sort would increase food production to the extent that Walters suggests unless, possibly, it was baited with something attractive that did not occur on the surrounding substrate.

But the main argument against the Warruwi pond being a fish trap remains—the sophistication of the structure is far beyond what would be needed to trap fish. There is also the issue of mining the laterite stone using the tools that were available to create enough material to build it.

Ellen (2003, p 49) mentions a type of low-walled lutur fish trap in the Maluku Islands that is used for trepang, but gives no details of how they function. As it would be virtually impossible to trap trepang except by physically catching them and placing them in an enclosure that they cannot escape from, one must assume that these are, in fact, enclosed stone ponds (tambak batu) similar to the Warruwi pond. This opens the possibility that the Warruwi pond was designed as a tool for wild stock management.

**Option 3 Wild Stock Management**

The FAO defines wild stock management as:

The integrated process of information gathering, analysis, planning, consultation, decision-making, allocation of resources and formulation and implementation, with enforcement as necessary, of regulations or rules which govern fisheries activities in order to ensure the continued productivity of the resources and the accomplishment of other fisheries objectives (Cochrane & Garcia, 2009).

Modern international treaties are sometimes effective in managing wild fish stocks in international waters where stocks are held in common, but all too often overcapacity of fishing fleets fails to take the overall ecosystems into account when devising management plans, and failure (or inability) to enforce regulations—especially reductions in fishing effort—have led to many treaties failing and the ensuing gross and unsustainable exploitation of fish stocks (Beddington et al, 2007; Cochrane & Garcia, 2009). The South Australian Government’s interventions in the Makassan Northern Territory trepang fishery—the imposition of punitive measures to reduce the fleet size followed by the eventual banning of foreign vessels altogether—could be said to be wild fishery
management in action (or it could be said to reflect greed and the ‘White Australia’ policy in action, depending on ones viewpoint).

Fishery management utilises tools ranging from closed fishing seasons, restricted areas such as marine reserves, or catch and size limits (Beddington et al, 2007; Cochrane & Garcia, 2009) and draws on knowledge obtained from several sources from the traditional through to scientific studies, depending on the location and circumstances. Wild stock management, both terrestrial and marine, which utilises these tools and knowledge is employed by all societies to conserve their reserves whenever stocks are threatened (Cochrane & Garcia, 2009).

But it is not wild stock management on a grand scale that I am concerned with in this study, but rather on a local, traditional scale where the primary requisite for stock management is usually ownership either by individuals, families or communities of an area, whether that area is a patch of sea, a reef or a sand bank. In the Arafura region (and world-wide) traditionally wild stocks are generally (but not always) managed by first establishing ownership or guardianship of a particular fishery or resource, followed by the imposition of some form of restrictions on harvest levels with defined punitive measures against offenders (Zemer, 1994, pp 19 – 32; Ellen et al, 2000; Henley and Osseweijer, 2005, pp 1 – 42; Antunes, 2005, pp 143 – 162).

In Arnhem Land each clan has rights over rigidly defined areas of sea and foreshore which are not necessarily continuous, but include different habitats that can be exploited at different times of year (Davis, 1988). Hunting and fishing an area indicates that a person is taking physical responsibility for its management, but spiritual management is also required—this is the responsibility of senior clan men and includes maintaining ritual song cycles and ceremonies. Neglecting these responsibilities leaves the man open to accusations of neglect and subject to punishment (Davis, 1988).

A feature of Arnhem Land management is the ‘fat cycle’ (Davis, 1988) that determines when a food source can be harvested based on its condition (ie when it’s fattest and/or best to eat). In this way each species is allocated an open and closed season, usually signalled by a natural phenomenon. For instance turtles are fat and good to eat when the wattle (*Acacia auriculiformis*) flowers, and when *Buchanania dbovata* flowers stingrays are fat (Davis, S., 1988; Oscar & Gali (Galiwink’u); Bunug, Tommy Gagaraba & Billy Nawaloinba (Warruwi), Per Com, 2005).
Yolngu management of all species of stock is based on complex Indigenous knowledge and is, barring the intervention of outsiders, efficient (Trudgeon, 2000). It does not, however, require any form of structures to be built (Personal Observation).

To the north several of the southern Maluku Island communities employ a traditional form of wild stock management called *sasi*, which enables local communities to regulate the harvesting of resources to ensure fair and equal opportunities of access for all community members. Like the Yolngu system, *sasi* is complex and comprehensive, based on Indigenous knowledge accumulated over generations of observations. Unlike the Yolngu system, *sasi* is intended to ensure sustainable and fair access to resources through a combination of enforced closed fishing seasons, gear restrictions and sanctions for offenders (Zemer, 1994; Ellen & Harris, 2000; Osseweijer, 2000; Arif Satria & Dedi Adhuri, 2001, p 31; Ellen, 2003; Henley & Osseweijer, 2005; Antunes, 2005). Restrictions are, however, placed on the harvest of a particular species by community elites rather than imposed according to natural cycles. Also unlike the Yolngu, whose management was/is based purely on maintaining their subsistence livelihood, Maluku *sasi* was/is intended to maintain both commercial and subsistence species (Zemer, 1994; Antunes, 2005)

Like most other Indigenous traditions, Indigenous knowledge was generally regarded by colonial scientists as a kind of ignorance and something inferior that needed to be overcome (Ellen & Harris, 2000), and the Yolngu system is so far outside the experience of Westerners that it is still barely understood. But, while it is generally regarded as a traditional system, Antunes says that *sasi* was actually started by the Dutch and the contemporary governing elite and quotes Zemer (1994a) as a:

... secular, social framework facilitating commerce between traders from distant Asian and European lands, local rulers, and small Maluku communities. Later, government and scientists saw in sasi a method to achieve sustainable development and community equity (Antunes, 2005, p 149).

However, traditionally *sasi* was, and sometimes still is, rooted in superstitions revolving around spirits and ancestors and involve ceremonies, taboos and offerings that must be observed. The traditional attitude on Aru was explained thus to Osseweijer while accompanying a trepang harvesting expedition:
You have to be aware that the sea is not yours, you see, you are wandering in the ancestors' yard. The sea is to the ancestors what the backyard in the village is to the people. When children are making too much noise, playing in your backyard, you will probably send them away. The same is true of the ancestors. So it is possible that you leave in the morning and the weather conditions are perfect, while in the afternoon, when returning to the coast, there are enormous waves and strong winds [which are the ancestors' grandchildren] (Osseweijer, 2000, p 68).

The role of the ancestors was further defined by Osseweijer as:

The ancestors of the sea are the keepers of the marine resources, so they can decide to take the sea cucumbers [trepang] to other areas temporarily.

If the ancestors do not want to give you sea cucumbers, then you have bad luck.

The sea cucumbers have become less because the ancestors are disappointed about our social behaviour (Osseweijer, 2000, p 73).

This was an explanation for the depletion of trepang stocks, but the villagers also know that stocks are depleted because of increased fishing effort and ignoring size limits (Osseweijer, 2000). Zerner's conversation with Maluku fishermen also revealed that superstition still plays a significant role:

... many of them imagine the marine world to be populated by a highly responsive community of invisible spirits who inhabit particular places, including promontories, graves, knolls, mountain tops, and submerged places within the marine petuanan. From these potent landscape nodes watchful spirits are believed to listen, see, and respond to the everyday practices of individuals and to respond to everyday practices of individuals and to the ceremonial performances of the community. A fisherman's fate and his luck in fishing depend on his relationship with these fractious spirits (Zerner, 1994, p 26).

These attitudes that stress the importance of ceremony are very close to Yolgnu beliefs and practices, and seem somewhat at odds with the Antunes' assertion that sasi was devised by the Dutch colonials. Commercial pressure has put sasi systems under considerable pressure and created the attitude that 'if I don't take it, someone else will' (Osseweijer, 2000, p 72). Christianity and Islam have undermined the traditional cosmology that sasi revolved around, but (ironically) recent efforts by both church and mosque have seen a revival in sasi as a conservation measure, albeit somewhat modified.
Today *sasi teripang* (trepang)—specific local level management of trepang stocks—has taken on a considerable significance due to its value. Linked to *sasi teripang*, in 1994 both the Catholics and the Moslems created sea nurseries (*tambak* or ponds/enclosures) to cultivate sandfish trepang (*Holothuria scabra*) in front of their villages in Aru (Osseweijer, 2000). Trepang were harvested communally and placed in the nurseries to grow out, but maintenance of the stone and wood structures and theft became a problem and the project was abandoned.

But this does not appear to have been a new concept. As previously stated, Ellen (2003, p 49) described a type of traditional low-walled stone structure (*lutur*) in Seram Laut that is designed especially to hold trepang. Although Ellen does not give a description of the trepang *lutur*, it is likely that they are the same structures that are known as *tambak batu* used to hold trepang elsewhere in the south Malukus (Per Com. Semy Rumahenga, Lembaga Ilmu Pengetahuan Indonesia (LIPI), Ambon, 2013).

Villagers in Seira, just off south west Tanimbar Island, told me that they knew of *tambak batu* and that they were used for trepang *sasi*, but they had not been used in some time so the villagers didn’t know how they were used, nor were there extant examples within their territory. It is also likely that the pond at the village of Selmona (Fig 4.10) in the north east Aru Islands (see Chapter 2) is also a *lutur*, as it was said to have once been used to hold trepang, although no one can recall who built it or when (Per Com, Baskara Mauliputra, 2012).
Figure 4.10  *Tambak batu* or *lutur* at Selmona in the Aru Islands (Photo courtesy of Baskara Mauliputra, 2007)

*Sasi* and *lutur* or *tambak batu* appear to be restricted to the Malukus. However, there is another form of marine stock management called *rumpun* that is practised extensively throughout the region that includes structures as an integral ingredient (Arif Satria & Dedi S. Adhuri, 2001, p 31; Shepherd & Terry, 2004). These structures are floating fish aggregating devices, usually a raft made of bamboo and palm fronds which is anchored and establishes ownership of an area (about 1ha) of sea defined by customary law and reserved for the *rumpun* owner. The owner is responsible for maintaining the fishery in that area—if he fails he is the one to suffer.

But the Warruwi pond does not resemble any known *rumpun* structure in any way so links between the two can be reasonably ruled out. On the other hand one aspect of *sasi* (if indeed it is *sasi*) appears to bear a striking resemblance—the trepang *lutur* or *tambak batu*, but using them to store trepang appears to be a point when wild stock management morphs into aquaculture.
Option 4  Aquaculture

The most authoritative definition of aquaculture is given by the United Nations Food and Agriculture Organisation (FAO):

Aquaculture is the farming of aquatic organisms: fish, molluscs, crustaceans, aquatic plants, crocodiles, alligators, turtles, and amphibians. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated (FAO Corporate Document Repository, 1988).

In reality most aquaculture systems sit on a continuum between the two extremes, but broadly speaking they fall into three categories (Luong Van & Dobson, 2000). The categories can be generally described as:

1) Intensive (Fig 4.11)

Farming systems are considered intensive when animals are concentrated in high densities in ponds, tanks or cages. For example, in Taiwan a stocking rate for prawns of 12.6 – 27.4 tons/ha is considered intensive (Phillips et al, 1991, 1993). Features of intensive farming are the need for artificial aeration, the regular input of food into the system and the resultant high levels of nutrients in the waste. Intensive aquaculture may be equated to terrestrial feed lots (Luong Van & Dobson, 2000).

![Figure 4.11](image)

**Figure 4.11** Intensive aquaculture. All of the stocks requirements are supplied artificially and the stock is closely managed (from Luong Van & Dobson, 2000)
2) Semi-intensive (Fig 4.12)

Semi-intensive systems employ ponds and cages, but seldom tanks, and involve a minimal level of intervention in the life of the stock. Stocking is at a lower density than in intensive systems. For example, a semi intensive prawn farm in Taiwan would have a stocking rate of 4.1 – 11.0 tons/ha (Phillips et al, 1991, 1993) and aeration and food input is minimal or absent. Stock feed on plankton or bacteria that are encouraged to grow in the ponds by the addition of fertilizer and a growing medium such as hay or lucerne pellets. The terrestrial equivalent of semi-intensive aquaculture is improved pasture farming of sheep or cattle (Luong Van & Dobson, 2000).

![Figure 4.12](image)

**Figure 4.12** Semi-intensive aquaculture. Some artificial inputs, such as aeration, are limited or absent. Stock are managed (from Luong Van & Dobson, 2000)

The line between intensive and semi intensive aquaculture is somewhat blurred. At the extremes the farming system in use is obvious, but in the middle ranges eg a prawn stocking rate of 12 ton/ha may fall into either category. Generally, it is the addition of aeration that marks a system as intensive.

3) Extensive (Fig 4.13)

Extensive farming uses the natural environment. Generally stock are obtained from a hatchery, although in some cases wild spat or juveniles may be collected, and placed into a position where they can obtain all their needs from an unmodified
environment. Intervention by the farmer is limited to (sometimes) providing shelter or holding structures and (sometimes) cleaning benthic growth and debris from the animals. The terrestrial equivalent of extensive aquaculture is open range ranching (Luong Van & Dobson, 2000).

Once again, the line between not only extensive and semi-intensive aquaculture at the upper end, but also between semi-intensive and stock management at the bottom end of the technology scale is blurred. Intensive aquaculture as it is practised today is a recent development and would not have been possible with the level of technology available even a century ago, therefore the Warruwi pond could not have been used for any form of intensive cultivation and they will no longer be considered here.

On the other hand, if the Warruwi pond were used for aquaculture it clearly modified the environment by enclosing an area and changing the substrate and would, therefore, be classified as semi-intensive aquaculture.

The cultivation of any given species may involve one or a combination of intensive, semi intensive or extensive stages—possibly all three—to produce the final product. They may also involve aspects of basic stock management and fish traps, depending on what species is being farmed and how it is being cultivated. For instance, for many bivalves, such oysters and mussels, cultivation largely depends on providing a suitable substrate to attract the target wild larvae to settle (FAO, 2004 – 2013)—a simple and small progression from placing rocks in convenient locations to establish an easily
accessible food supply. But, while this first stage of bivalve aquaculture qualifies as basic stock management, modern bivalve farming involves both ownership and considerable intervention in the animal’s life cycle after the wild spat has settled, which clearly renders it as aquaculture.

Developments over time have caused the progression of farming techniques for some species to progress from the extensive to the intensive—pearl farming is an example of this evolution from very simple to complex. For centuries pearl farming depended on collecting an adult pearl-producing species from the wild and seeding it with a pearl nucleus before placing it into a semi-controlled area of sea floor (where ownership was established) to be harvested when the pearl had grown (Kunz & Stevenson, 1908; Donkin, 1998; Haws, 2002). This involved aspects of both intensive (seeding) and extensive cultivation, but over a comparatively short period of time it evolved into modern pearl farming techniques (Haws, 2002) which use a hatchery to produce the spat (intensive) before they are placed in controlled conditions in the open sea to grow (semi-intensive) until they are seeded and placed back into a semi-controlled environment to grow the pearl (see Chapter 6).

For some other species the process may involve only one aquaculture stage—the hatchery where juveniles are produced and then released into a completely uncontrolled environment to grow before being harvested from the wild. This process is usually known as ranching when applied to such species as salmon (Piggins, 1981; Mahnken et al., 1983) or reseeding for species such as abalone, *trochus niloticus* (Crowe et al., 2000; Lee, 2000; Purcell et al., 2001) or *Holothuria* (trepang) (Gamboa et al., 2004; Bell et al., 2006).

Extensive and semi-intensive aquaculture was practiced in various forms in most parts of the ancient world and is of considerable antiquity. For example, in Egypt a 4500 year old bas-relief is believed to depict tilapia, a fresh water fish that is still cultivated in great numbers in north Africa, being raised in a pond (Pillay, 1990). The first manual on aquaculture—*Fan Li on Pisciculture* (Borgese, 1980)—was written by Fan Li, an advisor to the court in China during the Spring and Autumn period (8th – 5th C BC) and dealt with the cultivation of carp (*Cyprinus* spp). As a result of early Chinese expertise in its cultivation, carp farming spread to India by the 11th C and to Europe by the Middle Ages.

Because it is much easier to manipulate the environment in small, enclosed water bodies than in the sea with its tides, currents and predators, early aquaculture appears to
have been mostly in fresh water and probably evolved from fish traps—it’s a small step from trapping a fish in a pen and blocking up the entrance and feeding them for later use.

The first fully marine aquaculture was probably oyster farming—the Japanese, Greeks and Romans were all cultivating edible oysters around 2000 BP (Pillay, 1990). Basic oyster farming is a comparatively simple and hardy business that easily withstands the pressures of the marine environment, but the Romans (at least) had advanced beyond the basics and were using spat propagation techniques not rediscovered until quite recently (Higginbotham, 1997).

In SE Asia brackish water or marine aquaculture appears to have begun in 15th C Java with the cultivation of milkfish (*Chanos chanos*) (Pillay, 1990). At the time there were very active international contacts with China, India, Sri Lanka and the Middle East so it is unlikely that this technology evolved in isolation and milkfish cultivation (and other forms of aquaculture) was probably extensive throughout the region.

Aquaculture was not only the preserve of technically ‘advanced’ societies. For example the 13th C Hawaiians developed a very sophisticated integrated system of pond aquaculture (Costa-Pierce, 1987) that is still used today to grow both fresh and salt water species. All that they needed was a detailed knowledge of the local environment and ecology and a large workforce. In New Zealand Maori kept eels (*Anguilla Spp*) in specially constructed cages (*korotete*) (Best, 1977) where they were maintained and fed on sweet potato and worms until needed.

Similarly Torres Strait Islanders and Aborigines from all around Australia had forms of aquaculture that suited their culture and environment (Ross, 1996; Barham et al, 2004; Builth, 2005). Examples of pre-European Indigenous Australian aquaculture now coming to light from around the country include:

- Oyster enhancement at Moreton Island, Queensland, where Quandamooka oyster farmers enhanced stock by introducing artificial reefs to promote settlement and relocated oysters to improve spawning success and settlement (Ross, 1996)
- Eel farms in the Mt Eccles region of Victoria are examples of substantially altering the environment to both control stock and create additional environments suitable for eels (Builth, 2005)
• Clam gardens in the Torres Strait where giant clams (*Tridacnid Spp*) were (and still are) collected and brought to an area for grow out (Barham et al, 2004). This activity does not necessarily enhance the clam’s growth or promote settlement but simply endows ownership and makes them more accessible when they are ready for harvest.

• Pearl cultivation in north east Arnhem Land (see Chapter 6)

In most cases these systems simply, but very effectively, alter the environment to promote growth or settlement and increase the quantity of, or accessibility to a food source. Some traditional Australian Indigenous aquaculture has survived in small, isolated pockets, but many Indigenous groups are becoming involved in modern aquaculture including cultivating oysters, pearls, trepang, prawns, corals, clams, crabs, fin fish, eels and sponges.

No known traditional Indigenous aquaculture involves a structure in any way similar to the Warruwi pond. But if the pond was used for aquaculture, its site and its construction method may be used to understand what species could have been cultivated in it, and how.

For example, stone ponds used to grow pelagic species in the Arafura Sea region are much more likely to have been constructed in a similar way to one near Tual in the Kei Islands (Fig 4.14).
Figure 4.14  A basic fish farm near Tual, Kei Islands. Note the toilet and shower above the pond

The pond is situated well above the low tide level and its wall is $\sim 2$ m high, so the top is clear of the highest tide. The wall is constructed of stones and built around a natural depression in the reef. The stones allow oxygenated water and food (small fish and plankton) to pass through with the rise and fall of the tide but retain the fish, and the natural pond inside holds enough water to sustain the fish at low tide. Additional nutrients are supplied by the farmer’s toilet and shower being positioned above the pond—this stimulates the growth of sea weed and phytoplankton to feed vegetarian species such as mullet. A number of species (including turtles) are kept in this pond (personal observation, 2012). Although this would be classified as a semi-intensive system, productivity would be low and sales restricted to local markets such as restaurants.

The Warruwi pond, however, is located low in the intertidal zone and the walls are overtopped by water on every tide. All pelagic species would simply swim out at high tide—unless a net was added to the top of the wall. There are precedents for placing nets on top of a low stone walls to contain mobile species, for example Yunus Batkor in the village of Arma Kota on Tanimbar Island told me that they ‘put a net on top of the wall [of a stone pond] and use it to store lobsters for market’ (see Chapter 2)—lobsters are not pelagic, but without a net (which they cannot climb) they would simply walk out over the
rock wall. However Yunus also indicated that this was not the primary function of the pond, which was to hold wild harvested trepang prior to market.

Another example of netting on a stone wall base is the trepang pond in south Sulawesi (Fig 4.15), but in this case it seems that the netting is there to keep out predators and poachers.

Figure 4.15 Netting atop a low stone base forming an enclosure near Makassar in south Sulawesi

Both these examples are from the modern age when large nets are easily available. A century or more ago this was not the case and a net big enough to enclose the Warruwi pond (132 x 1.2m) would have been expensive to buy or time consuming to make—assuming the materials were available. Nor would a net be likely to keep out the large crocodiles and sharks that inhabit Arnhem Land waters which would inevitably be attracted to such a concentration of prey.

While it is not impossible that some form of addition was made from organic material to raise the wall height, the complex structure of the wall argues against it. If the
pond was designed to have a net (or similar) mounted on top there would be no need for a sophisticated construction where a simple row of stones to anchor the net and support poles is all that would be needed. Nor would there be any conceivable need to go to so much trouble to cultivate any pelagic species on a coast where wild fish were plentiful.

Therefore the Warruwi pond’s wall height combined with its location would seem to rule out the aquaculture of pelagic species.

Without the addition of a net, albeit a lower and less robust one than would be needed for pelagic species, the same argument—that the wall is overtopped by water at every tide—also rules out its being used to hold most mobile benthic species, such as lobsters, crabs or sea urchins that could walk out of the pond. With a net or similar barrier it would contain lobsters, sea urchins or gastropods (most crabs would swim out), but for what reason? Collecting and holding any of these species would not increase the food supply, indeed it would place a catch at risk of predation and loss to the catcher. It may serve to gather enough of a comparatively rare resource over time to cater for a gathering such as a ceremony, but easily constructed organic cages or simple enclosures would be more effective and more economical.

If the Warruwi pond was intended for aquaculture it is more likely to have been for sessile species such as oysters, clams or corals with no mobility, or species that cannot climb out, such as some species of *Holothurians* such as *H. scabra*. Determining if one or more of these species was being cultivated depends on:

- The known aquaculture techniques used for them today and if those techniques could have been applied in any form more than a century ago.
- If there was any reason to cultivate or hold it.

Many benthic species, both mobile and sessile, have historically had high commercial or cultural value (e.g. oysters, clams, abalone, *Holothurians*, *Trochus*) and techniques for cultivating some of them, especially oysters, have been known for at least two millennia (Kunz & Stevenson, 1908; Costa-Pierce, 1987; Pillay, 1990; Ross, 1996; Higginbotham, 1997; Donkin, 1998; Haws, 2002; Barham et al, 2004; Builth, 2005).

Most benthic species are ‘broadcast spawners’ which rely on releasing vast amounts of sperm and eggs into the water simultaneously to produce a ‘soup’ of gametes where sheer volume ensures egg meets sperm (Ellis, 1998; Counihan, 2001; Setyono,
This is especially noticeable on reefs when many species of coral spawn at the same time, producing such a huge cloud of gametes (personal observation) that predators are overwhelmed and cannot eat more than a fraction before they are dispersed by currents.

This spawning strategy requires both large numbers of animals to be in close proximity to each other and very precise timing to be successful. It relies on a series of environmental triggers, such as day length, UV levels, water temperature and salinity to achieve the necessary coordination (Ellis, 1998; Counihan, 2001; Setyono, 2004). These triggers differ slightly for temperate and tropical species, but broadly speaking rising temperature and/or UV radiation cause female ovaries to ripen and produce eggs and males to produce sperm. This is usually followed by a specific event, such as a spring or king tide, which triggers the mass spawning.

Some sessile species such giant clams (Tridacnids) are hermaphrodites (Ellis, 1998), which gives them a 'back up' reproductive strategy should they be isolated, but most mobile benthic species need to aggregate and use clues, such as the presence of coelomic (body) fluid from their own species in the water to ensure that they are not alone. Finally the presence of sperm in the water confirms the presence of other animals of the same species and gonadal condition in close proximity and stimulates others, especially the females, to expel gametes (Shokita et al, 1991; Ellis, 1998; Purcell & Lee, 2001; Counihan, 2001; Setyono, 2004; FAO, 2004). Spring tides and/or rough water are also triggers in some species such as Trochus.

Even under the best of conditions only a very small fraction of fertilised gametes will become juveniles, but if there are not enough individuals in close enough proximity to each other fertilisation will be inconsistent and eventual recruitment and settlement minimal. Because many benthic species have limited (or no) capacity to aggregate, broadcast spawners are highly susceptible to depletion and once the population drops below a certain level recruitment drops away rapidly (Junio-Menez et al, 2001). Overfishing of commercial species such as abalone, sea urchins and trepang has caused such depletions in many parts of the world (Cochrane & Garcia, 2009).

In the wild spawning is timed for spring tides because high tides bring stronger currents, which provide better mixing and dispersal of gametes and, because the stronger
currents carry them faster, sperm and eggs remain viable over a greater distance—important for species such as corals and clams that may be some distance apart.

Cultivation methods for most of these species are similar and comparatively simple. For the most part they involve assembling large numbers of mature adults in an unnaturally high aggregation under ideal conditions (and without predators) to maximise fertilisation rates. Animals are commonly conditioned (the gonads are ‘ripened’) by manipulating water temperature and artificial day length. Then administering a temperature shock (the sudden raising of the temperature to simulate exposure to air or a shallow pond at a night time low spring tide before a rapid return to ambient temperature by the incoming tide) will often be enough to stimulate a few males. If they are ‘ripe’ the presence of sperm will induce the other males and females to release their gametes (Shokita et al, 1991; Ellis, 1998; Purcell & Lee, 2001; Counihan, 2001; Setyono, 2004; FAO, 2004). Eggs and sperm are allowed to mix naturally before the fertilised eggs are removed and washed in clean water to prevent multiple fertilisation of each egg (polyspermy), then they are placed in specially designed tanks until they hatch after which larvae and juveniles are held in controlled conditions where they are fed, medicated and provided with an optimal environment for maximum survival and growth. During the larval phase care requirements vary considerably—for example some species require very specific feed whilst others do not require any food at all.


Assisted spawning techniques are being used to replenish some severely depleted natural stocks. Methods range from complex hatchery breeding and rearing to post settlement stage before releasing into a suitable habitat (used for species such as trochus and abalone) (FAO, 1990; Lee, 1997; Dobson, 1999) through to simple artificial aggregation of large numbers of mature adults in strategically placed enclosures (Juinio-Menez et al, 1998).

An excellent example of the latter is seen in the Philippines where sea urchins, important to both local reef ecology and village economies, are placed in 4 x 4m bamboo
enclosures within areas of suitable habitat. These enclosures function as reproductive reserves (Juinio-Menez et al, 1998). The sea urchins are held in high concentrations in the cages where they are fed until they are at optimum market size (~40 – 50mm). As they reach sexual maturity at >30mm the urchins all spawn at least once before they are harvested and, because they are in such high concentration, the eggs are virtually guaranteed to be fertilised before they are dispersed across the nearby reefs. This strategy has successfully resurrected a severely depleted sea urchin population where numbers were so low that they were unlikely to be able to aggregate naturally to achieve a successful spawning—and it has rejuvenated an important village industry.

According to two Elders on Elcho Island in east Arnhem Land, the same principle of artificially aggregating sessile species to enhance spawning success was known to, and practiced by Yolgnu (Per Com, Gali, 2004). During a discussion after an aquaculture training session, the old men were asked if they had seen any stone ponds such as one at Goulburn Island. After much consideration they said they had seen nothing like it, but that they did traditionally use smaller and more irregularly shaped enclosures—constructed by joining together natural outcrops—to store fish, giant clams and pearl oysters. As one old man said,

“We used to grow fish and clams and oysters. Trap fish, collect little clams and [pearl] oysters and put them in ponds to grow up”

And a second man added,

“Collect big clams and oysters, put them together in a pond and pretty soon there are lots of little ones around.”

The stimuli the clams and oysters would receive in these ponds includes temperature shock from the ebb and flow of the tide and concentrating coelomic fluid and sperm in an enclosed area—the same as the sea urchins receive in Juinio-Menez’s cages in the Philippines and virtually the same as they would receive in a basic hatchery.

With the ebb and flow of a spring tide the Warruwi pond would also provide these same stimuli, so it is conceivable that it was built as a simple hatchery for a sessile or semi-mobile benthic species. Determining which species depends on what reason there could have been to cultivate them.

On the Arnhem Land coast there is an abundance of sea food that would have been available to Yolgnu and visitor alike and there would have been no need to cultivate
anything for subsistence, so the question largely comes back to one of regional trade and economic opportunities.

The Arafura region, including Arnhem Land, abounds with ideal natural locations for aquaculture, but lacks both the infrastructure and the wealth to exploit them fully. Today air transport has opened markets for some species, such as live mud crabs and live grouper, that were previously closed because there was no way to transport them without spoilage. But historically, regional marine products were limited to those that could be easily and effectively preserved on site—such as sea weed, trepang, dried fish and shark fin—or those that needed no processing, such as turtle shell, pearl shell or pearls. Observers over the past four centuries recorded that all of these regional products were being exported to international markets (Kolff, 1840; Kunz & Stevenson, 1908; Sarcy, 1907, 1912; Lamilami, 1974; Macknight, 1976; Berndt & Berndt, 1954, 1988; Lape, 2002; Ellen, 2003; Hall, 2006).

Turtle shell, dried fish and shark fin can be ruled out as having any association with the Warruwi pond on the grounds that it would be highly impractical for any stage of the production of any of them. Sea weed could be easily grown inside the pond—but it can be grown equally easily outside it at much less cost and as its cultivation also requires considerably more area than the Warruwi pond encloses, any association between sea weed and the pond can also be ruled out on the grounds of impracticality.

There appears to have been no market—certainly no significant one—for corals, molluscs other than pearl shell, or any other significant sessile organisms; so apart from trepang, pearl shell and pearls, these can also be excluded on commercial grounds as candidates for culture.

This leaves only trepang and pearls as potential candidates for some form of association with the Warruwi pond.

There is considerable historic evidence for a wild pearl trade out of the Maluku Islands, especially around Aru and today a number of Indonesian and foreign companies are involved in pearl cultivation in east Indonesia. Tradition that the Selmona stone pond in the Aru Islands was once used to store pearl oysters (Per Com, Baskara Mauliputra, 2007) may be evidence of an historic pearl cultivation industry (the only reason to store pearl oysters is to seed them at a later date), but this was likely to have been contemporary with the early pearl industry in Broome.
Pearl cultivation was historically practiced in China and the Middle East (Kunz & Stevenson, 1908; Jackson, 1917—see Chapter 5) and they were also cultivated by Yolgnu in east Arnhem Land (Trudgeon, 2000; Personal observation—see Chapter 6). So it is not inconceivable that it was conducted in some form in the Malukus.

Sea cucumbers are harvested and/or cultivated extensively throughout the region. They are also harvested and kept alive in ponds, pens or cages until either a buyer is available or there are enough to make processing worthwhile (Tuwo, 2006). It is doubtful if the practice of harvest and storage is aquaculture or stock management but animals stored in this manner are sometimes included in modern aquaculture data (Tuwo, 2006).

In the east Malukus live storage involves *lutur* or *tambak batu* (Ellen, 2003), structures very similar to the Warruwi pond, but how old either the practice or the structures are is unknown. *Lutur* are ideally suited for traditional village-based, small-scale and low-technology trepang fishing where catches are often small and it is efficient to accumulate several catches and process them en masse. Traditional trepang fishing has been conducted in the south east Maluku Islands for several centuries (see Chapter 5) and it is likely that *lutur* have been in use for most of that time, a conclusion backed by Ellen’s (2003) statement that they have been handed down through the generations. Together this suggests that, in addition to similarities in construction and location, they may have an antiquity similar to the Warruwi pond.

There is no evidence that extant stone ponds were (or are) used for any form of aquaculture other than storage, but conditions in the ponds would create ideal conditions for spawning either trepang or oysters—such spawning would replenish local stocks and maintain the fishery.

Determining if either of these species was likely to have been associated with the Warruwi pond requires first an in-depth study of the region’s history, especially the development of its trade. The paucity of datable archaeology and the lack of any verifiable historic references makes accurate dating of the pond, based on local sources, almost impossible. But the history of Arnhem Land was inextricably linked to the history of the wider Arafura region and the origins of the Warruwi pond very likely lie outside Arnhem Land, somewhere in the history of the region. It is, therefore, essential to know if anyone in the region had the technology, the opportunity and the incentive to build such a structure in so remote a site and, if there was, who was most likely to have benefited.
Chapter 5

History of the Arafura region

As with most histories, the further we go back in time the fewer sources there are to draw on, a situation that seems particularly relevant to the Arafura region because of a dearth of pre-16th C information. Furthermore there is a tendency to interpret history in a manner that conforms to the current dominant view (Russell, 2004). In the case of the Arafura Sea that was a Eurocentric—Dutch and British—view (Ellen, 2003; Russell, 2004) that led to a skewing of history to highlight some issues and to downplay others. In the Arafura region this Eurocentrism has led to a heavy reliance on written colonial Dutch and English records. Most naturally deal largely with issues of trade and commodities that directly affected colonial interests—although there are a number of valuable observations of ‘native’ life among those records, especially the Dutch, who were assiduous chroniclers of the times.

The Arafura region (Fig 5.1), including the adjacent Banda, Seram and Timor seas, is geologically, culturally and ethnically diverse. Geology in the region ranges from the highly eroded ancient landscapes of north Australia to the mountains of Papua and active volcanoes of the north Malukus. The region’s people are equally diverse—from the Australian Aborigines in the south to the Papuans in the east and the Malays in the north and west. The majority of these people are Moslem, but there is a strong representation of Christians (especially in the south and east), and possibly animists in the remoter hinterlands.
Apart from Australia and Papua, the region is entirely made up of small to medium-sized islands each with distinct populations and cultures, but inter-island contact and navigation has been occurring for many thousands of years beginning some 50 – 60,000 years ago (Coutts, 1979; Lape, 2002) when the ancestors of Australia’s Aboriginals crossed a comparatively narrow 90km wide strait during the last ice age (Lape, 2000; Allen & O’Connell, 2008). At that time the sea level was ~ 80m below the present level (Fig 5.2). It began rising around 10,000 BP and stabilised between 5 – 6,000 years BP (Woodroffe et al, 1988)—however there is some suggestion that sea levels have continued to fluctuate in parts of the Arafura Sea (Woodroffe et al, 1992; Harsana, Per Com, 2012).
Austronesian speaking people reached the area, including Arnhem Land, between 4,500 and 3,500 years BP, bringing their distinctive domestic animals, pottery and language to the region (Fox, 2000; Lape, 2002. p 139) and introducing the dingo (*Canis lupus dingo*) (Corbett, 2001, p 17) and new stone working techniques to Australia. Recent genetic analysis suggests that about the same time north Australia was also visited by people from the Indian sub-continent (Pugach et al, 2013).

These ‘sea people’ probably also introduced the concept of an ‘island attitude’—that seas are roads that connect—in contrast to the dominant European ‘continental attitude’ that seas are a barrier to be crossed (Bennet, 2001). The island attitude fostered the development of inter-island trade links and cultures that were (and remain) comfortable traversing extensive tracts of open ocean, and it made journeys to and from north Australia by almost any of the multitude of island cultures entirely feasible—which means that almost any of them could have actually travelled to there and had the opportunity and know-how to build a pond at Warruwi.

Identifying the likely builders depends largely on determining which cultures had access to the relevant trade routes to enable them to profit from the pond’s products (neither pearls nor trepang were usually produced for local consumption).

The Arafura region, particularly the Maluku Islands, is famed for its export of valuable spices—up until the 17th C the north Maluku Islands were the only source of the world’s cloves and the Banda Islands the only source of nutmeg and mace. The region...
also produced a range of other products, but it was the spice trade that defined the region and it is through that that we know anything of the pre-European history of the region (Ellen, 2003). Rich profits obtainable from spices were the incentive to develop the international trade links and the internal networks that also allowed other products to be exploited.

As early as the 1st C AD cloves, at least, were being traded through south and east Asia and as far a field as Rome where, according to Pliny the Elder, they were a highly valued commodity (Fox, 2000; Fredericksen, 2000; Lape, 2002; Keay, 2005). There is even some suggestion that cloves were reaching the Middle East as early as 3,500 years ago (Fredericksen, 2000; Ellen, 2003).

The first known traders in east Indonesia were Indians who appear to have entered the Indonesian archipelago in the first few centuries AD, bringing Buddhism and Hinduism with them (Bellwood, 2007). It is these traders who were probably responsible for carrying the spices to the outside world—in fact the Indonesian word for nutmeg, *pala*, is derived from the Sanskrit *phala* meaning fruit (Ellen, 2003).

As the first traders were Indian it is likely that India was the first destination for Malukun produce; however, the east Asian trade is also thought to be millennia old (Hall, 1985; Ellen, 2003) as Maluku place names appear in Chinese documents in the 1st C BC (Lape, 2000). For this study it is the trade routes to China that are important, as China is historically the only known market for trepang (both Japan and Korea consumed trepang, but were not known to import tropical species).

The first specific mention of cloves and nutmegs being imported into China was by the *Hu* (probably Arab traders) during the T’ang dynasty (623 – 755) (Gungwu, 2003). This coincided with the establishment of Arab Moslem settlements on the west coast of Sumatra about 674 AD (Adib Majul, 1999) and may have been the beginning of Arab incursions into SE Asia that ultimately resulted in the conversion of most of the region to Islam, and eventually shut out the Hindu and Buddhist traders.

Lape (2000, p 142) states that there is no documentary evidence that Arab traders visited the Malukus until the 15th C, although the region was mentioned specifically in *The Book of Routes and Kingdoms* compiled by the Persian cartographer Ibn Khurdadhbih in 844 – 8 (Lape, 2000; Keay, 2005), which accurately locates the islands as ‘fifteen days sail from the Island of Jaba [Java?]’ (Lape, 2000, p 14). Whether Arab
traders were visiting the Malukus themselves at that time or buying their spices from Javanese ports or Malacca on the Malay peninsular (Fox, 2000) remains a moot point, but Ellen (2003, p 5) says that the trade was in the hands of the Javanese from the 12th C, and by the 14th C even the Chinese were forced to buy spices in Java.

This assertion appears to be somewhat compromised by the volume of Chinese pottery and coins found in Banda’s archaeological record, which increases after the 10th C and by the 13th C is such to suggest that there may have been a direct trade occurring (Lape, 2000), although the presence of pottery does not identify the traders—it may have simply been simply trade goods acquired in Malacca or Java. But regardless of the route their products were taking, it is clear that Maluku’s trade with the outside world was well established and well organised by the time Islam was adopted by the island states in the 15th C (although it had undoubtedly already been present with traders for centuries), and that the existing international connections would have made a trade in pearls and trepang (or anything else) feasible.

Gaining access to those trade connections would only be possible, however, if there were organised local trade foci where local producers could market their products to the international traders. Such foci existed in the islands that were the principle suppliers of spice—Ternate and Tidore (cloves), and Banda (nutmeg and mace)—with secondary trade nodes in Ambon, Goram (Seram Laut) and the Kei and Aru Islands (Fig 5.3).
Prior to the 15th C these were not population or trade centres as we know them today (Ellen, 2003); their importance lay in being comparatively small islands where buyers could meet sellers on neutral ground—a sort of no-man’s-land. Ellen (2003, p 9) points out parallels with modern Melanesia where small offshore islands are crucial nodes within wider trading networks.

It was only with the introduction of Islam in the 15th C that the kingdoms of Ternate and Tidore adopted the concept of the ‘state’ (Hall, 2006; Lape, 2000, 2002; Bellwood, 2007), although by this time they, along with the oligarchy of Banda in the south (Fig 4.3) were probably already ancient polities (Lape, 2000; Ellen, 2003). The current Sultan of Ternate traces his genealogy back to the 13th C when Tidore, Ternate and nearby Halmahera were one kingdom (Pak Saleh, Ternate museum [Sultans Palace] historian, Per Com, 2012).

Islam spread along trade networks where local rulers and traders saw advantage in becoming co-religionists with trading partners (Bellwood, 2007), so it is no surprise that Ternate, Tidore and Banda were the first in the region to accept Islam—they were the main trading entrepots and likely the only ones that had regular contact with foreigners. It was not until the 17th and 18th Cs that Islam spread to other eastern islands where it competed with Christianity for the animist souls of the Islanders.

Local tradition has it that sometime about the 14th or 15th C north Maluku federated into the kingdoms of Ternate, Tidore and Halmahera (divided between three of the Sultan’s sons) each with their own sphere of influence (Pak Saleh, Ternate museum [Sultans Palace] historian, Per Com, 2012). Despite being separated by only a few kilometres, Tidore and Ternate flourished as rival trading ports, while Halmahera slipped into the role of supplier. By the time the first Europeans, the Portuguese, arrived in 1512 Tidore and Ternate were wealthy Sultanates with well-established military organisations supporting a well-integrated regional trade (Lape, 2000). In the process they became bitter enemies, constantly vying for influence and trade and both exercising forms of coercive centralised political and economic influence in the region.

Their spheres of influence, which are likely to have varied considerably over time depending on the fortunes of war, were roughly divided east/west—Tidore’s influence (Fig 5.4) extended to Papua, east Seram, Seram Laut, and the Kei, Aru and Tanimbar Islands (Ellen, 2003) and Ternate west to the coast of Sulawesi (Amal, 2009) and south as
There is also some evidence (Barham et al, 2004) that, based on a rock painting of a prau in Fern Cave on Booby Island in the Torres Strait and some linguistic connection with Halmahera and/or Seram Laut, that the Torres Strait was included within the Tidore sphere.

Figure 5.4 Territory claimed by Tidore in 1797 (Sultans palace museum Tidore)

Ternate’s influence extended to the east coast of Sulawesi and south to Timor—its extent demonstrated by a letter from Dutch Governor-General Jacob Mossel to the Portuguese vice-regent of Goa in 1753 stating that, as far as the Dutch were concerned, the Portuguese had no claims in Timor as it had been given to the Netherlands as a present by the Sultan of Ternate in 1683 (Alderwerelt, 1904). The date of 1683 is somewhat at odds with developments in the region in the early 17th C, but Mossel’s letter does highlight Ternate’s early influence.

Tidore and Ternate are located in the north where much of the coastal shelf drops away quite quickly into comparatively deep waters, leaving few accessible trepang or pearl fishing grounds. While there were undoubtedly some pearls obtained in the area, there is very little trepang produced now or in the past (personal observation). These
products require the shallower, gently shelving seas found further south on and near the Australian continental shelf in the Arafura Sea—around Seram Laut, Papua, the Aru Islands, Tanimbar and Arnhem Land.

While the people of this region have variously owed political allegiance to either Tidore or Ternate, it was to the great trading emporium on Banda that they sent their trade goods and if pearls, trepang or other products were being produced or extracted from Arnhem Land they would also have been sent there.

Unlike its northern neighbours, Banda wielded economic dominance over a wide area, but without exercising any centralised political influence (Ellen, 2003) they were apparently able to trade reasonably freely within both Ternate’s and Tidore’s spheres. They thus achieve a leading position as a trade emporium, the principle terminus for international trade and an outlet for produce from across the south Maluku region. Banda may have owed this apparently privileged position in the region to the antiquity of its trade connections—as demonstrated by its name, which was probably derived from a Persian word for ‘emporium’ (Ellen, 2003, p 65), or perhaps it just came down to the political astuteness of its residents.

Politically, Banda never followed Ternate and Tidore in establishing a state with a single ruler, preferring to remain a loose oligarchy that never claimed any territory or sovereignty outside of Banda itself (Ellen, 2003). There were also longstanding foreign trader enclaves along the coasts (Lape, 2002; Ellen, 2003) that at various times appear to have controlled trade. Despite, or possibly because of its political arrangements Banda appears to have remained the region’s most important centre (Lape, 2000, 2002; Ellen, 2003; Hall, 2006)—in fact it was so dominant by the time the Portuguese arrived in 1512 Ternate was exporting its cloves through ports in Banda. This was quickly stopped when the Portuguese took up residence in Ternate (Hanna, 1978).

The first known specific mention of Banda was in the 1304 Chinese text Dade Nanhai zhi described in detail in the mid-14th C Daoyi zhilue (Lape, 2000). It was later included with the Maluku Islands’ first known appearance on a map—the Mappamundi in 1457 (Lape, 2000), which may have been derived from information from one Nicolo de’Conti. Another early map that showed Banda was the Rodrigues Map, probably derived from an Asian map and used by the first Portuguese known to visit the region in 1512 (Lape, 2000).
Products from the region reached Banda via secondary trade nodes located at Ambon, which drew on products from Buru and west Seram; Seram Laut (Goram) to the east of Seram, which drew on products from east Seram, Papua; and the Aru and Kei Islands (Ellen, 2003). In the extreme south the men of Tanimbar embarked on long distance voyages to surrounding islands, including Kei, Aru and to Banda itself to trade a variety of commodities—including trepang—for basics such as cloth and Ceramics (McKinnon, 1991, p 81; Lape, 2002; Ellen, 2003).

There are few details of this trade remaining, however two observations have survived:

• In 1513 Portuguese cartographer and explorer, Tome Pires, observed that the inhabitants from the Malukus, Papua and Tanimbar come to Banda to buy cloth (Ellen, 2003, p 65)

• Zerner observed during his travels through the region in 1825 – 26 that:

  … when the people of Banda had the trade exclusively in their hands, a picul of trepang might be obtained for a sarong (Zerner, 1994, p 26)

Banda also depended on its region to supply the very basics of life. The islands are not capable of supporting a large population—there is only one stream on the islands, the soil is poor and much of the land given over to nutmeg—so the Bandanese and traders alike were forced to import food and building materials along with trade goods from their outlying trade nodes (Ellen, 2003).

It is likely that foreign traders, especially Buginese and Arab, operated most of the long distance routes—to Malacca, Java and even China—while the Bandanese fleet occupied itself within the region moving produce to and from the secondary nodes to Banda. Transporting produce to and from island or village to the secondary nodes was done by small local craft (Ellen, 2003).

Banda’s trade received a major impetus with the Ming Dynasty’s ascension in 14th C China. The Ming oversaw an increased demand for new products and luxury goods (Ellen, 2003) that resulted in a visit by the 15th C Chinese exploration fleet under Ch’eng Ho (McMillan, 2001). This was the culmination of an ongoing Chinese search for ‘useful and valuable goods’ that began with the 5th – 6th C T’ang dynasty looking for decorative items such as pearls, ivory and feathers, before gradually expanding until it included
perfumes and dyes, and eventually drugs, medicines and spices (Gungwu, 2003, p 122). When they visited the south Malukus the fleet would have found not only spices, but also a source of other products including luxuries such as the large South Pacific pearls and medicinal products such as trepang.

There is no direct evidence that the Chinese ever travelled south of the Malukus to Australia, although the scholar Wei Chu-Hsien says that they visited North Australia in 593 – 592 BC to take astronomic observations, which were later used by Confucius in his ‘Spring and Autumn Annals’ (McMillan, 2001). The first apparent Chinese mention of Australia is in a map called ‘the Impossible Black Tulip Map’ (Fig 5.5) compiled in 1603 by a Jesuit Missionary in China named Matteo Ricci. At the bottom right of the map there is a coastline with annotations that Professor Richard Rigby, Executive Director of the ANU China Institute kindly translated for me.

The land appears to be New Guinea (Xin Runi), so called because it looks like the older Runi in 'Liweiya' (Rigby can't guess what this transliteration of a foreign place name represents). It also says that this is as far as Europeans have gone and that it is unclear if it is joined to a contingent land mass (presumably Australia) or is an island. Place names along the top, from right to left, read 'Beautiful Peak/Mt Beautiful', 'White Peak', Xin Runi, 'Xian Ouwsiding River', 'Bottle River' (Rigby, Per Com, 2013).
The phrase ‘this is as far as Europeans have gone’ suggests that, as a Portuguese, Ricco was able to access information acquired by the Portuguese explorers who had been active in the Arafura Sea for a century, and used this in drawing his map. But saying ‘it is unclear if it is joined to a contingent land mass or is an island’ indicates that he knew of Australia, but whether from Chinese or Portuguese exploration or second-hand information obtained by either Chinese or Portuguese from local sources cannot be said.

But could China have had any direct involvement with Arnhem Land and therefore, potentially, used their aquaculture technology to build and use the Warruwi pond?

It seems unlikely that Australia could have remained unknown to the Chinese while islands only a couple of days sail to the north were explored and regularly traded.
with, but knowing about and visiting are not the same. If they did come during this era they left no trace (at least none yet discovered), either physical or in Aboriginal history—there are pictures of prau, square-riggers and schooners, but none yet discovered that could be interpreted as a junk. Nor are there stories, except perhaps the ‘small white or golden people’ from the Bayini stories, which could be interpreted as describing Chinese. More importantly, there was no obvious reason for them to come to Arnhem Land when, assuming Arnhem Land was being exploited, they could have obtained its produce from trade centres such as Banda.

By the 16th C assemblages of considerable amounts of Chinese, Vietnamese and Thai Ceramics in Banda’s archaeological record (Lape, 2000) demonstrate extensive and sophisticated trade routes and a thriving, bustling, cosmopolitan community. In 1609 the English Captain Keeling described Banda as:

A collectious (sic) nation of many people compounded (Purchas & Hakluyt, 1625—in Lape, 2000, p 149).

This ‘collectious nation’ included Turks, Persians, Bengalese, Gujeratis, Chinese, Japanese, Malays, Javanese, Makassarese, and people from the other Maluku islands of Seram, Ambon, Kei, Ternate, Tidore and Aru (Lape, 2000, p 149). Banda was known far and wide as a prosperous entrepot—even to Yolgnu in Arnhem Land where it was known variously as Bandawee (the place where traditional information is owned), Bandayil (the place of the dead) and Bandaynga (where the big people come from) (Mcintosh, 1996).

The position of Arnhem Land and its people in the pre-European era Arafura community was (and remained in British Australia) that of a frontier. Physically it is inarguably part of the Arafura Sea region, but socially it was peripheral—similar to the North African littoral’s position in the Mediterranean—as the dry, alien and hostile continent that dissuaded settlement by sea people from the north. The people of the Arnhem Land coast were also restricted in their participation in the Arafura community—not by the environment, but by their technology. They were salt water people who had deep knowledge of their marine environment necessary to a hunter gatherer’s survival (Davis, 1988; Trudgeon, 2000; Sharp, 2002), but their sea-going technology was limited to sewn bark canoes, which had a maximum range of between 6.5 and 13km (Sharp, 2002, p 68) depending on conditions but were generally restricted to calm inshore waters.
The limits of their technology allowed Yolgnu only very limited access to off-shore islands such as Groote Eylandt and the Tiwi Islands and completely barred unassisted travel further afield. Therefore, to trade beyond their own coast they were wholly reliant on fishermen and traders coming to them, and sometimes they were able to travel when these people and took them on as crew (or as wives) for the return journey (Harney, 1946; Lamilami, 1974; Macknight, 1976: Trudgeon, 2000; Sharp, 2002; Ganter, 2006). As a result of these travels the islands to the north became well known to Yolgnu—in addition to Banda, Yolgnu stories mention specific places such as Badu (Badu Island) (Lamilami, 1974), Danimbbar (Tanimbar), Warru (Aru) and Layilayi (an island near Makassar) (Mcintosh, 1995).

Like all frontier people, the people of Arnhem Land focused on the main centres of power and source of trade items—in this case the islands to the north—but, like modern commercial capitals, those centres were focused on the wider world and probably only those traders or fishermen with a direct interest were aware of Arnhem Land. This is demonstrated by the rich Aboriginal oral history dealing with places and people from the north on the one hand, but on the other an almost complete lack of mention of either Aborigines or north Australia until after the arrival of Europeans in the 17th C.

This was when accounts of interaction between Arnhem Land and Makassar began to emerge, but there was still little or no mention of contact with any non-Makassans. It is easy to say now that, because there is no mention of anyone else, only the Makassans came; yet non-Makassan prau were known to visit Arnhem Land at the same time as (but not with) the Makassan fleet, as evidenced by Searcy’s observation (Whittington, 1905, p 42) of a wrecked prau and crew from Aru in the late 19th C. If prau from Aru were visiting independently then, they may have had a history of visitation, but it seems that, apart from Searcy, the only extant source of knowledge of non-Makassan visitors, and therefore the only way to explore all alternatives for the construction of the Warruwi pond, is Aboriginal history.

Aboriginal history is oral—recorded in story, song, dance and painting—and because of the nature of its inter-generational reproduction is often open to interpretation. Most non-Aboriginal researchers place such Indigenous history in the realms of mythology or endow it with over-cryptic meaning. This does not necessarily imply that it is false or fabricated, although undoubtedly this is applicable to some, but the histories presented here—while clearly interpreting actions or objects appropriate to Aboriginal
understanding at the time—appear (at least to the author) reasonably straightforward. All Aboriginal history presented in this thesis is based on publicly available secondary sources and occasions where elders have volunteered information.

**Aboriginal oral history**

Yolgnu stories tell of three waves of people coming from the north—first the *Wurramala* or Whale Hunters (*or Dhurrijiini, Djamulapu, Gelurru,*), then the *Bayini* and finally the *Makassans* (Dept Aboriginal Affairs, 1975; Berndt & Berndt, 1954, 1988; McIntosh, 1995). In north east Arnhem Land certain coastal clans, especially the Warramiri, believe that it is their historic role to act as mediators between Yolgnu and these foreigners from the north (Mcintosh, 1995), a role that has been sustained and reinforced from the arrival of the first visitors.

The *Wurramala* were said to be the first of the visitors. They were described as ‘Black people and Brothers to the Warramiri’ (Mcintosh, 1995) who lived on their boats. This description has led some European researchers to speculate that they were people from the east Maluku Islands or Sama Bajau (Mcintosh, 1995) who accompanied the Makassan fleet. However, Yolgnu insist that these people were the first of the three groups to come to Australia and therefore temporally removed from the Makassans who were the last group to arrive.

The second wave, the *Bayini* followed the *Warrumala* into north east Arnhem Land (Berndt & Berndt, 1988; McIntosh, 1995). The *Bayini* stories describe a small white or golden coloured people (although descriptions vary, for example Mcintosh (2008) described them as tall bearded men) who lived at various sites in north east Arnhem Land. They came in considerable numbers with men, women and children, built houses out of stone, planted rice and other crops, fished for trepang and other products of the sea, wove cloth, forged iron and made pottery (Isaacs, 2005). The stories even incorporate narrations about men coming ashore in east Arnhem Land dressed in mirrors (armour?) (Mcintosh, 2008) and there are extant ceremonies and artwork that feature men with helmets and swords (McMillan, 2001) According to the stories, eventually the *Bayini* looked up, saw a fire in their home over the water and sailed away (Isaacs, 2005). There are a number of sites associated with the *Bayini* in and around the English Company and
Wessel Islands off northeast Arnhem Land, but the principal site appears to be at Dholtji on Cape Wilberforce, near one of the Yolgnu clan's homelands at Barkhira.

The existence of the *Bayini* is a contentious issue; even the name 'Baiyini' does not appear to be accurate (various elders, per com.) as many Yolgnu claim that *Bayini* was a woman (sometimes also known as 'Nona', direct from Bahasa Indonesia for 'girl') who was specifically associated with the Port Bradshaw area on the Gulf coast of Arnhem Land (the name of 'Bayini' has been retained here as this is what these settlers have come to be called in the wider world). Several scholars have speculated on the identity of the *Bayini* and postulated variously that they may have been Makassan, Sama Bajau, Gudjeratis (Indian), Chinese, Dutch or Portuguese (Mcintosh, 1995a). For all the speculation, however, there is no definitive proof either of either their identity or existence and some, such as Macknight, maintain that they are essentially creations of the Yolgnu based on what they saw when they travelled to Makassar (Macknight, 1976).

The third wave were the Makassans who were concurrent with Europeans. These were fishermen and traders who came primarily to harvest trepang from the shallow waters off Arnhem Land. There is no contention about their existence and their activities are well documented, especially during the latter part of the 19th C.

Aboriginal history does not just deal with the arrival of groups, it also describes the arrival of a number of individuals. There are several versions of the stories of all of these creation beings from across Arnhem Land, however much of the detail contained in these versions is of little relevance to this thesis so the narrative concentrates on the versions recorded by the earlier researchers on the grounds that they were recorded closer in time to the original stories.

Oral traditions of coastal Arnhem Land differ from those in other parts of Australia in that many of the figures that feature in the stories arrived from over the sea, and that several of them are female (Elkin in Berndt, 1954). The mere existence of these stories suggests an era when such arrivals were uncommon and an event to be commented on and remembered—or perhaps they are a part of the coastal Aboriginal's Austronesian expansion heritage where such ideas are common and well recalled in oral histories.

The individuals of interest to this study are Djan'kawu and his sisters, Laindjung, Kunapipi, Luma Luma and Waramurunggoindju and her husband Wuraggag (Berndt, 1951; Berndt & Berndt, 1952, 1988; Dept Aboriginal Affairs, 1975; Foelsche, 1882;
Like the groups influenced its builders. Three of these figures—Laindjung, Kunapipi and Djan’kawu—continue to have strong influences on local Indigenous cultures but Luma Luma and Waramurunggoindju and her husband have mostly slipped away mentioned above, any of these individuals may have built the Warruwi pond or dealt with or, possibly because of the disruptions to tribal life recorded in Chapter 2. Luma Luma is still known in west Arnhem Land, but Waramurunggoindju and Wuraggag have been largely forgotten and seem to be only known today because early European observers recorded them.

Laindjung landed at Duwonmilingwu, near Blue Mud Bay on the Arnhem Land coast of the Gulf of Carpentaria—in the area of a circular structure and square feature identified from satellite imagery (Chapter 2). He is said to have brought sacred objects and been covered with ‘variegated water marks’ that became totemic clan markings when he established a cult in that area (Berndt & Berndt, 1988). At some point he had a son, Banaitja, who carried on with the religious teachings of his father after his death, but his teachings were not universally popular and Banaitja was murdered. The cult of Laindjung and Banaitja still exists but did not spread far beyond the Blue Mud Bay area.

Kunapipi came from the sea and landed at the Roper River mouth, also on the Arnhem Land coast of Gulf of Carpentaria (Berndt, 1951). She became a major fertility figure, the central character in many stories and in the early 20th C founded a cult that spread throughout Arnhem Land and across the Top End of the Northern Territory as far as the Daly River. Although it probably originated at a much earlier date, the spread of the cult coincided with, and may have been in response to, the missionaries’ repression of local religions and may have filled a spiritual need that Christianity couldn’t. Despite (or perhaps because of) the influences of missions the Kunapipi cult remains virulent and appears to have absorbed other local fertility figures, especially those that had been undermined and disempowered by missionaries.

Djan’kawu, along with his elder sister Bildjivuraroiuju, his younger sister Miralaidj and another man, Bralbral, came from a land far across the sea via the island of Bralgu (exact location unknown), east of Arnhem Land somewhere beyond Groote Eylandt (Berndt, 1954; Dept Aboriginal Affairs, 1975). They landed first at Rose River on the Arnhem Land coast of the Gulf of Carpentaria then paddled/sailed up the coast to Jelangbara in Port Bradshaw, also on the Gulf coast.
Djan'kawu then wandered north east Arnhem Land and its offshore islands with his sisters, naming sacred sites, creating water holes by inserting his mauwulan rangga pole into the ground and leaving a myriad of children from his relationship with his elder sister. The story makes it clear that people already inhabit the country, yet Djan'kawu's children are credited with populating the land. During his travels he encounters Laindjung, interacts with the Bayini and local people and founds a religious cult (expressed in the dhuwa moiety). He prescribed relationship and marriage laws, initiated ceremonies and began the practice of male circumcision (Berndt & Berndt, 1952).

Eventually Djan'kawu either sailed away to the north, presumably returning to his home, or continued his wanderings into the west. Very little is mentioned of Djan'kawu's male companion Bralbrall after they landed, but the sisters continue to form an integral part of the story.

Two aspects of Djan'kawu's behaviour are of particular interest. The first is the creation of water holes with a 'sacred stick'—in other words 'digging holes, some of which later filled with water', which is precisely what prospectors do. We know that a variety of minerals were being extracted from Arnhem Land in the mid-19th C from Earl, a settler at the early British settlement of Port Essington on the Cobourg Peninsular who wrote:

This part of the coast [Probable Island, near Elcho Island] is apparently the termination of a granite range, and is said by the Makassans to abound in minerals, among which they mention tin; but the only specimen I have which I will send to you by the first opportunity, appears to me to be antimony ore, which will yield perhaps $\frac{2}{3}$ $\text{rd}$ of its weight in metal.' (Earl, 1841 in Cameron, 1999, p 86).

Neither antimony nor tin is now known from that area, although tin is found in considerable quantities further west (Northern Territory Department of Mines and Energy 1997).

Later a British official, Alfred Searcy, observed manganese and gold being loaded onto a prau at a beach in Arnhem Bay, near Probable Island, in the late 19th C (Searcy, 1907; Macknight, 1976). Searcy did not mention the ethnicity of the crew—other than they were 'Malays'—and apart from these two observations I could find no linking Makassans to mining, so it is possible that the miners were not a part of the Makassan
trepang fleet. It appears, however, that the presence of gold in Australia was reasonably widely known as the Buginese (from Sulawesi) told two Englishmen—Alexander Dalrymple in the 1760s and Thomas Forrest in 1782—that gold could be got from Arnhem Land (Macknight, 1976).

The knowledge and exploitation of at least three valuable ores is not likely to result from random incursions by sailors, but rather indicates systematic exploration and prospecting—perhaps Djan’kawu’s ‘creating water holes’?

The second point of interest in the Djan’kawu story is the introduction of circumcision, which suggests the introduction of Islam and therefore would place Djan’kawu in or after the 16th C.

Luma Luma (Macknight, 1976; Berndt & Berndt, 1988; McMillan, 2001; Isaacs, 2005) came to west Arnhem Land from the north and travelled through the land causing trouble and jealousy among the people. He was finally speared for circumcising two boys who later died (Lami Lami, Bunug, Per Com, 2012), then allowed to take to his boat and go home. But before he left he revealed sacred designs to the people that have been painted on the chests of dancers ever since.

There is an interesting corollary between this story and one told in Makassar of the discovery of Arnhem Land by I-Baso who, according to Makassan oral tradition, left sacred triangle designs with the people of Marege (Arnhem Land) before sailing home (Saharuddin, Per Com, 2012).

The last entity is Waramurunggoindju, a fertility mother figure specific to the Cobourg peninsula area including the Tiwi, Croker and Goulburn Islands. She is important to this thesis because she is the only foreign entity that is specifically linked to the Goulburn Islands, but unfortunately she was one of those who were probably lost to Kunapipi and/or the missionaries and there seems to be very little surviving information on her. Her story survived at least into the 1950’s (Elkin in Berndt, 1954) when it was related to R. M. Berndt by the Maung elders on South Goulburn Island, but subsequently her memory seems to have been lost and survives only in European writing.

Paul Foelsche (Foelsche, 1882), Inspector of Police in the NT in 1881, briefly recorded the story of Warahmoorunee, who was probably the same figure as Waramurunggoindju. He was fairly terse in his description, but the story must have been locally very important for Foelsche (not renowned for his sensitivity to Indigenous
Waramurunggoindju (or Warahmoorunee), a pregnant (Foelsche, 1882) woman, arrived in the Goulburn Islands with her husband Wuraggag (according to Berndts) from Wongatdjara (Indonesia) via the Cobourg Peninsula (according to Swain they came via Melville Island where Wuraggag left her). At the time of her arrival there was no water on the Earth so she travelled through the Goulburn, Croker and Tiwi Islands and the Cobourg peninsula making Aboriginal people, the sea and all the water from a big fire.

It is unfortunate that there is only a little of the Waramurunggoindju story available and it is difficult to make anything from what there is, but it is evidence of early foreign activity on the Goulburn Islands. For a woman to have arrived on the islands she would have been a member of one of the groups who lived on their boats as family units, such as the Sama Bajau, and may well have been a Warrumala.

The veracity of all the figures and groups mentioned here can be challenged on the grounds that there is no direct evidence for any of them to have existed outside Yolgnu mythology. Taken literally, however, they point to a series of visits to the Arnhem Land coast, some of them deliberate and organised, by people from the north.

These arrivals may have all been Makassans, or at least associated with the Makassan fleet—except that the Makassans were not known to carry women, so Kunapipi and Waramurunggoindju must have come independently—and also Djan 'kawu with his sisters.

Aboriginal knowledge of foreign places may also be ascribed to their well-documented contact with Makassans and travels aboard Makassan prau. Except that, curiously, the island of Banda features large in Yolgnu (Warramiri) lore. It is said to be a place symbolic of ownership of ‘traditional Aboriginal information’ (Mcintosh, 1995), the place where Bayini leaders came from and very rich. Yet Banda ceased to be a centre of influence in 1621 and, although it regained some status as a trading centre, it should have been no more important to Yolgnu than any of the other islands, and certainly less so than Makassar itself. This suggests a significant pre-1621 Bandanese influence in Arnhem Land, but how far back that influence went is impossible to tell.
The only indication of age from Yolgnu stories is the suggestion that *Djan’kawu* may have introduced Islam and, as *Djan’kawu* and *Laindjung* were said to be contemporaries with the *Baijjini*, this would place all three in north east Arnhem Land in the 16th C. *Luma Luma*’s attempted circumcision suggests that he also was a proselytising Moslem and therefore probably also came in or after the 16th C, however he appears to be linked to west rather than east Arnhem Land as were the *Baijjini, Djan’kawu, Laindjung*, and *I-Baso*’s story may link him to Makassar rather than Banda as the Bayini were.

This just leaves *Waramurunggoindju* and *Kunapi*pi, whose stories originated from opposite ends of Arnhem Land, without clues to possible time-lines, but the location of their landing sites may hold a clue to their origins. The *Bayini, Kunapi*, *Djan’kawu* and *Laindjung* all made landfall on the east coast of Arnhem Land, precisely where wind and currents deposit flotsam originating in Indonesia and Torres Strait onto Arnhem Land beaches between February and November (Chapter 3) and therefore where those same winds and currents would have taken them if they had sailed from the east Malukus (Fig 5.6). On the other hand *Luma Luma* and *Waramurunggoindju* both made landfall in the west, suggesting their origins were in the north or west—Tanimbar, Timor or Makassar.

If the *Baiyini* (and by association *Djan’kawu* and *Laindjung*) were linked to Banda in the 16th C, their travels are likely to have been a result of the impetus and possible diversification given to Maluku trade by the increased demand from the Ming Dynasty in the 14th C. Ch’eng Ho’s treasure fleet in the 15th C must have led to the Bandanese and their suppliers actively searching for the goods the Chinese were seeking—a search which may have taken them to explore and exploit the riches of Arnhem Land.
The arrival of Europeans

This was, however, also a time of great upheaval in the region brought about by the arrival of the Europeans with very aggressive trade policies and rivalries that disrupted, and eventually destroyed the region.

In 1511 Bandanese trade was seriously interrupted when the Portuguese under Affonso d’Albuquerque conquered Malacca and the Javanese ports (Hanna, 1978; Fox, 2000; Lape, 2002; Ellen, 2003; Keay, 2005; Hall, 1985, 2006), closing the major distribution hubs for east emporia, such as Banda. The loss of Malacca may have been the beginning of the rise of Makassar as a trade centre (Ellen, 2003).

After Albuquerque took Malacca he sent one of his captains, Antonio d’Abreu, to the Malukus with a Malaccan pilot/guide and three ships. He arrived in the Banda Islands and Ambon in 1511 (Ellen, 2003) and the captain of one of his ships, Francisco Serrao, accidentally became the first European to reach the north Malukus in 1512 when he was
shipwrecked (for the second time), rescued by locals and taken to Ternate (McIntyre, 1987; Berndt & Berndt, 1988; Peters, 2003; Russell, 2004).

The Portuguese were allowed to establish themselves on Ternate where Serrao remained, married and rose high in the Sultan’s service. In this position he would have been privy to all the knowledge Ternate had of the region and its resources—he may have sailed to much of it in Ternatean ships—and was able to gain all the navigational and commercial knowledge the Portuguese needed without the risk of going there themselves. Serrao’s knowledge, whether acquired in person or second hand, may also have ultimately led to the Portuguese/Topass slave raids on the Australian coast.

Inevitably other Europeans arrived in the wake of the Portuguese. First the Spanish, implacable rivals and sometime enemies of the Portuguese, came across the Pacific from South America in 1520 and established themselves in Tidore in 1521 (Collingridge, 1906; Keay, 2005). They remained until 1663 when they withdrew to the Philippines in the north.

Serrao died in 1521, just before the arrival of the Spanish, and Portuguese relations with Ternate declined from that time. The Portuguese were eventually expelled in 1575 (Hanna, 1978; Keay, 2005) and relocated to the island of Ambon (which had been given to them by the Ternatian Sultan Tabariji in about 1540) where they remained until ousted by the Dutch in 1605.

Under Papal authority only the Spanish were permitted to enter the Pacific Ocean and only the Portuguese could enter the Indian, but after the Reformation in Europe Protestants, especially the English and the Dutch, considered themselves no longer bound by this prohibition (Collingridge, 1906; Keay, 2005). The English under Francis Drake were the first to arrive in the Malukus in 1579 (Fox, 2000; Keay, 2005), followed by a Dutch fleet under Cornelis de Houten in 1599 (the Dutch had been in west Indonesia since 1595) (Ellen, 2003; Keay, 2005). Both the English and Dutch ventures were purely commercial and resulted in the establishment of the English East India Company in 1600 and the Dutch East India Company (Vereenigde Oost-Indische Compagnie—VOC) in 1601.

During the 16th C Amsterdam had acted as a major clearing house for Portuguese spices (Collingridge, 1906; Keay, 2005) so they knew the trade. In the last few years of that century their growing economic and maritime power enabled them to turn that
experience to profit and challenge both the established Portuguese power and fledgling English claims in the Indonesian Archipelago. After a short and nasty rivalry with the English the Dutch assumed total control of Indonesia, including the Malukus and as far south as Australia (where they explored and charted the coast, but made no claims). By this time Portugal was no longer in an economic or military position to resist (Ellen, 2003; Keay, 2005) and the Portuguese were steadily ousted from all their ports except Dili in East Timor (Timor Leste).

The Dutch occupation of Indonesia was similar to the English in India, and was as efficient as it was brutal. In the east the Dutch formed (and broke just as readily) alliances with all the local rulers and manipulated local rivalries to their own gain. After the Spanish departed, a Dutch alliance enabled Ternate to briefly regain a degree of the ascendancy they had enjoyed in the region prior to the 17th C when Tidore and Ternate each claimed and vied for control of vast territories extending from Sulawesi to Papua (Ellen, 2003). But the alliance with the Dutch was to the ultimate disadvantage of Ternate—not only did it cost them their spices, but also their empire (Fox, 2000; Ellen, 2003).

There was one major local player, arguably the most important of all from Arnhem Land’s perspective, yet to enter the regional trading floor. Makassar was a late-coming opportunist founded in south west Sulawesi during the 16th C from an alliance between the kingdoms of Gowa and Tallo as a trading centre to fill the vacuum left by fall of Malacca (Ellen, 2003). Right from its founding Makassar’s fortunes were intertwined in one way or another with those of the Europeans.

Oral tradition has it that Gowa, the leading partner in this alliance, was founded in the 8th C as an agricultural village with little sea-going capacity or interest. This changed in the 14th C when a woman called Tumanurung came from the sea (Pak Andi Jufri, historian, Museum Gowa. Per Com, 2012) and became Gowa’s first ‘Sultan’ (at the time Gowa was probably Hindu (Ramstedt, 2004), as was Tallo (Fig 5.7) before the formation of Makassar, so Tumanurung’s title was probably Rani, or simply Queen). Tumanurung’s origins are unknown, but tradition has it that after she assumed power Chinese traders arrived and with them Sama Bajau, who lived on their boats and ranged widely to fish, particularly for trepang that they supplied to the Chinese. It is tempting to suggest that, while the events are an accurate account, the time line may not be (as is not uncommon
with oral histories) and Tumanurung, the Chinese traders and the Sama Bajau were refugees from the fall of Malacca in 1511.

Figure 5.7 A banyan growing over the grave of a Rajah in the old kingdom of Talo, now a part of Makassar and a strongly Islamic region, is one of the few remaining reminders of the region’s Hindu past. (Photo by author)

According to Pak Jufri, the people of Gowa learned how to sail and fish from the Bajau in the 15th C. Prior to this time Gowa was within Ternate’s sphere of influence, but with their new sea-going skills and the wealth brought by the Chinese they began to assert their independence and by the 17th C had grown to be a major regional power (Fox, 2000). Using the riches generated by trade, Makassar began to expand eastward and by the middle of the 17th C claimed an extensive territory, much of which they had won from Ternate in a series of conflicts (Andaya, 1981). According to a map displayed in the Balla
Lompoa Sungguminisa Gowa Museum in Makassar (Fig 5.8), this new territory extended from Borneo in the west almost to the shores of Papua in the east and included the trade centres of Ambon, Seram, Aru and Banda, and in the south, north Australia.

**Figure 5.8** The Balla Lompoa Sungguminisa Gowa Museum map bears the legend ‘The map of the kingdom of Gowa and regions which recognise the sovereignty of Gowa until 1660. Sultan Gowa was accepted as the defender and protector of Islam in Maluku’ (Savage, 2008) (Photo by author)

In 1666 Makassar, in alliance with Tidore who seemed to work on the theory that their enemy’s enemy was their friend, was readying an attack on Ternate itself (Andaya, 1981). European politics was in upheaval at this time, the Dutch were at war with England in Europe and the conflict spilled over into Indonesia (Ellen, 2003; Keay, 2005). Gowa (Makassar) saw this as its chance to expand without undue interference.

This was a miscalculation on their part. The Dutch saw the rising power of Makassar as a threat to their trade monopolies in the region—the Makassans were flouting the embargo on independent spice trading in a big way (Ellen, 2003)—and, in alliance with Ternate and the Bugis from Bone (on Sulawesi), attacked. They finally
defeated the Makassarese in 1669, assuming control of the city and all the trade that passed through it (Macknight, 1976; Ellen, 2003). Unfortunately for Ternate, the Dutch took advantage of the situation to shear them of much of their remaining territory and power (Andaya, 1981). And to consolidate their interests in the region the Dutch developed Makassar into the major trade hub in East Indonesia—under Dutch control (Ellen, 2003).

Ultimately its alliance with the Dutch led to the demise of Ternate, along with Tidore which had been in alliance with Makassar against them, when the Dutch instigated their policy of extirpation (spice eradication) to limit production of spices to a few areas they could control (Ellen, 2003; Keay, 2005). This destroyed the economic base of several Maluku islands, not just Tidore and Ternate, and relegated them to economic backwaters. By comparison, however, Ternate and Tidore fared much better than Banda where, after ejecting other foreign traders, the Dutch consolidated their control through a remorseless program of genocide.

Banda had long been a thorn in the Dutch side because they insisted on continued independence in their trading and maintained relations with rival nations, especially the English. In 1621 the Dutch East India Company (VOC) put an end to this show of independence by killing, enslaving or banishing about 90% of Banda’s population (Hanna, 1978; Lape, 2002; Ellen, 2003). The VOC then replaced the Bandanese with slave labour on the nutmeg plantations and established a total monopoly in the production and trade in nutmeg and mace, which they rigidly enforced (although not always successfully) throughout the region. Survivors fled to surrounding islands where they found refuge and where some established bases, but only 1,000 of the original population of 15,000 survived on Banda—most of them as slaves who were forced to teach the newcomers how to cultivate nutmegs (Ellen, 2003). Although Banda made some comeback as an emporium, it never regained anything like its pre-Dutch status—a collections nation of many people compounded—and any trade links they (or Ternate or Tidore) may have had with outer regions such as Arnhem Land were ruptured.

But it was during this turbulent time that Arnhem Land appears to be first mentioned in recorded history. The Balia Lompoa Sungguminsa Gowa Museum map, which is probably a reproduction of one published in 1967 in a History of Gowa by Abdul Razak Daeng Patunru (Ganter, 2006; Savage, 2008), appears to claim Makassan sovereignty over North Australia in 1660. When and how the Makassans learned of
Australia is a matter of conjecture. Patunru gives dates that Gowa acquired some of their territories—after founding of Makassar 1512 they claiming the east coast of Sulawesi and the Salayar Islands, then in 1640 Buru, Ambon, Seram, Timor (all previously Ternatean) and Australia were added (Ganter, 2006). The timing of these acquisitions coincides with the conflicts mentioned by Andaya (1981) when Makassar gained control over much of Ternate’s territory—in fact by 1660 they appear to have claimed all but Ternate itself (Fig 5.9).

Figure 5.9 Eastern territories claimed Makassar, Ternate and Tidore (Map by ANU CartoGIS CAP)

They also claimed a slice of Tidore’s traditional sphere—east Seram, Seram Laut, and the Aru, Kei and Tanimbar Islands (Ellen, 2003), although in 1797 Tidore’s map still maintained their claim over these islands. The Makassan claim must have been done with at least the tacit approval of the Dutch. East Seram, Seram Laut, and the Aru and Kei
Islands were all trade nodes channelling goods to and from Banda and the outlying regions (Ellen, 2003), and after the fall of Banda became havens for Bandanese refugees and hotbeds of dissent and smuggling (Ellen, 2003). The Dutch would have found it easier to control a region and its trade that was nominally under one client state than fragmented under several.

Despite the riches on offer, the Makassans made no claim over Papua and Halmahera, which indicates that they (or the Dutch) were content to leave Tidore largely alone—minus their spices and except for those parts that had been closely linked to Banda. But they usurped virtually all of Ternate’s possessions, and the mere fact that they included Arnhem Land while ignoring the potentially much richer Papua suggests that Arnhem Land may have been within Ternate’s sphere.

In any case, with the acquisition of so many trade nodes from Banda, Ternate and Tidore, Makassar must have also acquired knowledge of all the outlying regions of the Arafura Sea and known exactly where to go for what products. Under the Dutch, Makassan trade flourished with goods being imported from right across the region, including north Australia, and re-exported across the world. In the 19th C a range of commodities were known to have been being extracted from Arnhem Land (Macknight, 1976; Spillett, 1996), including:

- **Trepang**

  Trepang, the dried and preserved body walls of sea cucumbers that were (and are) highly valued by the Chinese for culinary and medical purposes, were the major export product of Arnhem Land for the Makassans. They were harvested from Arnhem Land waters, processed on Arnhem Land beaches and exported in large volumes (see Chapter 5).

- **Pearls**

  Arnhem Land coastal waters are rich in pearl-producing molluscs, including *Pinctada maxima*, the oyster that produces the large and valuable ‘South Seas Pearl’. The Makassans traded with local clans for a range of pearls and, according to Searcy, took away considerable quantities of varying sizes and quality (see Chapter 6).
• Pearl Shell

Pearl shell (Pinctada maxima) was traded from the coastal clans for commodities such as iron, rice, tobacco and alcohol. From Makassar it went to craftsmen, probably mostly in China, where it was used in inlay and decorative artwork. Despite being labelled as an inferior product (Macknight, 1976), pearl shell became an important industry for the North Territory in the first half of the 20th C.

• Turtle shell

Shell from the Hawksbill turtle (Eretmochelys imbricate) was a highly prized commodity that may have rivalled trepang in value, it may also have been the target for Asian fishermen and traders before the trepang industry became established (Macknight, 1976; Stacey, 2000). Like pearl shell, it was usually obtained by trade (Searcy, 1905) and used for decorative purposes. Although, like Arnhem Land pearl shell, it was labelled inferior by later Europeans, the Makassans and other fishermen found turtle shell profitable.

• Dried fish

Dried fish have probably always been an important part of the SE Asian economy and continues to be important up to the present day. The term ‘dried fish’ includes many products (technically trepang is ‘dried fish’), but the one that was of economic importance to the Makassans was shark fin, which was exported to China where it may have given a return comparable to trepang. Macknight relates that:

Robert Brown, accompanying Flinders on Podassoo’s prau observed dried shark tails hanging on board these they told us they sold to the Chinese (Macknight, 1976, p 45).

The fact that it was a lot more difficult to obtain than trepang, and then in comparatively small quantities, relegated it to the role of a secondary trade item.

• Timber

The Makassans used mangroves in the processing of trepang, but by the later part of the 19th C they were also harvesting other species that were valued for their timber. The main one was cypress pine (Callitris intratropica), valued for its resilience—some Arnhem Land cypress is still to be found in old buildings in Makassar (Macknight, 1976). Makassans also collected some sandalwood (Santalum spp), but the local sandalwood is
inferior to that from Timor and nearby islands so it appears to have been only sought if nothing else of value was available to fill spare cargo space. They also collected ironwood (*Erythrophleum chlorostachys*), which was valued for its weight and hardness, especially in the manufacture of anchors (Macknight, 1976).

- **Bezoars**

  Bezoars are hard mineral or organic concretions found in animals. Fish otoliths (a small calcareous ball from the ear of fish, part of the balance mechanism), highly compressed and mineralised hair balls from animal stomachs, gall and kidney stones and even pearls are all examples of bezoars. They were highly prized for their medicinal properties.

- **Minerals**

  Minerals were being mined in Arnhem Land in the late 19th C, but whether the miners were Makassan is debatable. Earl was told by ‘Makassars’ that an area in east Arnhem Land abounds in minerals (Macknight, 1976; Earl, 1841 in Cameron, 1999) and he later described antimony (or tin) that he had found in that vicinity:

  .... among them [the minerals] they mention tin; but the only specimen I have which I will send to you by the first opportunity, appears to me to be antimony ore, which will yield perhaps $\frac{2}{3}$ of its weight in metal (Earl, 1841 in Cameron, 1999, p 86).

  Searcy also observed manganese and gold being loaded onto a prau by ‘*Malays*’ at a beach in Melville Bay in the late 19th C (Searcy, 1907; Macknight, 1976). Apart from the comment by Earl and Searcy’s observation, Makassans have not been linked to mining, so it is possible that the miners were not a part of the Makassan fleet.

  It appears that the presence of gold in Australia was reasonably widely known as the Buginese told two Englishmen—Alexander Dalrymple in the 1760s and Thomas Forrest in 1782—that gold could be got from Arnhem Land (Macknight, 1976). If they had told these Englishmen of it (twenty years apart) they had probably also told the Dutch and the Portuguese. Searcy recounts a story about the Spanish (or Portuguese) looking for it:

  Where the tradition comes from I cannot say, but it said that this portion of the coast was once visited by the Spaniards in search of gold (Searcy, 1907, p 94).
Iron was also mentioned, but this time in the mythology of the Warramiri, Dhalwangu and Gumatj clan members who claim that, after instruction from a visitor called Birrinydji, they mined and fashioned metal tools from locally occurring iron-ore outcrops (Mcintosh, 1997).

Of the minerals mentioned, only deposits of manganese are known in east Arnhem Land today—in some areas it occurs in vast quantities and is mined extensively at Groote Eylandt. Tin is found further west and gold occurs in to the south and west in the same geological formation as occurs on the west side of Arnhem Bay (Fig 5.10).

Figure 5.10 Geological regions of Arnhem Land (Northern Territory Geological Survey, 1997)

Geologically Arnhem Land is composed of six regions (Northern Territory Geological Survey, 1997). The area where ‘Malay’ mining was reported coincides with the area where the McArthur Basin, a geological formation known to contain these minerals, extends northward to the sea.

Each of these products had considerable value and, with the possible exception of timber, would have been on Ch‘eng Ho’s shopping list as ‘useful and valuable goods’ (Gungwu, 2003) so could have been being taken from Arnhem Land since the 15th C. Most observations (Searcy, Earl, Flinders) and studies (Walter & Campbell, 1916; Spillet, 1988, 1096, 1990; Clarke, 2000; Russell, 2004; Schwerdtner, 2010; Macknight, 1976, 1969, 2012) point to trepang fishing being the Makassan’s primary activity in Arnhem Land in the 19th C, but the balance may have been different in earlier days.

Even an approximate date for the Makassan’s first visits to Arnhem Land is uncertain, but they were probably concurrent with European exploration—although first the Portuguese, and then the Dutch may have preceded them. The first recorded sighting
of the Makassan fleet off Arnhem Land by a European was by the English Captain Mathew Flinders in 1803.

Flinders had initially been sent by the British Admiralty in 1801 to explore and chart the hitherto unknown south coast (Flannery, 2004), but his mission became one to circumnavigate and chart Terra Australis—a mission that made him the first known Englishman in Arnhem Land. Flinders paid great attention to detail, which is why, in November 1803, his crew found a square piece of teak 2.13m long on Sweers’ Island in the Gulf of Carpentaria. Then on nearby Bentinck’s Island they found some broken pottery and the stumps of trees that had been cut with an iron axe. Flinders concluded that these artefacts were the leavings of a ship from the East Indies that had been wrecked there, the crew either killed by natives or escaped to the mainland. But a month later he found further evidence of foreigners in the Sir Edward Pellew’s Group of islands, also in the Gulf of Carpentaria.

Besides pieces of earthen jars and trees cut with axes, we found remnants of bamboo lattice work, palm leaves sewed with cotton thread into the form of such hats as are worn by the Chinese, and the remains of blue cotton trousers, of the fashion called Moormans. A wooden anchor of one fluke, and three boats rudders of a violet wood were also found; but what puzzled me most was a collection of stones piled together in a line, resembling a low wall, with short lines running perpendicularly to the back, dividing the space behind into compartments. In each of these were the remains of a charcoal fire, and all the wood nearby had been cut down. Mr Brown saw on a nearby island a similar construction, with no less than thirty-six partitions, over which was laid a rude piece of framework; and the neighbouring mangroves, to the extent of an acre and a half, had been cut down. It is evident that these people were Asiatics, but of what particular nation, or what their business here, could not be ascertained; I suspect them, however, to be Chinese, and that the nutmegs [which Flinders had found on the islands] might possibly be their object (Flannery, 2000, p 180).

Flinders had discovered the camps of Makassan fishermen, but it was another two months before he met the actual fishermen themselves. On February 17th he left the Gulf of Carpentaria, rounded Cape Wilberforce and encountered manned canoes and prau (traditional fishing boats).
Under the nearest island was perceived a canoe full of men; and in a sort of roadstead, at the South end of the same island, there were six vessels covered over like hulks, as if laid up for the bad season. Our conjectures were various as to who these people could be, and what their business here; but we had little doubt of their being the same, whose traces we had been found so abundantly in the gulf. I had inclined to the opinion that these traces had been left by Chinese, and the report of the natives in Caledon Bay that they had firearms, strengthened the supposition; and combining this with the appearance of the vessels, I set them down for piratical Ladrones who secreted themselves here from pursuit, and issued out as the season permitted, or prey invited them (Flannery, 2000, p 203).

Flinders initial suspicions indicate that the north coast was suspected of being a pirate haven, but his fears regarding this particular group were soon laid to rest when he met the Malay captains under their chief Pobassoo and learnt that the prahus belonged to fishermen from Makassar. After several days of socialising, during which Flinders mined a wealth of information about the Makassan’s activities, Pobassoo sailed with his six prau for the Gulf of Carpentaria. He took with him a Union Jack flag and left a warning to Flinders:

... much to beware of the natives (Flannery, 2000, p 206).

The Makassans visited Australia in considerable numbers, were very visible and, despite Pobassoo’s warning to ‘much beware of the natives’, had a major physical and cultural impact on coastal tribes (Clarke, 2000; Cole, 1979). Many ceremonies among Indigenous tribes today originate from their visits and all modern Arnhem Land coastal languages contain many words borrowed from Bahasa Malay (or Makassarese—they share many words) (McMillan, 2001). When the English arrived Malay was the Lingua Franca of Arnhem Land (Clarke, 2000) and Malays were employed as translators. There is also some suggestion that some form of treaty existed between Makassans and Yolgnu (Mcintosh, 2000), but this is not confirmed.

There was some technology transfer, for example iron and the dug out canoe or lipa lipa, which together allowed coastal tribes to better exploit their resources (Clarke, 2000) and irrevocably altered the Indigenous economy. The canoes allowed people to fish further from land and hunt turtle and dugong more efficiently with iron-tipped harpoons. Iron and other goods obtained from either trade or labour also made coastal people rich.
and provided goods for inland trade (Clarke, 2000). But there were negative influences as well—alcohol, gambling and tobacco were introduced; and diseases such as smallpox and gonorrhoea came, along with contributions to the gene pool.

Arguably the most important impact in the long run was the opportunity for travel and an awareness of the outside world that Makassans brought to Aboriginal Australians. Local tribes learnt about Europeans and firearms before they had to confront them on their home soil and this helped them adapt and resist, at least for a time, when the British colonists arrived.

The Makassans' influence did not stop with the Indigenous coastal clans—they were influential in the development of European fisheries, trade and commercial exploitation of natural resources in the north. Today in communities across Arnhem Land there are constant reminders of the Makassan visitors despite the more than one hundred years since the last prau landed. For example, people can often be seen (personal observation) sitting on rugs under tamarind trees, playing card games their ancestors learnt from Makassans, smoking pipes (elyarra) identical to the ones that the Makassans introduced (Brady & Long, 2013) and gambling for 'rupiah' (Bahasa Indonesia for money). They regard the Makassan times as something of a golden age and still consider trepang as 'their industry'—despite being excluded from it entirely until very recently.

Apart from the introduction of tamarinds, the influence of the Makassans on the coastal and marine ecosystems is impossible to estimate. They may have introduced some plants that we now consider native because there is no record of what was here before (although it may be possible to determine what plants were introduced through pollen records). And they almost certainly introduced marine organisms on the hulls of their boats, insects from their cargoes and possibly fresh water organisms in the drinking water they carried. If these became established they would now be considered native as there is no way of knowing what the marine, fresh water or insect assemblages were three hundred years ago.

During the centuries that the Makassans were visiting Australia the region changed dramatically and Dutch and English colonialism took their toll on the Indigenous states and tribes. A decline in Dutch fortunes in the early 18th C, along with complex European politics, curtailed Dutch exploration. Besides, the Dutch had found Australia to be both an inhospitable barrier to the south and devoid of apparent commercial value, and
the decline in the spice trade meant a decline in the financial resources available to the VOC for speculative voyaging, especially when there was unlikely to be a return from such voyages (Keay, 2005).

It also seems likely that they did not want to make discoveries that they could not capitalise on but that may have been of use to enemy states such as England and France. Their explorations were sufficiently well published, however, for James Cook to concede as he passed through the Torres Straits in 1770:

... on the west side I can make no new discovery the honour of which belongs to the Dutch navigators and as such they may lay claim to it as their property (Thomas, 2004, p 127).

The British Admiralty, who presumably had no intention of conceding anything to the Dutch at that time, later crossed this rather gentlemanly concession out of the log and proceeded to claim the whole of the Australian continent, in the process dividing the region and creating an international boundary where none had ever existed before.

In 1817 Flinders was followed by Phillip Parker King who continued the mapping of the north coast, including west Arnhem Land and the Tiwi Islands (King, 1827). He re-established the fact of the insularity of the Tiwi Islands, explored and charted the Cobourg Peninsular and the nearby off-shore islands including Croker and the Goulburn Islands. King appears to have not had the best of relationships with the Indigenous inhabitants and was in violent confrontation with the Goulburn Islanders in particular (King, 1827; Cole, 1979, 1980).

In the early 19th C Britain determined to strengthen its claim over the whole of the Australian continent and forestall Dutch, American and French territorial ambitions (Cameron, 1999). They planned to do this by establishing a series of ‘stakes’, or scattered settlements near important sea lanes. In the north they drew on King’s charts and decided initially on Melville Island for the first settlement and Fort Dundas was founded on the 30th September, 1824 (Cameron, 1999). Three years later a further settlement was established at Fort Wellington in Raffles Bay on the Cobourg Peninsular (Cameron, 1999).

Neither of these settlements was able to endure either the enmity of the Indigenous Tiwi population at Fort Dundas or the malaria that ravaged Fort Wellington (Raffles Bay) and they were abandoned in 1828 and 1829 respectively (Cameron, 1999). However the
reasons given by their commandants for wanting to abandon the settlements were soon seen to be suspect. When Commander Laws of the Royal Navy was diverted to Melville Island in 1828 to answer an urgent distress call he concluded that

... adverse reports from both settlements were a direct result of wilful misrepresentation of actual conditions by commandants who objected to their isolated postings (Cameron, 1999, p 2).

The British Government received this report too late to reverse the decision to abandon the settlements, but they were soon persuaded by favourable assessments by Laws and the persistent optimism of Sir John Barrow (second or permanent secretary of the Admiralty from 1804 to 1845) to try again. As a result the settlement of Fort Victoria was establish at Port Essington in 1838 (Cameron, 1999).

This settlement showed all the signs of initial success and a bright future, but neglect and malaria soon took their toll and it was closed down in 1849, officially because it was too far from sea lanes and too difficult to approach and enter under sail (Cameron, 1999). While it existed, however, the settlement was something of a revelation in attitudes to the north neighbours that prevailed at the time.

One of the principle objectives of the settlers was the establishment of trade, the first target being the large numbers of Makassans that frequented the coast. These were primarily fishermen, but they had been trading with the Indigenous people for centuries and appeared interested in also trading for English goods. Unfortunately this ambition was stymied when trade goods failed to appear from NSW and when the Makassans came with their goods the English had virtually nothing to trade with (Cameron, 1999). Ultimately this may have been for the good as the Dutch are unlikely to have tolerated such a challenge to their monopoly in the region and conflict may have resulted.

The settlers then changed tack slightly and attempted to attract Chinese traders to set up trading emporia at Port Essington to take advantage of the trepang resources of the coast. The theory behind this scheme was sound, even if the ultimate aim of building a trading emporium to rival Singapore may have been somewhat ambitious. But it was also stymied by the Government’s inaction and its refusal to release land with security of tenure to the traders (Cameron, 1999).

This lack of secure land also discouraged Asian farmers from the islands to the near north from coming to the new settlement, despite the Commandant’s repeated
attempts to persuade them to bring their expertise in tropical farming. The settlers badly lacked knowledge of tropical agriculture and felt that bringing in Asian farmers would feed the colony. The Europeans' attempts at agriculture had occasional limited success, but for the most part were hamstrung by trying to use temperate crops and techniques in a tropical monsoonal climate (Cameron, 1999). As a result the settlement was almost entirely reliant on obtaining food supplies from trading, mostly in the Tanimbar and Aru Islands that lay a few days sail away.

While they remained, the people at Port Essington seemed to have enjoyed cordial relations with both the Indigenous people, the visiting Makassans and any other Asian traders such as the odd Buginese, but the regular contact with Asians was the ultimate undoing of the settlement when malaria was introduced to the colony. Despite the existence of vector mosquitoes and the almost certain regular introductions of malaria parasites to the Indigenous inhabitants by visitors, malaria was (and is) not endemic in Arnhem Land (Wheelan, Per Com, 2005) The nomadic lifestyle of the Indigenous inhabitants meant that as soon as the visitors left with the onset of the dry season the local people moved on to tend to matters elsewhere and the infected mosquitoes had no one to bite and died long before they could pass on the parasite. As they moved about their estates in the dry the people would seldom have remained near suitable mosquito breeding grounds for long enough to establish a malaria breeding cycle (about 10 days after a mosquito has bitten an infected person before it can re-infect a second person) (Wheelan, Per Com, 2005). Over the dry months people infected during the wet probably died and the parasites with them, eliminating the disease until the next infected Makassan arrived. But the fixed settlement at Port Essington was ideal for the development of a malaria epidemic.

It appears that toward the end of the settlement's life the majority of the European population (none of whom would have had any tolerance for the disease) suffered from malaria and the day-to-day running of the colony was severely hampered. After briefly considering using Port Essington as a convict settlement in lieu of NSW where convicts were becoming unwelcome (Cameron, 1999), it was decided that the site was too unhealthy even for that purpose and orders were given to abandon it. After a last-ditch attempt by Father Angelo Conflonieri to establish a Catholic mission at Victoria failed, the site was finally abandoned on the 1st of December 1849.
Despite the short life of Port Essington it left a unique insight into life and trade in the east Indonesian islands at the time, and first-hand observations of Makassan fishermen (and occasional other Asian traders) and Indigenous tribes.

After the closure of Port Essington British activity on the coast dropped off until the Northern Territory came into existence in 1863 under the control of the colony of South Australia. The South Australian Government pre-sold about 250,000 acres at Escape Cliffs, 80kms east of present-day Darwin and established the fourth European settlement in the north. On the 28th of June, 1864, Lieutenant Colonel Boyle Travers Finniss, Government Resident of the North Territory, founded the new settlement with about fifty men and two women (James, 2006). It was short-lived and ill-tempered, with mutiny and poor relations with the local Indigenous people an everyday feature.

Escape Cliffs was abandoned in 1867 and official British presence was again absent from the north until 1869 when George Goyder was sent to establish the new settlement of Palmerston at Port Darwin (Darwin City Council, 2013). The settlement changed name and finally took root and survived to become the modern capital of the Northern Territory, Darwin.

The British were active on the north coast for 89 years before the establishment of the mission at Warruwi, but this presence was sporadic and outside of the settlements of Fort Dundas (Melville Island), Fort Wellington (Raffles Bay), Fort Victoria (Port Essington), Escape Cliffs and Darwin, it generally consisted of enforcing British law (eg Inspector Foelsche) or exacting taxes (eg Alfred Searcy, Edward Robinson). Toward the later part of the 19th C European fishermen, trepangers, cattlemen, hunters and adventurers began to infiltrate Aboriginal lands, but until the early 20th C they were few and the major foreign presence and influence on the coast remained the Makassans.

The beginning of the Makassan era may be shrouded, but the end is well documented. The number of prau visiting Arnhem Land began to decline in the 1870s (Macknight, 1976) and by the end of the 19th C only a few made the voyage. The accepted reason for this decline is that the South Australian Government’s imposition of ever more onerous conditions and taxes on the Makassan fishermen in the late 19thC made the industry less and less viable. But in 1899 the government made it even more difficult for the fishermen by insisting that payment of duties be made in English gold sovereigns that had to be got from Singapore, not easy for Dutch-controlled Makassans. However,
although undoubtedly a severe imposition, it is unlikely to have been the deciding factor in the rapid drop in the number of prau making the annual voyage unless the harvests were no longer high enough to offset the increased costs.

Idriess presents a different theory as to the demise of the Makassans. He maintains that when the Thursday Island pearling fleets turned to harvesting trepang on the Great Barrier Reef:

... the great quantities quickly obtained went far toward supplying the East market (Idriess, 1946, p 96).

In other words they flooded the market and drove the Makassans out of business.

An alternative scenario, which I believe may be closer to the truth, is that Makassan fishing methods—especially dredging—destroyed the fishery and made voyages unprofitable, and excessive taxes were just the last straw. In any case when a request from the Northern Territory Government Resident in 1905 was granted and a telegram delivered to Darwin (Fig 5.11) on 26th July 1906 banning foreign vessels from all Australian waters, there appears to have been few Makassans left to be affected.

![Figure 5.11](image)

The telegram that ended the Makassan voyaging to Arnhem Land (NT Archives 1879-1912. item 15236):

The text of the cable reads
This was not just the end of Makassan trepang voyages, it made it hazardous for anyone from the north to visit Australia’s north coast in search of any of the products they had been extracting for centuries—possibly as far back as Ch’eng Ho’s fleet in the 15th C. But they left behind both cultural and physical legacies, including the Warruwi pond, although just who left it remains in question.

From Chapter 4 it was concluded that the pond was most likely linked in some way to either trepang or pearl production, which rules out the Europeans—English, Dutch or Portuguese—who, apart from a few British in the late 19th C, had scant interest in the former and were only interested in trading the latter.

**Conclusion**

The summary of the region’s history in this chapter shows that there were two groups who had the opportunity, means and motive to construct the Warruwi Pond:

- Makassan fishermen who visited in such high numbers some-time after Arnhem Land appeared on the Balla Lompoa map in 1640.

- Fishermen allied to Ternate (or possibly Tidore), based anywhere in the archipelago from Tanimbar to Seram Laut and supplying the Banda market before 1621. Included in this latter group must be the pre-eminent sailors and trepang fishermen, the Sama Bajau.

The survey reported on in Chapter 2 revealed a structure similar to the Warruwi Pond in the Aru Islands, and in Chapter 3 similar structures in the form of *lutur* or *tambak batu* were reported from Seram Laut to Tanimbar (Ellen, 2003). No similar structures were found or reported near Makassar, suggesting that such structures were not a part of their culture. This is, however, in itself not conclusive. Determining which of these peoples were the most likely builders will need an understanding of both the trepang and pearl trades—methods of harvesting, cultivation, processing and marketing—and, as the
two groups of possible builders are separated temporally (pre-1621 and post-1640), the histories of the production technologies and trades are of paramount importance.
Chapter 6
Sea cucumber cultivation and the trepang trade

Trepang is the more prominent product regionally and the one which is historically more prominently linked to Arnhem Land, therefore it will the first to be described.

Description

Trepang is known variously as *swallo* (old English), *tiripang* (Indonesian) and *beche-de-mer* (French/Europe) (Macknight, 1976), and *namako* (Japan) (Ellen et al, 2000) or *hoi sam* (China and Korea) (Schwerdtner et al, 2010). The terms refer to the dried and preserved body walls of sea cucumbers or sea slugs (*holothuria* spp). *Holothuria* belong to the phylum *Echinodermata* which are distinguished by a pentaradial (five-sided) body plan and a water vascular system (Cannon & Silver, 1987)—this phylum includes star fish, brittle stars, sea urchins and crinoids. *Holothuria* are detritovores with mouth and anus located at opposite ends of the body. They feed by using tentacles around the mouth to ingest considerable amounts of substrate (sand and detritus) and digesting the microscopic animals it contains (Cannon & Silver, 1987; Secretariat of the Pacific Community (SPC), 2004).

There are more than 1,000 species of sea cucumber in the world, of which only about 20 are commercially valuable (SPC, 2004). In the cold waters of the north Pacific *Apostichopus japonicus* is the most commonly harvested, farmed and consumed species, but in the Arafura it is the tropical species *holothuria scabra* (sandfish) that is the most commonly harvested and farmed (Bell et al, 2006). This may not have always been the case as other species, such as *H. nobilis*, are more valuable but have become scarce through over-fishing; however, it seems likely that *scabra* has always made up a significant portion of the catch. Currently *scabra* is the only tropical species that is being cultivated, hence it is *scabra* which will be described here.
Scabra (Fig 6.1) have a cylindrical, mucus-coated body up to about 350 – 400mm long (but more commonly about 220mm), 50mm thick and attain weights of ~ 600g at maturity (more commonly about 300g) (SPC, 2004). When disturbed they contract their bodies and appear shorter and thicker, taking on a more ball-like appearance.

Figure 6.1  *Holothuria scabra* (contracted)

*Holothuria* are distinguished by the presence of calcareous spicules within the body wall that are diagnostic to species level—the spicules in *scabra* are described as ‘well developed tables and knobbed buttons’ (Cannon & Silver, 1987) (Fig 6.2).
Different species of holothurians display varying patterns of diurnal activity, but most, including *scabra*, feed actively during the night. When in the intertidal zone *scabra* bury themselves in the substrate during the day to escape the sun and during low salinity conditions from wet season run-off (Mercier et al, 2006). They are mobile, using tube feet on their ventral surface, but are slow moving and usually more or less sedentary (Cannon & Silver, 1987).

*Scabra* occupy sandy intertidal and shallow inshore zones throughout the tropical Indo/Pacific regions from east Africa to the east Pacific between the latitudes of about 30° N and 30° S. Local distribution is size specific (Mercier et al, 2006) with most specimens >250mm found at depths of >1 m (from the intertidal zone to deeper water, possibly up to or beyond 20m), those between 10 – 250mm usually occupy the intertidal zone and newly settled juveniles <10mm are found in sea grass. Preferred substrate is also size specific with adults preferring sand with a lower organic content and juveniles a more muddy substrate with a slightly higher (up to 10%) organic content (Mercier et al, 2006). They appear to avoid very fine or very coarse substrates and very high organic loads and are

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**Figure 6.2**  *H scabra* ‘well developed tables and knobbed buttons’ spicules (from Cannon & Silver, 1987)
normally restricted to soft sand or mud substrates and seldom (if ever) travel over hard or rough surfaces (Mercier et al, 2006).

Consumption and uses

Apart from occasional small-scale and localised consumption in SE Asia and the Pacific Islands, trepang use has always been restricted to north Asia—China, Japan and Korea. Today trepang consumption is most strongly linked to China (Fabiyini, 2011), but Japan and Korea also have an ancient history of sea cucumber use (Ellen et al, 2000)—in Japan it is normally consumed raw as sashimi, in sushi or as an ingredient in cooked dishes. When used in Chinese cuisine, trepang has a texture somewhat like a mushroom and, while it tends to take on and enhance the other flavours in the dish, is generally considered an acquired taste.

The Chinese regard trepang as a delicacy, an aphrodisiac and a potent medicine to treat a range of ailments up to and including cancer. Traditionally it is consumed dried and powdered (sometimes mixed in tea to ease stomach complaints), raw, pickled or boiled in various dishes (Dharmananda, 2014). The medicinal qualities of trepang are reflected in the Chinese name for it—Hoi sam or sea gin-seng (Bordbar, 2011; Schwerdtner et al, 2010) (although, if there's anything in a name, the Japanese namako (sea rat) suggests that they did not share the Chinese belief in healing qualities). Recently those same medicinal qualities have attracted the attention of west pharmaceutical companies which are finding valuable medicinal compounds in trepang (Chen, 2004; Wen et al, 2010; Bordbar, 2011). In recent times, powdered trepang has been packed into capsules, made into a lotion or topical salve; or used as a beauty product, for example mixed with clay and applied as a face pack (Rakuten, 2014).

Antiquity of sea cucumber use, aquaculture and the trepang trade

Logically trepang use, in some form, must have come before trade developed, but exactly when consumption first began is difficult to determine with any degree of certainty—and when China first began importing it from SE Asia is a matter of pure conjecture. Chinese importation probably began when demand outstripped local resources, but once again it is matter of conjecture as to whether this began with imports from temperate north Asia (Japan or Korea), or from tropical south east Asia.
Normally the development of the consumption of (and therefore a market for) any commodity must start with just a few consumers. If the product gains acceptance the number of consumers will increase, and this will in turn increase demand (Schiffman et al, 2005). If a product is sufficiently attractive its popularity may expand exponentially, if it’s not attractive it will remain a ‘local delicacy’, or die out altogether. The time that elapses between a ‘local delicacy’ and being broadly popular enough to be mentioned in literature may be measured in years, or possibly centuries. But under some circumstances consumption, and therefore a market, may expand suddenly and dramatically as occurred, for example, with the introduction of novel commodities such as potatoes, tea and tobacco into high English society in the 17th C following their conquest of India and America.

Conand (1990) puts the start of the trepang industry at about 1000 years ago and says that at that time the Chinese were sourcing trepang from India, Indonesia and the Philippines. This appears to be widely accepted among holothurian specialists—possibly because of Conand’s standing in the field—but she does not provide any sources or evidence to back this claim and is therefore viewed more critically by historians and related disciplines (Schwerdtner Mánez & Ferse, 2010).

Evidence for earlier Chinese trepang consumption is found in a paper by Wang Gungwu ‘The Earliest Chinese Reference to Trepang’. In this paper Gungwu states that:

The earliest reference to Hai-su (sea-rat) in a Chinese 4th / 5th C (?) [sic] work about food is preserved in a Japanese encyclopaedia, the Wa Myo-rui ju-so, compiled in 931 – 37. This hai-su was identified as namako (a holothurian which when dried is edible and is called iriko, which is trepang) in the 18th C encyclopaedia, the Wa-kan san sai tsu-e (1715) (Macknight, 1976).

This dates Chinese trepang consumption back to at least the Jin Dynasty (265 – 420) or the period of the South and North Dynasties (420 – 589). The time of the South and North Dynasties were periods of empire expansion that saw the beginning of large-scale migration of ethnic Han Chinese from the north into the south (Gungwu, 2003). This may have been the first encounter between large numbers of Han Chinese and south sea-going people, and the large ocean-going vessels that brought exotic goods to south China’s ports (Levathes, 1994). The northers would have encountered exotic tropical food and medicinal species, possibly including sea cucumbers, being used in the South
Kingdom and taken them north as novelties—in much the same way that the British adopted tea, tobacco and potatoes from newly conquered territories.

Thus it may be postulated that trepang use began in the south of China where tropical species were readily available, then adopted by the Han and taken north where the temperate species, *Apostichopus japonicus*, was tried and added to the menu (on the basis that it looked and behaved like the south trepang). The addition of *japonicus* enabled trepang use to spread to Korea and Japan as a novel food. Japan first recorded the production and processing of trepang (*iriko*) in the 8th C, but without reliable access to (or a taste for) south species, the Koreans and Japanese restricted themselves to the locally available *japonicus*. Meanwhile, with their access to a variety of species, the Chinese tastes became more catholic and they made use of their extensive SE Asian trade networks to import exotic species. Early Chinese references indicate that the south product was considered inferior (Macknight, 1976), but this may have simply referred to the south Chinese product as Sutherland quotes Van Schinne, the Dutch Makassar Harbour Master in 1814, as reporting:

The so-called ‘trepang Marege’ [Australian trepang] is the most prominent and in China the most sought after and sold there for a very high price (Sutherland, 2000, p 454)

During the early to mid-Ming period (1368 – 1644) Chinese literature reflected a flowering of science, art, exploration and culture. During this renaissance trepang use appeared in *Bencao Gangmu*, a Materia Medica written by Li Shzhen in the 16th C (Chen, 2003) and later in the ‘Miscellanies of Five Items (Wuzashu)’ written in 1602 by Xie Zhaozhi (Akamine, 2002), but did these refer to *japonicus* or a tropical species and, if tropical, could they have been coming from the Malukas at that time?

The opportunity was there. The Chinese knew about the Malukas from at least 1304 when they were mentioned in the *Dade Nanhai zhi*, which was described in detail in the mid-14th C *Daoyi zhilue* (Lape, 2000). They appear again when Banda was included on the *Mappamundi* in 1457 (Lape, 2000), and again in the Rodrigues Map, which was probably derived from an Asian version and used by the first Portuguese known to visit the region in 1512 (Lape, 2000). By the time of the ‘Miscellanies of Five Items’, which was written contemporaneously with Matteo Ricco’s 1603 ‘Impossible Black Tulip’ map,
Chinese knowledge appears to have extended to the New Guinea and/or Australian coasts.

The trade routes and traders (courtesy of the spice trade) that could move trepang from Banda (or any of the other entrepots in the region) to the markets in China certainly existed. By the 5th C long-distance traders bringing goods into south China included Indian, Arab (Hu) and Po-sse, who were either Persian or Malays from either the Malay peninsular or Sumatra (Gungwu, 2003). It was these traders, Indian, Arab and Malay, who were carrying spices, either directly or via intermediaries, from the Malukas to the wider world from at least as early as the 1st C (Keay, 2005), so they certainly had the capacity and opportunity to carry trepang. But why would they give over valuable cargo space that could otherwise carry spices? It is a big step from saying the Chinese used trepang, knew about the Malukas and had trade networks linking them, to saying that they imported trepang from there. So what scenario would make it feasible that such a trade existed?

The Chinese trade in non-luxury items such as medicinal products gained importance in the 5th and 6th Cs (Gungwu, 2003) and trepang, as a medicinal product, may have been included among them. Traders are entrepreneurs and therefore, by nature, opportunists. If they saw a product and knew there was a profitable market for it elsewhere they would have been more than likely to have carried it, even if only in small quantities that may not even have been noticed by the port authorities of the time. But this argument has a significant flaw. Trepang were not used in the Malukas so they could not have seen it there—they would have seen live sea cucumbers, which do not resemble processed trepang. For the trader-instigated trade scenario to be possible, at least one of the traders would need to have been familiar with both the raw and end product. This is possible, but the first trader to carry them would also have had to actively look for sea cucumbers in the water (no fishermen would be landing useless catches), then known how to process them, and trained local fishers in its production techniques.

An alternative scenario was that they were included in the Ch’eng Ho’s shopping list when he came to the Malukas in the 15th C (McMillan, 2001) looking for ‘useful and valuable goods’ (Gungwu, 2003, p 122). To have appeared in the Ming era literature indicates that consumption of trepang was not uncommon in China by that time and therefore it may have been included as a ‘useful and valuable’ product. Ch’eng Ho would have carried experts in the products he was searching for, so it would have been easy for
him to recognise both the product and the vast reserves of it that existed around the east and south islands.

But as there are no records of the trepang trade in the Malukas before the advent of the Dutch in the 17th C, this is all speculation. The first mention of the trade was by Earl (1837, p 461), who recorded that in 1636 the Dutch navigator Pieter Pietersen reported the trepang fishery in the Aru Islands as ‘merely existing’. As there was no significant local consumption of trepang, for the fishery to have existed at all meant that trepang must have been being exported from the Malukas before 1636.

A reference by Kolff to an observation during his travels through the region in 1825–26 that:

When the people of Banda had the trade exclusively in their hands, a picul of trepang might be obtained for a sarong (Kolff, 1840, p 175).

This indicates that the trade dated from a time when the Bandanese were free to trade—meaning that it predated the brutal Dutch take-over of Banda in 1621. Pietersen’s observation of the fishery ‘merely existing’ 25 years later may well indicate the state into which it had been rendered by the loss of Banda, as the trade in all local products would have been thrown into a state of chaos and would have remained so until new networks were established.

However the Chinese trepang trade evolved, by the end of the 17th C China was importing it from both north and south Asia. In 1698 the Japanese and Koreans were recorded as exporting _japonicus_ to China (Akamine, 2002) and Pietersen’s mention of a trepang trade in Aru in 1636 confirms that the Chinese were also obtaining it from SE Asia. This strongly suggests that by the 17th C Chinese stocks (or fishing effort) were inadequate to meet domestic demand—which is, in turn, an indication of its popularity—but why this should be is an interesting question.

The coasts of China, Korea and Japan are ecologically similar and the Chinese sea cucumber beds, under normal circumstances, should be equally productive. There are three possible reasons for the need for large-scale importation:

• Consumption had grown so large that local production could not supply enough to meet demand
Chinese stocks had been exhausted either through disease, natural disaster (which would have to had been unusually widespread) or overfishing.

Chinese fishing effort declined dramatically.

The third scenario is the most likely. Ch’eng Ho’s was one of the last Chinese fleets to sail, and after his return the Ming Dynasty was wracked by divisions between outward-looking advisors and traditional Confusion isolationists. The isolationists won and China began to turn in on itself. From about 1500 laws against maritime activity were enacted, foreign contact and trade were curtailed or largely restricted to a couple of south ports where foreign traders brought goods. More importantly, the marine navy was wound back and all but disbanded. This opened the door for Chinese/Japanese pirates and marauders (Wo-K’ou) who controlled large parts of the coast during the 16th C (Matsui, 1969; Levathes, 1994; Bosworth, 1999; Dubner, 2010). Access to fishing grounds and markets by Chinese fishermen must have been seriously curtailed (to use a modern analogy—it would have been like having a vegetable garden in a mine field) and domestic production collapsed. The state of relations with Japan (not to mention the serious pirate issues) around then probably only allowed sporadic imports from there, so if the Chinese were to eat trepang they had to look south, which meant looking to foreigners and foreign suppliers.

Development of the trepang fishery in the Arafura Sea region

The early references to trepang in east Indonesia, such as there are, are centred in the Malukas prior to the destruction of Banda in 1621 and it is likely that trepang from around the Malukun region was traded in Banda. After 1621 Schwerdtner (2010) says that it appears that Malukun fishermen took their catch to Ambon where they may have sold it to Makassan, Bugis, Chinese or Arab traders, who then either exported it directly or trans-shipped it to another regional port. If the trepang was trans-shipped, the most likely destination would have been Makassar—the city that has come to be regarded as the most closely associated with the east Indonesian trepang industry—when it was an independent kingdom.

By this time Makassar had largely filled the vacuum left by the fall of Malacca in 1511 (Ellen, 2003) and was building its power and establishing itself as a major trading centre (Fox, 2000; Ellen, 2003), to a large extent at the expense of Ternate (Andaya,
1981). After the destruction of Banda the Makassan influence extended far into the east islands, but their aggressive trading methods do not appear to have made them popular. The Makassan merchants operated a credit system and their debt collection methods were often heavy handed. If a debt was ‘more than one monsoon’ overdue any partial payment the debtor could make was considered to be interest and the full sum of the principal still remained, which inevitably meant that most of their villager customers were permanently in debt (De Jong, 2012, p 6). This patron-client relationship is still in place and was described in 1996 by Osseweijer in the following manner:

When sailing out on a collecting trip, Aruese take either a fellow villager’s boat or an Indonesian-Chinese shopkeeper’s craft. All have a barter relationship with a shopkeeper. Goods can be taken from the shop in advance and the amount settled afterwards when selling the trepang. Most villagers on a collecting trip take products (including fuel) on credit from the store first and many end up in debt; but sometimes, when the sea cucumbers offered are worth more than the articles bought on credit, no cash money will be given, so villagers are effectively forced to spend their profits at the same store, or leave it chalked up for another occasion (Osseweijer, 2000, p 62).

It was not until 1710 that trepang first gets a mention by the Dutch when a brief note in the official diary (daghregister) of Makassar records it as being harvested off the island of Buton near south Sulawesi (Schwerdtner et al, 2010). If trepang was an export commodity from Makassar before this the Dutch would probably have noted it, so it is more likely that the Malukun trepang were being exported direct from Ambon (or other east ports) up until the early 18th C.

From the humble beginnings mentioned in the daghregister the Makassan trepang trade increased rapidly from 11 ton in 1718 to 59 ton in 1726; 71 ton in 1734; 301 ton in 1767 and 512 ton by 1788—in just the seven years between 1718 and 1725 there was an almost 500% increase in Makassan trepang exports (Schwerdtner et al, 2010). This suggests that the Makassan traders expanded both their sphere and range of operations from the opening of the 18th C, including going from just trading for trepang to actively fishing for it. Their fishing methods appear to have been no less aggressive than their trading practices and are described as the ‘roving bandit syndrome’ (Schwerdtner et al, 2010; Berkes et al, 2006) where the fleet fishes out an area then moves on to the next,
leaving the local fishermen (the traditional owners of the fishing grounds) without resources.

A gradual expansion of the fishery is unlikely to have produced the surge in production during the 18th C, but sequentially exploiting large and productive new grounds would have. The Makassan fleet expanded across the region where Makassar had assumed hegemony, from Sumbawa in the west to Aru in the east and the Kimberley coast of Western Australia (not far from Ashmore and Cartier Islands, and the Rolly Shoals, traditional fishing grounds in the Indian Ocean for fishermen from the island of Roti, near Timor) in the south (Schwerdtner et al, 2010).

A robust organisational and trading infrastructure in Makassar itself would have been required to cope with the rapidly increasing volumes of trepang. Under Dutch patronage Makassar had become the principle regional trade hub and as such would have had the necessary expertise available to handle the expanding trepang trade, but nevertheless aspects of the infrastructure—such as the fleets and the marketing networks—would all have taken time to develop.

The Makassan trepang fishing fleet may have evolved from the traders streamlining their supply chain—which would both increase profits and secure their supplies—by cutting out the village fishermen and sending out their own prau. The traders employed the same credit – debt (or patron – client) system (Schwerdtner et al, 2010; Sutherland, 2000) in their fishing operations as they did in their trade deals with villagers. A poor man or family could borrow from a rich patron enough money to buy the equipment needed for an extended voyage and to maintain his family in his absence. On his return the debt was called in when the cargo was sold and the proceeds divided. This arrangement kept the fleets fishing, but it was not necessarily kind to the average crewman, as Earl noted:

Many of the Bajau ... are chiefly employed by the Chinese in fishing for trepang ... and according to the policy invariably adopted by the latter in their dealings with the natives, are generally involved in debt, from which extrication is nearly hopeless ... no instance is on record of ever having absconded to avoid the payment of their debts (Earl, 1837, p 461).

Patrons were often the trepang buyers and wielded considerable power, to the point that they could direct their clients to harvest products according to market demand,
and even control the methods the fishermen used to fish (Meereboer, 1998, in Schwerdtner et al, 2010). Prior to the advent of the Makassans, fishing was on a family or village basis where fishing grounds were owned and managed (through sasi) and the fishermen had a vested interest in sustaining their stock. The client patron system used by the Makassans put the fishery onto a business rather than an artisanal footing where the fishermen had no incentive to sustain the fishery—on the contrary, their incentive was to take as much as possible to try and pay off their debt.

As their resources were systematically plundered throughout the 18th C village fishermen would have been forced to join the new order, especially when Makassar’s Dutch enforced monopoly limited their options for independent trading.

There is no certainty when the ever-expanding Makassan fishing fleet reached Arnhem Land, but in 1754 Dutch correspondence between the Governor General and the Dutch East India Company in Amsterdam states that:

The Southland which is in the South East of Timor not far from thence, is made now and then from Timor and Makassar, but produces so far (as) we know nothing but trepang, being dried jellyfish, and wax (Macknight, 1976, p 95).

This certainly appears to refer to Australia, but does it mean Arnhem Land or the northwest Kimberly coast? The mention of wax, which has never been listed as an Arnhem Land product, suggests that it may be the Kimberly. Similarly, the Englishman Alexander Dalrymple’s report of ‘Bugis’ in Australia in 1768 (Schwerdtner et al, 2010) is vague about the location.

Flinders also learned that Pobassoo had made six or seven voyages to in the past twenty years and that he was one of the first (Flannery, 2000), which would put his first voyage to Arnhem Land in about 1780 – 85. Did Pobassoo mean that he was in one of the first fleets from Makassar, or was he one of the first from Bone, which is a neighbouring Bugis state to Makassar? The Rajah (or Sultan) of Bone may have simply become involved with the Makassan Arnhem Land fleet some years after it first began.

When exactly that was is a matter of conjecture, however MacKnight (1976) recounts a legend he encountered which may throw some light on the subject. According to the legend a number of Makassan ships escaped after the Dutch victory over the Makassan fleet in 1667 and sought shelter on the Arnhemland coast. They remained for some time before returning to Makassar and while in Arnhemland named the places they
lived after their leaders. Some of these, such as the Bay of Karaeng Mangngellai (Gray’s Bay), the Bay of Mangko (Northwest Bay), the Island of Daeng Lompo in Dalumba Bay, and Karakaraenga (Wobalinna Island in Port Bradshaw) are still known (MacKnight, 1976 p96) When they returned to Makassar they brought with them the first cargo of trepang from North Australia, thus starting the trade.

Escaping to Arnhem Land implies that they knew it was there and that it was remote enough to offer refuge, prior knowledge that they may well have acquired from Ternate or Banda.

The phrase ‘The Southland is made now and then from Timor and Makassar’ implies that the Southland fleet, whether it was bound for Arnhem Land or the Kimberley coast, was in 1754 sporadic and not a major enterprise. Certainly not the sixty prau and one thousand men voyaging every year that Pobassoo described (Flannery, 2000).

In summary, trepang consumption in China dates back to the 4 – 5th C or earlier, and its use had become significant by the mid-Ming period (1368 – 1644). The Malukun fishery probably started with the visit of Ch’eng Ho’s 16th C fleet to the Malukas in search of valuable and useful items. Initially the trade was centred on Banda, but with the fall of Banda in 1621 and Makassar’s take over of Ternatean territory during the first half of the 17th C the trade passed first into the hands of Makassan merchants operating out of Ambon (or one of the other east trading ports), then to Makassar itself.

Finally, in the early 18th C Makassan merchants took control of the trepang fishery itself. By providing prau and recruiting crew on a client – patron system and then dispatching their fleets across the Arafura and Timor Seas (including to Australia), they were able to harvest from all accessible trepang grounds regardless of traditional ownership or restrictions. These actions saw the fishery move out of the hands of the traditional village-based fishermen and placed on a more efficient ‘industrial’ scale. At this point the fishery was controlled by the merchants (patrons) and operated by indebted fishermen with no traditional connections to, or care for, the areas they harvested other than profit—a prototype for modern fishing enterprises. Nor was there any evidence that the Makassans carried out any form of aquaculture; they simply concentrated on harvesting as much as possible from the wild stocks.
Fishing and processing methods

Village-based fishermen in the southern Malukus kept operating—they still do until this day—but the 'roving bandit syndrome' as practiced by the large commercial fleets introduced by the Makassan merchants decimated their resources and probably forced many to sign on with the big fleets, working for wages in a foreign sea rather than in their own, carefully husbanded fishing grounds. Working in the Makassan fleet they would, initially at least, have employed the same fishing and processing methods as fishermen had been using for trepang since the beginning of the industry, but the Makassans did it on a larger scale, with greater intensity and perhaps more organisation. It was not until later that the environmentally damaging technique of dredging was introduced—an innovation that may have led to the decline of the fishery in Arnhem Land.

There appears to have been four fishing methods employed—walking across shallow or exposed sand banks, diving, spearing and dredging.

Walking

Simply picking trepang up while walking across shallow or exposed banks is probably the original and most basic fishing method used. It requires no specialised equipment and is, when stocks are abundant, efficient. Osseweijer (2000, pp 55-75) describes accompanying Aruese villagers on trepang collecting expeditions in the late 1990’s, an activity still subject to tradition and superstition and unlikely to have changed (other than travelling to the collection site in a motorised craft) in centuries.

Although traditionally only done by men, today collection by walking is conducted by both men and women and is tied to the seasons and tides (Osseweijer, 2000). Usually collections are made on neap tides when the water remains low for longer and visibility is better than on spring tides. Collection during the east monsoon (dry season) is normally made at night with torches, but in the west monsoon (wet season) collection is made during the day when the banks are accessible around noon—this can vary when demand is high. The wet season appears to be preferred, as was explained to Osseweijer:
It was drizzling and the sky was cloudy; “perfect for going on a sea cucumber trip” Jahari explained, “because sea cucumbers show up when it’s less hot (Osseweijer, 2000, p 62).

Collectors travel in groups to the fishing grounds in boats, anchor and wait until the water is about calf deep Then everybody arms themselves with a sack and roams across the bank until the water level rises to the point where they are forced to return to the boat. The Aruese continue to return to a spot where trepang are plentiful until stocks at that site are exhausted before they look for another. The reasoning behind this appears to be not to leave anything for rivals:

... it is like planting something today, but then tomorrow someone else harvests it prematurely. It is because of the price increase....The price goes up and up, but each day the amount of sea cucumbers is less and less (Osseweijer, 2000, p 65).

When Osseweijer raised the possibility of total depletion he was told:

No, maritime resources may decrease but they will not become extinct. What we might do is stop harvesting a particular species temporarily, just as we used to do with sir (sasi).

For the Aruese (and probably other Malukuns) responsibility for all marine resources rests with the ancestors, who grant access to people and to whom ritual gifts should be offered and customary rules should be obeyed (Osseweijer, 2000)—it would be interesting to know if this applied to non-traditional fishing grounds, such as Arnhem Land, where the ancestors of these modern day fishermen worked. Certainly they have a strong resonance with Yolgnu beliefs (see Chapter 4).

Spearing

Spearing, which is carried out with short spears at low tide (Kolff, 1840; Searcy, 1907), is a short progression from simply picking up trepang by hand and appears to be a way of extending a person’s reach—and therefore the collection time—by being able to operate in deeper water as the tide comes in. In 1840 Kolff described a concentrated trepang spearing session in the Aru Islands (carried out specifically to meet the demands of Makassan and Buginese traders).
At low water hundreds of men, with their wives and children, may be perceived wading from Vorkay towards these islets, (the water being only two or three feet deep,) carrying a basket at their backs, and having in their hands a stick provided with an iron point. When the water is deeper than this, they make use of canoes (Kolff, 1840 p 365)

Kolff also said that for fishing away from the village the fishermen travelled in prau with their ‘entire families’. Like picking up trepang by hand, this method of spearing was limited to intertidal and very shallow waters and did not touch the deeper water where large numbers of mature sea cucumbers live. Returning to the same banks until they were completely depleted may pick up many of these mature animals as they migrated up and down, but there should always be a breeding reserve in deeper water. When subject to local sasi and seasonal restrictions, these fishing methods should be entirely sustainable.

Another spearing method employed a weighted three-pronged spear used from a canoe in deeper water. The spear was lowered on a rope until it was just above the sea cucumber, then dropped so that the weight drove at least one of the prongs through the animal (Schwerdtner, 2010). This would have required clear water—often in short supply in Arnhem Land—so may not have been a common method used there. Certainly it was not recorded by Searcy or any of the other observers in the late 19th C. This method of spearing extended the range of the fishers downward several meters, but it would still not have had a significant impact on stocks because turbidity would not have allowed access to water more than ~ 4 – 5m deep at most. This method of fishing also seems inefficient compared to the other methods described—the prey must be identified, the spear lowered and positioned, dropped, then pulled in and the slug removed before another can be targeted, compared with just walking, seeing and spearing (or picking).

**Diving**

Diving increased the range of the fishermen even further, down to about 15m, and a good diver could harvest considerable quantities. After he encountered Pobassoo in 1804, Flinders provided our first description of Makassan fishing methods:
They get the trepang by diving, in from 3 to 8 fathoms [5.5 – 14.5m] water; and where it is abundant, a man will bring up eight or ten at a time (Flannery, 2000, p 205)

Like previously described methods, the act of diving causes no damage to the environment apart from the removal of sea cucumbers, and even then the number removed would have been limited by the physical capacity of the divers, particularly the depth they were able to reach. Nevertheless, the removal of any significant number of sea cucumbers has a detrimental impact on sea grass beds and produces a negative ‘knock on’ effect to the whole inshore ecosystem (Convention on International Trade in Endangered Species, 2002).

Because of the amount of substrate they process—a single sea cucumber can process several kilograms of substrate per day (Convention on International Trade in Endangered Species, 2002; Purwati, Per Com 2008)—holothurians are sometimes called ‘earthworms of the sea’ and fulfil a similarly valuable role in marine sea grass meadows as worms in a terrestrial garden. If a population drops below a sustainable carrying capacity (for seabra under natural conditions this is estimated at ~ 225g/m²) (Bell et al, 2006) there is likely to be some impact. Concentrated dive harvesting could have dropped localised populations well below this level.

If he was on a productive ground the number of sea cucumbers a diver could collect on each dive was maximised by the diver either stringing them on a hook and line which is ‘dragged along until full’ (Isaacs, 2005) or by holding them in the crook of his elbow. When pinched in the middle sea cucumbers narrow to only a centimetre or so and form an hour-glass shape, enabling several to be held in a bent elbow—so many that the diver needed to hold onto his hair to gain extra support for the elbow holding the sea cucumbers (Macknight, 1969). 

Bill Harney, an early European trepang fisherman, gives a detailed description of Makassans diving expeditions as told to him by the Aborigines—he later based his fishing methods on them.

Five or six canoes would go out to fish, every now and then a man leaping over to prospect the bottom for the slug. Then one would give a shout, as a diver rose to the surface with his arms full of trepang. Out they would all jump with a loud splash and down to the bottom of the bay; then up would come divers from
everywhere with arms loaded with slugs, toss them into the canoes and down again to the bottom (Bill Harney, 1961, p 105).

Life for a trepang diver does not appear to have been altogether comfortable—Searcy (1907) describes the Makassan trepang divers as being covered in sores from the bites of small fish, which is interesting as small fish do not normally nibble on divers. This may, however, hold the answer to an interesting question—why did the Makassans not appear to have a high mortality rate from marine stingers when they dived virtually naked in the wet season when deadly stingers are prolific? Although there is no direct evidence for the practise, the probable answer is that they smeared themselves with fat, most likely turtle fat which would have been readily available, to both keep themselves warm and for protection from stingers—in the same way modern swimmers sometimes smear oil or Vaseline on themselves as protection against cold and stings. This would explain the fish bites—the fish were not attracted to the divers, but to the fat.

A free diver was limited by both the time he could spend underwater, which restricted his catch and the depth at which he could harvest. But in the 20th C the use of SCUBA (Self Contained Underwater Breathing Apparatus) or, more commonly, hookah (surface supplied air) has allowed divers to remain submerged for long periods and boosted the potential CPUE (Catch Per Unit Effort) well beyond that possible by free diving, which, combined with ever increasing demand, has inevitably affected the sustainability of the fishery.

**Dredging**

The final fishing method to be described here is dredging. This method was not mentioned by any observer before Searcy (1912) described it being used by Makassans in Arnhem Land at the end of the 19th C and may have been an innovation that was not introduced until the later half of the 19th C (Schwerdtner, 2010). It appears to have become a common practice and was an efficient way to harvest large numbers of sea cucumbers in areas free from rocks and reefs. In ‘Amongst the Proas’ Searcy described dredging in Mardbulk Bay on Goulburn Island:

In the Bay, running before the wind, were sixteen large outrigger canoes with masts somewhat similar to those of the proas [sic], dredging for trepang; and a fine sight they made as they as they came towards us, almost in line, gliding
gently over the rippling water, with their great mat sails full of wind. When they had run a certain distance, the sails were lowered, and they were paddled away to windward, the paddles making an awful squeaking noise in the rattan becketts, to again come down with the wind. And this was repeated until necessary to take the catch to the smoke house (Searcy, 1912, p 161).

Searcy also described the dredging canoes as:

...about 25ft [8.2m] long, 2ft [65cm] deep and 4ft [1.3m] beam, and are cut out of solid logs, being perfect models. The solid portion is raised about 2ft [65cm], the planks being fastened on with tree nails and caulked with leaves. An immense outrigger is fixed to one side, up on which the men perch themselves when the outrigger is to windward, the more wind the more men on it. They carry large mat sails and when under sail present an extremely fine sight. Many of the canoes have two-pounders (canon) slung in the bow (Whitington, 1905, p 8).

Unlike the other trepang harvesting methods described, dredges, no matter what their design, are not species-specific and damage fragile substrates and nursery grounds (Watling & Norse, 1998; Erftemeijer & Robin Lewis, 2006). As much of the ground dredged would have been highly productive sea grass beds, dredging, although efficient, would have been environmentally destructive. Dredges increased fishing efficiency in shallow waters and enabled the fishermen to reach depths previously unattainable and must have led to over-fishing and habitat (particularly nursery habitat) destruction. Together these impacts may have led to the collapse of the Arnhem Land fishery in the late 19th and early 20th Cs (from 300 ton in 1882 to 30 ton in 1905) and ultimately to the temporary closure of the fishery from 1903 – 1905 (Macknight, 1969), and finally to closing the fishery to foreigners altogether.

**Makassan processing sites and camps**

Normally trepang processing was done in the fisherman’s home village or on board their prau (Macknight, 1969), but because of their numbers and the duration of their stay in Arnhem Land the Makassans usually made semi-permanent camps close to their trepang fishing grounds. These camps have left archaeological evidence on the Makassans’ living conditions and trepang processing methods and it is from these sites, along with observations by British officials and recollections of Aboriginals, that most of
what is known about historic processing methods comes—although methods do not appear to have changed significantly at village level and the methods described here are still used (personal observation) in east Indonesia.

Preferred Makassan sites were on beaches where their canoes could be drawn up, adjacent to good anchorage and close to reliable sources of fresh water and mangroves for their fires and to use in dyeing the trepang. The camps were often built on easily defended spits or islands. They brought much of the material needed to construct their camps with them—bamboo poles for construction, woven bamboo mats for walls and palm leaf thatch for roofs (Macknight, 1976).

In a 1987 report on Makassan sites in Arnhem Land and its offshore islands, Baker (1987) recorded 107 sites, 100 of them on the mainland. Today these sites can be identified by the presence of tamarind trees, pottery and/or Ceramic sherds, smoke house depressions, stone lines (Baker, 1987) and in some cases Muslim graves. But these indicators cannot be taken to automatically indicate Makassan activity. Tamarind trees—originally brought by the Makassans to flavour their food—usually occur at Makassan camp sites, but the also occur at other sites as the seeds get spread along the coast by both animals and humans. They may also have been planted by the Makassans as marker beacons (Cole, 1979). Similarly, stone lines and smoke house depressions are not always Makassan. Later European and Japanese trepangers used Makassan methods to process their product, so the remains of their camps were very similar to those of the Makassans, although the Makassans were usually larger with more stone lines (Baker, 1987). To further confuse the issue, European and Japanese trepangers often occupied old Makassan camps for their operations, so the remains of their camps often overlay Makassan ones. The presence of all six features together (especially pottery and graves) is, however, usually diagnostic of a Makassan processing site (Baker, 1987).

A trepang processing camp consisted of lines of joined stone fireplaces (stone lines), one or more thatched smoke houses built of bamboo poles and matting (Searcy, 1911) and assorted accommodation structures. The stone lines consisted of a low wall of stones with a series of equidistant returns protruding from one side to form five to eight hearths (like a comb with widely spaced teeth) (Baker, 1987). A fire was built in each hearth and a large iron pot was placed over it and supported by the stones, into which the trepang were thrown. The smoke house had a depression in the middle in which a fire was
set, and racks on which the boiled and gutted trepang were placed for smoking—only the depressions with their loads of charcoal (sometimes) remain today.

Descriptions of historic processing methods vary somewhat, but they are all similar. Once again, the first description comes from Mathew Flinders in 1804:

The mode of preserving it is this: the animal is split down one side, boiled, and pressed with a weight of stones; then stretched open with slips of bamboo, dried in the sun, and afterwards in smoke, when it is fit to be put away in bags, but requires frequent exposure to the sun (Flannery, 2000, p 205).

Nearly one hundred years later Searcy described the process as:

When landed, the trepang are cast into great iron boilers, boiled slightly, then cleaned, and boiled again in a tan of mangrove bark, why, I am not certain. It gave it a red appearance, whereby the wily Malay perhaps thought he could get to windward of the more wily Chinaman, the consumer, for red fish is of greater value than the grey, the only variety found on our coast. After the second boiling it was dried, and then smoked, by which time the great slug had a very insignificant and objectionable appearance (Searcy, 1907. pp 27-28).

Apart from the second boiling with mangrove bark, this description is essentially the same as Flinder’s, so little had changed over 100 years. The use of mangrove bark in the process appears to have been primarily a marketing ploy, but it may also have been a preservative as it was also used on ropes and lines, which, according to Searcy, were boiled with the trepang to make them:

...beautifully smooth, and they did not kink. Being a fisherman myself, I always, when possible, obtained lines from proas (Searcy, 1907, p 28)

Sunter, a British trepanger operating in Arnhem Land in the late 1920s, said that the Chinese buyers insisted on the red colouring from mangroves being added. He did not seem to know the reason but:

...it was found necessary to follow their wishes (Sunter, 1997).

In the mid-20th C Lamilami (in Cole, 1979) presented a more detailed description, although this description is not from personal observation but was handed down from parents and grandparents:
Groups of Makassans and Aborigines would establish subsidiary camping places on various beaches in the vicinity. At these places they would then collect, spear or drag-net trepang from dug out canoes. When they had collected enough trepang at these places they would transport it to the main centre. Here it was processed.

The Makassans appear to have used several methods in curing the trepang. They employed Aborigines to help them in this work. Sometimes they would boil the animals, then gut and clean them. These were then buried in sand overnight. When dug up next morning the skins would come off, leaving the white flesh exposed. They would then be boiled again, dried and then smoked.

At other times the Makassans would bury the trepang in a large hole in the sand as soon as it was brought ashore. Hot water was poured over the hole. The next morning they would remove the trepang, skin it, squeeze out the innards and wash it. They then boiled, dried and sometimes smoked it.

In many cases it seems that the Makassans undertook a final curing of the trepang just before leaving for Makassar. They assembled at several vantage places, and pooled the trepang which had been collected during the previous few months. They boiled this up again in water mixed with mangrove bark which kept the trepang for its journey back to Makassar and then on to China (Cole, 1979, pp. 58-59).

Lamilami's description probably derives from a time contemporaneous with Searcy, but it introduces a new element—burying the trepang after a light boiling, or pouring boiling water over them after they had been buried.

The Makassans taught their processing methods to the Aboriginals who worked for them, in turn the Aboriginals passed the method on to European fishers, such as Sunter, Harney and Gray who came after the Makassans. Sunter described the processing method he was taught thus:

It [the sea cucumber] is thrown into boiling water for a few minutes to kill it. If this were not done, when it was cut, the fish would twist itself into all shapes. When taken out, it is found to have swelled up and is then cut down the back for a couple of inches but not so deep as to cut through to the bottom part. After this it is then returned to the tubs and then boiled steadily for fifty minutes.
It is then taken off the fire, and when cool enough to handle is placed on wire netting over a smoky fire. Each piece has to be turned over every twelve hours and is thus smoked for the full twenty-four. After that the trepang is dried in the sun for four days, being covered over with bags after sunset (Sunter, 1997, p 42).

Finally Harney provided the most detailed description of the process, which would have been virtually identical to the method used by Makassans in their last years on the coast:

Once loaded with trepang we would return to camp. The boilers would be steaming away merrily and into these the trepang were thrown alive and cooked for a few minutes, to make them swell up into a large cucumber-like shape. They were then lifted out of the pot with a mesh on the end of a forked stick and slit open by the natives, who threw them into another pot to complete their cooking. This was right when the cooked article would bounce like rubber when thrown onto a piece of bark on the ground. They were then taken out and heaped up on a paper-bark. The natives sat around and opened them along the belly; another lot of natives spread these over the trays in the smoke-house, belly-side down; when this was completed, fires were made under the trays and the smoking commenced. After smoking all night, they were then dried on the sandy beach for a few days and bagged till they were ready to be dyed. The dyeing was a form of adulteration, for the Chinese market. As chalk fish [scabra] was of poor quality—the better variety being the red fish [nobilis]—the markets demanded it should be dyed red, apparently a heritage from the Malay. For this the bark from the black mangrove was pounded and boiled in a boiler. When the right colour was obtained, we would fill up a boiler with the dye and let it boil; then empty in a lot of trepang, cook it for a few minutes, and ladle it out onto the bark for draining. It would now be spread out to dry, and when dried enough, would be bagged and sewn ready for market (Harney, 1961, pp 105-106)

Variations in processing methods may have been practised according to the different traditions of the various ethnic groups (eg Makassar, Bugis, Bajau, Malukun) engaged in fishing in Arnhem Land at that time, or to variations in the requirements of differing patrons or markets within China.
However it was achieved the processing was long and time-consuming, but necessary for two reasons.

- To preserve the product
- To remove spicules and saponins from the skin. The saponins are highly toxic—they were occasionally licked by aboriginals to give an intense (and sometimes fatal) hallucinogenic high (Pers Com, Gali, 2005).

The preservation was not perfect and the trepang required reprocessing before it was loaded—along with other products collected over the wet season—for the return trip to Makassar. Lamilami speaks of all the prau:

...going together to a place called Widjba on the Cobourg [Peninsula]. That's where they did their tanning. They would get the bark from mangroves and boil up their trepang. We called the boiling pots gawa. This would take about two weeks and then they would load up the bags of trepang (Lamilami, 1974, p 71)

This may explain why all descriptions of processing did not include dyeing—it was done as a group on the way home.

Today methods employed by village fishermen for processing sea cucumbers into trepang are very similar to those observers of Makassan fishermen in Arnhem Land described in the 19th C. This is a simple but labour intensive process—the animal is split lengthways ventrally and eviscerated, boiled with papaya leaves or mangrove bark, buried in sand to allow the outer part of the body wall (which contains calcareous spicules) to slough off, then re-boiled before being stretched open and dried. While the end product (Fig 6.3) is probably indistinguishable to that sold in China in the 19th C, it is of variable quality and value.
But away from the villages market demand for high and consistent quality has driven trepang processing to undergo considerable modernisation over the past few decades. Essentially the process remains the same, but it is done under better controlled conditions in a food processing plant and may involve innovations such as vacuum drying instead of sun drying. This has created a two tier market—low-value village product and high-value product from modern processing plants—and has encouraged fishermen to, where possible, sell their catch of sea cucumbers live to an agent rather than process them themselves (the practise of holding the sea cucumbers live while awaiting an agent is becoming more widespread (Bell et al, 2006)). The agent splits and eviscerates the animals before filling the gut cavities with salt and packing them into boxes of salt (Fig 6.4). They are then stored for between two days and two weeks before being on-sold to a processor (Hermann, Trepang dealer, Sulawesi. Per Com, 2012).
Sea cucumber cultivation

Increased harvesting brought on by high prices and improvements in fishing methods inevitably saw a drop in wild sea cucumber stocks (Bordbar, 2011) that reduced the spawning efficiency of the species. As previously stated, holothurians are broadcast spawners that require aggregations of several animals to be successful and increased harvesting efficiency means that locally numbers can be reduced to the point where they cannot aggregate, therefore they cannot spawn successfully and the population cannot sustain itself.

The ever-increasing demand coupled with declining wild stocks created interest in aquaculture to fill the shortfall. As wild stocks became harder to find they required a greater CPU (catch per unit effort) and therefore became more expensive to harvest and aquaculture became a financially viable option. As early as the 1950s, artificial production of sea cucumbers was tested in China and Japan on *A. japonicus* (Chen, 2003) but it was not until the 1980s that it became a viable industry. By 2002 Chinese sea cucumber output had reached 6,335 tonnes, of which 5,865 tonnes were from cultured production and 470 tonnes from wild harvest (Chen, 2003). According to estimates, the
total area of Chinese sea cucumber farming will soon reach about 51,000 ha and the total output will reach 6,750 tonnes (dry weight), equivalent to 135,000 to 202,500 tonnes of fresh weight—the ratio of wet/dry is about 1:20-30 depending on the salt level and processing methods (Chen, 2003).

Nevertheless, the Chinese output cannot meet the increasing demand and China still imports a great deal of trepang, much of it from south east Asia. This high demand (and the ensuing high prices) put pressure on the diminishing wild stocks of tropical species and made tropical cultivation the subject of considerable research in recent years. *H. scabra* is the species which proved most amenable to cultivation (Bell et al, 2006) and hence most of the recent work has been directed to gaining a better understanding of *scabra*’s physiology, life cycle and ecology. This has, in turn, led to the establishment of hatcheries to produce millions of juveniles and the development of the methodology to farm *scabra* intensively (Battaglene, 1999; Morgan, 2000; Battaglene et al, 2002; Pitt, 2004; Bell et al, 2006; Dabbagh & Sedaghat, 2012). But reliable cultivation methods for *scabra* are more problematic than those for *japonicus* and reliable farming techniques for them are still being refined.

Modern hatchery techniques for sea cucumbers are essentially the same as those described in Chapter 4. Temperature shock is the most commonly used method—approximately even numbers of mature males and females with ripe gonads are placed in a small tank in groups of 30 – 60 and stimulated to spawn by rapidly raising the water temperature by 3 – 5°C above ambient (Battaglene, 1999; Morgan, 2000; Pitt, 2004; Bell et al, 2006; Dabbagh & Sedaghat, 2012). The close proximity of the animals ensures that once the temperature shock stimulates the release of coelomic fluid males will respond by releasing sperm which will, in turn, stimulate the females to release ova. It is interesting to note that with all broadcast spawners, including *scabra*, the best results for artificially stimulated spawning are obtained on a full or new moon (Morgan, 2000), which demonstrates that they respond to lunar, and therefore tidal cycles even when remote from the sea.

When spawning the animals raise their bodies up from the substrate and expel their ova and sperm upward into the water column (Fig 6.5). This ensures that the gametes are not trapped on the substrate where water movement is usually reduced, but picked up by currents and given the best chance to mix, fertilise and disperse.
After spawning the fertilised eggs are collected, rinsed to remove excess sperm and placed in incubation tanks where the larvae hatch after 12 – 24hrs. The larvae remain in the water column for about two weeks (Battaglene, 1999; Battaglene et al, 2002; Bell et al, 2006; Dabbaghl & Sedaghat, 2012) before settling onto a suitable substrate where they remain for about three months. When they reach ~20mm in length they can be placed on a natural substrate or pond to grow out. It is recommended (Bell et al, 2006) that if juveniles are released in the natural environment it should be in water <2.5m deep with sea grass cover >25% and a substrate that enables them to easily bury themselves. Even when these conditions are met _scabra_ record variable survival of 0 – 20% to maturity (~ 200g) and survival to market size (>500g) is ~ 5% or less (Bell et al, 2006).

There are three methods used to grow-out sea cucumbers after they have left the hatchery (Chen, 2003)—pond culture, pen culture and sea ranching (sometimes called bottom culture). Of these sea ranching is the most popular in China because it has a lower investment requirement and therefore offers a higher return. In China sea ranching accounts for 75% of the total area devoted to sea cucumber cultivation—for example in Shandong Province alone ranching occupies 13,000ha, whereas pens total 2,500ha and ponds 1,800ha (Chen, 2003).

Pond culture (land based and normally excavated—not to be confused with stone structures, such as the Warruwi pond, in the Arafura Sea) falls into the category of intensive
aquaculture; however, it has become popular in part because it can use recycled shrimp ponds left over from the boom in shrimp farming in the 1990s (Chen, 2003). Ponds are not yet a significant feature of the tropical sea cucumber cultivation and are therefore not relevant here.

Although low technology and requiring minimal financial input, sea ranching is also not yet established in the Arafura region. The two main impediments appear to be the lack of established hatcheries to supply the large numbers of >20mm juveniles needed for release (Chen, 2003) and security—the ‘roving bandit syndrome’ (Berkes et al, 2006; Schwerdtner et al, 2010) is still alive and well. As Osseweijer’s informant said, it would be:

...like planting something today, but then tomorrow someone else harvests it prematurely (Osseweijer, 2000, p 65)

Between the intensive pond cultivation and extensive cultivation by ranching lies semi-intensive pen cultivation, which is practiced in the Arafura region—although by no means on the scale that it is in China, where pens, stocked with hatchery reared juveniles, occupy huge intertidal areas (Fig 6.6). Sea water flows naturally in and out of the pens with the tide, bringing oxygen and nutrients in the form of organic debris that supplements the feed provided by the farmer. At low tide the pens retain about 80 – 100cm of water. Pen cultivation is regarded as a highly efficient and low-cost farming model, but it is limited to coastal areas with suitable substrate, water flow and low pollution (Chen, 2003).
In east Indonesia most sea cucumber cultivation occurs in Papua (378 tonnes wet weight per year), Central Sulawesi (200 tonnes), south east Sulawesi (3 tonnes) and east Kalimantan (1 tonne). These figures cover all types of cultivation and include product from ponds where fishermen retain their catch until there is enough to sell or process (Tuwo, 2006), an increasingly popular practice (Bell et al, 2006).

As described in Chapter 4, the practice of holding sea cucumbers in ponds was sometimes linked to *sasi teripang* in tradition stone enclosures (*lutur*) in the south Malukas, particularly in Seram Laut, that were built specifically for trepang (Ellen, 2003). In some cases these were old and had been passed down through the family (Ellen, 2003)—an example of these enclosures is probably the stone pond at Selmona that the villagers said was once used to hold trepang (Baskara Mauliputra, Per Com. 2012).

In the Arafura region pens are considerably smaller and less sophisticated than their Chinese equivalents (or even those in south Sulawesi) and commonly bypass the hatchery stage, relying instead on the collection of ~20mm long juveniles from seagrass beds where they have settled naturally. These juveniles are stocked into enclosures built on mixed sand and mud flats in the low intertidal zone where sea cucumbers occur
naturally. Enclosure size ranges from \(-400\text{m}^2\) up to \(-2,500\text{m}^2\) or larger (personal observation).

A modern day example of this practice was described by Osseweijer (2000, p 64) in the Aru Islands when a party of Muslim youth on a general purpose collection trip for the local Mosque specifically collected juvenile sea cucumbers under 10cm (considered immature by Arunese fishers) for the Haji’s sea nursery for cultivation. He does not say if the Haji’s nursery was constructed from mesh or stone, however Osseweijer (2000) recorded that in 1994 both the Catholics and the Muslims had trepang nurseries constructed from stone and wood. Another example is the large, three-sided mesh enclosure north of Makassar (see Chapter 2), which was described by a local trepang dealer as used by a fisherman to hold small trepang until there was enough to send to market (Herman, Per Com, 2012).

Feeding the sea cucumbers is simple and indirect—a mixture of one part chicken or animal manure and one part rice bran (personal observation) is placed in sacks inside the enclosure. Feeding is at \(0.2 - 0.5\text{kg mixture} / \text{m}^2\) every two weeks (Tuwo, 2006; personal observation). Each sack, holding \(~10 - 15\text{kg of mixture}\), is punctured to allow nutrient from the mixture to slowly leak out where it promotes the growth of the microorganisms that the *scabra* feed on. Grow-out period varies according to the market and ranges from six months for harvest of \(~200 - 250\text{g animals}\), up to 9 – 12 months for \(~400\text{g animals}\). Given a carrying capacity of \(2 \times 400\text{g sea cucumbers} / \text{m}^2\), an \(800\text{m}^2\) pond would produce about 1,600 sea cucumber (~640kg live weight) in a season.

According to data presented by the Northern Territory Division of Business, Industry & Resource Development (2004) and Chen (2003) sea cucumbers lose about 95% of their weight when they are processed, therefore 640kg of sea cucumber would become 32kg of trepang. Assuming a farm-gate price of A$20 / kg this equates to an income of about A$640 / season (~6.4 million Rupiah in 2012) before expenses. If this were the only income for the farmer during a year it would equate to only A$1.75 / day (17,500 Rupiah), a minimum income for a villager, but it is likely that it would be supplementary to fishing, sea weed farming or some other form of income.

Enclosures are also used to store and fatten stock over a comparatively short period. This scenario sees small fishing boats bringing in small catches of all sizes of sea cucumbers and placing them in pens or ponds where they may be fed and selectively
harvested for processing when they reach a suitable size; or just held until a buyer is available (Tuwo, 2006; Bell et al, 2006; Herman, Per Com, 2012)—it is easier to store live animals than preserved ones.

In east Indonesia there are three types of enclosures used to hold sea cucumbers—mesh pens, stonewall ponds (*lutur* or *tambak batu*) and a combination of both (Tuwo, 2006; personal observation).

Mesh pens (Figs 6.7 and 6.8) are constructed from a robust fine meshed polymer material attached to a frame of bamboo or mangrove poles about 3 – 4m long. The poles are driven securely into the substrate to form a fence enclosing a (normally) square area of 20 × 20m or 40 × 20m. The cage is generally located in shallow coastal areas (water depth ~75-100cm) (Tuwo, 2006; personal observation). The mesh fence is generally ~2 – 3m high and buried all around the perimeter to a depth of about 500mm to prevent the stock from burrowing out.

![Diagram of a mesh pen enclosure](image)

**Figure 6.7** Four-sided mesh enclosure as seen in Kupang Bay, Timor
Scabra are able to compress their bodies to a remarkable degree and pass through very small holes, so the mesh needs be no more than 5mm wide, which has the potential to present considerable water resistance. Mesh enclosures are limited in size by structural constraints—although incorporating stones as a reinforcing base appears to enable the construction of larger structures as seen near Makassar (Fig 6.9)—and are limited to areas where they are not subject to strong tidal currents, storms and high winds, or potentially damaging flotsam.

The requirement for a robust fine mesh makes it unlikely that mesh pens have been in use for more than about 50 years as suitable material only became available with the invention of polymers, but they appear to form the majority of sea cucumber enclosures now being built and used (personal observation).
Where there are strong currents or tides, or there is a risk of debris, stone enclosures (*lutur / tambak batu*) (Fig 6.10) present a safer option than mesh. These appear to be more common in the Malukas, possibly because access to mesh is limited either because of distance or cost, or simply because tradition holds that ponds be built of stone.

Like mesh ponds, stonewall ponds are sited in the intertidal zone where they are flooded at each tide, ensuring regular good water exchange. The walls are made from locally available rocks packed tightly enough to prevent the stock escaping—*scabra* do not move on coarse rock substrates (Mercier et al, 2000). Stocking, feeding and harvesting methods are the same in stonewall ponds as in mesh pens.

Figure 6.9  Mesh and stone enclosure near Makassar, Sulawesi
Figure 6.10  Stone enclosure on Ohoider Tom, Kei Kecil

Unlike mesh enclosures which are limited by structural strength and their ability to withstand water currents, the size of stonewall ponds are limited only by access to (or ownership of) suitable intertidal land and the availability of suitable stones and labour to build them.

Enclosures serve three distinct functions:

1. Create an optimal environment to cultivate sea cucumbers and other sessile organisms

   Currents near the substrate within the enclosures, especially smaller ones, are disrupted by the wall and are more likely to circulate nutrients within the pond rather than wash them away, thereby retaining the benefits of the artificial feed supplied and ensuring a better supply of food within the pond than outside it.

2. Define ownership of the enclosed stock

   Ownership of resources was set by ancient tradition (sasi laut) which was enshrined in law by early Dutch colonial administration (Ellen, 2003; Bell et al, 2006). However, as this system was undermined and stocks depleted, placing sea cucumbers
within an enclosure made a statement of ownership. The practise became something of a double-edged sword, however, as enclosures make an easy target for thieves.

3. Offer good spawning stimuli and fertilisation enhancement

By confining mature adults in a protected environment and at a high density, good spawning and fertilisation rates are ensured (Bell et al, 2006)—in a similar way that sea urchin stocks are enhanced in the Philippines (Juinio-Menez, 1998). The shallow body of water left in the pond would cool to several degrees below ambient during a night low tide. The rising tide would rapidly raise the temperature again when it floods the enclosure, providing a temperature shock very similar to that used in a modern hatchery to stimulate spawning.

The gametes are expelled upward into the current as it passes over the pond where they are mixed and dispersed toward nearby sea-grass nursery grounds. Eggs hatch into mobile larvae in about 12-18 hours and then into benthic juveniles in about two weeks (Battaglene et al, 2002; Pitt, 2004; Bell et al, 2006; Dabbagh & Sedaghat, 2012). Bell et al (2006) estimate that larvae will settle within a 40ha area around a spawning site. It is therefore probable that, provided it is located at a site that ensures that currents carry larvae to suitable settlement grounds in seagrass beds, a pond will provide a level of local recruitment of sea cucumbers that would otherwise be negligible and will provide a ready source of juveniles to restock enclosures or grow to saleable size in the wild.

Stone walled ponds are likely to be more effective than mesh enclosures in enhancing spawning success. Comparatively low stone walls would allow currents to swirl within and through the enclosure more freely than a high fine-mesh wall and provide better mixing and dispersal, although specific trials would be needed to demonstrate this conclusively.

The antiquity of trepang aquaculture

As trade necessarily follows the development of demand, so aquaculture follows trade when it out-strips the capacity of the wild harvest.

Determining the antiquity of sea cucumber aquaculture depends very much on the definition of aquaculture that is applied. If aquaculture is taken as being ‘hatchery-to-harvest’, then it only dates back to the 1950s when the cultivation of *A. japonicus* was
first instigated in China and Japan (Chen, 2003), and is, in fact, still being developed for other species. If, however, intervening in a natural spawning cycle to provide the best possible recruitment of wild stock, or the collection of juveniles from the wild and growing them out in captivity, or simply storing wild harvested sea cucumbers prior to sale is considered to be aquaculture then its origins may be much older.

Sea cucumber aquaculture is likely to have simply evolved from one practice to another—from holding small batches of harvested sea cucumbers in ponds until there was enough to process or market (or when the labour force was ready) (Tuwo, 2006; Herman, Per Com, 2012), to collecting and feeding easily available juveniles for grow-out. Both are still practiced today.

It is not possible to put an accurate date on the transition from simply storing the harvest to actively cultivating wild harvested juveniles. The big 17–18th C fleets were unlikely to have needed to use this strategy because their fishing methods and large work force generally provided large catches that were more efficient to process immediately than to store. Although there would inevitably have been periods when catches were small, the number of fishermen engaged in harvesting at any one time would have usually produced enough sea cucumbers to fill at least one boiling pot. Therefore the use of ponds for live storage of small catches probably originated with, and was the preserve of, small traditional fishing villages. But with the advent of large fleets manned by foreigners with little respect for local tradition or ownership, storing catches would have invited theft unless they could be guarded constantly, so the practice probably began either before the fleets’ arrival or somewhere the fleets did not reach.

The most likely scenario is that live storage began at an early phase of the industry, possibly at (or near) the genesis of the fishery, in the Arafura region in the 16th or 17th C. At this time the fishery was in the hands of local fishermen who accumulated enough product for when a buyer came by, or to make processing and a trip to market worthwhile. At this time there was no suitable mesh available so storage must have been in stone ponds (*lutur* or *tambak batu*).

The same need would have been present when a fisherman, or small group of fishermen, was working far from his home village and needed a way to store his day to day catch without having to engage in time-consuming processing to preserve small quantities. His only option would be to keep his sea cucumbers live in a secure area,
adding to the cache every few days until he was ready to return home. Such a scenario would explain the occurrence of ponds in remote areas such as at South Goulburn Island and implies that the builders of the Warruwi pond lived far enough away from Arnhem Land to make regular trips home with daily (or even weekly) catches inconvenient. It also implies that the builders worked either alone or in small groups and took some time to accumulate a viable number of sea cucumbers—a large group would reach the pond’s holding capacity too quickly to make the construction worthwhile.

Finally there is the potential use of the ponds as tools to enhance sea cucumber recruitment in an area. As previously stated, sea cucumbers spawn in response to a number of stimuli. Placing a large number in an enclosed pond located low in the intertidal zone at the right season and lunar cycle would create ideal spawning conditions and ensure a great many fertilised eggs were distributed across nearby sea grass beds. This scenario is promoted as a modern-day option to restore trepang beds in Indonesia by Bell et al (2006, p 3), who refer to the technique as ‘fertilisation enhancement’.

But whether the ponds builders knew this or not is a moot point. Osseweijer reported that

When asked about the regeneration of sea cucumbers, only a couple of men, including the Chinese-Indonesian trader in the village, reported that the semi putih [white teatfish] and matahui [sandfish-scabra] reproduce in April. You can see the semen coming out of them when boiling trepang (Osseweijer, 2000, p 64)

He goes on to say that:

But although many Aruese subscribe to cosmological beliefs [that ancestors control the sea cucumber harvest] which may thus influence their harvesting behaviour, at the same time they are aware of the ‘natural’ reproductive cycle of trepang, as well as the fact that they evidently over-exploit their reefs (Osseweijer, 2000, p 69)

This does not mean that they knew that they could enhance spawning success by aggregating mature adults under the right conditions, but if the Yolgnu on Elcho Island knew that placing sessile animals in close proximity to each other produced good recruitment, it is quite likely that it was known to other groups in the region who were closely associated with the sea.
Conclusion

The consumption of trepang in China dates from at least the 4th / 5th C and had become significant enough in the Ming period (1368 – 1644) that merchants were looking for alternative sources of supply. They found this in Maluku, possibly when Ch’eng Ho’s 16th C reassure fleet visited the Malukus in search of valuable and useful items. As the main trade hub of the region, the trade would probably have been initially centred on Banda with its ready-made trade routes courtesy of the ancient spice trade.

The fall of Banda in the 17th C saw the trepang trade ultimately shift to Makassar in the early 18th C. The Makassans built on traditional village harvesting techniques—walking across shallow or exposed sand banks, diving, spearing and dredging—to build a huge and efficient fishing operation. They then utilised Indigenous labour to process and preserve their catches on the beaches of Arnhem Land before taking back to Makassar for sale to the Chinese. All this added up to a very efficient business model that saw the trepang trade increased from 1 ton in 1718 to 512 ton by 1788.

But the Makassan business model did not include either cultivation or storing live sea cucumbers. That appears to have been the preserve of Malukun fishers, who traditionally stored live sea cucumbers in ponds until they could be sold. Modern hatchery techniques demonstrate that storing sea cucumbers in a pond such as traditional Malukun stone ponds or the Warruwi pond would create ideal conditions to promote spawning, fertilisation and local recruitment for sessile organisms such as sea slugs.

It is likely that they Warruwi pond was used for storage of live animals and, whether by design or accident, for enhancing breeding. Based on similarities between the Warruwi and Malukun ponds it was probably built by Malukun fishers to hold sea cucumbers ready for processing. However the principle of spawning enhancement also applies to the other candidate for aquaculture in Arnhem Land—pearls—and it may be that the pond was used to enhance numbers of oysters in the area to boost pearl production.
Chapter 7

Pearls—history, trade and cultivation

In the late 19th C Alfred Searcy wrote:

... the Malays procured and took away great numbers of pearl. It is impossible to estimate the value of the treasure, but some idea of it may be formed from what I saw myself, and also from the information I gained along the coast. On one occasion I saw on board one of the proas three pickle bottles full of pearls of many shapes and sizes, but I don’t think any among them were of great value. The master of the proa, I was informed, did not produce the good ones. He was too suspicious I suppose. I received reliable information that a proa the previous season had taken away 35 catties weight (about 21.2kg) of pearls. The natives collected the pearls and kept them for the Malays and received grog and tobacco in exchange. On the outlying reefs at low water pearl shell can always be procured (Whittington, 1905, p 11).

Searcy again noted in ‘By Flood and Field’ that, when searching a Makassan proa for valuables to confiscate as a fine:

We ... came across several pickle bottles full of pearls, mostly small, but containing others that would bring good prices; also a bag of splendid tortoise shell (Searcy, 1911, p 188).

There is no indication of the size of a ‘pickle bottle’ (he is unlikely to have meant a ‘picul’ bottle as that would be about 60kg), but the strong inference is that it held enough pearls to impress. When multiplied across even half of the Makassan fleet this would represent a considerable volume of pearls. Clearly pearls were a valuable Arnhem Land export.

But here lies a conundrum—the 35 catties, or about 21.2kg, that Searcy reported is a considerable volume of pearls to be collected by a well-equipped fishing expedition, let alone a small number of Aboriginals who had limited access to even the most basic diving technology (i.e. boats and ropes). Searcy (1911, p 188) said, ‘On the outlying reefs at low water pearl shell [oysters which produce mother-of-pearl and, potentially, pearls] can always be procured’, but the bulk of the stocks are in deeper water where they would
have been beyond the reach of free diving Aborigines—even those with a dug-out canoe and prodigious lung capacity. And pearl diving was not an Indigenous activity associated with Arnhem Land, probably because it would have been singularly unrewarding. In the wild pearls are usually extremely rare—roughly one in 2000 oysters will contain a pearl (Haws, 2002)—and in the Northern Territory the incidence of pearls in wild oysters proved so low that collecting them was economically unviable even for well-equipped luggers (Kunz & Stevenson, 1908) in the early 20th C. The luggers relied instead on pearl shell for income and what pearls that were found, even seed pearls, were considered a bonus.

If those luggers, which were equipped with diving equipment, could not make a living out of pearls it is unlikely that a few Yolgnu in east Arnhem Land without diving equipment could have collected the volume of pearls that Searcy recorded—unless they were cultivating them, which they were. Trudgeon says that:

...the Yolgnu not only collected pearls; they also seeded oysters and large clams with sand to make the pearls grow. This was done by working over their oyster and clamshell beds in a methodical way, returning to the beds to harvest from a particular section after a number of years (Trudgeon, 2000, p 14).

Yolgnu cultivated pearls in a variety of bivalve species for trade with Makassans, but mostly they used the Silver Lipped (Pacific Pearl) oysters (P maxima) and giant clams (Tradaclid Spp) to produce both gem quality pearls and pearls for use in Asian traditional medicines. The description below uses giant clams (T. squamosis) as the example, but the technique applies to all pearl-producing bivalves.

I had previously read Trudgeon’s sketchy account of Yolgnu pearl cultivation in his book ‘Why Warriors Lie Down and Die’ (2000). When I mentioned it at an aquaculture training session Dungatunga, a senior Yolgnu elder and the Traditional Owner of Barkhira in east Arnhem Land, agreed to demonstrate it. The technique, as it was explained and demonstrated, is simple and would produce an end product indistinguishable from natural pearls.

The shell is wedged upright so that its incurrent syphon is at the top (clams are naturally in this position) and left until they relax, the shells open and they resume pumping water through their gills. Two or three pieces of shell ~1-2mm thick and about
the size and shape of a man’s thumbnail (Fig 7.1) are then introduced into the incurrent syphon (Fig 7.2) where they become caught in the gills (Fig 7.3).

Figure 7.1  Shell pieces used as pearl nuclei

Figure 7.2  Giant clam used for demonstration
Introducing large pieces of shell into the gill and propping it upright so it must fight gravity means that it is almost impossible for the animal to expel the irritant, as it would with smaller particles. Over time the action of the adductor and pedal muscles break the shell down into several more comfortable sized pieces, some of which may be expelled but most remain trapped and form ‘sacs’ in the gill, forcing the animal to resort to its secondary defence—produce nacre to encase them.

Figure 7.3  Yolgnu pearl manufacture technique  (Indicates water flow)

After a period of time (not specified) to make sure that the oyster or clam has retained the shell fragments, the seeded bivalves are returned to accessible beds and left to grow. The gill will continue to lay down nacre around the irritant so long as the animal lives or until the irritant is removed. Pearls were harvested by killing the animal, opening it and removing the pearls—this may have been after only about a year, at which time the harvest would have been ‘seed pearls’ and probably used mostly in medicine, but the longer the oyster was left, the larger and more valuable the pearl.
After Dungatunga’s demonstration, a trial seeding using the Yolgnu technique was done using giant clams under controlled conditions in a large holding tank in an aquaculture unit. The clams retained all the shell pieces that were placed in them and they were left to develop pearls. Unfortunately when, after one year, the clams were to be harvested it was found that they had disappeared (probably accidentally given away as brood stock), but the fact that they retained the shells in their gill means that they must have coated them with calcium carbonate to protect their organs and therefore formed porcellaneous pearls.

But the question remains—how and why did the Yolgnu learn to seed pearls in the first place? Along with other coastal tribes, the Yolgnu used pearl shell as a trade item to inland tribes (Berndt Museum of Archaeology), but they did not appear to have any use for pearls apart from occasionally using particularly large ones in magic or charms. There was, therefore, no need to cultivate pearls for their own use, and without a need it is unlikely they would have learned how to seed them themselves.

The advent of foreign trade, however, abruptly turned a low value or useless product into a desirable commodity. When the demand arose they may have drawn on their knowledge of marine creatures to develop their own pearl seeding techniques, but given the somewhat esoteric nature of pearl production (it occurs naturally in only a very few molluscs and does not affect the animal’s habits, growth or reproduction—the normal subjects of traditional learning), it is more likely that they were taught. Determining who could have taught them and where the technique originated will require a close look at the pearls, the long history of the pearl trade and pearl cultivation.

Pearls are one of the most ancient gems to be valued by man (Kunz & Stevenson, 1908), possibly because their natural lustre requires no cutting, polishing or processing to turn them into objects of beauty—and pearls from the Arafura region are among the most valuable in the world. Arnhem Land is within the natural habitat of the world’s largest pearl oyster, the Pacific or Silver Lipped pearl oyster, *Pinctada maxima*, which produces the largest and most valuable of the gem quality pearls (Kunz & Stevenson, 1908).

In the Arafura region there are two main pearl-producing species—the Silver Lipped oyster which produces a silvery white pearl and the less common Black Lipped oyster *Pinctada margaritifera*, which produces a black pearl. It was probably pearls from Silver Lipped oysters that the Makassans were seen exporting from Arnhem Land.
(Whittington, 1905; Searcy, 1911; Trudgeon, 2000), although there were reports (Trudgeon, 2000) that suggest that the lustreless pearls form *Tridacnid spp* were also taken.

The Silver Lipped oyster will be described here as its morphology may be taken as broadly representative of pearl oysters and the process by which it forms pearls is identical to that which occurs in all bivalves.

**Silver Lipped Oyster (*Pinctada maxima*) description and pearl formation.**

**Classification:**

<table>
<thead>
<tr>
<th>Phylum</th>
<th>Mollusca</th>
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<tr>
<td>Class</td>
<td>Bivalvia</td>
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<tr>
<td>Order</td>
<td>Pterioida</td>
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<tr>
<td>Family</td>
<td>Pteriidae</td>
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<tr>
<td>Generus</td>
<td>Pinctada</td>
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<tr>
<td>Species</td>
<td>maxima (Jameson, 1901)</td>
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*P Maxima* (Fig 7.4) is a large, tropical, marine bivalve that can grow to ~ 300 mm across and can live for up to 40 years (W.A. Fisheries, 2013). It occurs at depths ranging from low tide down to ~ 80 m and is found from the north coast of Australia in the south to the Philippines in the north (from approximately 20°S – 20°N), including Papua New Guinea and the east Indonesian islands. It is also found in Burma and Thailand (FAO, 1991).
Like all bivalves, the Silver Lipped oyster is a broadcast spawner. Its main spawning season (in Australia) is just before the wet season in October/November with a secondary, smaller spawn at the end of the wet in February/March. It is a protandrous hermaphrodite that begins life as a functional male before changing to female. Some change at 2 – 3 years old (about 110 – 120mm). By 150 – 170mm about half have changed sex and when they reach 190 mm they are all female (Haws, 2002; W.A. Fisheries, 2013).

Larvae remain planktonic and free swimming for 28 – 35 days (Fig 7.5) before settling permanently onto a hard substrate, where they attach themselves with fine threads (byssus) and generally remain for the rest of their lives, although if conditions prove poor (e.g. periodically rough) they can detach and move on (W.A. Fisheries, 2013; Haws, 2002)—if a larva does not find a suitable site to settle within this time it will metamorphose in the water column and die. Once settled the oyster grows by secreting from its mantle edge a thin, uncalcified cuticular conchiolin layer or periostracum which extends beyond the margin of the calcareous shell. Just behind the periostracum the mantle forms a sequence of layers composed of calcareous prisms, each new one beneath the last—the inner-most being the mother of pearl (FAO, 1991).
Figure 7.5  The life cycle of the pearl oyster (from Haws, 2002)

The oyster feeds and breaths by pumping water across gills (Fig 7.6) that filter out both minute food particles and extract oxygen. Pearls form naturally in response to an irritant introduced into the gills or between the oyster’s body and its shell (FAO, 1991). In nature this irritant may be a piece of shell, grit or detritus that has found its way in between the animal and its shell or been washed in (or ‘inhaled’) as the mollusc pumps water across its gills; or it may be a parasite, small fish or other small marine animal that has blundered in; or it may be a worm or sponge that has drilled through the shell creating a breach and an irritation (Kunz & Stevenson, 1908; FAO, 1991; Haws, 2002).
The mollusc responds to irritants by covering them with **nacre**, the same translucent substance that is secreted onto the inside of the shell by the mantle of the mollusc, and forms a pearl sac around it (FAO, 1991; Nudelman et al, 2006). When nacre is laid in a sheet on the shell it is known as ‘mother of pearl’, but when laid on an irritant it becomes a pearl. Nacre continues to be laid down around an irritant so long as it remains inside the oyster.

Nacre is an extremely tough, iridescent substance containing alternate layers of aragonite and conchiolin particles. The conchiolin is organic and contains mucopolysaccharides to form a binding agent for the aragonite (FAO, 1991). Aragonite, which is made of laminated crystals of calcium carbonate, is laid down in layers 0.29 – 0.60 mm thick (W.A. Fisheries, 2013) which act as a series of minute prisms to give the pearl and mother-of-pearl their lustre. The quality and distribution of the aragonite crystals determines the quality of the nacre and therefore the quality of the pearl (FAO, 1991; Nudelman et al, 2006).

Broadly, there are two types of pearl produced—full rounds which grow independently of the shell and half rounds (mabes) which grow on the inside of (and as a part of) the shell. Extracting a full round pearl does not necessarily harm the oyster, but it must be killed and the shell cut to harvest mabes.
Pearls are produced by a wide range of molluscs, both marine and fresh water. There are a number of pearl-producing marine gastropod species (such as abalone), but they only produce mabes that form on the inside of the shell in response to damage by burrowing organisms. Full round pearls, both fresh water and marine, are derived only from bivalves. Pearls produced by non-nacre producing species, such as giant clams (Tridacnid Spp), are known as ‘porcellaneous’ and generally have little value except in traditional medicines, especially Chinese medicine (Kunz & Stevenson, 1908), whereas the very high-value jewel grade nacre produced by Pinctada spp such as the Silver Lipped Oyster is extremely valuable in the gem market.

A history of pearls

Possibly the first specific mention of pearls in literature (Kunz & Stevenson, 1908) was in the Shu King (~2350 – 625 BC) where it was recorded that in the 23rd C BC Chinese Emperor Yu received pearls as tribute (although it is not certain if these were marine or fresh water) and they continued to be mentioned in Chinese literature throughout history (Kunz & Stevenson, 1908). The Persian Gulf and Indian Ocean are some of the most productive and ancient pearl fisheries in the world and pearls were a well-known product in Persia, India and Sri Lanka from ancient times, and they are first mentioned in 6th C BC Sanskrit and Cingalese literature. The oldest extant pearl ornament—a necklace found in the sarcophagus of a Persian (Achaemenid) princess at Susa—and many Persian ‘coin and gem’ portraits showing ear pendants also date from about this time (Kunz & Stevenson, 1908). Finding an ancient pearl is a rare event because, unlike other gems that are wholly minerals and so do not decay, natural pearls are in large part organic in origin and do not survive well, especially in an acidic environment.

The value placed on pearls would certainly have made them a desirable commodity for traders, and the size and portability of pearls (a fortune could be carried in a small box without compromising cargo space reserved for other goods) would have only enhanced their desirability. The size and quality of Silver Lip pearls from the Malukun Islands would have made them even more sought after.

If spices were finding their way across the world on Indian, Persian, Arab or Chinese boats (Adib Majul, 1999; Lape, 2000, 2002; Ellen, 2003; Hall, 2006; Bellwood,
2007) it is very likely that pearls from the Malukun region were also being exported, and, given Banda’s ancient trade links, it is quite likely that they were being exported through there along with nutmeg, mace and cloves. There are very few references in the historic records, written or oral, referring to a pearl trade in the Malukas, which is probably not surprising—if pearls were being carried along with spices they would also have shared the secrecy that surrounded that trade.

Pearls were on early Chinese shopping lists and those from the Sulu Sea and Luzon are mentioned as being known from at least 1226 (Donkin, 1998). This was concurrent with rapid increases in the volume of Chinese pottery and coins found in Banda’s archaeological record, indicating an increase in foreign trade and possibly a direct link to China (Lape, 2000), and shortly before the first known specific Chinese mention of Banda in the 1304 text Dade Nanhai zhi which was described in detail in the mid-14th C Daoyi zhilue (Lape, 2000).

The Chinese extensive shopping list for products that could only be obtained from the region—sandalwood from Timor, spices from Ambon and Banda and birds and bird-of-paradise feathers from Aru and Papua—meant that they had to have been very active in the Malukun area. This was an extension of the Sulu Sea trade that ran through the Celebes Sea to Ternate, Banda, Ambon and around the Banda Sea from Papua and Aru to Timor (Soselisa, Per Com 2008)—an area rich in many of the sought-after goods. And if they were trading for pearls in the Sulu Sea it is unlikely that the traders, whether Chinese or other, would have missed the extensive pearl beds further south, especially around the Aru Islands. The existence of this historic pearl trade in the Arafura Sea was confirmed (albeit lacking in specifics) by Jackson who stated that:

For hundreds of years, pearl-shell and pearl have been gathered by the natives from these waters, and especially on the coast of the Aru Islands, Halmahera, and adjacent Islands, on the east coast of Celebes [Sulawesi], and about the Sunda group (Jackson, 1917, p 94)

In 1405 – 1433 the Ming Dynasty exploration fleet under Ch’eng Ho visited the Arafura region to search for ‘useful and valuable goods’, among which pearls were specifically mentioned (McMillan, 2001; Gungwu, 2003). As with trepang, Ch’eng Ho must have carried pearl experts both to assess the quality of specimens and the quality
and quantities of the oyster beds—in the seas around the Aru Islands and Halmahera they
certainly would not have been disappointed.

These experts may have been Tan—an ancient tribe that settled on the coast in the
Gulf of Tonkin where they operated the first known organised pearling fleet (Schafer,
1952). The industry was centred around Hainan and in the nearby NE Gulf of Tonkin, in
an area called Ho-P’u in the estuary of the Ho River, which was famous for pearls as
early as the 2nd C BC (Schafer, 1952) and appears to have produced prodigious quantities
and sizes. Early Chinese documents refer to the ‘pearl ponds and islands’ of Ho-p’u—
these must have been numerous as a new county named ‘Pearl Pond’ was briefly formed
between about 632 to 638 (Donkin, 1998). The use of the terms ‘ponds’ and ‘islands’ is
interesting as it suggests a man-made sea-scape created specifically to cultivate oysters,
however Donkin (Donkin, 1998) interpreted them as referring to natural shoals and deeps.

The Tan were accomplished sailors and by the time of the Sung period (960 –
1279) some of them had taken to living full time on their boats and were operating a
highly organised pearl harvesting business (Donkin, 1998). They worked cooperatively,
sailing together to the oyster grounds and diving as a group. Once the boats were in place,
ropes weighted with rocks were dropped with the divers holding onto the rocks. Once on
the bottom they collected as many oysters into baskets as they could, and when their
breath ran out they pulled on the rope and an attendant pulled them and their basket to the
surface. By the 17th C their diving had become more sophisticated with the addition of
breathing tubes, described in the 1637 Sung Ying-Hsing (Creations of Nature and Man) as
being either of metal or a flexible material, probably leather, reinforced with metal rings
and a leather face mask (Donkin, 1998).

As pre-eminent sailors, Tan may have been among Ch’eng Ho’s crew members,
and as pearlers they may have been among those who remained in the islands when their
ships sailed (Donkin, 1998). They remained ostensibly as hostages to ensure the fleet’s
return to the islands, but quite possibly, having seen a good business opportunity, opted to
stay to develop, secure and conduct the trade in ‘useful and valuable goods’.

This may have been the beginnings of the long history of Chinese settlers and
traders in the Arafura region. Until recently some of the local Chinese traders were still
buying wild pearls and pearl oysters from villagers in the Aru Islands for pearl cultivation
(Baskara Mauliputra, Per Com, 2012), but today hatchery technology has largely superseded the use of wild stock on pearl farms.

The south Malukun pearl fishery spilled over into north Australia with opportunist fishermen who came to Arnhem Land seeking turtle shell, fish, perhaps trepang and other products. Exactly when this happened is uncertain, but Makassans were certainly taking pearls in considerable quantities by Searcy’s time in the late 19th C (Whittington, 1905; Searcy, 1911).

Pearl cultivation

Pearl cultivation possibly dates back thousands of years, and is today practiced at a range of technical levels from comparatively low-level, village-based production—usually of black pearls—to the highly structured and multimillion dollar industry found in north Australia and sites throughout south east Asia and Japan.

While the pearl industry is referred to as aquaculture, it differs from most other forms of aquaculture in that it uses the animal to repeatedly produce a product rather than cultivating the animal as the end product. Today modern pearl cultivation and the aquaculture of pearl oysters are inextricably linked operations—pearls aren’t produced without some degree of oyster cultivation under more or less controlled conditions—but historically (up until the early 20th C) this was not the case. Oysters were collected from the wild, seeded and dropped back into a holding area to develop pearls—there was very little actual aquaculture involved.

Until comparatively recently adult pearl oysters were harvested from the wild, seeded and placed in a defined area for grow-out—a very low technology approach. Today where technology permits oysters are generally produced and grown in a hatchery, but in remoter areas or where technology is too expensive or unreliable, spat (freshly settled juveniles) are collected on custom-made spat collectors made from such material as folded plastic or shade cloth or natural materials such as shells or coconut fronds (Haws, 2002).

Once the spat have grown sufficiently into juveniles they are placed in mesh pockets on ropes in the sea until they are ready to be implanted (seeded) with a pearl nucleus. This is usually made from a fresh water mussel—the horse hoof mussel from the Mississippi river in America—which has proved best suited to the purpose (pearl shell,
which is otherwise suitable, is too thin to make the size of nucleus required) (Haws, 2002). After seeding the cultivation process becomes a comparatively extensive and low technology one—apart from being constrained in net pockets hung from ropes and perhaps the occasional x-ray, the only intervention in an adult oyster’s life after being seeded is being subjected to a regular cleaning regime (Haws, 2002).

Pearl seeding is a specialised trade carried out by highly skilled technicians that are normally contracted to a farm for that specific purpose. Until quite recently the art of seeding pearls was a tightly held and jealously guarded secret of Japanese pearlers who hired themselves out around the world at very high fees. The secret leaked, however, and today pearl seeding technicians are as often home grown as visiting Japanese.

At about two years of age (120 – 150mm) the oyster is usually ready to be seeded with its first pearl (Haws, 2002). At this age the oyster is still growing rapidly and therefore will produce nacre more quickly than an older animal. The oyster is clamped in a horizontal position and its shell held open with a wooden wedge—wood because it is soft enough not to damage the shell. With the shell held open the oyster’s ‘foot’ is located, a small incision made in the foot’s base and, avoiding the internal organs, a tunnel is opened through the oyster’s tissues to reach the bundle of connective and gonadal tissue.

An incision is made in the tissue bundle and a piece of nacre-producing epithelium (mantle) from a donor oyster is inserted, followed by a smooth, round pearl nucleus and finally another piece of donor-mantle. Nucleus sizes range from 7mm, usually used for first time seeding, up to 14mm for older animals (Haws, 2002). Once the nucleus and pieces of mantle have been properly inserted and the incision closed the oyster, if it has not expelled the nucleus, begins to produce a pearl. The outer epithelial cells of the donor-mantle tissue obtain nutrients from the host oyster, multiply and rearrange themselves over the nucleus to form a ‘pearl-sac’ and resume nacre secretion; while the inner donor-epithelium and mantle connective tissue are absorbed by the host oyster’s surrounding tissue. The grafted mantle tissue coats the nucleus in concentric micro-layers of nacre, a process that will continue until either the oyster dies or the pearl is removed (FAO, 1991).

The gonadal tissue is the preferred site to form the pearl sac as the oyster is less able to expel the nucleus from it, the nucleus is less likely to inhibit the oyster and the pearl’s formation will not be impeded by the action of the adductor muscle, which can
cause the pearl to grow malformed. Once the nucleus is in place the sac is closed, sometimes using a dab of superglue, and the oyster set aside for forty days for monitoring and recovery (Haws, 2002). A proportion of oysters expel the nucleus, but in most such cases the donor tissue remains and often forms a ‘baroque’ (irregularly shaped) pearl without a nucleus, known as a ‘keshi’. These oysters are set aside for two years or more and can produce large, attractive and quite valuable ‘natural’ pearls.

After the recovery period the oysters are returned to the sea (in mesh pockets hung on ropes or suspended on thin ropes tied into holes drilled through the shell hinge) to look after themselves. In more technologically advanced operations pearl formation is monitored by randomly x-raying seeded oysters.

After 12 – 24 months the oysters are collected, tranquillised, opened and the pearl extracted. If the oyster is healthy and the pearl well formed—if the first pearl is malformed subsequent ones are also likely to be—another, larger nucleus is inserted into the pearl sac (Haws, 2002). Each oyster may produce three or more round pearls in its lifetime depending on growing conditions and the required thickness of nacre. If the oyster produces a poorly shaped pearl or has already produced three or four pearls, hollow plastic hemispheres are glued to the inside of the shell to produce half round pearls (mabes). The oyster is killed to harvest mabes.

A pearl produced by seeding with a nucleus normally has time to form only a few millimetres thickness of nacre at the most (in some cases only 1mm) before it is harvested, whereas natural pearls are produced over many years and are, like keshis, virtually all nacre.

In short, modern round pearl cultivation techniques are based on artificially creating a nacre-producing sinus (the ‘pearl sac’) inside the body tissue of the oyster and placing a large, round shell nucleus inside it to be coated with nacre and (hopefully) produce a perfectly round pearl. This technique has only come about through long study of pearls and experimenting with artificial production.

Both the Persians (and Arabs) and Chinese were experimenting with cultivating pearls nearly two millennia ago. Both of these people had long-standing contacts with the Malukun Islands through the spice trade and therefore could have been in a position to transfer their knowledge of pearls and their cultivation to the oysters of the Arafura Sea.
If this were the case it may explain the quantities of pearls that Searcy saw, but were there viable techniques to transfer?

Pearl cultivation closely mimics nature—placing an irritant between the oyster’s body and shell or inside its gills to stimulate nacre production—so before any form of artificial seeding could be developed an understanding was needed of how pearls are formed. For millennia fantastic theories abounded, probably the most widespread and persistent through the centuries was that pearls formed as the result of the oysters swallowing rain or ‘heavenly dew’ (Kunz & Stevenson, 1908; Jackson, 1917; Donkin, 1998). This theory was first recorded in the 6th C BC in the Atbarva-Veda Sambita (Donkin, 1998) and held that oysters come to the surface at night during the rainy season, open their shells to receive the rain or dew, then return to the bottom where they transform the drops of fresh water into pearls. This link between rain and pearls was summarised by a 19th C American consul to Aden who explained an unusual shortage of pearls in the Red Sea:

There is a belief among them [Arabs] that a pearl is formed by a drop of rain caught in the mouth of the pearl-oyster, which by some chemical process after a time turns into a pearl; and as there has been very little rain in that region for several years past, there are few pearls (Kunz & Stevenson, 1908, p 38).

Fantastic as it may sound, this theory has some basis in fact and, given the almost complete lack of knowledge of the microscopic natural world up until a few centuries ago, probably the only conclusion that could be drawn from the known facts.

The flaw is that oysters of any description do not swim to the surface—or anywhere else for that matter—so one must assume that the people who formulated and held the theory were either not acquainted with the actual animal or that they assumed that pearl oysters had a magical power that allowed them to defy gravity. But otherwise there could be two logical explanations for the link between rain and pearl production:

1) Research by a number of naturalists in the 18th and 19th Cs established that in many regions—notably the highly productive pearling grounds in the Middle East, India, Sri Lanka and the streams and rivers of Europe—pearl production was strongly linked to the presence of parasites, principally nematodes. When the oyster is infested with parasites its natural defence mechanism is to coat them with nacre and thus begin the process of pearl production. As Raphael Dubois said in 1901:
La plus belle perle n’est donc, en définitive, que le brillant sarcophagi d’un ver [The most beautiful pearl is only the brilliant sarcophagus of a worm] (Kunz & Stevenson, 1908, p 43).

Nutrient-rich runoff from nearby land stimulates the production of these parasites, either directly or indirectly, by increasing the number of intermediate hosts the parasites need.

2) Rainfall, or at least the runoff from it, stirs up sediment that can enter the oyster as it feeds, either as coarse particles or fine silt that becomes trapped and coalesces into small balls. These also would be irritants that would stimulate pearl production.

Another theory to explain pearl production that gained currency in the 17th C was that pearls were formed from a few of the oyster’s own eggs that were not discharged properly during spawning, instead lodging inside the animal where they were coated with nacre. This theory shows that the researchers of the time were on the right track and were beginning to consider foreign bodies as bringing about the formation of pearls, but as to whether the oyster’s own eggs would be an irritant or simply be reabsorbed is a moot point.

The true origins of marine pearl cultivation is unknown, but it probably began in some form before the 3rd C AD when it was first mentioned by a Greek writer by the name of Philostratus who repeated the following story he had heard from the Red Sea:

The most interesting feature in connection with these fisheries is the fact that the ancient inhabitants of the shores of the Red Sea were acquainted with an artificial method of producing pearls. According to the philosopher Apollonius, the inhabitants rendered the sea smooth by flooding it with oil; they then dived into the sea and halting alongside the pearl-oyster they induced it to open by holding out a case of myrrh before it as a bait. The oyster was then pierced with a long pin and the liquid which exuded from the wound was received into an iron block which was hollowed out in regular holes, where it petrified in regular shapes, just like the natural pearl (Jackson, 1917, p 73).

This story contains enough facts and coincides enough with what is known today to make it, for the most part, credible and probably have a basis in fact.

Firstly the use of oil to render the sea smooth enough to enable a diver to see the oysters from the surface. Sponge divers in the Mediterranean and the Red Sea used (and
possibly still use) olive oil to calm the water’s surface when searching for sponge (Warn, 2001). This allows the diver to see the bottom clearly (personal observation) and locate sponges before diving—it is very likely that pearl divers employed the same strategy.

Then there is the use of myrrh to induce the oyster to open its shell. Myrrh comes from trees of the *Commiphora* and *Balsomodendron* spp, native to the Red Sea region. The myrrh extracted from both the *Commiphora* and *Balsomodendron* trees have been used as medicines for millennia to cure a variety of ills, including mixed with vinegar for pain relief (Yeung, 1983). It is quite possible that this analgesic quality was employed on the oysters to relax the adductor muscle and open the shells.

Piercing the oyster with a long pin is very reminiscent of modern pearl cultivation techniques. It is unlikely that simply piercing the oyster would be enough to stimulate pearl genesis, however if the pins were actually being used to accurately insert an irritant such as a piece of grit or small clay ball (a detail either not known or deliberately missed out by the informant), the description makes perfect sense. If the irritant were being inserted and wedged deep into the gill in some way that prevented the oyster expelling it—which is very likely given that the gill occupies most of the space exposed when the shell opens—there is a good chance that it would form a pearl.

The last piece of this description—pouring the fluid into a mould—is nonsense and seems likely that Apollonius may simply have seen freshly harvested pearls placed in such a block for grading (similar blocks are used today) and filled in the missing bits himself to ‘round off’ the pearl making process for the reader. Or perhaps the story was deliberate misinformation from the pearl farmers to throw an over-inquisitive Greek off the trail of an industrial secret.

The description is logical enough to say that this technique, which is defined by the use of the gill to produce nacre to grow a pearl, was used to cultivate pearls and will in this thesis be referred to as the ‘Red Sea Method’.

After Apollonius the next method for cultivating marine pearls was described by the Swedish naturalist Linnaeus who wrote in 1748:

> At length I have ascertained the manner in which pearls originate and grow in shells; and in the course of five or six years I am able to produce, in any mother of pearl shell the size of one’s hand, a pearl as large as the seed of the common vetch [bean] (Kunz & Stevenson, 1908, p 268).
At the time Linnaeus tried to keep his discovery a commercial secret and made several attempts to market it, all to no avail, but the details of his method did not become known until 1821, well after his death. Linnaeus drilled a small hole in the mussel’s shell (he used fresh water mussels) and inserted a fine silver wire with a small limestone nucleus attached to the end into the animal, then fixed the wire in place and sealed the hole. The wire held the nucleus clear of the shell so it formed a round pearl (Kunz & Stevenson, 1908: Donkin, 1998). Linnaeus’s method was later used by Bouchon-Brandely to successfully produce pearls in Tahiti (Kunz & Stevenson, 1908).

Linnaeus’s method is an extension of a 6th or 7th C AD Chinese technique which Mr. F. Hague, an 18th C British Consul at Ningpo (Ningbo, northeast Zhejiang province), and Dr. McGowan, an American physician also resident at Ningpo investigated and recorded (Jackson, 1917).

The industry was carried on in two villages in the north part of Chihkiang (Chekiang, now Zhejiang Province) on the central coast south of Shanghai. In May or June quantities of large freshwater mussels were brought from the Tahu (Tai Hü), a lake in nearby Kiang-su (Jiangsu), and placed in bamboo cages in fresh water for a few days' recuperation before being seeded for mabe pearls (Jackson, 1917).

Seeding was done by gently prizing the shells open with a bamboo or pearl shell spatula before lifting the mantle away from the shell with a metal probe and introducing several nuclei onto each valve with a split bamboo stick. The nuclei were made of a variety of materials, the most common being beads made of shell or mud (probably baked clay) moistened with the camphor seed oil, and flat lead images (usually) of the Buddha. After seeding the mussels were placed in canals, streams or ponds at a depth of ~1 – 2m, where they were fed each month with tubs of human excreta—this stimulated the growth of microorganisms which the mussels fed on. After only 5 – 6 months the mussels were harvested, killed and the mabe pearls separated from the shells. The mud or lead nuclei were removed from inside the half pearls and replaced with resin or wax, which was then covered with a piece of shell (Kunz & Stevenson, 1908; Jackson, 1917). Apart from the material used as a nucleus, this method is virtually identical to the modern way a mabe is created.

Both Linnaeus and the Chinese used nacre produced by the mantle to coat a nucleus attached to the inside of the shell—so it seems to be a technical evolution. The
Chinese may also have been making full rounds in marine species—in 1855 Mary Roberts wrote in her book ‘Popular History of the Mollusca’ that:

...in the possession of Sir Joseph Banks were several Chinese Chamae [Chamae spp – oysters] in the shells of which were contained bits of iron wire, covered with a substance of a pearly nature. These wires had evidently once been sharp, and it seemed as if the mollusks, anxious to secure themselves against the intrusion of such unwelcome visitors, had encrusted, and thus rendered blunt the points with which they came in contact (Jackson, 1917, p 105).

She was astute enough to note the similarity between these bits of ‘evidently once been sharp’ wire and Apollonius’ description of pearl cultivation back in the 3rd C that ‘the oyster was then pierced with a long pin’, and suggests that they may have been ‘bits of wire that had slipped from the hands of Chinese workmen’.

Possibly the workmen had been seeding pearls by ‘piercing’ them (introducing an irritant nucleus) after the Red Sea method, but the mention of several shells containing ‘bits of wire’ argues against this. If she had said that there were one or two shells containing wire it would be reasonable to assume that they may have been lost by the workmen, but several shells suggests a degree of carelessness not normally associated with such a valuable and exacting industry.

The description does not say if the bits of wire were attached to the inside of the shells or were inserted through them, but it seems more likely that the wires were left after pearls, grown using the Linnaeus method, had been cut free. Linnaeus was only a few years before Banks so if Banks’ oysters had been used to grow pearls with Linnaeus’ method it would mean that either his method was very quickly taken up and used on marine oysters or was already in use when he invented it.

The technical evolution in pearl cultivation picked up speed when the Chinese method of cultivating fresh water pearls by inserting mabe nuclei became known and spawned copycat industries in Japan, Europe and America (Kunz & Stevenson, 1908). In Japan Kokichi Mikimoto utilised the method in marine *akoya* pearl oysters at Ago Bay, where he developed a very large operation. By the 1890s he was using an extensive integrated aquaculture system to produce between 30,000 and 50,000 pearls annually (Kunz & Stevenson, 1908). He placed rocks on shoals to collect oyster spat in the spring and in autumn moved the rocks, with oysters attached, to depths >2m where the oysters
were left to grow for three years. They were then brought to shore, seeded and returned to deep water to develop their pearls.

At first Mikimoto only produced mabes, then full rounds (possibly using the Linnaeus method) and eventually progressed to seeding nuclei free of the shell and developing the foundation of the modern pearl cultivation industry.

While these developments all occurred in the north, it seems that pearls were also being produced in the south of China at an early date. When discussing Hague, Jackson said that:

There is a note that at the commencement of the seventh century, pearls were made of a composition or medicine. The art may have been lost, or it may be the same as that now employed at, and which originated at, Canton [Guangzhou] (Jackson, 1917, p 104)

Whether this refers to fresh water or marine, half or full round pearls—or what is meant by a ‘composition or medicine’—is unknown, but Guangzhou, while a long way from Zhejiang Province, is not far from the pearl ponds of Ho-p’u.

Ho-p’u was clearly a very productive pearling ground, possibly more productive than could naturally occur. Also the fact that the Tan fishermen could confidently drop a diver on a weighted rope to collect a basketful of oysters before needing to come up for air suggests an unnaturally high concentration. Uncommon concentrations of pearl-bearing oysters may be explained by high levels of nutrients and irritant-sized particles from the Ho River, but the fishery also seems to have been remarkably resilient to heavy fishing over a very long time, especially considering that if only one in 2000 (or even one in 200) contained a pearl (Haws, 2002), a very large number of oysters would have had to be harvested.

Ho-p’u had its hey-day in the 7th C, just when the Hu (Arab or Persian traders) were first mentioned as visiting China (Gungwu, 2003). The Hu were allowed to establish at Guangzhou and appear to have continued trading there up to (and during) the closed seas in the Ming period (Keay, 2005; Hall, 2006). Tan sea-farers would have had contact with those traders—they may even have crewed on their dhows and traveled to the Middle East—which means that it is just as likely that they had access to knowledge of Red Sea pearl cultivating methods as to the Chinese method.
Although highly speculative, it seems likely that the Tan were seeding oysters and growing pearls using the Red Sea method (and similar to early modern pearl farming practice). If this was the case, then Jackson was talking about a completely different pearl-cultivating industry in the south to that being conducted in the north—one that had been imported from the Middle East (or vice versa) by the foreign traders.

Summary

Based on available evidence it is apparent that pearl cultivation developed independently in the Middle East and China at roughly the same time, each utilising a different nacre-producing organ in the oyster—the mantle in China and the gill in the Red Sea—and different techniques that produced mabes in China and full rounds in the Red Sea.

The Chinese technique evolved over time, from nuclei glued to the shell to rounds suspended above the shell to finally using transplanted mantle tissue to produce unattached rounds, and ultimately became the widespread and valuable modern pearl farming industry.

Meanwhile, the Red Sea technique has not actually been recorded again since Philostratus in the 3rd C—except for the Yolgnu method, which clearly follows the Red Sea model by using the gill to produce the nacre. There are comparatively minor variations such as the lack of an anaesthetic (using myrrh to induce the oyster to open its shell) and dropping the irritant into the gill instead of inserting it. These variations can be simply explained by the Yolgnu’s lack of access to either myrrh or ‘slender metal probes or pins’ to introduce the irritant (although they would have had substitutes available), but instead used their own ingenuity to develop their own method. But could the technique have been imported to Arnhem Land, or was it a case of parallel development?

If—and it is a big if—the Tan were cultivating pearls after the Red Sea method it would be likely that they took their expertise with them when (if) they travelled with Ch’eng Ho in the 15th C. Or perhaps early traders from the Middle East brought the knowledge to the Malukas. There is no extant account, written or oral, of pearl cultivation in the Malukun Islands, but this is not surprising given their history of intervention and upheaval—the Yolgnu themselves have almost lost the knowledge and they appear to have been able to retain a great deal more traditional knowledge than most other people in
the region. It was pure serendipity that the Yolgnu method was recorded and it may very well be that there are remote villages in the Malukas that have a similar knowledge. Dunatunga is one of the very few Yolgnu men remaining that know the technique (even his son had never heard of it), and it is possible that with the passing of his generation the knowledge, and possibly the last use of the two thousand year-old Red Sea cultivation method, will be lost.

I postulate that the Yolgnu method is an extension of the Red Sea method, which was taken first to south China, then brought to the Malukas with Ch’eng Ho’s 15th C fleet and on to Arnhem Land by someone, possibly the Bayini, eager to fill the Chinese demand for ‘useful and valuable items’.

If they had found and exploited minerals and trepang in east Arnhem Land, the settlers are unlikely to have missed the extensive beds of Silver Lipped pearl oysters and the opportunity they presented. After the departure of these settlers the Yolgnu found a new market with the arrival of the Makassan fishermen, but when they departed and the British disrupted their trade (and society) pearl cultivation was discontinued.

The question remains, however—could the Warruwi pond have been associated with pearl production? The answer is yes, it could have held oysters waiting to be seeded, or recovering from being seeded, or set out to develop pearls. But pearl cultivation appears to have been an east Arnhem Land activity, although at that time people who knew how to cultivate pearls may have occupied the Goulburn Islands. There is also the question of why—oysters and clams do not escape, so there is no need to build such an elaborate structure to hold them. If the pond was meant to define ownership a simple stone border, similar as that found in Torres Strait clam gardens, would suffice, provided the site was not subject to strong currents that could displace the markers or stock.

It seems likely that, while the Warruwi pond could have been a part of the pearl production process, it would have been unnecessary and therefore unlikely.
Chapter 8

The case for pre-European and pre-Makassan introduction of aquaculture into Arnhem Land

This project began with two principle aims:

1. Determine the origins and uses of a stone pond-like structure near Warruwi, South Goulburn Island, west Arnhem Land, Northern Territory, Australia
2. Describe the methods and origins of traditional Yolgnu pearl cultivation in north east Arnhem Land

Once the first aim of identifying the probable use for the Warruwi pond and why it was built was achieved, the problems posed for the two aims became similar—who had the technology and the opportunity to build the pond and cultivate the pearls, and were the two linked? Was the technology Indigenous or introduced, and, if the latter, who introduced it.

The Warruwi pond

From a research point of view the remoteness of the Warruwi pond turned out to be a blessing because it both ensured the preservation of the structure from disturbance and (at least at first) seemed to limit the number of potential candidates for building and using it. But it was soon recognised that, while Arnhem Land is remote today, historically it was a veritable hive of activity and international connection (Coutts, 1979; Lape, 2000; Allen & O’Connell, 2008). Over the past two or three centuries fishing and trading boats from the city of Makassar in Sulawesi frequented the coast, including the Goulburn Islands, in large numbers to harvest sea cucumbers and process them into trepang. They traded with coastal Aboriginal clans for commodities such as turtle shell and pearls. Their camps were centres of activity where local Aborigines were employed, selling their labour in exchange for goods such as iron tools, rice, tobacco and alcohol.

But the Indigenous people didn’t just work in the camps; both men and women took ship with the Makassans and through their experiences with them at home and abroad gained a degree of familiarity and worldly sophistication well beyond anything available to their south cousins (Harney, 1946; Lamilami, 1974; Macknight, 1969, 1976;
European and Japanese trepang fishermen and pearlers, all of whom established camps of one sort or another on the Arnhem Land coast, followed in the wake of the Makassans and, like them, all employed coastal Aborigines.

No visitors, however, have been recorded as using either the Warruwi pond or any similar structures on the Arnhem Land coast so there was no direct connection with any of them until, by serendipitous coincidence, the Wessel Island structure and the stone arrangement in a gallery at Dalywoi Bay (see Chapter 7) provided a direct association with Indonesia. A comparison of the stone arrangement with both the Warruwi pond and the Wessel Island structure (Fig 8.1) show that the three are very similar.

Figure 8.1  Comparisons between the Wessel Island fish trap structure (centre), the Warruwi pond structure (right) and the Wurrawurrawol depiction (left)

The similarity is even more striking when a close examination of the satellite image of the Wessel Island structure (Fig 8.2) shows a faint line that traces the remains of a continuation of the wall onto the intertidal beach to the west. This line is faint and without ground-truthing is open to interpretation (it may be a natural feature), but no similar lines are seen on adjacent beaches.
The only significant difference between the Warruwi pond and the Wessel structure lies in a gap in the Wessel structure’s north wall and a short length of wall set at an angle in the right side of the gap. This gap serves as an entrance for fish and is evidence that it was used as a fish trap, but the possible extension of the wall onto the beach and the extension of the wall across the high reef outcrop to seaward would appear an unnecessary waste of effort for a fish trap and argue against it being originally built as such. Rather, I would conclude, it was built as an enclosed structure very similar to the Warruwi pond.

The gap was likely created by someone (possibly by Djul-djul) removing stones to turn it into a functional fish trap and the feature, so accurately depicted in the Wurrwurrrawol gallery, was either made after the structure was altered or the depiction itself was altered to reflect the change. The Wessel Island structure (and by extension, the Warruwi pond) is linked to the Indonesian trepang trade by its grouping with the other material depicted in the gallery—all of which appear to represent practical Indonesian
articles. These depictions were probably all made by someone recording what they had seen while working with Indonesians or crewing on an Indonesian prau.

But the gallery only links the ponds to east Indonesia in general, not to any specific region or people. There is little evidence in Arnhem Land to help narrow the field. The presence of successive waves of fishermen often had a negative impact on the physical evidence of earlier activity in Arnhem Land because each new wave often reused camp sites—Japanese occupied old Makassan camps, Europeans occupied both Japanese and Makassan sites and, if Macknight’s assertion that he accidentally sampled charcoal from old Aboriginal cooking fires when he collected evidence from Makassan stone lines is correct (Macknight, 1976; see also Chapter 2, pp. 87 – 90), Makassans also occupied old Aboriginal camp sites. Each fresh occupation added both an occupation layer and compromised the older archaeology. Nevertheless, the Makassans are considered to be the oldest trepang fishers and trepang-processing sites are assumed to be Makassan relics unless they are known to have been used by subsequent trepang fishermen.

Macknight’s charcoal samples, however, open the possibility that this may not always be the case and that there is really no way of being certain if a camp was established by a Makassan crew, or if it was an older one (Aboriginal or other) which the Makassans later utilised and added to with their stone line fire places.

Unlike processing sites, the Warruwi pond is very unlikely to have been altered since it was built (although it may possibly have been reused). This means that the pond is one of the few non-Indigenous artefacts in Arnhem Land that can be said to be uncompromised, and as such it is in a unique position to enable identification of early foreign activity by making physical comparisons with other structures in the area and extrapolating their use and origins back to the Warruwi pond.

**Ponds in the region**

Stone ponds were found in southeast Maluku and south Sulawesi. The known ponds in Sulawesi are all modern, but those in east Maluku appear to vary considerably in age, ranging from the Alma Kota one which was built within the past ten years (Yunus Batkor and Domiggus Buktor Ubawa, and K.P. Impoawa, 2012) to some of those reported from Seram Laut that were described as family heirlooms handed down through the generations (Ellen, 2003).
Today both Maluku and Sulawesi pond structures are used to store live sea cucumbers prior to processing into trepang, a practice that probably has its origins in antiquity as demonstrated by the Selmona pond. This pond is old enough that no one remembers its original use (Maulipuri, Per Com, 2010), however there is currently a modern mesh enclosure built inside it to hold trepang. The mesh enclosure could have been placed anywhere in the intertidal zone (and probably in a more convenient location), so the fact that the fishermen chose to place it inside the stone pond may have been influenced by stories or memories that this was its original function.

The construction and use of ponds is, therefore, an ongoing tradition that may have considerable antiquity, but whether they date from a few hundred years or a few thousand cannot be said.

There is some evidence that historically ponds were not simply used for storage. In Seira, a village off southwest Tanimbar where trepang has traditionally held considerable economic importance, *tambak batu* (stone ponds) are said to have been used in the past but there are no surviving examples. The villagers of Seira however, maintain that the ponds were used for *sasi teripang* (Osseweijer, 2000). Sasi is a traditional Malukun conservation practice that is applied to most commercial species, both marine and terrestrial. In most cases this involves closed seasons or placing periodic harvesting prohibitions or limits on harvesting or fishing effort (Zerner, 1994; Antunes, 2005). *Sasi teripang* is unique in placing sea cucumbers in enclosures and probably derives from the old practice of accumulating catches of mature animals in enclosures by small-scale fishers (Ellen, 2003).

Placing mature adult sea cucumbers in high concentrations will enhance spawning success (Shokita et al, 1991; Ellis, 1998; Purcell & Lee, 2001; Counihan, 2001; Setyono, 2004; FAO, 2004) and, if they are placed near a suitable larval nursery ground, this will increase local recruitment. Yolgnu Elders put this principal of spawning enhancement very succinctly:

Collect big clams and oysters [or sea cucumbers], put them together in a pond and pretty soon there are lots of little ones around.

If the Yolgnu knew this it is probable that fishers from east Indonesia also knew it and used that knowledge to develop *sasi teripang*. It may have even developed as shared knowledge, which would account for similarities between southeast Malukun and Yolgnu
marine management that included declaring open and closed seasons, maintaining ritual
song cycles and ceremonies to propitiating ancestors and guardian spirits. In both cultures
neglecting these responsibilities leaves the guardian open to accusations of neglect and
subject to punishment (Davis, 1988; Zerner, 1994; Ellen et al, 2000; Henley &
Ossweijer, 2005; Antunes, 2005). Thus, the Warruwi pond’s use was very likely both the
storage and enhanced spawning of sea cucumbers (*sasi teripang*).

The style, distribution and use of the ponds lead to the conclusion that the
Warruwi pond was built and used by fishers from southeast Maluku rather than from
Makassar: There are two reasons for reaching this conclusion:

1) Pond-like structures identified in Sulawesi do not match the Warruwi pond
in either location within the tidal range or in construction (Fig 8.3), but ponds found or
reported (Ossweijer, 2000; Ellen, 2003) from southeast Maluku are very similar in the
important features of location within the tidal zone and construction, varying from the
Warruwi pond only in shape and size.

![Figure 8.3](image)

*Figure 8.3*  Comparison between Sulawesi enclosures and Maluku/Warruwi ponds.

(A) The fully enclosed Warruwi pond located low in the intertidal zone
and (B) Sulawesi enclosure using the beach as a fourth side
The two pond styles appear to occupy distinct geographic regions (Fig 8.4) and the fully enclosed style as represented by the Warruwi structure is discrete to the Arafura Sea region.

Figure 8.4 Identified ponds in east Indonesia and Arnhem Land (Map by ANU CartoGIS CAP)

2) Neither sasi nor any other conservation practices have ever been associated with Makassan fishing—indeed the structure of Makassan fleets and crews, together with their fishing methods virtually precluded conservation (see Chapter 5, pp. 188-191). The Makassans operated on a business footing that used large numbers of people employed across the region on a new credit – debt system to crew large purpose-built prau (Earl, 1837; Meereboer, 1998; Sutherland, 2000; Schwerdtner et al, 2010). The whole operation was designed to harvest as many sea cucumbers and process as much trepang as possible in the limited amount of time they had available. Little or no attention was given to conserving local product.

This level of fishing effort meant that catches were large and the fleet organisation included the capacity to process sea cucumbers as soon as they were brought in so they
had no need for storing their catches live. Recorded observations at the time confirm that the Makassans processed their catches immediately (Whittington, 1905; Searcy, 1907, 1912; Lamilami, 1974). If, for any reason, they needed to store a small catch over a short time they would hardly need a sophisticated purpose-built structure when a natural rock pool, or even an open stretch of sea grass, would serve just as well for short-term storage—sea cucumbers do not move very far or fast (personal observation).

The Makassans fished the Arnhem Land coast in large fleets that would have left little room for competition, at least during the monsoon season. Independent prau were known to visit the coast from time to time, but it is uncertain if they were after trepang or were looking for other products. At this time the Makassans were so dominant (Earl, 1837; Andaya, 1981; Osseweijer, 2000; Sutherland, 2000; Ellen, 2003; Schwerdtner et al, 2010; De Jong, 2012, see also Chapter 5, pp. 188-191) that it is unlikely that any independent trepang fishers would have been willing to invest the time and energy in conserving sea cucumbers when it was likely that the Makassans would be the only beneficiaries.

Ruling the Makassans out as the pond builders places Warruwi pond’s construction before the mid-18th C (when the Makassan fleets first began to fish off Arnhem Land) and possibly as early as the 16th C. There are few early references to the trepang trade in the area, however a report by the Dutch navigator Pieter Pietersen in 1636 noted that the trepang fishery in the Aru Islands was ‘merely existing’ (see Chapter 6) indicates that the industry existed at that time and, although in serious decline, was being conducted by Malukun fishers. Reference by Kolff to ‘when the people of Banda had the (trepang) trade exclusively in their hands’ points very strongly to the Malukun fishers using that great international trade emporium to sell their trepang (and probably other products) (Kolff, 1840, p 175).

This being the case, the trepang trade probably became virtually non-existent in the period between the Dutch destruction of at Banda in 1621 (see Chapter 4, pp. 161 – 163) and the rise of Makassar the 17th C.

The Warruwi pond’s purpose was the harvesting of trepang, so it is unlikely that it would have been built when the trade was severely depressed, especially as Warruwi was a considerable distance from the fisher’s villages and, if markets were down, the home
stocks would have increased making the long journey been unnecessary. On this logic it is likely, therefore, that the pond was built before 1621.

How long before is more difficult to estimate and depends largely on the history of trepang consumption and trade routes—the trade could not have existed without a market or a means to get the trepang to it. The earliest known recorded reference to trepang was in a 4th or 5th C Chinese work about food. (Gungwu, in Macknight, 1976, see Chapter 5, pp. 182 – 185), so conceivably this could be the earliest date for the trade, however an increase in Chinese pottery and coins in Banda’s archaeological record after the 13th C suggests that the trade links between Banda and south China had evolved sufficiently to allow a major trepang trade (Lape, 2000, see Chapter 4, p 139). Assuming that the fishery must have taken time to grow large enough to make the hazardous journey to distant Arnhem Land viable, in this scenario the Warruwi pond’s earliest date would have been about the 15th C.

To suggest that trepang were being harvested in Arnhem Land at this early period is speculation, but there is evidence for foreign activity on the west Arnhem Land coast within a one hundred km radius of the Goulburn Islands before or during the early 17th C, (Fig 8.5). This evidence comprises:

- A rock painting depicting a prau (by its design, probably from Indonesia) dated to between 1517 – 1664 (Tacon et al, 2010)
- A piece of coarse stoneware that is provisionally dated to the 15th or 16th C (Bulbeck & Rowley, 2001)
- Three separate samples of charcoal taken from Makassan stone lines (fire-places) that have been carbon-dated to between 1280 – 1615, 1160 – 1390 and 1004 – 1280 (Macknight, 1976)
- A small segment of a west Arnhem Land story describing the arrival of Waramurunggoindju and her husband Wiraggag, a wife and husband who came from Indonesia some time in the distant past (Foelsche, 1882; Elkin in Berndt, 1954; Swain, 1993)
With the exception of the depiction of a prau, the provenance and antiquity of all these points is open to dispute, possibly the most contentious being the early dates Macknight (1976) obtained from his charcoal samples in Makassan stone lines. Macknight (Per Com, 2013) suggested that these dates resulted from the remains of old Aboriginal cooking fires that became mixed with charcoal from fires burnt in Makassan stone lines. That this may have occurred at one, or even two sites is feasible, but at four sites (there were another two similarly aberrant dates from Groote Eylandt) is less so. More likely is that Makassans found old abandoned trepang fire-places and renovated, expanded and reused them—in the same way that Europeans and Japanese later reused Makassan stone-lines (such as McPherson reusing an old Makassan camp at McPherson Point)—and that the charcoal dates are an accurate record of pre-Makassan trepang fishing.

Taken together these fragments of evidence represent a significant body of evidence to support the hypothesis that Indonesians were active on the west Arnhem Land coast, the charcoal samples suggest that they were harvesting and processing trepang. Based on similarities between stone ponds in the region they were likely have been from
south east Maluku, and were probably selling their product either directly or indirectly through Banda (Schwerdtner, 2010).

**Determining the probable builders of the Warruwi pond using Bayes’ Theorem of Probability**

With the available evidence it is possible, although very tenuous, to determine the most likely builders of the Warruwi pond by using Bayes’ Theorem of Conditional Probability

\[
P(B/A) = \frac{P(A) \times P(B/A)}{P(A) \times P(B/A) + P(A1) \times P(B/A1)}
\]

To apply Bayes’ Theorem four assumptions are needed:

1. Aboriginals did not build the Warruwi pond, therefore it was built by foreign visitors to the Arnhem Land shore. Although Aboriginals have an undeniable constant presence in Arnhem Land the structure of the pond, together with the lack of any known comparable Aboriginal structures on the coast and the denial of ownership by local Traditional Owners allow this assumption.

2. The pond was built some time in the Millennium before the clam shells were deposited in the pond (c. 1920).

3. Maluku fishers were visiting the Arnhem Land coast before or concurrently with Makassans.

4. There are three candidates for building the pond—Makassans, Europeans or others (Islanders, Chinese) and Malukus.

Each of these groups (Makassans, Europeans or others and Malukus) is assigned two values—Prior and Posterior Probabilities—as required by Bayes’ Theorem. The Prior Probability is a measure of each group’s opportunity to build the Warruwi pond. The Prior Probabilities were obtained by estimating the percentage of the total number of foreign visits to the Arnhem Land coast that can be attributed to each:

- **Makassans:** 70% (.7)
- **Malukus:** 15% (.15)
- **Europeans and other:** 15% (.15)
The Posterior Probability is a measure of each group’s knowledge of, and capability to, build the Warruwi pond. To assess these I have allocated one point for each of the known intertidal structures in each area (Makassar/Sulawesi, Molluku and north Australia) that can be reasonably attributed to one of the groups—this is a measure of each group’s ability to build the pond rather than comparing like structures. I then allocated further points to each of the structures if they resemble the Warruwi structure in that they are pre-modern (built before the local people can remember) and fully enclosed. Two points were then added for probable identifications of further ponds from satellite imagery, accounts of pond like structures in the region by other researchers and local knowledge of old (pre ~ 1920) ponds. The scores were then added and the percentage of total points for each group was used to estimate their ability or propensity to build the Warruwi pond.

Two structures were identified in reasonably close proximity to Makassar that can be reasonably attributed to Makassan builders, both are of comparatively recent construction and neither is enclosed. No similar structures were seen on satellite photography and accounts of old structures in the area were absent.

Similarly there were two structures positively identified in two distinctly separate locations in the Maluku Islands, one old and one modern and both enclosed. In addition, a number of submerged potential pond structures were identified on satellite photos. Pond like stone structures (lutur or tambak batu) were recorded in the region (Ellen, 2003) and villagers on Tanimbar were aware of ponds historical use.

Assessing the European / other’s pond building capacity is more problematic. There are two incidences of building very broadly similar structures (semi-circular stone fish traps) in Arnhem Land but there was no apparent tradition of pond building, however Torres Strait Islanders on Warruwi may have had knowledge of similar structures from their home islands.
<table>
<thead>
<tr>
<th></th>
<th>Makassan</th>
<th>Maluku</th>
<th>European/other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number known structures</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Fully enclosed</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Old</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Satellite identifications</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Accounts of structures</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Local knowledge</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>2 (16%)</td>
<td>11 (91%)</td>
<td>3 (25%)</td>
</tr>
</tbody>
</table>

For Bayes' Theorem I used the following:

<table>
<thead>
<tr>
<th>Prior Possibility (A)</th>
<th>Posterior Possibility (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Makassan (P/Ma)</td>
<td>.7</td>
</tr>
<tr>
<td>Maluku (P/Mo)</td>
<td>.15</td>
</tr>
<tr>
<td>European (P/E)</td>
<td>.15</td>
</tr>
<tr>
<td>Ma + Mo (P/E1)</td>
<td>.85</td>
</tr>
<tr>
<td>Ma + E (P/Mo1)</td>
<td>.85</td>
</tr>
<tr>
<td>Mo + E (P/Ma1)</td>
<td>.3</td>
</tr>
</tbody>
</table>

The theorem for the probability that Makassans built the pond then becomes

\[
P(B/A) = \frac{P(A/Ma) \times P(B/Ma)}{[P(A/Ma) \times P(B/Ma)] + [P(A/Ma1) \times P(B/Ma1)]}
\]

\[
P(B/A) = \frac{.7 \times .16}{[.7 \times .16] + [.3 \times 1.16]} = \frac{.112}{.46} = .2434
\]

Probability Makassan = 24%
The probability that **Malukus** built the pond becomes

\[
P(B/A) = \frac{P(A/Mo) \times P(B/Mo)}{P(A/Mo) \times P(B/Mo) + [P(A/Mo1) \times P(B/Mo1)]}
\]

\[
P(B/A) = \frac{.15 \times .91}{.15 \times .91 + [85 \times .41]} = \frac{.1365}{.485} = .28144
\]

**Probability Malukun** = 28%

The probability that **Europeans or others** built the pond becomes

\[
P(B/A) = \frac{P(A/E) \times P(B/E)}{P(A/E) \times P(B/E) + [P(A/E1) \times P(B/E1)]}
\]

\[
P(B/A) = \frac{.15 \times .25}{.15 \times .25 + [85 \times 1.07]} = \frac{.0375}{.947} = .0395
\]

**Probability European or other** = 4%

**Conclusion**

With the available evidence Bayes' Theorem of Conditional Probability determines that there is a 28% probability that the most likely builders of the Warruwi pond were Malukun.

**Pearl cultivation and other activities in north east Arnhem Land**

A similar body of evidence in support of early, non-Makassan activity presents itself in east Arnhem Land. Chief amongst this is the Yolgnu’s tradition of pearl cultivation. It is very unlikely that Makassan fishermen introduced pearl cultivation—they traded for considerable quantities of pearls, but there is no suggestion that they ever cultivated them—so someone else must have introduced it. The other evidence strongly hints at more sophisticated travellers, this evidence consists of:

1. Five 14\textsuperscript{th} – 15\textsuperscript{th} C Kilwa Sultanate (Africa) coins found in the Wessel Islands and sherds of Wanli china from Wincelsea Island off Groote Eylandt (Bulbeck & Rowley, 2001)

2. Mining from Melville Bay (Macknight, 1976; Searcy, 1907) and the nearby areas (Earl, 1841 in Cameron, 1999)

The Wanli china was unlikely to have been in the possession of fishermen. The identification of the ceramics as Wanli is disputed by Macknight (Per Com, 2013), who asserts that they may be a more common Ceramic from a later date, but the fact remains that they were fine Ceramic-ware that would seem to be out of place on a crowded, working fishing prau, Makassan or otherwise. Similarly, despite being found in association with an 18th C Makassan shipwreck, it is unlikely that the Kilwa coins were brought from Makassar by fishermen because they would be worthless in Australia to a Makassan fisherman, even a captain. Their only purpose would be trade and the Yolgnu had no use for such things. Based on this logic, I suggest that the coins had been taken to Australia by someone other than a fisherman—possibly a merchant—to be used in trade with another foreigner.

It isn’t disputed that mining was occurring during the Makassan era but, like African coins and fine china, mining is not normally associated with fishermen. It is quite possible that someone travelling with the Makassan fleet had ventured inland, discovered minerals and initiated mining. But that man would have to have been very knowledgeable in geology as there were at least three different minerals being mined, so if he did come with the Makassans he was probably sent with the fleet by the merchant-owner specifically to prospect. Had this been the case we would expect to find some records of minerals from Australia passing through Makassar, but there are none known—Makassans were recorded as carrying trepang, timber, turtle shell, bezoars, pearls and pearl shell, but not minerals.

Yolgnu stories relate that there was another group of pre-Makassan foreigners, the *Bayini*, who established a settlement in north east Arnhem Land complete with women and children, stone house and gardens. They were not simple fishers and it was these who probably initiated mining and pearl farming, but in the absence of more evidence determining who they were and when they were active can only be guessed at. Neither the Dutch nor Makassans archival records make mention of any settlement in Arnhem Land, so if there were maritime visitors from the north they must have arrived before the 17th C, which would strongly link them to Banda as the outlet for their produce. The sophistication of Banda and the skills it had available through its trade links would have
provided both the means and the incentive to establish presence in resource rich Arnhem Land under the protection of a militarily strong Ternate Sultanate between the 15th and 17th C.

From the little that is known of the region’s early history it appears that prior to the 17th C it was divided between the rival Kingdoms of Ternate and Tidore and, despite their ongoing enmity, comparatively stable. But with the coming of Europeans Makassar was able to usurp most of Ternate’s and some of Tidore’s territories (Fig 8.6), destabilised Malukun trade and forced Maluku, especially Banda, from a position of prominence into exploited subservience (Ellen, 2003; Ganter, 2006). Like the trepang fishers, this upheaval would have made life very hard for any Arnhem Land settlers and without a secure market—and possibly a home base—it would have been difficult and unprofitable to live and work in such a remote and possibly hostile environment as Arnhem Land, even with the acquiescence of the local people (Ellen, 2003; Keay, 2005).

Figure 8.6 Territories claimed by Makassar, Tidore and Ternate (Map by ANU CartoGIS CAP)
As to who taught Yolgnu their pearl cultivation techniques, the most likely candidates are either the Chinese or Arabs. The northern Chinese certainly had the knowledge to cultivate fresh water pearls and there had been a thriving marine pearl industry in the south of China for centuries and it is probable that the southern Chinese also knew how to cultivate them.

The Yolgnu method follows an ancient Middle East technique that could easily have been introduced into the Hainan region of southern China by Arab traders and then passed on to Yolgnu by Chinese (or Arab) experts, possibly among the Bayini settlers.

Evidence for a Bayini settlement in Arnhem Land lies solely with Yolgnu oral history (Chapter 5), (Foelsche, 1882; Berndt, 1951; Dept Aboriginal Affairs, 1975; Macknight, 1976; Berndt & Berndt, 1952, 1988; McIntosh, 1995; McMillan, 2001; Isaacs, 2005), but taken together with the Wanli China, the Kilwa coins, and the introduction of pearl cultivation this history provides reasonable grounds to speculate that such a settlement existed.

For their part the Yolgnu travelled to Banda and beyond where they watched and learned. Their stories tell how they discarded most of what they learned as being of little use in their culture, but retained and adapted pearl cultivation because of its trade advantages. Yolgnu history also tells of the end of the Bayini settlement:

… eventually the Bayini looked up, saw a fire in their home over the water and sailed away (Isaacs, 2005).

This could easily have been the Yolgnu’s interpretation of the destruction of Banda, destruction that would have seen the loss of the logistical support and trade base necessary to maintaining a settlement in remote Arnhem Land and resulted in its abandonment.

**Antiquity of contact**

There is one feature (or rather several features) that has not been discussed here—the apparently sunken square structures seen off the Aru Islands and in Blue Mud Bay in Arnhem Land (Fig 8.7). These features are well defined but exactly what they are and what their origins may be is purely guess-work, although it may be speculated that they are early versions of trepang ponds.
These features are of particular interest for two reasons:

- They imply very early, deliberate contact between Maluku and east Arnhem Land
- Their implications for our understanding of sea level stability in the region. They may support suggestions that Arafura Sea levels (including the Gulf of Carpentaria) continue to fluctuate as hydro-isostatic deformation causes land in the east to sink and in the west, including parts of north Australia, to rise (Woodroffe et al, 1992; Harsana, Per Com. 2012). If this is the case, it may mean that some of the Gulf of Carpentaria has been exposed much more recently than previously thought, which in turn has implications for our current understanding of the length of the communal memory of coastal clans—they may remember features previously thought submerged for at least 5,000 years (such as sacred sites, burials and fresh water springs) but which may have been exposed much more recently.

Figure 8.7 Sunken square structures in the Arafura region (photos by Google Earth)
Conclusion

This thesis started out with two stated aims:

1. Determine the origins and uses of a stone pond-like structure near Warruwi, South Goulburn Island, west Arnhem Land, Northern Territory, Australia
2. Describe the methods and origins of traditional Yolngu pearl cultivation in north east Arnhem Land.

The first aim was achieved by concluding that the Warruwi pond was built by trepang fishers from the south Maluku Islands to hold sea cucumbers until enough were accumulated to constitute a viable quantity of trepang for market. The Warruwi pond also provided ideal conditions for enhanced spawning and restocking sea cucumbers into the local area and was therefore a form of *teripang sasi*. The Warruwi pond was built before the advent of Makassan fishermen on the Arnhem Land coast in the mid 18th C, and probably before the fall of Banda in 1621.

The second aim was achieved by concluding that pearl cultivation was introduced into north east Arnhem Land by foreign technicians, Chinese or Arab probably based in Banda, sometime before the 17th C. The practice was adopted by a select group of Yolngu and continued into the early 20th C for the purpose of trade with visiting foreigners.

These activities were concurrent, but independent, and the trepang fishers predated the pearl cultivators, but as both products were marketed through the international emporium at Banda the two were probably acquainted. A possible time line for foreign involvement in Arnhem Land is posited in Fig 8.8
Figure 8.8 Possible time line of contact
Further research

1 The most obvious target for further research is to identifying and cataloguing stone ponds (lutur/tambak batu) in Maluku and north Australia.

Intertidal stone ponds are a newly identified feature in north Australia and are an indication of early foreign contact. Only a few have been identified from this thesis, and of those only one was examined in any detail. A detailed catalogue of these features will provide an insight into a hitherto unknown period of Australia’s history and a record of the extent of pre-European activity in the region. It may also provide material that will enable accurate dating for the ponds, including the Warruwi pond, and enable an accurate date for the commencement of foreign fishing in Australian waters.

Investigation of the submerged features mentioned above should be included in this research.

2 Research and document the history of pearl cultivation.

It became clear in the course of this study that pearl cultivation, in one form or another, has a very long history, but for the most part all that is known of it comes from ancient references or 17th or 18th C sources. Descriptions of practices such as the use of myrrh and pricking the oyster with wires or pins have a basis in practical science and further research may produce information of value to the modern pearl cultivation industry.

Investigation of the history of the industry in South China, particularly the ‘pearl ponds of Ho-pu’ would add to our knowledge of the history of the region and may provide a new aspect to the activities of early Chinese emigrants throughout south east Asia.

3 Field test lutur/tambak batu (or practical modern variations of them).

These structures have the potential to provide a practical, cheap and efficient alternative to expensive and technologically demanding hatcheries for re-stocking depleted stocks of appropriate species—especially sea cucumbers—in poor and/or remote regions.

Re-establishing tambak batu would, in essence, re-establish teripang sasi and have the potential to rejuvenate an industry that has been flagging at village level in most places. Sustainably restocking trepang would provide a stable income for fishermen who
have seen their resources, and therefore their ability to earn an income, decline sharply in recent times and forced many into unsustainable practices, such as collecting coral or fishing with poison.

The technique could also be beneficial to more advanced trepang industries, such as that in the Northern Territory, by ensuring an ongoing sustainable supply of stock whilst still allowing a comparatively high harvest rate.

Each of these topics has the potential to:

- Contribute to Australia’s body of historic knowledge
- Contribute to the historic knowledge of pearl cultivation, an important north Australian industry, and possibly contribute to the evolution of techniques used in that industry
- Contribute to the restoration of stocks of important marine species, thereby enhancing both the environment and incomes for fishermen in all strata of the industry

There are also a number of other issues raised in this thesis that merit further in-depth research, for example, slave harvesting in the Tiwi Islands and west Arnhem Land, archaeological investigation of identified Bayini sites in north east Arnhem Land and locating the sources of the minerals that were still being exported in the 19th C. All of these topics are, however, intricately woven with traditions and Indigenous sensitivities and considerable negotiations would be needed if they were to go ahead.
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