Abstract

This dissertation examines archaeological study of shell adzes in the Pacific. It provides a critical review of archaeological methodology and terminology used in descriptive analysis of this artefact class. It raises important problems that are hindering this subject including a lack of clarity and conformity in the selection of criteria used to describe shell adzes, ambiguity in nomenclature, and the restricted capacity of existing criteria to accommodate a wide range of morphological variation of these artefacts. In addition, it argues that archaeologists have focused almost exclusively on describing typological variation for culture historical purposes. This is problematic as it has resulted in the neglect of a wider range of issues important in shell adze study, specifically technology, function and ecology.

A revised methodology is proposed to address these problems and is applied in the descriptive analysis of two collections of shell adzes from Solomon Islands: one stored at the Otago Museum in Dunedin, New Zealand and the other at Solomon Islands National Museum in Honiara, Solomon Islands. The morphological and metric characteristics of the different shell adze varieties is described, as well as evidence of manufacturing processes involved in their creation. The findings of this analysis are then discussed in relation to their implications for broadening shell adze analysis by incorporating technological, functional and ecological issues. Problems encountered in the analysis are highlighted, and recommendations are made to further develop methodology in shell adze analysis.
Acknowledgements

Honours year was tough. But it would have been a lot tougher without the encouragement and willing assistance provided by the following people. Thanks, first and foremost, goes to my supervisor Richard Walter. Thank you for your steady guidance and support, and for putting up with my ever-shifting draft deadlines. Other people associated with the department who I’d like to show my appreciation include Marshall Weisler, Les O’Neill, Tim Thomas, Phil Latham, Emma Brooks and Chris Jacomb. Thanks Marshall for your generous assistance with shell adze identification and for your advice for my future studies! Thanks Les for helping me with those pesky maps and your useful suggestions. Cheers Tim for helping me out with references, and thanks Phil for sorting out the lab and drawing gear. Thank you kindly Emma and Chris for your tips for writing, editing, etc and helping me with printing! Thanks in general to the Archaeology Department, staff and students. You’re a great bunch.

This dissertation would not have been possible without the permission and helpfulness of the staff at the Otago Museum (OM) and Solomon Islands National Museum (SINM). At OM, I owe an enormous thank you to Jamie Metzger, Scott Reeves and Moira White. Thanks Jamie for your time, patience and friendliness! Thank you Scott for your amazing photography skills, and Moira for giving me the opportunity to study artefacts from my home country. At SINM, I am indebted to Lawrence Kiko, Rita Sahu, Tony Heorake and the always welcoming museum staff. Tangio tumas Lawrence and Rita for giving me access to the archaeological samples and letting me work in the air conditioned room! It really helped.

Thanks also Katherine Szabo for the helpful references. Last but not least, thank you family and friends for your support. Thanks paps, big sis and any others who took time out of their day (not always voluntarily) to help me with editing or to simply have a chat about shell adzes! Big shout out to the rest of ARCH490/ANTH490 students. Thanks for making this year a memorable one!

Apologies if I’ve adzedidently missed anyone. I hope you shell forgive me.

Tangio tumas ui fala eferi wan!
Contents

Abstract ........................................................................................................................................ iii
Acknowledgements ......................................................................................................................... iv
List of Tables ................................................................................................................................... vii
List of Figures .................................................................................................................................. viii

Chapter 1 Introduction ...................................................................................................................... 1
1.1 Stone Adze Study ......................................................................................................................... 1
1.2 Shell Adze Study ......................................................................................................................... 3
1.3 Research Aims ............................................................................................................................. 4
1.4 Outline of following Chapters .................................................................................................... 5

Chapter 2 Review .............................................................................................................................. 6
2.1 Polynesia ..................................................................................................................................... 7
2.2 Micronesia .................................................................................................................................. 11
2.3 Melanesia .................................................................................................................................. 16
2.4 Discussion .................................................................................................................................. 20
2.5 Summary ................................................................................................................................... 22

Chapter 3 Methodology .................................................................................................................. 23
3.1 Context of Museum Collections of Shell Adzes ........................................................................ 24
3.2 Nomenclature ............................................................................................................................. 26
   Valve Anatomy ............................................................................................................................. 26
   Definitions of Cutting-Implements ............................................................................................... 29
   Adze Terminology ......................................................................................................................... 32
3.3 Criteria Selection ......................................................................................................................... 36
   Discrete Variables ......................................................................................................................... 37
   Metric Variables ........................................................................................................................... 44
   Indices ......................................................................................................................................... 45
3.4 Summary ................................................................................................................................... 46

Chapter 4 Results ............................................................................................................................. 47
4.1 Material ..................................................................................................................................... 47
4.2 Description of Shell Adze Varieties ........................................................................................... 48
   Tridacnidae ................................................................................................................................. 48
   Cassidae ..................................................................................................................................... 53
   Terebridae .................................................................................................................................. 55
Srombidae

4.3 Metric Variation & Correlations ................................................................. 56
  Length and Thickness ........................................................................ 56
  Cutting Edge Width and Adze Angles ................................................. 58
  Correlation of Angle of Attack with Cutting Edge and Bevel Shape .... 60

4.4 Evidence of Manufacturing Processes .................................................. 61
  Manufacturing Techniques ................................................................. 62
  Manufacturing Sequence of C. cornuta Adzes ...................................... 63
  Tridacna Valve Morphology and Manufacture .................................... 65
  Butt Modification ................................................................................ 68

4.5 Summary ................................................................................................. 69

Chapter 5 Discussion and Conclusions .................................................... 71
  5.1 Summary of Shell Adze Sample ......................................................... 71
  5.2 Technological, Ecological and Functional Implications ..................... 72
    Technology ......................................................................................... 72
    Ecology ............................................................................................. 75
    Function ............................................................................................. 76
  5.3 Methodology in Shell Adze Analysis .................................................. 78
    Problems and Recommendations ...................................................... 80
  5.4 Conclusion ............................................................................................ 81

Bibliography ............................................................................................... 82

Appendix ........................................................................................................... 89
  Appendix 1. John Craib’s Typological Flow Chart ................................... 89
  Appendix 2 Patrick Kirch and Douglas Yen’s Typology of Tikopia Shell Adzes. 90
  Appendix 3. Criteria used in Previous Shell Adze Studies ....................... 91
  Appendix 4. Methods for Measuring Bevel Angle and Angle of Attack .... 93
List of Tables

Table 3.1 Descriptive terms of Tridacna valves ............................................................. 28
Table 3.2. Anatomical features of Tridacna valves. ....................................................... 29
Table 3.3. Revised definitions of cutting-implements .................................................. 31
Table 3.4. Revised list of criteria .................................................................................. 36
Table 3.5. Adze portion attributes ................................................................................ 39
Table 3.6. Degree of grinding of Tridacna adzes. ......................................................... 39
Table 3.7. Degree of grinding of Cassis sp. adzes......................................................... 40
Table 3.8. Degree of grinding of Terebra sp. adzes. ..................................................... 41
Table 4.1 Museum sample material ............................................................................. 48
Table 4.2. Range of striking angles and bevel angles .................................................. 59
Table 4.3. Range of striking angles corresponding to cutting edge shape ................. 60
List of Figures

Figure 1. Distribution of shell adzes in Polynesia .......................................................... 8
Figure 2. *Cassis rufa* shell, outer lip adze-chisel, and inner lip adze-gouge .................. 9
Figure 3. Cylindrical type of shell adze and thick poll type of shell adze ..................... 11
Figure 4. Map of Western Pacific .................................................................................. 12
Figure 5. *Terebra maculata* and shell adzes ................................................................. 13
Figure 6. Body cross sections of shell adzes .................................................................. 14
Figure 7. Tridacna adze, *Conus* sp. adze, and *Lambis* sp. adze ............................. 15
Figure 8. *Tridacna gigas* hinge region adzes .............................................................. 17
Figure 9. Type 1 'micro-adzes' ...................................................................................... 18
Figure 10. A ceremonial adze type from Takuu Atoll .................................................... 19
Figure 11. Map of natural distribution of *Tridacna gigas* and *Tridacna maxima* ...... 20
Figure 12. Dorsal region adzes of *Tridacna maxima* ................................................... 21
Figure 13. Map of Solomon Islands .............................................................................. 25
Figure 14. Exterior and interior views of *Tridacna* valves ............................................. 27
Figure 15. ‘Reversed’ hafted shell adze from Roviana, Solomon Islands .................. 33
Figure 16. Adze terminology ......................................................................................... 35
Figure 17. Cross section types ....................................................................................... 42
Figure 18. Butt form, cutting edge shape and bevel attributes ...................................... 43
Figure 19. Metric variables ........................................................................................... 45
Figure 20. Dorsal region adzes ...................................................................................... 49
Figure 21. Hinge region preforms .................................................................................. 50
Figure 22. Finished hinge region adzes ......................................................................... 51
Figure 23. Varieties of chisels ...................................................................................... 52
Figure 24. Finished *Cassis cornuta* adzes .................................................................. 53
Figure 25. Finished *Cassis rufa* adzes and wedges ..................................................... 54
Figure 26. *Terebra maculata* adzes ............................................................................ 55
Figure 27. *Lambis* sp. adze ....................................................................................... 56
Figure 28. Length histogram ......................................................................................... 57
Figure 29. Thickness histogram ..................................................................................... 57
Figure 30. Thickness/width by thickness/length scatterplot ........................................ 58
Figure 31. Cutting edge width histogram ................................................................. 59
Figure 32. Average striking angles ............................................................................... 61
Figure 33. Evidence of chipping and bruising of Tridacna adzes .......................... 62
Figure 34. Manufacturing sequence of Cassis cornuta adzes ................................ 63
Figure 35. Manufacturing sequence of Cassis rufa adzes ........................................ 64
Figure 36. Interior and exterior views of Tridacna maxima valves ............................ 66
Figure 37. Distinctive morphological features of dorsal region adzes ....................... 66
Figure 38. Interior and exterior views of Tridacna gigas valves ............................... 67
Figure 39. Distinctive morphological features of hinge region adzes ....................... 68
Figure 40. Evidence of butt modification .................................................................. 69
Figure 41. Marshall Islands C. rufa adze and Western Marianas C. cornuta adze ....... 74
Figure 42. Beaked adze from Nukuoro atoll showing stepped reduction .................... 75
Figure 43. Possible ceremonial adze and micro-adze ............................................... 77
Figure 44. Adze type used for brideprice on Takuu atoll ........................................... 78
Chapter 1 Introduction

1.1 Stone Adze Study
Archaeological studies of stone adzes have contributed enormously to our understanding of culture history in Oceania. This is not surprising given their abundance in the past, having been a necessary part of prehistoric Pacific Island life, their extreme durability allowing them to survive in the archaeological record, and their interpretive value for the culture-historian (Best, 1977: 307). Ethnographic and ethnohistoric accounts have provided useful, although mostly basic, descriptions of traditional practices of stone adze manufacture, hafting and function (Aitken, 1930; Linton, 1923; Buck, 1950). In addition, they have contributed some insight into the complex social significance and roles of the artefact class, for instance, performing part of ceremonial dress in ritual festivals (Christian, 1899: 296) and inspiring chants (Emory, 1975: 99). The bulk of archaeological research of stone adzes has centred upon formal classification, particularly of finished specimens found in Polynesian island regions (Best, 1912; Buck, 1927; Skinner, 1943; Duff, 1959; Figueroa and Sanchez, 1965). Roger Duff’s typology of Eastern Polynesian adzes (1959) was particularly profound in shaping culture historical understandings and approaches to investigating the tool in the Pacific. This was because it established a basic typology of adzes that could be used by archaeologists, in combination with classifications of other material items such as fish hooks (Emory, et al. 1968), to form cultural sequences of different island groups and assess patterns of similarity or change between them (Cleghorn, 1984: 415). However, the widespread practice of categorising adzes according to these prominent adze typologies has been criticised by some authors (Turner, 2000; Kahn and Dye, 2015). Marianne Turner, for instance, argues that the preoccupation with adzes as an “archaeological tool” for defining cultural relationships through time and space neglects the implications of the adze as an “actual tool” (Turner, 2000: 1).

Archaeological experimentation and inquiry into adze manufacture and function have been the primary means by which stone adzes have been analysed as ‘actual tools’ as opposed to ‘archaeological tools’. Technological study of stone adzes in the Pacific has been undergoing for some time (Best, 1977), although on the whole it is has been given little attention by archaeologists compared to formal classification. Since the publication of Simon Best’s landmark study of adze function and its relationship with
temporal changes in New Zealand adze forms, archaeologists have shown a growing interest in investigating technological issues. These issues have varied considerably, including acquisition of raw material and adze production (McCoy, 1977; Leach and Leach, 1980; Leach and Witter, 1987; Leach and Bonica, 1994), material choice and its impact upon stylistic variation (Turner, 2004), and the functional and economic performance of adzes (Winterhoff, 2005). Other technological studies have examined the ‘life-history’ of adzes including refurbishment and reuse processes (Smith and Leach, 1996), and assessed human handedness indicated by unilateral usewear shown on adzes (Spenneman, 1987). Such studies have been profound in broadening technological and functional understandings of adzes which ethnographic and ethnohistoric accounts have only somewhat elaborated upon.

Stone adzes have also become important to archaeological investigation of prehistoric voyaging, mobility and interaction in the Pacific (Collerson and Weisler, 2007; McAlister, et al. 2013; Ditchfield, et al. 2014; Rolett, et al. 2015). Developments in geochemical sourcing techniques and their increasing accessibility to archaeologists have broadened the scope of stone adze research. This has enabled issues such as quarrying, distribution and transportation of adzes to be examined. The restricted distribution of major sources of volcanic glass in Remote Oceania, found commonly only in New Zealand, Rapa Nui and Hawaii, and their rarity in East Polynesian prehistoric assemblages, has led many archaeologists to focus on identifying the geographical origins of tools made from basalt (McAlister, et al. 2013: 257). Geochemical analysis of basalt adzes has been important to examining patterns of large-scale distribution in Polynesia, namely the transfer of materials from large, high-quality stone sources to islands either possessing basalts of lower quality or lacking adze-quality stone altogether (McAlister, 2013; Collerson and Weisler, 2007; Rolett, et al. 2015). For example, some studies of assemblages from the Hawaiian archipelago, which is naturally rich in high-quality fine-grained stone, have demonstrated widespread distribution of local basalt throughout the region but no imported stone (Mills, 2010; Kirch, 2012). In contrast, Kenneth Collerson and Marshall Weisler’s (2007) study of basalt adzes recovered in Tuamotu Archipelago, which possess no natural sources of the material, exhibited a notably high diversity of imported tools.
1.2 Shell Adze Study

Shell adzes used in Oceanic prehistory have received far less attention by archaeologists compared to stone adzes. They indeed were not as widely produced in the Pacific, due partly to the environmental restriction of large workable shell species, such as giant clams, to the shallow warm waters of coral reefs (Rosewater, 1965, 1982). Shell is also not as effective as a raw material for tool manufacture as stone (Szabo, 2004: 341). Nor does shell endure as well in the archaeological record because of its partially organic composition and vulnerability to bioerosive agents (Szabo, 2008: 130). Nevertheless, archaeological analysis of shell adzes still holds significant value for broadening our understanding of the role and importance of shell cutting-implement technology in Oceanic prehistory.

The archaeological investigation of shell adzes has followed a similar historical trajectory to stone adze studies. Some of the earliest scholarly writing about adzes manufactured from subfossil or fresh shell in the Pacific date to colonial times (Keate, 1788; Hedley, 1897). These accounts, written by European antiquarians, poets and ethnologists documenting the ‘way of life’ and unique material items of ‘native’ societies, provided very basic descriptions of shell adze styles, functions and manufacture. It was not until the early twentieth-century with growing ethnographic research in the Pacific that more in-depth examination of shell adzes and other woodworking tools such as chisels, gouges and scrapers began (Skinner, 1920; Kennedy, 1931). Early ethnographers started the trend of describing and categorising shell cutting-implements according to variations in form and morphology to explore culture historical relationships. Since then, archaeological analysis of shell adzes has developed but remains directed predominantly by a culture-history explanatory framework (Thompson, 1932; Spoehr, 1957; Osborne, 1966; Rosendahl, 1969; Garanger, 1972; Craib, 1977; Kirch and Yen, 1982; Fujimura and Alkire, 1984; Wickler, 2001; Bedford, 2006; Leach and Davidson, 2008).

Most archaeologists have instinctively approached the analysis of shell adzes in the same fashion as stone adze study, focusing almost exclusively on forming typologies for culture historical purposes. In the process, they have neglected a wider range of issues important to shell adze analysis, namely technology, function and ecology. The protection of giant clam shells in the Pacific as threatened species (IUCN, 2015), and
the difficulty of acquiring the shell as a raw material has made experimental archaeological study of shell adze manufacture and function challenging. Although, some archaeologists have been able to investigate these issues. For example, Katherine Szabo examined the influence of microstructure of shells on their flaking properties and argued that Tridacna shell was favoured as a raw material possibly due its low organic content and lithic-like qualities (Szabo, 2004). Paul Cleghorn (1977) conducted a small experiment to replicate flaking patterns observed on Tridacna shell tools from the Philippines. He concluded that better flaking occurred from the use of a softer basalt hammerstone and fresh shell was easier to flake than fossilized specimens. Ernest Winterhoff (2005) tested the functional performance of a Tridacna adze against a basalt adze in tree felling. He found that the effort required to maintain and re-sharpen the adzes was comparable, however, the basalt adze was generally more durable and economically efficient. Other technological studies have investigated pre-treatment techniques of Tridacna valves used for adze production (Moir, 1990), and evidence of butt modification of shell adzes to enhance hafting (Rawson, 1988).

1.3 Research Aims
The focus of this dissertation is on methodology used in descriptive shell adze studies, which make up the bulk of archaeological literature about the artefact class. Methodological approaches undertaken in technological study of shell adzes are undeniably important, however, they will not discussed in depth. This dissertation is a critical review of methodological approaches to shell adze analysis in Oceania. It aims to provide a systematic and revised methodology for descriptive analysis of shell adzes and similar shell cutting-implements. The methodology is structured by three research goals:

1) To draw upon past methodological approaches undertaken by archaeologists in their cataloguing of shell adzes, to form a comprehensive set of criteria that can account for a wider range of variation seen among Oceanic shell adzes.
2) To address terminological ambiguity in shell adze analysis.
3) To employ a systematic method for shell adze description that follows standard practice of describing morphological and metric variation, but also places analytical emphasis on functional, technological and ecological issues.
This revised methodology is applied in the analysis of two museum collections of shell cutting-implements from Solomon Islands. One comprised 39 specimens belonging to the Otago Museum (OM) in Dunedin, New Zealand. The other consisted of 132 specimens belonging to the Solomon Islands National Museum (SINM) in the country’s capital city, Honiara.

1.4 Outline of Following Chapters

This chapter has provided a historical background to the archaeological study of stone and shell adzes, and has set out the research aims. Chapter 2 will provide a critical review of analytical and classificatory approaches that have been undertaken in descriptive studies of shell adzes. It will also provide an overview of the geographic distribution of the artefact class. Chapter 3 will describe the revised methodology and terminology applied in the analysis of the museum collections of shell adzes. Adaptations made to criteria used in previous shell adze studies will be defined and justified in this chapter. Chapter 4 will detail the results of the analysis of the shell adze sample in relation to the revised list of criteria, and will highlight any patterning between these attributes that can expand upon functional, technological or ecological issues. Chapter 5 will summarise the findings of the analysis of the museum collections of shell adzes. It will also assess the significance of the revised methodology for systematizing shell adze analysis, and broadening its scope to encompass a wider range of morphological variation of adzes and incorporate issues concerning shell adze technology, function and ecology.
Chapter 2 Review

Shell adzes have received far less attention than their stone counterparts in material culture study in the Pacific. This is despite the reality that these ground shell tools, particularly those made from giant clams, have been studied for about as long as stone adzes have been. Furthermore, they are known ethnographically in most areas of the Pacific and are commonly found in prehistoric assemblages in Near Oceania, particularly Micronesia (Poulsen, 1970: 42). In similar fashion to stone adze study, much of the archaeological analysis of shell adzes has been performed in a culture historical framework. It has been driven almost exclusively by the establishment of typologies to assess spatial and temporal patterns important to culture history. In the process, descriptive studies of shell adzes have often neglected a wider range of issues such as technology, function and ecology. Methodology in shell adze analysis has also been impeded by a lack of specification and consistency of analytical processes, irregularities in terminology, and the inadequacy of existing sets of criteria to account for desired ranges of variability.

Some studies have already made efforts to address these methodological issues in the more recent past (Kirch and Yen, 1982; Moir, 1986). For example, Patrick Kirch and Douglas Yen have highlighted the “failure, as yet, to develop a suitably comprehensive classificatory scheme” in shell adze study which has withheld the potential of the artefact class to elucidating culture history (Kirch and Yen, 1982: 207). They employed a ‘multivariate approach’ to their analysis of Tikopian shell adzes which has been reapplied and proven effective in more recent shell adze research (Wickler, 2001; Bedford, 2006). Barbara Moir has underlined the disregard of ecological factors in shell adze analysis, arguing that “a fundamental understanding of tridacnid ecology is essential to the study of tools made from this material” (Moir, 1986 104). As an alternative to relying solely upon typological variation to examine the distribution of shell adzes in prehistory, Moir provided an ecologically based model useful for the comparative analyses of assemblages between island groups and across marine habitats. She undertook the most comprehensive review of shell adze literature to date, and found that “very few archaeological reports of sites where Tridacna adzes were recovered have even mentioned whether tridacnid species – to say nothing of which species – were present on associated reefs” (Moir, 1986: 112). She also highlighted the
lack of consideration of the anatomy of giant clam shells, which has resulted in valve portions being frequently misidentified and thus causing misunderstanding and irregularity in terminology (Moir, 1986: 104).

This chapter expands upon the critical assessment of methodology in shell adze analysis. It takes a regional approach, examining Polynesia, Micronesia and Melanesia. For each region, two components will be reviewed. The first is the known distribution of the artefact class there. The second includes major shell adze studies that have been performed in that region. These studies provide detailed analysis and descriptions of the shell adzes as opposed to merely mentioning them in material culture finds, and most of them involve the examination of large assemblages (approximately 100 or more shell adzes). Three key components of their methodologies are examined:

1) Their cataloguing process, involving what attributes they selected in their descriptions of the specimens.
2) Their classification method, involving how the specimens were grouped.
3) Their acknowledgement of functional, technological and ecological variables in their analysis of the adzes.

Some terminological discrepancies will be highlighted. However, this issue will be discussed in more detail in the next chapter. In the discussion segment of this chapter, an overview is given of shell adze distribution in the Pacific. In addition, the regional reviews of Polynesian, Micronesian and Melanesian shell adze study will be summarised. Ultimately, this chapter aims to showcase ways to improve and systematize methodology in shell adze analysis which I have implemented in my approach to studying the OM and SINM shell adze collections.

2.1 Polynesia

Little in-depth archaeological research of shell adzes has been undertaken in Polynesia compared to Micronesia and Melanesia. Studies in this region have featured a fairly narrow range of adze forms almost all manufactured from *Tridacna maxima* valves. Larger giant clam shell species such as *Tridacna gigas*, which have shown to give the adze-maker greater variability in the production of finished adze styles, are limited to the western Pacific (Rosewater, 1965: 353). Shell adzes have been recorded in numerous island regions in Polynesia (Figure 1). Some of the largest assemblages have
been found on coral atoll islands in Tuvalu (Hedley, 1897; Kennedy, 1931; Koch, 1961), Tokelau (MacGregor, 1937), Cook Islands (Buck, 1932a, 1932b; Chikamori and Yoshida, 1988), the Tuamotus (Emory, 1975) and Marquesas Islands (Suggs, 1961). They have also been recovered in Tonga (Oestergaard, 1935; Poulsen, 1976), including one of its volcanic islands Niutatoputapu Island (Rogers, 1974), and in Samoa. Although, in the latter, they have appeared very rarely in prehistoric assemblages (Hunt and Kirch, 1988: 172). In Niue, it has been ethnographically documented that adzes were manufactured from Tridacna shell (Loeb, 1926). A few shell adzes made from the hinge of *T. maxima* have also been found as far east as Henderson Island, in the Pitcairn Island group (Weisler, 1994). In New Zealand, two imported Tridacna-adzes have been recovered in the south island Arahura District and in Milford Sound (Skinner, 1920).

![Figure 1. Distribution of shell adzes in Polynesia. Stars indicate countries or island groups where shell adzes have been found.](image)

Kenneth Emory’s (1975) analysis of a collection of about 90 Tuamotu shell adzes from the Bishop Museum is one of the most detailed studies of shell adzes in Polynesia. It also includes the largest described sample size of the artefact class in the region. Emory
specified what attributes he used to analyse basalt adzes he found in the region but did not do the same for the shell adzes. He classified the Tridacna adzes into two types based on morphological appearances. These included the evenness of the front face and the curvature of the bevel (i.e. whether they were flat or convex) (Emory, 1975: 108). Forty of the shell adzes Emory examined were manufactured from *Cypraecassis rufa*, also known as *Cassis rufa* or cameo shell (Figure 1). This was significant as it is one of the largest analysed samples of adzes made from a species of *Cassis* in the Pacific. He differentiated these tools as “adze (or chisel)” manufactured from the thicker outer lip of the shell, and “adze (or gouge)” made from the thinner inner lip (Emory, 1975: 110).

Emory identified a manufacturing pattern among these adzes. He described how the broken surface of the outer lip, once detached from the shell, would be ground to form the front of the adze while the cutting edge would be ground on the opposite face and “always at the same end of the lip – the apex or wider end” (Emory, 1975: 110). His study explored manufacturing processes of the Tuamotu shell tool kit to some degree. However, it lacked in its description of functional traits of the tools and inclusion of ecological variables.

![Figure 1. *Cassis rufa* shell (a), ‘adze (or chisel)’ made from outer lip (b), and ‘adze (or gouge)’ made from inner lip of shell (c) (Emory, 1975: 111).](image)

Donald Kennedy’s (1931) study of about 70 “undamaged specimens of shell adzes and allied implements” in Tuvalu provided detailed descriptions of one of the larger
assemblages of these artefacts in Polynesia. His method of analysis of the shell adzes was influenced by Emory’s (1928) study of Pitcairn stone adzes. As a result, his discussion of the variation within the assemblage was based almost entirely on metric differences. Kennedy only briefly mentioned variation caused by other morphological attributes such as shell morphology and raw material. He classified the Tridacna adzes into two groups based on their general width and thickness. Group 1 adzes he described as appearing broad and fairly thick in comparison to length, and were “made from the more solid material of the side of the valve” (Kennedy, 1931: 289). Group 2 adzes appeared fairly narrow and thin, and were made from “the lip-edge of the original shell” (Kennedy, 1931: 289). The remaining cutting-implements he separated into seven further groups “based on either the shape of the specimens or the material from which they were made” (Kennedy, 1931: 290). These included gouge-shaped adzes, chisels and coconut graters which were indicated by a “series of small sawn indentations on the back of the edge” (Kennedy, 1931: 291). Kennedy made mention of one of the adze groups (Group 3) “probably [being] used in the rotating socket adze”, and observed that one of the “bulky adzes”, referring to those manufactured from hinge portions, had a blunt edge and was reused as a hammer (Kennedy, 1931: 298, 288). Other than this brief reference to the reuse and possible function of some of the shell adzes, this study did little to expand upon technological and ecological factors.

Robert Suggs’ (1961) archaeological study of Nuku Hiva in the Marquesas Islands and Jens Poulsen’s (1967) PhD thesis on the prehistory of Tonga provided relatively in-depth descriptions of Polynesian shell adzes, however, involved much smaller assemblages. In relation to the cataloguing processes undertaken in these studies, both authors did not specify what attributes they recorded. Suggs examined about 16 shell cutting-implements made from the “heavy lip of shells of species of Cassis”, and divided them into types “distinguishable on the basis of the overall shape” (Suggs, 1961: 115). These implements were very small, measuring an average of about 5-7 cm in length and 1-1.5 cm in width, and were long, thin and tapered to one end (Figure 3). Suggs classified them as “shell adzes”, however, they may have also functioned as wedges due to their tapering shape and small size. He also identified a large Terebra crenulata shell with bifacial facets on its sharp point resulting “from [its] use as a gouge” (Suggs, 1961: 133). He observed that shells of this species, along with the similar appearing Terebra maculata, were modified and used as drills points in Nuku
Hiva. This was indicated by “most specimens [having] been dulled by use almost to the point of exhaustion” (Suggs, 1961: 131). Poulsen examined a total of 19 shell cutting-implements from Tonga, and grouped them based on raw material and tool type. These included 10 *Tridacna* adzes, 2 *Terebra* chisels, and 7 *Conus* gouges. The *Tridacna* adzes were all identified as “hinge portion” fragments, and were divided into rectilinear and curvilinear cross sections (Poulsen, 1967: 231). Similar to what Suggs noted in the Marquesas Islands, the *Terebra* chisels in Tonga were bevelled at the pointed end of the shell. However, Poulsen also pointed out that one of the *Terebra* chisels was double bevelled, which has not been commonly found in the Pacific (Poulsen, 1967: 235).

Poulsen and Suggs’ analyses of shell cutting-implements provided some unique findings concerning functional comparisons of the artefacts in the wider Pacific, however, lacked in their exploration of technological and ecological variables.

Figure 3. “Cylindrical type of shell adze” (left) and “thick poll type of shell adze” (right) (Suggs, 1961: 135).

### 2.2 Micronesia

Micronesia has been the most productive region in the Pacific from which detailed analytical studies of large shell adze assemblages have been produced. The highest concentration of *Tridacna* adzes has been recorded on coral atoll islands in Federated States of Micronesia (FSM) and Marshall Islands (Moir, 1986) (Figure 4). In FSM, they have been identified mainly on atolls in the Caroline Islands (Davidson, 1971; Sinoto, 1984; Fujimura and Alkire, 1984), but as well as on many of its volcanic islands including Yap (Gifford and Gifford, 1959) and Truk (LePar, 1964). In the Marshall Islands, shell adzes have been well-studied on Utrok Atoll (Weisler, 2001) and on the
raised coral island, Lib (Rosendahl, 1987). Tridacna adzes have been found in many other parts of this northern Pacific region including the Northern Marianas (Thompson, 1932; Spoehr, 1957), Guam (Hiro and Clayshulte, 1983) and Palau (Osborne, 1966). Towards eastern Micronesia, they have been found in Nauru (Lampert, 1968) and Kiribati, primarily within the Gilbert Islands (Piazza, 1999) but also in the Line Islands group which stretch into Polynesia (Dixon, 1878). Although Tridacna adzes were in use in Near Oceania several millennia before Micronesia was even occupied, shell adze-making became most widespread in this region of the Pacific. Furthermore, Marshall Weisler has suggested that “it is perhaps on the low coral, non-volcanic islands of Micronesia that the greatest diversity of shell tools – in raw material and finished artefact forms – is recognised” (2001: 93).

Figure 4. Map of Western Pacific with Micronesian and Melanesian island groups distinguished.

Janet Davidson’s (1971) analysis of 165 shell adzes from Nukuoro atoll, located in the eastern Caroline Islands, is a prominent Micronesian shell adze study. Her analysis of *Terebra maculata* adzes, which numbered 69 specimens in total, was noteworthy as it is
the largest recorded sample in the Pacific of the shell adze variety. Davidson did not clearly specify what attributes she used in her analysis. Although it was evident that shell species and the region of the shell from which the cutting-implements were made were key criteria in her classification process. Unlike most culture historical studies of shell adzes, Davidson did not group the specimens into numerical types. Rather she grouped them into adzes made from *Terebra* and *Mitra* species, *Cassis* or *Conus* species, as well as the “central or hinge area of *T. maxima* or other large shells” and, what she incorrectly labelled, the “ventral margin” of *T. maxima* (Davidson, 1971: 58). Her study explored functional and technological issues in some depth, but placed only minor emphasis on ecological and environmental factors. For example, she cited an ethnographic account containing “considerable information on the manufacture and function of the shell adzes on Nukuoro,” and compared the described functional types with her analysis and grouping of the tools (Davidson, 1971: 66). She also examined evidence for manufacturing processes among the large collection of *T. maculata* adzes (Figure 5). She argued that they were worked in two ways: 1) shaping the bevel and back by both chipping and grinding, but also 2) shaping the back by chipping, and grinding only the bevel (Davidson, 1971: 53). Furthermore, she noted that “butt modification was present on several [hinge region] examples” (Davidson, 1971: 58), although described this in no further detail.

![Figure 5. Natural *T. maculata* shell (centre), and adzes (Davidson, 1971: 66).](image-url)
John Craib’s (1977) study of western Micronesian shell adzes is one of the most in-depth and largescale analyses of shell adzes in the Pacific. He examined patterns of regional variability among approximately 220 shell adzes, the majority of which were surface finds collected in Palau, Marianas and Yap. Craib’s study was valuable as it listed and described the 16 variables used in the cataloguing process (Appendix 3). He divided the entire collection into nine types based on morphological variation, with primary emphasis given to body cross section and cutting edge shape. He provided a flow chart to illustrate this process (Appendix 1). The elliptical cross section was a particularly important attribute in his analysis (Figure 6). This was because he found “it best divided the total collection into two mutually exclusive groups”, and had an additional benefit of most effectively reflecting the dorsal/hinge shell division (Craib, 1977: 44). Before Craib’s study, archaeologists had created typologies predominantly using shell adze assemblages from individual sites or a single island group (Rosendahl, 1969 and Garanger, 1982 are exceptions). His formation of a classificatory system based upon a combined collection of shell adzes from multiple islands was therefore an innovative approach. Craib incorporated some aspects of function, manufacture and ecology in his descriptions of the shell tools. He noted, for example, that the variation in length of some of the finished adzes may have been a “function of wear, resharpening and reuse of these implements” (Craib, 1977: 98). In addition, he highlighted the ecological importance of *Terebra* and *Mitra* species to adze-manufacture: “these shells are heavier and more solid than other turret shells, thus making them more suitable as woodworking tools” (Craib, 1977: 78). He also described a manufacturing process among the *T. maculata* adzes which substantiated Davidson’s (1971) reconstruction. He proposed the process involved three stages: 1) pecking away of the half of the shell exterior, 2) grinding down the rough edges and 3) grinding the bevel (Craib, 1977: 77-79).

Figure 6. Body cross sections of shell adzes (Craib, 1977: 35).
Other noteworthy studies of Micronesian shell adzes include Marshall Weisler’s examination of 39 percussive ground shell cutting tools from Utrok Atoll in Northern Marshall Islands, Laura Thompson’s (1932) analysis of over a thousand shell artefacts from the Marianas Islands, and Paul Rosendahl’s (1969) terminological and classificatory examination of 156 Micronesian shell adzes. Weisler’s study, although comprising a meagre sample size, provided detailed descriptions of one of the most diverse collections of shell adzes in terms of the different parts of shell used and identifiable species (Figure 7). He utilised a comprehensive list of criteria, formed of 10 discrete and 12 continuous variables (Appendix 3), and grouped the cutting-implements into species and tool type (e.g. “Tridacna gigas adzes” and “Conus sp. adze/gouge”) (Weisler, 2001: 89-92). His work was also significant in its acknowledgement of ecological restrictions of atoll environments and their mollusc biodiversity that would have influenced adze manufacture and function on Utrok.

![Figure 7. Adzes made from Tridacna (a), a Conus species (b), and the body whorl of a Lambis species (c) (Weisler, 2001: 91).](image)

Thompson’s work was one of the earliest major typological studies of shell adzes in the Pacific. Her cataloguing process was unclear, although she divided the implements made from Tridacna according to probable use into adzes, scrapers and spoons. The implements classed as spoons, she described, were “thinner than scrapers and lacking
the cutting edge” (Thompson, 1932: 53). She distinguished the shell adzes as “implements thick enough to withstand the shock of heavy blows when hafted, fairly straight longitudinally, and finished with a straight edge” (Thompson, 1932: 53). She acknowledged that her functional grouping process was challenging at times because most of the small flat adzes in the collection may have also served as scrapers. Rosendahl’s work was constructive in his approach to designing a preliminary terminology for the analysis of adzes made from *Tridacna*, *Terebra*, and *Cassis* species (1969: 2-5). He adapted this terminology from conventional adze terms used in Polynesian stone adze study (Buck et al., 1930). Although the stone adze terms were useful to clarifying his descriptions of the major features of the shell adzes, not all of them were suitable. This issue will be addressed further in the following chapter.

2.3 Melanesia

Melanesia has also been an important area in the Pacific from which detailed study of large shell adze assemblages has been undertaken. Comparable to their distribution in Micronesia, shell adzes have been recorded by archaeologists across much of Melanesia. Melanesian shell adzes have also demonstrated an equally high variability of blade styles and forms, particularly among those manufactured from the hinge region of *T. gigas* (Figure 8). The highest distribution of these shell tools have been recorded in Vanuatu, Solomon Islands and on the eastern margins of the Bismarck Archipelago (refer to Figure 4 for map of Melanesia). In Vanuatu, they have been recovered in almost the entire island chain. They have been found there mainly on volcanic islands (Garanger, 1982; Bedford, 2006), but also on one of its raised coral islands, Pakea (Ward, 1979). In Solomon Islands, they have been found in their hundreds in the Santa Cruz region on the volcanic islands of Tikopia (Kirch and Yen, 1982), Anuta (Kirch, 1983), and Vanikoro (Kirch and Rosendahl, 1973). They have also been identified on the coral atoll islands Sikaiana and Ontong Java (Bayliss-Smith, 1978), the raised coral islands Rennell and Bellona (Poulsen, 1972), and on parts of its mainland chain of continental islands including nearby Buka (Wickler, 2001). In Papua New Guinea, they have been closely studied on Takuu Atoll (Moir, 1989). Shell adzes have also been identified in Fiji (Gifford, 1951; Parke, 1964) and New Caledonia (Sand, 2004), although they have received only brief descriptions.
Patrick Kirch and Douglas Yen’s (1982) study of 234 *T. maxima* adzes from Tikopia is the most comprehensive analysis of a Solomon Islands assemblage of shell adzes. They selected 23 variables in their analysis of the assemblage which were similar to the criteria used by Craib (1977) and Weisler (2001) (Appendix 3). These included 12 discrete attributes assigned for the provenance and morphological features of the adzes, and 11 continuous attributes which recorded metric data and indices. The authors grouped the Tikopia assemblage into 11 types primarily based upon shell species and the morphological region of the shell (i.e. dorsal or hinge), but also incorporated cross section, degree of grinding, and butt form as important determining factors. Similar to Craib’s (1977) study, Kirch and Yen provided a flowchart illustrating their classification process (Appendix 2). Although theirs differed as it was designed to account for variability specific to the Tikopian assemblage and emphasised “attributes that significantly covary with respect to time” (Kirch and Yen, 1982: 221). Unlike Craib’s method, the authors did not use the distinction between straight and curved bevel shape in their primary types. They justified this decision because they observed that “both kinds of bevel are relatively constant overtime” (Kirch and Yen, 1982: 223). Although they highlighted that bevel shape and overall adze size would have likely had important functional significance. Most of their types were significant to exploring temporal relationships of shell adzes. Although Type 1 ‘micro-adzes’ represented a functional grouping which, they argued, were “clearly intended for fine carving work of some sort” (Kirch and Yen, 1982: 230) (Figure 9). Their study encompassed a broad understanding of the influence of ecological factors for prehistoric adze-making in Tikopia, such as the absence and presence of certain *Tridacna* species in its reef system. Furthermore, they placed considerable emphasis on recognising shell morphology.
Barbara Moir’s (1989) ethnoarchaeological study of giant clam shell cultivation and “aging” on Takuu Atoll is another very comprehensive study of Melanesian shell adzes. It included the analysis of over 200 shell cutting-implements fashioned from several giant clam species including *T. gigas*, *T. maxima*, the Fluted giant clam (*Tridacna squamosa*), and Bear paw clam (*Hippopus hippopus*). Some gastropod species were also used as raw material including *T. maculata*, *Mitra mitra*, *Cassis cornuta*, and *C. rafa* (Moir, 1989: 363). She focused primarily on adzes made from the hinge portions of *T. gigas* valves and certain types that were continuing to function as items of cultural capital in contemporary Takuu society. Her study diverged from conventional classificatory approaches taken in shell adze study by forming an adze typology from an emic perspective. She noted that some variables such as butt shape and the extent of grinding were dismissed by her Takuu informants as being irrelevant in their assortment process. In addition, she observed how in most cases they would lump rather than split such tools into types which resulted in “considerable variation… in such attributes as blade length, width, thickness and even bit [or cutting-edge] shape” (Moir, 1989: 364). She described 10 adze types. Six of these, her informants explained, “functioned primarily as tools and secondarily as cultural capital in the payment of compensation and restitution” (Moir, 1989: 362). The remaining four types were used exclusively as brideprice and grave goods, and were never hafted (Figure 10). Her investigation of the cultivation and aging of *T. gigas* in ‘coral gardens’ on Takuu contributed valuable insights into technological and ecological issues of prehistoric adze-making. She described how in the past it served as a long-term strategy for producing and reserving a supply of essential tool material, and also for enhancing the physical properties of the shell by ‘aging’ them in seawater (Moir, 1989: xi). Furthermore, she made an important argument that ethnohistoric evidence for the
‘aging’ of *T. gigas* valves demonstrates that “early atoll craftsmen within the distribution of this species were not inevitably restricted in their range of local tool materials as might be inferred from the lack of lithic resources in their environment” (Moir, 1989: 502).

Figure 10. A ceremonial adze type from Takuu Atoll (Moir, 1989: 376).

Other major studies of Melanesian shell adzes include Kirch and Rosendahl’s (1973) analysis of 208 shell adzes from Anuta and Jose Garanger’s (1982) study of over 200 specimens from Efate and other Central Islands of Vanuatu. Kirch and Rosendahl’s cataloguing process focused primarily on metric variation of the Anuta shell adzes, particularly differences in length. They classified the large shell adze assemblage into 12 groups based on differences in their stages of manufacture (i.e. complete, unfinished or rough-outs) (Kirch and Rosendahl, 1973: Table 17). Garanger did not specify the attributes he selected for his analysis although it was clear that variation in cross section, shell portion and shell species were the most important factors in his classification approach. He grouped the Vanuatu shell adze collection into five types. The Tridacna material he divided into two types made from the “external surface” and the “thick part” of the valve (Garanger, 1982: 102). The remaining three included “adze-gouges” made from *Lambis*, *Mitra* and *Terebra* species. Both studies gave important insights into the spatial and temporal significance of their shell adze assemblages within Melanesia and the wider Pacific. However, they made only minor contributions to exploring technological, functional and ecological issues.
2.4 Discussion
The manufacture and use of shell adzes and other ground shell cutting-implements was very widespread in Pacific prehistory. The natural distributions of *T. gigas* and *T. maxima* closely resemble the artefact distribution of shell adzes recorded by archaeologists (Figure 11). Giant clam shells were utilised in Pacific prehistory for the production of adzes, among various other shell material items, basically everywhere they were available. In relation to temporal distribution, shell adze technology has existed in Near Oceania almost since the outset of the Holocene but developed considerably and became far more commonplace following Austronesian expansions into Remote Oceania about 3,500 years ago. The earliest known Tridacna adzes were recorded at Pamwak rockshelter site on Manus Island in Papua New Guinea, excavated in a context dated to between 7,000 to 10,000 years old (Frederickson, *et al.* 1993).

In the Western Pacific region where there is a greater natural distribution of large giant clam species, including both *T. maxima* and *T. gigas*, these tools have appeared abundantly in the archaeological record. Adzes made from the hinge region of *T. gigas*, which can grow up to about 1.7 m (Rosewater, 1965: 353), show some of the greatest

---

**Figure 11.** Map of the Pacific outlining the natural distribution of the two most commonly identified shell species used in adze-making, *T. gigas* and *T. maxima.*
variability in shell adze style and form found in the Pacific. Adzes made from the dorsal region of *T. maxima* are found far more commonly than *T. gigas* adzes, particularly in Polynesia (Figure 12). However, variability of their finished forms has appeared more limited, primarily because the species is much smaller and reaches a maximum length of only about 35 cm (Rosewater, 1965: 387). Shell adzes are conventionally associated with cultures inhabiting atolls and raised coral islands lacking in good quality stone sources (Moir, 1986: 95). However, this review has highlighted that they have been found on numerous volcanic and continental land masses as well, establishing a fairly broad range of island habitats for their distribution.

![Figure 12. Most commonly found shell adze type in the Pacific made from the dorsal region of *Tridacna maxima* (image from Garanger, 1983).](image)

Some of the most detailed studies of Polynesian shell adzes include ethnographic research (Kennedy, 1931), and only a handful of more recently published archaeological analyses (Poulsen, 1962; Suggs, 1961; Emory, 1975). As was demonstrated in the review of these studies, the methodological approaches employed by the archaeologists varied considerably. Most of them did not specify what attributes they recorded for their analysis and for the one that did (Kennedy, 1931), the attributes he selected were problematic as they were borrowed directly from stone adze analysis. The classification methods used were based predominantly on differences in the general size and overall shape of their adze types. As a result, most of their analytical emphasis was placed on metric variation and complete shell adze specimens. Only passing discussion was given to functional and technological variables such as evidence of tool reuse (Kennedy, 1931: 288) and a manufacturing sequence (Emory, 1975: 110).
Methodological approaches that have been taken to the study of Micronesian and Melanesian shell adze assemblages have demonstrated to be more systematic and comprehensive compared to shell adze research in Polynesia. The review of Melanesian and Micronesian shell adze studies demonstrated that many of them were relatively explicit in their cataloguing and classificatory processes. Some noteworthy examples specified clearly what criteria were selected to analyse their assemblages (Craib, 1977; Kirch and Yen, 1982; Weisler, 2001). Most of the classification methods used in these studies were centred upon differentiating between shell species and the morphological region of the shell used to create the adze. The few exceptions to this approach include Moir’s (1989) emic classification of Takuu shell adzes, Thompsons’ (1932) functional classification of shell artefacts from the Marianas, and Kirch and Rosendahl’s (1973) assortment of shell adzes from Anuta based on differences in manufacturing stages. In relation to the incorporation of functional, technological and ecological variables in shell adze analysis, some of these studies have excelled (Kirch and Yen, 1982; Moir, 1989; Weisler, 2001). Such studies have demonstrated the importance of acknowledging the anatomy of giant clams and other shell species that were used in prehistoric adze-manufacture. In addition, they have contributed valuable insights into the multiple functions of shell adzes, ranging from practical use in canoe building and other woodworking craft to acting as ceremonial gifts created purely to serve in economic and cultural traditions.

2.5 Summary
This chapter provided an overview of the distribution of shell adzes in the Pacific and critically examined methodologies used in descriptive studies of the artefact class. It has demonstrated that shell adzes are a standard component of prehistoric Oceanic material culture, found basically all throughout Micronesia and Melanesia, and in most island regions of Polynesia. Despite their ubiquity, this review has shown that archaeological research of shell adzes is lacking and that methodology in the analysis of the artefact class is impeded by several issues. These include a lack of clarity and conformity in analytical processes, irregularities in terminology, and the inadequacy of existing criteria to account for desired ranges of variability. The next chapter will provide a revised terminological system for shell adze analysis and describe the criteria selected for my analysis of the OM and SINM shell adze collections.
Chapter 3 Methodology

Archaeological methodology used in analysing and describing Oceanic shell adzes has been hindered by several issues. First, there is a lack of clarity as to what variables and attributes should be selected when cataloguing shell adzes. Apart from some noticeable exceptions (Craib, 1977; Kirch and Yen, 1982; Weisler, 2001; Wickler, 2001), most typological studies of shell adzes in the Pacific have not specified explicitly what criteria were used to describe their assemblages. This has been problematic as it makes it very challenging for researchers to replicate analytical methods or reproduce results. Furthermore, only rarely has justification been provided to explain the reasoning behind the analysis of certain variables. When archaeologists have not been explicit in their selection, and reasoning behind the selection, of criteria in their studies it can lead to misunderstanding.

Secondly, there is a lack of conformity in analytical approaches to shell adze study. This is demonstrated by the often narrow or mixed set of criteria that have been used to classify shell adzes and similar shell cutting-implements. For example, they have been classified based upon variation in stages of manufacture (Kirch and Rosendahl, 1973), perceived functional differences (Thompson, 1931), and by the size and overall shape of adzes (Emory, 1975; Kennedy, 1931; Suggs, 1961). This lack of conformity in methodology is also demonstrated by the formation of a new typology almost every time an excavated assemblage or museum collection has been analysed. I am not suggesting that there should be one, absolute method of classifying this artefact class. Instead, I argue, that it would be practical in shell adze analysis for there to be a standard list of criteria that can be used to guide a systematic method of cataloguing and describing the artefact class. Such a list could be built by drawing upon past shell adze studies, as I have done in this study, and its compilation would be a valuable step towards advancing shell adze studies. In addition, exploring a wider range of issues such as manufacture, function and ecology would add further depth to studies that have focused predominantly on typological variation.

Thirdly, there has been a lack of consistency in terminology used in shell adze analysis. The most common terminological discrepancies have concerned the anatomy of giant clam shells and other gastropods used in shell adze-making. There has also been an issue related to differentiating between classes of shell cutting-implements. Some
archaeologists have addressed this by considering all shell tools as “adzes” (Kirch and Rosendahl, 1973; Rosendahl, 1987: 104), or by combining different tool types into categories such as “adze-gouges” (Garanger, 1982) and “adze/chisels” (Weisler, 2001). A growing number of studies of shell adzes have shown greater consensus in terminology (Kirch and Yen, 1982; Moir, 1986; Wickler, 2001; Weisler, 2001; Bedford, 2006; Leach and Davidson, 2008). For example, terms which are customarily used in the study of these artefacts include the dichotomy between “hinge region” and “dorsal region” adzes made from giant clam shells. This issue will be discussed further in the nomenclature section of this chapter.

The aim of this chapter is to describe the revised terminology and list of criteria used in my shell adze study. First, it provides a background to the ethnographic and geographic context of the museum specimens. Secondly, it addresses the issue of ambiguity in shell adze nomenclature. This section reviews three key terminological issues - 1) shell anatomy, 2) definitions of cutting-implements and 3) adze terminology - and explains the revisions made to the terminology used in this study. Thirdly, the cataloguing process used in my analysis of the museum samples is discussed. This section describes the revised set of criteria used in my analysis. It also explains how the variables and attributes I selected have expanded upon those utilised in previous studies of shell adzes, and provides a justification for my selection. Lastly, a summary is given of this chapter.

### 3.1 Context of Museum Collections of Shell Adzes

The OM sample comprised 39 specimens. Very little contextual information was available for these shell tools other than where they were collected and, for some of them, by whom. The majority of these specimens were collected from the eastern Santa Cruz region of Solomon Islands (Figure 13). These included Santa Cruz Island (N=18), also known as Nendo, which is the largest volcanic island in that area, and the Reef Islands (N=7) which is a small cluster of low coral atolls located about 80 km north of Nendo. The remaining Solomon Island specimens were collected from provinces in the main island group including Makira (N=2), Malaita (N=1), and New Georgia (N=1). Three specimens derived from the northwest region of the country on Mono Island in the Shortland Islands group. In addition to the Solomon Islands material, a specimen from Bougainville (N=1) and Torres Islands in Vanuatu (N=1) were included in the
analysis. The context of three specimens of this collection was unknown. The Santa Cruz specimens were collected by two colonial Anglican missionaries, Bishop George Augustus Selwyn and Reverend George H. West, in the mid-nineteenth and early twentieth-century. Both men visited and lived in areas of Solomon Islands as part of the Melanesian Mission (see Armstrong, 1900; Hilliard, 1970; Davidson, 2000).

Figure 13. Map of Solomon Islands. Red stars indicate island regions where the museum specimens were collected.

The SINM sample comprised 132 specimens almost all of which were collected by Tim Bayliss-Smith during his ethnographic fieldwork in Luangiua Village and Pelau Village in Ontong Java during the early 1970s (see acknowledgements in Bayliss-Smith, 1978). Some of the specimens were labelled as “surface finds at Luangiua Village”, however, most gave no further details of provenance other than being donated by Bayliss-Smith and which of the two villages they were collected from. One specimen was labelled as being from Sikaiana, but unfortunately did not have any further contextual information.

Shell adzes from Ontong Java and Sikaiana have received little archaeological attention other than brief mentions in ethnographic studies (Woodford, 1906: 168; Hogbin, 1941: 214; Bayliss-Smith, 1978: 64). The most detailed archaeological analyses of shell adzes
in the Solomons have been performed on assemblages from the Santa Cruz Islands region, namely Anuta (Kirch and Rosendahl, 1973), Vanikoro (Kirch, 1983), Tikopia (Firth, 1959; Kirch and Yen, 1982), and Taumako (Leach and Davidson, 2008). Shell adzes from Santa Cruz Island and Reef Islands have been described only in minor detail (McCoy and Cleghorn, 1988: 107, 110; Doherty, 2009: 202-204). The lack of detailed analysis of shell adzes from these regions, specifically Ontong Java, Santa Cruz Island and Reef Islands, demonstrates the significance of this sample collection. However, its value for culture historical investigations is not the main focus of this study.

3.2 Nomenclature
There has been considerable ambiguity in nomenclature used in descriptive analysis of shell adzes. As was highlighted in Chapter 2, much of this ambiguity has concerned descriptions of anatomical features of giant clam shell valves. In addition, there have been terminological discrepancies in some shell adze studies concerning the definitions of cutting-implements and adze terminology provided by Buck, Emory, Skinner and Stokes (1930).

Valve Anatomy
Anatomical features of Tridacna valves have been described inconsistently in shell adze study (see Figure 14 for anatomical diagram). In particular, the dorsal region of the valve has been described using a variety of terms including “thinner inner lip” (Emory, 1975: 111), “lip-edge” (Kennedy, 1931: 289), and “exterior” (Rosendahl, 1969). This part of the valve has also been misidentified as being the “ventral” portion (Davidson, 1971; Kirch and Rosendahl, 1973). Kirch and Yen have addressed this issue, highlighting that “the term ‘ventral margin’ would be correct for most Bivalvia, [however] it is decidedly in error with regard to the Tridacnidae” (Kirch and Yen, 1982: 210). For anatomical and evolutionary reasons described in detail by Joseph Rosewater (1965: 350-353), in Tridacna the hinge area is ventral and the thinner portion of the valve is in fact dorsal (Kirch and Yen, 1982: 210).
Descriptions of the exterior surface of giant clam shell valves, specifically their scales, have also shown irregularities (see “scales” in Figure 14). This anatomical feature has been described, for instance, as “flutes” (Wickler, 2001: 196), “natural irregularities” (Kennedy, 1931: 291), and “striations on the shell” (Thompson, 1932: 54). Rosendahl labelled them as “ridges” in his terminological study of shell adzes (1969: Fig. 1, pg. 4). This is a matter worth addressing in shell adze studies as the appearance of exterior scales is a primary diagnostic criterion used to identify Tridacna species. It is especially useful for distinguishing *T. maxima* (Weisler, 2001: 88). Simplifying the description of this feature to its anatomically correct name, scales, would be an effective way to avoid terminological confusion.

Terms used to describe adzes made from the hinge region of Tridacna valves have also varied. These have included, for example, adzes made from the “bulky… [or] more solid material of the side of the valve” (Kennedy, 1931: 289), “central or hinge area” (Davidson, 1971: 58), and “thick part of a giant clam valve” (Garanger, 1982: 102). Again, simplifying the description of adzes made from the thicker hinge portion of valves to ‘hinge region’ would address this issue. This has already been demonstrated in more recent shell adze study (Kirch and Yen, 1982; Moir, 1986, 1989; Wickler, 2001; Weisler, 2001; Bedford, 2006; Leach and Davidson, 2008).
Revised Tridacna Valve Terminology

The Tridacna valve terminology used in this shell adze analysis was adapted from Rosewater’s (1965) well-cited biological study of the giant clam shell family, Tridacnidae, and valve terminology used by Moir (1986, 1989). Figure 14 gives a pictorial depiction of the descriptive terms and anatomical features of Tridacna valves used in this study. The descriptive terms listed below were important to describing the two ends of the valve, the anterior and posterior ends, and the two surfaces of the valve, the interior and exterior surfaces (Table 3.1). They were also important to distinguishing the two portions of valves commonly used in shell adze-making, the dorsal region and hinge region.

Table 3.1 Descriptive terms of Tridacna valves used in this shell adze analysis.

<table>
<thead>
<tr>
<th><strong>Descriptive Terms</strong></th>
<th><strong>Definition</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorsal Region</td>
<td>The thinner portion of the valve between the dorsal margin and hinge line/ventral margin.</td>
</tr>
<tr>
<td>Hinge Region</td>
<td>The thicker ventral portion of the valve encompassing the umbo, ventral margin and hinge line.</td>
</tr>
<tr>
<td>Anterior</td>
<td>The end of the valve adjacent to the hinge line.</td>
</tr>
<tr>
<td>Posterior</td>
<td>The end of the valve adjacent to the ventral margin.</td>
</tr>
<tr>
<td>Interior</td>
<td>The smooth inner surface of the valve.</td>
</tr>
<tr>
<td>Exterior</td>
<td>The sculptured outer surface of the valve.</td>
</tr>
</tbody>
</table>

The anatomical features described in this study do not concern the giant clam organism itself. Rather, these terms were used to describe and identify different portions of the Tridacna valve used in adze-making. Tridacna adzes were distinguished as being manufactured from either the dorsal region or hinge region of the valve in this study. Although, the anatomical features listed in Table 3.2 were used to describe more specific portions of the hinge and dorsal regions used to manufacture the adzes. For example, Tridacna adzes showing a ligament attachment scar which is located on the hinge line of the valve were classified as hinge region adzes. Manufacturing processes and the different portions of valves used in the production of this sample are discussed in more depth in the following chapter.
Table 3.2. Anatomical features of Tridacna valves used in the description of this shell adze sample.

<table>
<thead>
<tr>
<th>Anatomical Features</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Margins</strong></td>
<td></td>
</tr>
<tr>
<td>Dorsal Margin</td>
<td>The edge of the valve opposite the umbo.</td>
</tr>
<tr>
<td>Ventral Margin</td>
<td>The edge of the valve proceeding posteriorly from the umbo, which provides an orifice for the byssal attachment of the animal to coral.</td>
</tr>
<tr>
<td>Hinge Line</td>
<td>The edge of the valve proceeding anteriorly from the umbo, which encompasses the hinge teeth, ligament buttress and attachment scar.</td>
</tr>
<tr>
<td>Umbo</td>
<td>A beaked protuberance located between the ventral margin and hinge line.</td>
</tr>
<tr>
<td><strong>Exterior Surface</strong></td>
<td></td>
</tr>
<tr>
<td>Fold</td>
<td>A rib-like undulation proceeding dorsally from the umbo.</td>
</tr>
<tr>
<td>Fold Interstice</td>
<td>A gap or cleft between two folds.</td>
</tr>
<tr>
<td>Scales</td>
<td>Layered sculpturing on the exterior surface of the valve.</td>
</tr>
<tr>
<td><strong>Interior Surface</strong></td>
<td></td>
</tr>
<tr>
<td>Cardinal Hinge Tooth</td>
<td>A large projection located directly beneath the umbo.</td>
</tr>
<tr>
<td>Lateral Hinge Tooth</td>
<td>A small projection located along the hinge line near the anterior end of the valve.</td>
</tr>
<tr>
<td>Ligament Attachment</td>
<td>A band-like scar created by the hinge ligament which joins the left and right valves.</td>
</tr>
<tr>
<td>Ligament Buttress</td>
<td>A long projection that stretches posteriorly from the umbo.</td>
</tr>
</tbody>
</table>

**Definitions of Cutting-Implements**

Another key terminological issue in shell adze analysis has concerned distinguishing between classes of shell cutting-implements. Buck *et al.* (1930) is the standard reference for definitions of ground stone tools and has been applied in much of shell adze study (Rosendahl, 1969; Craib, 1977; Weisler, 2001). They distinguished between adzes, axes and chisels fundamentally by the manner of hafting. An adze, they defined, is hafted with the cutting edge running transversely to the long axis of the haft (Buck *et al.* 1930: 175). An axe, on the other hand, is hafted with the cutting edge running parallel to the long axis of the haft. They defined a chisel as an implement hafted with its long axis continuous with the long axis of the haft, and highlighted also the
difficulty of drawing a definite line between small adzes and large chisels (Buck et al. 1930: 179). They defined a gouge as “a special form of chisel in which the edge is curved to such a degree that the bevel is hollow or grooved” (Buck et al. 1930: 179). They defined a wedge as an implement that is “thick at one end and tapering to a thin edge at the other, used in splitting or separating material such as wood” (Buck et al. 1930: 179).

Craib underlined several issues in his application of these definitions in his study of shell adzes from Marianas Islands (1977: 27-29). The first was their neglect of functional differences, specifically between the profile (sagittal section) of the cutting edges of the tools and the angle at which they were used against a working surface. He added that an axe “has a relatively symmetrical profile… [and] is used so that the cutting edge approaches the plane of the working surface at a right angle” (Craib, 1977: 27). For an adze, “its profile is relatively asymmetrical… [and] cuts in a plane parallel to the surface being worked without biting into the surface as would a symmetrical axe” (Craib, 1977: 28). The second issue he highlighted concerned the vagueness of the definition of a gouge proposed by Buck et al. (1930). He argued that their definition posed a “typological problem as to what degree an edge must be curved before it leaves the adze group and becomes a gouge?” (Craib, 1977: 29). Instead, he suggested that more often than not gouge-like implements are simply adzes with concaved bevels.

Revised Definitions of Cutting-Implements
The definitions of cutting-implements used in this study incorporated using Buck et al. (1930) as a foundation. However additions made by Craib (1977), specifically the difference in symmetry of the cutting edges of an adze and axe, and the angle at which they meet the working surface, have also been taken into account. Given none of the specimens examined in this collection were hafted, characteristics used to distinguish between the cutting-implement types were restricted to the symmetry of the cutting edge, angle of attack, the general size of the specimen and cross section shape.

Cutting-implements described as adzes, in this study, were typically characterised by a relatively asymmetrical cutting edge with a single high angled bevel. They tended to have a low angle of attack of approximately 30 degrees. In contrast, specimens described as axes were characterised by a relatively symmetrical cutting edge with two, more or less, equally angled bevels. They tended to have a higher angle of attack of
approximately 40 degrees. Cutting-implements described as chisels were usually circular in cross section and narrow (approximately 30 mm in width). Similar to adzes, chisels typically had an asymmetrical cutting edge, single bevel and low angle of attack of about 30 degrees. Implements described as gouges shared the same characteristics as a chisel although were distinguished by a concave bevel. Implements described as wedges were typically small (approximately 5 mm in length), thick at one end and tapering to a thin cutting edge. The revised definitions are listed below.

Table 3.3. Revised definitions of cutting-implements used in this study.

<table>
<thead>
<tr>
<th>Cutting Implement</th>
<th>Definition</th>
</tr>
</thead>
</table>
| Adze              | - A cutting-implement with the cutting edge running transversely to the long axis of the haft.  
- Relatively asymmetrical cutting edge with one high angled bevel.  
- Low angle of attack (approximately \(30^\circ\)).  
- The power is supplied by a swinging blow in a plane parallel to the working surface (hewing action). |
| Axe               | - An axe is a hafted cutting-implement with the cutting edge running parallel to the long axis of the haft.  
- Relatively symmetrical cutting edge with two, more or less, equally angled bevels.  
- High angle of attack (approximately \(40^\circ\)).  
- The power is supplied by a swinging blow in a plane perpendicular, or at a right angle, to the working surface (chopping action). |
| Chisel            | - A cutting-implement which can be handheld or hafted with its long axis continuous with the long axis of the haft.  
- Usually circular in cross section.  
- Relatively asymmetrical cutting edge with one high angled bevel.  
- Low angle of attack (approximately \(30^\circ\)).  
- The power is supplied by pressure or mallet blows in a plane parallel to the working surface (trimming action). |
| Gouge             | - It is a special form of chisel in which the bevel is concave.  
- The power is supplied by pressure or mallet blows in a plane parallel to the working surface (grooving action). |
Wedge
- It is a small cutting-implement (approximately 5mm in length) thick at one end and tapering to a narrow cutting edge, used for splitting or separating wood.
- The power is supplied by pressure or mallet blows and is used in a plane perpendicular, or at a right angle, to the working surface (splitting action).

Adze Terminology
Another area of ambiguity in shell adze nomenclature has involved descriptions of ‘reversed’ hafted adzes and their contradiction of the definitions of the front and back of an adze proposed by Buck et al. (1930). The authors define the front or face of an adze as “the longitudinal portion of the adze, distal from the operator and proximal to the material being dressed” (Buck et al. 1930: 177). In opposition, the back of the adze is “the longitudinal portion proximal to the operator…” which possesses the bevel (Buck et al. 1930: 177).

Shell adzes made from the dorsal region of giant clam shells have been consistently identified by archaeologists to have been manufactured with the bevel on the surface of the adze formed by the exterior valve surface (Davidson, 1971: 56; Kirch and Rosendahl, 1973: 70; Craib, 1977: 52; Rosendahl, 1987: 107). However, the orientation of these adzes and the position of its bevel when hafted have not received the same consensus. Janet Davidson argued that in Nukuoro, “adzes with straight cutting edges… were usually, if not always, hafted with the bevelled surface uppermost” (Davidson, 1971: 67). Her observation has been supported by several other studies (Crosby, 1973: 73; Kennedy, 1931: 290; Emory, 1975: 109; Firth, 1959: 151). Kennedy described how the exterior valve surface of dorsal region adzes from Ellice Islands was convex in shape and thus “less suitable for placing against the foot of the helve than the concave interior [valve] surface” (Kennedy, 1931: 290). As a consequence, he noted that “the bevel on all specimens of these two groups is on the front of the adze, in strange contrast with the bevelled back of the typical Polynesian stone adze” (Kennedy, 1931: 290). Similarly, Raymond Firth recorded that “in the lashing of Tikopia traditional adze blades, it was said that it was equally good for the bevel to be on the upper face or under face of the adze” (Firth, 1951: 151). He explained further, writing that “if the
work would be spoiled by striking with the bevel on the under face (giving too much ‘bite’), the blade would be reversed” (Firth, 1951: 151).

Hafted shell adzes that have the bevel on the surface of the adze facing the working surface, see Figure 15, contradict definitions of front and back proposed by Buck et al. (1930). However, as Davidson acknowledged, “conventions are so well established and so widely understood that it will doubtless prove convenient to use the accepted definitions of front, back and bevel” (Davidson, 1971: 67). Therefore, the terminology used in this study will follow standard definitions of front and back, specifically that the bevel is always located on the back of the adze.

![Figure 15. Hafted shell adze from Roviana, Solomon Islands, with bevelled surface facing the working surface (Crosby, 1973: Plate A7, p. 68).](image)

Revised Adze Terminology

The adze terminology used in this study was adapted for the most part from Buck et al. (1930), although some reference was made to the shell adze terminology used by Rosendahl (1969). Revisions have been made to these terms to incorporate the descriptive and anatomical valve terminology previously described. The definitions listed below are illustrated in Figure 16.

**Adze** – the term is restricted to the implement without being hafted.
**Butt** and **Blade** – the butt is the upper portion of the adze engaged by lashings when hafted. The blade is the lower remaining portion. The exact line of division between the butt and blade is indistinguishable unless the shell adze is hafted.

**Back** and **Front** – the back is the surface of the adze where the bevel is located. The front is the opposite surface. The back of a dorsal region adze is usually formed by the exterior surface of the valve, while the back of hinge region adzes is usually formed by the interior surface (see dorsal region adze and hinge region adze in Figure 4).

**Sides** – the sides are the lateral surfaces of the adze.

**Poll** – the poll is the upper surface of the butt.

**Bevel** – the portion of the back which is ground to form the cutting edge. The bevel is always on the back.

**Chin** – the margin formed by the meeting of the bevel and the back. The exact outline of the chin is not always clearly defined on shell adzes, especially hinge region adzes.

**Cutting Edge** – the thin, sharp edge of the blade that cuts into the working surface.

**Shell Interior and Exterior** – the interior is the inner structure of the shell. The exterior is the outer surface of the shell. These terms only served the description of adzes made from *Cassis, Terebra* and *Lambis* species (gastropods).

**Teeth** – the teeth are projections on the lip of the shell. This term only served the description of adzes made from the outer lip of *Cassis* sp.

**Columella** – the columella is the column like structure visible only within the shell interior. This term only served the description of *Terebra* sp. adzes.
Figure 16. Adze terminology used in shell adze analysis (front, back, side profile and mid cross section shown).
3.3 Criteria Selection
The criteria used in this revised methodological analysis of shell adzes were selected by consultation with Craib (1977), Kirch and Yen (1982), Weisler (2001), and Wickler, (2001). These studies were selected as they are among the few descriptive analyses of shell adzes which explicitly stated the attributes used in their analytical processes (Appendix 3). The cataloguing method used in this study involved using Microsoft Excel to record certain attributes of each shell cutting-implement (Table 3.4).

Table 3.4. Variables and attributes utilized in this shell adze analysis.

<table>
<thead>
<tr>
<th>Discrete Variables, Provenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Catalogue Identification Number</td>
</tr>
<tr>
<td>2. Geographic Region</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Discrete Variables, Morphology</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Material (<em>Tridacna, Cassis, Terebra, Lambis</em>)</td>
</tr>
<tr>
<td>4. Shell Morphology (dorsal region, hinge region, shell body, whorl, lip)</td>
</tr>
<tr>
<td>5. Manufacturing Status (finished, preform)</td>
</tr>
<tr>
<td>6. Portion (1-6)</td>
</tr>
<tr>
<td>7. Degree of Grinding (minimal, medium, extensive, total)</td>
</tr>
<tr>
<td>8. Mid Cross Section (elliptical, elongated elliptical, oval, plano-convex, triangular, curvilinear triangle, quadrangular, irregular)</td>
</tr>
<tr>
<td>9. Butt Form (blunt, rounded, pointed, angled, bevelled)</td>
</tr>
<tr>
<td>10. Cutting Edge Shape (straight, wide curved, U-curved, pointed)</td>
</tr>
<tr>
<td>11. Bevel (flat, concave)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Continuous Variables, Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>12. Length (mm)</td>
</tr>
<tr>
<td>13. Poll Width (mm)</td>
</tr>
<tr>
<td>14. Midpoint Width (mm)</td>
</tr>
<tr>
<td>15. Cutting Edge Width (mm)</td>
</tr>
<tr>
<td>16. Maximum Width (mm)</td>
</tr>
<tr>
<td>17. Maximum Thickness (mm)</td>
</tr>
<tr>
<td>18. Weight (g)</td>
</tr>
<tr>
<td>19. Bevel Angle (°)</td>
</tr>
<tr>
<td>20. Angle of Attack (°)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Indices</th>
</tr>
</thead>
<tbody>
<tr>
<td>21. Thickness/Width Index</td>
</tr>
<tr>
<td>22. Width/Length Index</td>
</tr>
<tr>
<td>23. Thickness/Length Index</td>
</tr>
<tr>
<td>24. Taper Index (\frac{CE\text{Width} - P\text{Width}}{Length})</td>
</tr>
</tbody>
</table>
Discrete Variables
The provenance of this sample of shell adzes was restricted to recording only the catalogue identification numbers of the OM and SINM specimens and the island regions they were collected from. The remaining variables and their attributes are described below.

Material
This variable was incorporated to assess what species of mollusc was used to create the shell adze. It involved hand specimen identification, and the specimens were identifiable to at least one of four mollusc genera used in the creation of this sample of shell adzes: *Tridacna, Cassis, Terebra* and *Lambis*. Initial cross referencing with published shell adze literature (Weisler, 2001: 90-92 provides useful illustrations), and gradual familiarity with the morphological characteristics of the different shell genera were important in this process. Wherever possible the material type was narrowed down to include both the genus and species names, for example *T. maxima* or *C. cornuta*. The morphological characteristics of the shell species identified in this sample are described and illustrated in the following chapter.

Shell Morphology
Shell morphology was included as a variable to assess what part of the shell was used to create the cutting-implement. It involved basic visual assessment of the specimens as well as cross referencing with other shell adze literature and online images of shell species (Poutiers, 1998 provides useful images). Its attributes dorsal region and hinge region applied only to adzes made from *Tridacna* valves.

Distinguishing between dorsal and hinge region implements was based primarily on the presence of exterior scales and general size and thickness of the tool. Dorsal region adzes were characterised by the presence of exterior scales, and usually appeared smaller and thinner. Hinge region adzes, on-the-other-hand, were usually extensively or completely ground and much larger. They sometimes showed distinctive anatomical features or ‘markers’ of the interior hinge region. These markers included the ligament buttress and scarring from the ligament attachment tissue of the valve, and scars visible where the cardinal or lateral hinge teeth had been ground. Although, judging between hinge region and dorsal region adzes was not always straightforward. This method of differentiation is complicated, for example, by some hinge region adzes also
occasionally showing exterior scales. However, in those instances the difference in general magnitude of the adze was the determining factor. These features are illustrated in the following chapter.

Specimens recorded as being manufactured from shell body represented shell adzes manufactured from whole gastropod shells, which for this sample were only applicable to *Terebra* sp. adzes. The remaining attributes, whorl and lip, represented distinctive anatomical features of the gastropod shell species used to create the tool. The former applied only to a singular *Lambis* sp. adze identified, while the latter was applicable to *Cassis* sp. adzes.

**Manufacturing Status**
This variable was included to assess the stages of manufacture of the shell adzes, specifically if they were finished or preforms. Judgement between these two statuses was based primarily upon the degree of grinding of each specimen, particularly of the bevel. Specimens categorised as preforms typically showed little or no grinding of anatomical features of the shell (e.g. exterior scales or teeth) and, most importantly, no development of a bevel. They were shaped as adzes although were considered to be in an early stage of manufacture and not able to function as a cutting tool due to their undeveloped cutting edge. In contrast, specimens judged as being finished possessed developed bevels and were typically well-ground.

**Portion**
This variable was included to assess what portions of shell adzes were represented in the museum collections. The attributes selected for this variable were adapted from Wickler’s study of 20 Tridacna adzes excavated on Buka Island, north of Bougainville (2001: 196). He used a scale of 1-5 to record to the portion of each shell adze, although he used the term “status” instead of portion. These included 1) complete, 2) butt, 3) bevel, 4) midsection, and 5) complete with segment of bevel missing. I added a sixth attribute to the scale to accommodate complete specimens that were missing part of their butt, and a seventh attribute to take into account indeterminate portions (Table 3.5).
Table 3.5. Attributes used in the recording of adze portions.

<table>
<thead>
<tr>
<th>Portion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Complete</td>
</tr>
<tr>
<td>2) Butt</td>
</tr>
<tr>
<td>3) Bevel</td>
</tr>
<tr>
<td>4) Midsection</td>
</tr>
<tr>
<td>5) Complete with portion of bevel missing</td>
</tr>
<tr>
<td>6) Complete with portion of butt missing</td>
</tr>
<tr>
<td>7) Indeterminate</td>
</tr>
</tbody>
</table>

**Degree of Grinding**

This variable was incorporated to assess the extent of grinding of each specimen. The scale used for this variable, which ranged from minimal to total grinding, was also adapted from Wickler’s study (2001: 196). The author described minimally ground adzes as having the exterior valve surface unground, and sides/bevel ground. Medium ground adzes, he described, as having “recessed and some protruding flutes visible” (2001: 196). Extensive ground adzes were described as having only recessed flutes visible, while adzes described as total had their flutes completely ground. Modifications were made to his descriptive scale to accommodate revised anatomical terminology used in this study (i.e. he used the term “flutes” while I use the anatomical term “scales”). In addition, I have provided illustrations representing each attribute (Table 3.6).

Table 3.6. Attributes used for assessing the degree of grinding of Tridacna adzes.

<table>
<thead>
<tr>
<th>Minimal</th>
<th>Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Scales unground</td>
<td>- Recessed and some protruding scales visible</td>
</tr>
</tbody>
</table>

39
Wickler’s descriptive scale was adapted further to take into account a wider range of shell adze types in the sample including adzes made from *Cassis* and *Terebra* species. The degree of grinding of *Cassis* sp. adzes was assessed primarily by the extent at which the teeth were ground. Specimens with unground teeth were categorised as showing minimal grinding, while specimens which had been completely ground and showed no teeth were categorised as total (Table 3.7).

Table 3.7. Attributes used for assessing the degree of grinding of *Cassis* sp. adzes.

<table>
<thead>
<tr>
<th>Minimal</th>
<th>Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Teeth unground</td>
<td>- Teeth slightly ground</td>
</tr>
<tr>
<td>- Bevel and butt ground</td>
<td>- Bevel, front, back and butt ground</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Extensive</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Teeth extensively ground but outline visible</td>
<td>- Teeth completely ground</td>
</tr>
<tr>
<td>- Bevel, front, back and butt ground</td>
<td></td>
</tr>
</tbody>
</table>

Only four *Terebra* sp. adzes were identified in the sample which made it difficult to determine a comprehensive range of grinding of this adze type. Nonetheless, this variable was assessed as minimal, medium, extensive or total using a provisional scale (Table 3.8). This scale was formed by comparing the level of grinding of the *Terebra* sp. adzes available in the sample. It also drew upon Davidson’s detailed descriptions of
about 57 *Terebra* sp. adzes found on Nukuoro Atoll (1971: 52-54). It was adequate for the analysis of the small group of *Terebra* sp. adzes found in this sample. However, it is recommended a larger collection of these adzes be analysed to form a more comprehensive measure of grinding.

Table 3.8. Attributes used for assessing the degree of grinding of *Terebra* sp. adzes.

<table>
<thead>
<tr>
<th>Degree of Grinding</th>
<th>Appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal</td>
<td>Only bevel ground</td>
</tr>
<tr>
<td>Medium</td>
<td>Bevel and body whorl ground</td>
</tr>
<tr>
<td>Extensive</td>
<td>Bevel and body whorl ground; about half of spire ground</td>
</tr>
<tr>
<td>Total</td>
<td>Almost entire surface of back ground</td>
</tr>
</tbody>
</table>

**Mid Cross Section**

This variable was included to assess the variation of the shape of the midsection of the shell adzes. The attributes used in the analysis of this variable drew upon the cross section types used by Kirch and Yen (1982) and Craib (1977). The first two authors used three types: plano-convex, elliptical/oval and quadrangular. Craib used a wider range, specifically five types: elongated elliptical, elliptical, oval/circular, plano-convex and triangular. These cross section types were able to account for most of the variation in this sample of shell adzes, although some additions had to be made. This was because adzes manufactured from the hinge line of Tridacna valves and the outer lips of *Cassis* shells were found to be particularly variable in their cross section shapes. To account for their greater variation, curvilinear triangle and irregular cross section shapes were used (Figure 17).

Curvilinear triangle cross sections were created to encompass distinctive hinge region adzes made from the ligament buttress of the hinge line. The irregular cross section type was designed to accommodate the variable shape of adzes made from the outer lip of *Cassis* shells. These shell adze types are discussed in further detail in the next chapter.
It was difficult on occasions when analysing this variable to decisively categorise specimens to each shape because some of them appeared to overlap. For example, shell adzes with oval and elliptical cross sections were difficult to distinguish at times, as well as some plano-convex and triangular shapes. In these few instances, the cross section shapes were recorded as “indeterminate rounded” or “indeterminate semi-circular”.

**Butt Form**
This variable was included to assess the variation of the shaping of the butts of the shell adzes. Its attributes included a blunt, rounded, pointed, and bevelled form (Figure 18). These attributes were originally used by Kirch and Yen (1982: 213). The blunt, rounded and pointed butt forms accounted for nearly all of the variation of this feature in the sample, and could have been used on their own. The bevelled butt form was included, however, as Kirch and Yen (1982) found it in their analysis to have some potential typological significance, specifically that it was “dominantly associated with dorsal region adzes” (1982: 215). A problem with their use of this attribute, however, was that they did not specify whether the back or front of the adze was bevelled. This made it difficult to apply in my analysis. To clarify, the bevelled butt attribute used in this study applies to bevelling visible on the front of the shell adze.

---

**Figure 17. Cross section types used in shell adze analysis (back of adze facing downwards).**
Butt Form

Cutting Edge Shape

Bevel

**Cutting Edge Shape**

This variable was included to assess the variation of the shapes of the cutting edges of the shell adzes. The attributes utilised for this assessment derived from Craib’s shell adze study (1977: 36), which comprised pointed, straight, wide curved and U-curved cutting edge shapes (Figure 18). No changes were made to these attributes as they adequately accommodated the range of variation of the shell adze sample. They had an added value of contributing towards describing potential functional characteristics of the cutting-implements (discussed in following chapter).

**Bevel**

This variable was included in the analysis to record the hollowness of the bevels of the shell adzes, which was categorised as either flat or concave (Figure 18). This variable

Figure 18. Butt form, cutting edge shape and bevel attributes used in shell adze analysis.
was included in the shell adze studies by Kirch and Yen (1982) and Weisler (2001). The first two authors used the term “bevel transverse section”, and described the feature as either convex or concave. Weisler used the term “bevel” to represent this variable and the attributes “flat” and “concave”, which were reused in this study. The difference in appearance between flat and concave bevels was a striking feature in preliminary examinations of the museum samples which prompted the inclusion of this variable. Furthermore, in support of what Kirch and Yen have argued, bevel shape would likely hold considerable value to exploring functional characteristics of shell adzes (1982: 223).

**Metric Variables**

The metric variables selected in this study followed standard conventions used in shell and stone adze analysis. These included measuring adze length, poll width, adze midpoint width, cutting edge width, maximum width and thickness, and bevel angle (Figure 19). Linear measurements were taken using a calliper and recorded in millimetres to the nearest 0.5 mm. Large specimens required using a ruler or tape measure and were recorded to the nearest 1 mm. The specimens were weighed using an electronic scale, and the results were recorded to the nearest 1 g. Bevel angles were measured using a universal bevel protractor and recorded to the nearest 5 degrees. The angle of attack, or striking angle, was measured using a standard plastic protractor and was recorded to the nearest 5 degrees (see Appendix 4 for exact methods for measuring adze angles).

Angle of attack has not yet been incorporated in published shell adze studies. Simon Best defined it as “the minimum angle at which the blade will bite into the wood” (Best, 1977: 311). He found in his technological study of a collection of Auckland Museum stone adzes that the attribute “account[ed] for a massive difference in function” (Best, 1977: 311). This variable was thus included in the list of criteria to enable greater emphasis to be placed on describing functional characteristics of the cutting-implements. More specifically, I wanted to ascertain whether any patterned correlations were apparent between different ranges of striking angles and different varieties of adzes or cutting edge shapes (discussed in following chapter).
Indices
The indices calculated in this study included midpoint width/length, thickness/length and taper. Taper was calculated by subtracting poll width from cutting edge width, then dividing the answer by length (see Table 3.4 for equation). No extensive statistical manipulation was performed in this study (refer to Kirch and Yen, 1982: 218–221 for in-depth statistical analysis of a shell adze collection). These ratios were applied instead to assess basic metric correlations between the morphological attributes that would add to the description of the variation of the sample collection.

Figure 19. Metric variables used in shell adze analysis.
3.4 Summary
This chapter has provided a revised terminological system and list of criteria used in this shell analysis. It has demonstrated that methodology in descriptive analysis of shell adzes has been hindered by ambiguities in nomenclature, and argued that there is a lack of consistency in what variables and attributes should be selected. Terminological discrepancies concerning shell anatomy, definitions of cutting-implements and adze terminology have been reviewed and amendments have been suggested. This chapter has also defined the attributes used in the cataloguing process and justified reasons for their inclusion. These attributes have built upon previous shell adze studies, and are designed to accommodate a wider range of Oceanic shell adzes and be easily reapplied in future shell adze analysis. The next chapter will provide the results of the analysis of the museum sample of shell adzes.
Chapter 4 Results

This chapter provides the results of the analysis of the shell adze collections from the SINM and OM. First, it gives an overview of the sample including the total number of artefacts analysed, their degree of fragmentation, and material types. Secondly, it describes basic morphological and metric characteristics of the shell adze varieties classified in this study. Descriptions and illustrations of these shell adze varieties are categorised into the four major shell families used in the manufacture of the shell adzes which include Tridacnidae, Cassidae, Terebridae and Strombidae. Thirdly, it examines basic metric variation and similarities of the shell adzes and investigates evidence of a patterned relationship between cutting edge shape, bevel shape and angle of attack. Fourthly, it presents evidence of manufacturing processes identified in this analysis. This section examines four issues including the 1) different manufacturing techniques used, 2) a manufacturing sequence of one of the adze varieties, 3) the influence of shell morphology and biology of Tridacna valves on shell adze manufacture, and 4) evidence of butt modification of some of the Tridacna adzes. Lastly, a summary is given of this chapter.

4.1 Material

A total of 171 shell artefacts were analysed in this study (Table 4.1). Most of the sample was collected in Ontong Java (76.7%), including all of the Cassis implements and lone Lambis adze. The bivalve shell species identified among the sample collection included *T. maxima* and *T. gigas*. The gastropods identified included the helmet shell species *C. cornuta* and *C. rufa*, the auger shell species *T. maculata* and a Lambis species, most likely the Spider Conch (*L. lambis*). The vast majority of the material was manufactured from Tridacna shell (84.9%). The second largest portion was formed by the Cassis shells (12.2%). While only 4 shell adzes were made from *T. maculata*, and 1 from a Lambis shell. Most of the specimens were finished and in complete condition, with a small number being fragmented (5.3%) or in a preform state (14.8%). There was considerable morphological variation among the Tridacna adzes, particularly those made from the thick hinge region of *T. gigas*. Adzes manufactured from Cassis, Terebra and Lambis species were far more restricted, morphologically, due to the natural configuration and smaller size of the shells.
Table 4.1 Regional distribution, portion and material type of shell adzes and other shell tools in museum collections.

<table>
<thead>
<tr>
<th>Region</th>
<th>Complete</th>
<th>Bevel Frag.</th>
<th>Butt Frag.</th>
<th>Other*</th>
<th>Tridacna</th>
<th>Cassis</th>
<th>Terebra</th>
<th>Lambis</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ontong Java</td>
<td>99</td>
<td>4</td>
<td>2</td>
<td>26</td>
<td>107</td>
<td>21</td>
<td>2</td>
<td>1</td>
<td>131</td>
</tr>
<tr>
<td>Sikaiana</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Reef Islands</td>
<td>6</td>
<td>1</td>
<td></td>
<td></td>
<td>6</td>
<td>1</td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Santa Cruz</td>
<td>17</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td>19</td>
</tr>
<tr>
<td>Tikopia</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Mono Island</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Makira</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Malaita</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>New Georgia</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Bougainville</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Torres Islands</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Unknown</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>135</td>
<td>6</td>
<td>2</td>
<td>28</td>
<td>145</td>
<td>21</td>
<td>4</td>
<td>1</td>
<td>171</td>
</tr>
</tbody>
</table>

*Includes adze preforms, a Tridacna hammerstone and possible grinding shell.

4.2 Description of Shell Adze Varieties

This analysis is basically descriptive and utilises a general classification scheme based primarily on material and shell morphology. The main adze varieties discussed include dorsal region adzes, hinge region adzes, *Cassis* sp. adzes, *Terebra* sp. adzes and *Lambis* sp. adzes. Finer variation within these adze varieties is distinguished on the basis of distinct morphological appearances of the adzes. The finer adze varieties described include ‘fold adze-gouges’ made from the folds of *T. gigas* and ‘beaked adzes’ made from the hinge region of *T. gigas*.

**Tridacnidae**

Of the 143 cutting-implements manufactured from Tridacna shell, 33 of them (23.1%) were adzes made from the dorsal region of the valve while 110 items (76.9%) were made from the hinge region. The dorsal region adzes were made primarily from *T. maxima*, apart from two large adze-gouges made from the fold of *T. gigas*. The hinge region cutting-implements included 103 adzes, 2 chisels, 2 gouges and 3 ‘waisted’ shell axes (two axes illustrated in Figure 40b and d). Most, if not all, of the hinge region adzes were manufactured from the larger *T. gigas*, although some of the smaller specimens may have well been made using the hinge of *T. derasa or T. maxima*. 
Dorsal Region
Dorsal region adzes were fairly uniform in their morphological variation, generally appearing small, thin and either triangular or trapezoidal with sides divergent towards the cutting edge (Figure 20). The extent of surface grinding ranged from medium to extensive. Exterior scales on dorsal region adzes were almost never completely ground. The cross section shapes varied evenly between elongated elliptical, elliptical and quadrangular. The fold adze-gouges had elongated elliptical cross sections which were curved (Figure 20f). The butt forms were mostly blunt or rounded in shape, although some were also sharply pointed (Figure 20c). In plan the cutting edges appeared universally straight, apart from some wide curved exceptions (Figure 20a) and the fold adze-gouges which were U-curved.

Figure 20. Dorsal region adzes illustrating the range of variability of butt forms, cross sections, and cutting edge shapes. All are finished and made from T. maxima, apart from a T. gigas fold adze-gouge (f).

There was very little curvature of the bevels of these adzes apart from those made from the fold. The bevels were predominantly flat or occasionally slightly convex, and showed a low range in bevel angle of 40 to 75 degrees, with a median of about 55
degrees. On average, they measured approximately 80 mm in length, 50 mm in maximum width and 15 mm in thickness.

**Hinge Region**

Of all the shell adzes in the sample, those made from the hinge region displayed the widest range of morphological variation. There was considerable variation in the extent of surface grinding among both the preform (N=15) and finished (N=91) specimens. Although, finished hinge region adzes generally appeared well-ground, as was supported by about 85% of the sample appearing either extensively or completely ground. The adzes categorised as preforms lacked developed bevels and typically displayed minimal grinding. Many of these preforms, particularly among the Ontong Java collection, showed a commonality in being manufactured with the ridge-like ligament buttress feature of the valve forming the butt (Figure 21a and c).

Figure 21. Hinge region preforms. Specimens a and c are made with ligament buttresses forming the butt. Large hinge tooth scar visible on front of specimen b.
Hinge region adzes showed the widest range of cross section shapes, with plano-convex, elliptical and triangular shapes being most prevalent. The distinctive triangular cross section type was only identified among hinge region adzes, and this feature was commonly associated with a beaked cutting edge and concave bevel (Figure 22b). Similar to the dorsal region adzes, the butt forms of the hinge region adzes were typically blunt or rounded in shape, with some occasionally appearing pointed. Hinge region adzes showed the most evidence of bevelling of the butt, which presumably served to enhance hafting (Figure 22c).

Figure 22. Finished hinge region adzes illustrating the range of variability of their general size, cross sections and cutting edge shapes.
There was considerable cross variation between the shape of the cutting edges of hinge region adzes and the hollowness of their bevels. Although this was the case, these two variables were particularly significant in differentiating among various forms. In contrast to dorsal region adzes, the cutting edges of hinge region adzes were primarily curved in shape. The most common variety of these adzes had a wide curved cutting edge and flat bevel (Figure 22a and d). Beaked cutting edges and straight cutting edges were less common, and the latter almost always possessed flat bevels due to the curvature required to form a concave bevel (Figure 22f). Adzes with deep U-shaped cutting edges varied evenly between flat and concave bevels, and were commonly associated with plano-convex cross section (Figure 22e). Some specimens were classified as chisels, appearing uniformly narrow and oval-like in cross section (Figure 23). Two of these specimens had concave bevels and were classified as gouges; one of them possessed an unusually elongated bevel (Figure 23d). Overall, hinge region adzes varied extensively in length, width and thickness. On average, they measured about 135 mm in length, 55 mm in maximum width and 30 mm in thickness. These adzes possessed a relatively high range of bevel angle of 40 to 90 degrees, with a median of 60 degrees which was slightly higher compared to dorsal region adzes.

Figure 23. Varieties of chisels (a and c) and gouges (b and d).
Cassidae

Of the 21 Cassis sp. adzes identified in the sample, 11 of them were manufactured from the outer lip of C. cornuta and 10 from the outer lip of C. rufa. Most of these specimens were finished, apart from 3 of the C. cornuta adzes and 5 of the C. rufa adzes. Differentiating between the two species was based upon the overall size of the implements and the appearance of the teeth of the outer lip. C. cornuta adzes were generally much larger and their outer lip teeth appear widely spaced and rounded. In contrast, C. rufa adzes were generally smaller and the teeth of their outer lip appear closely spaced and narrower.

Cassis cornuta

Adzes manufactured from the outer lip of this species of shell were generally long, curved and tapered slightly from a narrow poll towards a wider cutting edge. There was wide variation in the extent of surface grinding of finished specimens. Some were extensively ground so that the teeth were almost completely reduced and the entire surface of the adze was smooth (Figure 24a). Others were ground only on the back and bevel to form a suitably flat hafting surface and functional bevel (Figure 24c). The cross sections were mostly elongated and irregular in shape. Most of the butt forms retained their original blunt shape, although few extensively ground specimens had pointed or rounded polls (Figure 24b).

![Figure 24. Finished Cassis cornuta adzes. Specimen b is shorter from attrition and resharpening.](image)
The cutting edges were typically wide or U-shaped in shape, and most of the bevels were flat. Some bevels were concave (Figure 24a), although, were shallow compared to hinge region adze-gouges. *C. cornuta* adzes were characterised by an average bevel angle of about 45 degrees, and usually measured about 160 mm in length, 45 mm in maximum width and 28 mm in thickness.

*Cassis rufa*

In contrast to *C. cornuta* adzes, this variety appeared shorter, straighter, and relatively consistent in width from poll to cutting edge. Finished *C. rufa* adzes generally exhibited a higher degree of grinding, often over virtually the entire surface of the tool. The cross sections were also irregularly shaped, but appeared noticeably more rounded or oval-like. The polls of the finished specimens tended to be ground down to a blunted or rounded form, although one was pointed (Figure 25a). The cutting edges were predominantly U-shaped and the bevels flat. There was only one instance of a shallow concave bevel (Figure 25b).

![Figure 25. Finished Cassis rufa adzes (a and b) and wedges (c-e).](image)

54
Three of these implements were classified as wedges, most likely made from the outer lips of juvenile *C. rufa* shells (Figure 25 c-e). They measured approximately 60 to 70 mm in length and 14 mm in maximum width, and tapered to a narrow cutting edge. The bevel angle of *C. rufa* adzes ranged from 45 to 60 degrees, similar to *C. cornuta* adzes, but with a slightly higher average of about 50 degrees. On average, *C. rufa* adzes measured 106 mm in length, 23 mm in maximum width and 18 mm in thickness.

**Terebridae**

*Terebra* sp. adzes were particularly uniform in their morphology. Although the assessment of the variation of this adze type was based upon 4 analysed specimens, they are conventionally characterised by their cone shape, layered shell body exterior and interior columella structure. Finished specimens tended to be ground extensively on the back of the adze to create an almost completely flat surface for hafting (Figure 26a and b). The cutting edges were distinctly U-shaped and the bevels concave. The bevel angle and striking angle of these adzes measured to approximately 50 degrees and 30 degrees respectively. On average, these adzes measured 93 mm in length, 37 mm in maximum width and 20 mm in thickness.

![Figure 26. *T. maculata* adzes. Specimens a and b are finished. Specimens c and d are preforms.](image-url)
Strombidae
Only one *Lambis* sp. adze was identified (Figure 27). It was manufactured from the body whorl of, mostly probably, *L. lambis* and appeared triangular with sides divergent towards the cutting edge. Its bevel, sides and poll were ground. Similar to the Tridacna fold adze-gouges, the *Lambis* sp. adze had an elongated elliptical cross section that was curved. The cutting edge was U-shaped and the bevel concave. This specimen had an acute bevel angle of 30 degrees, similar in range to the dorsal region adzes, and a striking angle of 30 degrees. It measured 109 mm in length, 57 mm in maximum width and 15 mm thick.

![Figure 27. Lambis sp. adze.](image)

4.3 Metric Variation & Correlations
Shell adzes manufactured from the dorsal and hinge regions of Tridacna valves and the outer lip of *Cassis* species demonstrated noticeable patterns of similarity and difference in their some of their metric attributes. Length and thickness demonstrated the highest degree of variation between these adze groups. In contrast, cutting edge width, bevel angle and angle of attack showed patterns of uniformity. Due to the proportionally small sample size of *Terebra* sp. and *Lambis* sp. adzes, the variation of their metric results have not been included in this section.

Length and Thickness
Hinge region adzes demonstrated the widest range in length (Figure 28). The smallest specimen measured 34 mm and resembled Kirch and Yen’s (1982) microadze type, while the largest specimen was 10 times as long, measuring an impressive 351 mm in length (see Figure 43, Chp. 5). *Cassis* sp. adzes ranged considerably in length as well.
Those made from the smaller *C. rufa* species never exceeded beyond 130 mm. In contrast, the adzes made from *C. cornuta* shells were noticeably larger, measuring an average of 160 mm in length. Dorsal region adzes showed the least amount of variety in length, with most falling within a range of 90 to 120 mm.

![Figure 28. Histogram of length for hinge region, dorsal region and *Cassis* sp. adzes.](image)

Hinge region adzes were by far the thickest adze variety and demonstrated the highest degree of variation of this attribute (Figure 29). Dorsal region adzes were typically the thinnest variety, possessing an average thickness of around 15 mm. *Cassis* sp. adzes showed some variation in thickness, however, on average, they measured around 22 mm thick.

![Figure 29. Histogram of thickness for hinge region, dorsal region and *Cassis* sp. adzes.](image)
Comparing the relationship between the thickness and width index and thickness and length index of these adze varieties reinforced key differences in their metric qualities (Figure 30). Hinge region and *Cassis* sp. adzes were far more variable in their combinations of length, width and thickness compared to dorsal region adzes. Hinge region adzes showed the most variation in their thickness to length ratio, although the majority were longer than they were thick. In addition these adzes were generally broad, often measuring wider than they were thick. In contrast, *Cassis* sp. adzes were narrower bodied and tended to be thicker than they were wide. Dorsal region adzes were far more limited in their overall shape, predominantly appearing slimmer and wider in relation to their length.

![Figure 30. Scatterplot of thickness/width index by thickness/length index for hinge region, dorsal region and *Cassis* sp. adzes. Striped images adjacent to axes illustrate change of shape of the adze corresponding to the increase in ratio.](image)

**Cutting Edge Width and Adze Angles**

The cutting edge widths of the three adze varieties showed some regularity (Figure 31). Most of these shell adzes had cutting edges that measured between 40 to 60 mm, although there were some deviations. Adzes manufactured from the outer lip of *C. rufa*, including the small wedge implements, had distinctly narrow cutting edges which measured an average of 17 mm in width. Larger, wide curved dorsal region and hinge
region adzes possessed the highest range of cutting edge width, ranging between 70 to 100 mm.

![Histogram of cutting edge width for hinge region, dorsal region and Cassis sp. adzes.](image)

Figure 31. Histogram of cutting edge width for hinge region, dorsal region and Cassis sp. adzes.

The angle of attack and bevel angle of these shell adzes were relatively consistent (Table 4.2). The striking angles of the adzes exhibited little deviation from 30 degrees. Only a minor difference was evident between the dorsal region and Cassis sp. adzes, which indicated the former variety was more likely used at a slightly steeper angle to cut into the working surface. This may also reflect upon the durability of the Tridacna adzes which were able to be struck at a higher angle and thus experience more resistive force than the other more less robust shell adze materials. Most specimens had a bevel angle that fell within a range of 50 to 60 degrees. Although hinge region adzes typically formed the upper end of the spectrum due to their thicker, more bluntly edged bevels. In opposition, Cassis sp. adzes exhibited the lowest range of bevel angle due to their generally flatter and sharper edged bevels.

Table 4.2. Lowest, highest and median ranges of angle of attack and bevel angle of hinge region, dorsal region and Cassis sp. adzes.

<table>
<thead>
<tr>
<th>Adze Variety</th>
<th>Angle of Attack (°)</th>
<th>Bevel Angle (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lowest</td>
<td>Highest</td>
</tr>
<tr>
<td>Hinge Region Adzes</td>
<td>20</td>
<td>45</td>
</tr>
<tr>
<td>Dorsal Region Adzes</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>Cassis sp. Adzes</td>
<td>20</td>
<td>40</td>
</tr>
</tbody>
</table>

59
**Correlation of Angle of Attack with Cutting Edge and Bevel Shape**

Adzes made from the hinge region of Tridacna shell, which comprised the largest sample of finished specimens from one adze variety in this collection (N=87), demonstrated a patterned relationship between their angle of attack and cutting edge shape. Straight edged adzes generally exhibited the highest angle of attack, with an average of approximately 32.2 degrees. They were followed by wide curved, U-curved and lastly by beak shaped adzes which possessed the lowest average striking angle of roughly 25.6 degrees (Table 4.3).

Table 4.3. Lowest, highest and median ranges of angle of attack of hinge region adzes corresponding to cutting edge shape.

<table>
<thead>
<tr>
<th>Cutting Edge Shape</th>
<th>Angle of Attack (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lowest</td>
</tr>
<tr>
<td>Straight</td>
<td>20</td>
</tr>
<tr>
<td>Wide Curved</td>
<td>20</td>
</tr>
<tr>
<td>U-Curved</td>
<td>20</td>
</tr>
<tr>
<td>Pointed (Beaked)</td>
<td>20</td>
</tr>
</tbody>
</table>

The relationship between the striking angle and cutting edge shape of these adzes indicated that there was a negative correlation between the curvature of the cutting edge and the minimum angle at which the adze would theoretically bite into the working surface. Specifically, it appeared that the more abruptly curved or pointed the adze was, the lower its striking angle tended to be. This is reflected by the adzes with highly arched U-curved cutting edges and beaked cutting edges generally having lower striking angles than adzes with wide curved and straight cutting edges. Furthermore, this relationship signified that the more focalised the first point of contact the cutting edge of the adze made with the working surface, the lower its striking angle tended to be. For example, the bevels of beaked and U-curved adzes were shaped so that they cut into the working surface at the very centre of their cutting edges. In contrast, adzes with straight cutting edges were designed to cut into the working surface using the entire edge of the blade.

The shape of the bevel of hinge region adzes demonstrated to have influenced the angle of attack of only its U-curved and beaked varieties (Figure 32). Adzes with straight cutting edges showed no difference in this respect as they possessed only flat bevels.
Adzes with wide curved cutting edges, which varied between flat and concave bevels, exhibited virtually no difference in their average striking angles. U-curved adzes, on the other hand, exhibited a minor difference in this respect. Those with flat bevels were generally able to cut into the working surface at a slightly lower angle than those with concave bevels. Beaked adzes demonstrated the greatest difference between the average striking angles of its concave and flat bevelled varieties. For these adzes, it was indicated that concavity of the beaked shaped bevel could enable them to cut into the working surface at an angle more parallel with the working surface compared to those with flat bevels.

Figure 32. Average striking angles of wide curved, U-curved and beaked hinge region adzes corresponding to bevel shape.

4.4 Evidence of Manufacturing Processes
Using the available sample of preforms and finished adzes, four issues related to the manufacturing processes of the shell adzes were investigated. The first involved examining evidence of the different manufacturing techniques used in the creation of the Tridacna adzes. The second entailed reconstructing a manufacturing sequence of the Cassis sp. adzes. The third involved examining the influence of shell morphology and biology of Tridacna valves on shell adze manufacture. The fourth technological issue concerned butt modification of the Tridacna adzes.
**Manufacturing Techniques**

Direct percussive techniques, specifically light or coarse chipping to remove flakes and bruising to reduce surfaces, were most apparent among the Tridacna adzes (Figure 33). In Figure 33, the preforms (b, c, and d) show evidence of an early stage of the shaping process of the adze blanks which involved light chipping of their sides and cutting edges. This method of chipping or light flaking of the edges of the adze blanks predominantly appeared unidirectional with percussive force being applied to the face of the adze formed by the exterior surface of the valve. For dorsal region preforms, this resulted in small flake scars being visible on the front of the adze (Figure 33b). While for hinge region preforms, small flake scars were visible on the back of the adze (Figure 33c). Chipping appeared to be an important process in the manufacture of the Tridacna adzes, however, it was often untraceable due to the extensive grinding of the finished specimens.

![Figure 33. Evidence of chipping and bruising of Tridacna adzes. Specimen a is a finished hinge region adze. Specimen b is a dorsal region preform. Specimens c and d are hinge region preforms.](image)
Bruising was also evident in the Tridacna sample (Figure 33a and c). These surfaces appeared dulled down by repeated blows most likely from rounded hammerstones, and served to help level the sculptured exterior valve surface. Grinding and polishing typically formed the final stages of manufacture. This ranged from minimal grinding of the bevel and sides only, to total grinding that obliterated all natural features of the valve, as in the case of most of the hinge region specimens.

**Manufacturing Sequence of *C. cornuta* Adzes**

Two manufacturing sequences were reconstructed using a series of preforms and finished adzes made from the outer lips of *Cassis* species shells. One sequence was reconstructed using the sample of adzes made the outer lip of *Cassis cornuta* (Figure 34), and the other from the sample of adzes made from the outer lip of *Cassis rufa* (Figure 35).

![Manufacturing sequence of *Cassis cornuta* adzes. Ventral view of *C. cornuta* shell is shown with the outer lip outlined in bold. Adzes are arranged to show the reductive process from preforms (a-c) to finished specimens (d and e).](image)

The first stage in the manufacturing sequence of *C. cornuta* adzes involved detaching the outer lip from the shell using percussive force to create the adze preform (Figure 34a). Once detached, the second stage involved coarse chipping of the anterior and
posterior ends of the outer lip to achieve the desired length. This stage also involved lighter chipping of the curved lateral edges of the outer lip to prepare the back surface to be ground (Figure 34b). The third stage involved grinding the roughed out edges and surfaces of the back to begin to flatten the hafting surface and shape the bevel (Figure 34c). The final stage of manufacture entailed grinding the bevel to create a sharp cutting edge. Some finished specimens showed additional grinding of their teeth to reduce their prominence, and of the butt to alter it from a blunted shape into more pointed form (Figure 34d and e).

The stages of manufacture of the smaller C. rufa adzes followed a similar pattern. However, they usually exhibited a greater degree of surface grinding. The first stage involved detaching the outer lip from the shell to create the adze preform, followed by immediate grinding of the broken surface (Figure 35a). The second stage entailed chipping the pointed anterior end of the outer lip to serve as the bevel end of the adze (Figure 35c). The third stage involved the removal of the ridge of teeth on the back of the adze by initial chipping and subsequent grinding (Figure 35d). The final stage entailed more extensive grinding of the back, to create an almost completely flat hafting surface, and bevel to fashion a sharp cutting edge. The butt was also ground, sometimes to the extent of creating a blunt or rounded form (Figure 35e).

Figure 35. Manufacturing sequence of Cassis rufa adzes. Ventral view of C. rufa shell is shown with the outer lip outlined in bold. Adzes are arranged to show the reductive process from preforms (a-c) to finished specimens (d and e).
Two distinctive manufacturing patterns were evident when comparing the manufacturing sequences of *C. cornuta* and *C. rufa* adzes. The first was that the anterior end of the outer lip was always used to form the bevel end of the adze. For *C. cornuta* adzes, it was theorised that this manufacturing pattern could be explained by the difference in the natural shape of the two ends of the outer lip. Specifically, the anterior end of the outer lip appeared better suited to serve as a bevel as it was less irregularly curved than the posterior end. For *C. rufa* adzes, on-the-other-hand, determining the reason for this pattern was more challenging as there was no marked difference in shape between the anterior and posterior ends of the outer lip. There does not appear to be any functional differences between the two ends, thus perhaps it was influenced by personal preference in working technique. The second distinctive manufacturing pattern observed was that the interior surface of the outer lip was always chosen to form the back of the adze. For both *C. cornuta* and *C. rufa* adzes, it was inferred that this pattern was indicative of the adze-makers taking advantage of the naturally smooth exterior surface of the outer lip and focusing efforts on grinding only the detached surface.

**Tridacna Valve Morphology and Manufacture**

The unique biological and morphological characteristics of the shell species used in the creation of this sample of adzes played highly influential roles in the adze-making processes and variation of the finished adze forms. This was particularly evident within the larger sample of adzes manufactured from *Tridacna* valves.

**Tridacna maxima**

The limited natural size of *T. maxima* and the relatively level surface of the dorsal region of it valves were important morphological factors in the production of shell adzes made using this species. The species can reach lengths of up to 350 mm, which is less than a third of the size of *T. gigas*, and typically inhabits reefs along shallow waters where they partially imbed themselves in coral (Rosewater, 1965: 387). Their exterior valve sculpturing is highly variable, due partly to their moulding into coral crevices. Although this feature, specifically the raised appearance of their scales, is what distinguishes them differ from other *Tridacna* species (Rosewater, 1965: 384). *T. maxima* are typically elongate to triangular in shape, and due to their small size no more than two adzes can be manufactured from the dorsal region of each valve (Gifford and Gifford, 1959) (Figure 36).
Figure 36. Interior and exterior views of *T. maxima* valves. Dorsal region used for adze manufacture is outlined in bold (image adapted from Moir, 1986: 106 and Copland and Lucas, 1988: 25).

Adzes manufactured from the dorsal region of *T. maxima* valves were characterised by two distinctive morphological features. The first was the appearance of densely-layered, semi-tubular scales on the back of the adze. These scales were most commonly visible in recessed fold interstices and extended in an oblique or right angled orientation to the longitudinal axis of the adze (Figure 37b). Remnants of these scales were almost always visible as adzes made from this species were rarely completely ground. The second distinctive morphological feature of *T. maxima* dorsal region adzes was an undulated or wavy appearance of the front of the adze. This feature was usually limited to thinner dorsal region adzes (Figure 37a), although some thicker specimens also showed slightly undulated surfaces (Figure 37b).

Figure 37. Distinctive morphological features of dorsal region adzes manufactured from *T. maxima* valves.
*Tridacna gigas*

The enormous size of *T. gigas* and its particularly thick hinge were integral morphological factors in the adze-making processes. It is the largest known species of bivalve, growing to 1.7 m in length and weighing up to over 300 kg (Rosewater, 1965: 369). In contrast to *T. maxima*, this species relies on its weight to anchor itself to the sandy lagoon bottom and its valves are fan-shaped. Their exterior valve sculpturing typically appears smoother or more worn compared to *T. maxima*. These valves can also be distinguished by the highly convex and uneven plane of their dorsal regions. Young *T. gigas* valves can appear very similar to the second largest Tridacnidae species, *T. derasa*, which can complicate confident identification (Rosewater, 1965: 375). However, this species grows up to approximately 50 cm in length or only half the size of *T. gigas* (Rosewater, 1965: 376). Therefore, Tridacna adzes exceeding over 30 cm in length can confidently be identified as being manufactured from *T. gigas*. Dependant on the size of the valve and desired magnitude of the tool, multiple adzes could be made from the hinge region of this species.

Figure 38. Interior and exterior views of *T. gigas* valves. Morphological portions of *T. gigas* valves used in shell adze-manufacture are outlined in bold (image adapted from Moir, 1986: 105 and Copland and Lucas, 1988: 22).
Apart from the occasional use of the folds of *T. gigas* valves, the hinge region was
demonstrated in this sample to be the most important and frequently used segment in
adze-making (Figure 38). In particular, the hinge line and umbo portions were most
commonly used. In addition to their noticeable difference in magnitude and typically
high degree of grinding, adzes made from the hinge region of *T. gigas* valves were
characterised by three anatomical features. The first was the appearance of the exterior
scales which were more evenly and widely spaced compared to *T. maxima* (Figure
39a). The second was the thick ligament buttress feature which usually formed the butt
end of the adze. The third was the very thick and rounded shape of adzes made from the
umbo portion of the valve (Figure 39b). It was also observed in this sample that these
adzes were usually positioned so the naturally thickest portion of the valve formed the
butt, thinning towards the cutting edge.

Figure 39. Distinctive morphological features of hinge region adzes manufactured from *T.
gigas* valves.

**Butt Modification**
Evidence of butt modification was observed among some of the hinge region adzes.
These included the creation of singular or opposing notches or ‘waists’, and the
reduction of the side of the butt to create a lateral shoulder (Figure 40). In Figure 40,
specimen a has been flaked on its previously ground lateral surface, with powerful
force being applied directly upon one side of the adze to create a large depression.
Specimens b and d have been flaked bilaterally to create opposing notches or waists.
Specimen b’s waist is located much nearer to the cutting edge than specimen d although it possible that the blade has been reduced overtime from use and resharpening, and the notches were originally created closer to the poll. The butt of specimen c was modified by the flaking and removal of a large portion of its side. This method of reduction of the butt was unique to this specimen, and created the appearance of a lateral shoulder more commonly seen among ‘shouldered’ stone adzes.

Figure 40. Evidence of butt modification presumably to facilitate hafting.

4.5 Summary
This chapter presented the results of the descriptive analysis of this shell adze sample. It provided an overview of the material used in the manufacture of the shell adzes and described the morphological and metric characteristics of the main adze varieties classified in this study. This included dorsal region adzes, hinge region adzes, Cassis sp. adzes, Terebra sp. adzes, and a single Lambis sp. adze. Finer adze varieties were described including fold adze-gouges and beaked adzes, as well as other cutting-implements types including chisels, gouges, wedges and waisted axes. This chapter examined patterns of metric variation and similarity between the dorsal region, hinge
region and *Cassis* sp. adzes. These results demonstrated adze length and thickness to be the most variable attributes, while cutting edge width, bevel angle and angle of attack exhibited evidence of regularity and presented some correlations. This chapter also presented findings related to the technological processes involved in the production of the shell adzes. It examined evidence of manufacturing techniques and sequences, butt modification, and the influence of valve morphology and biology in the making of the *Tridacna* adzes. The next chapter will provide a discussion of these findings and the implications of this study for systematising and improving methodology in shell adze study.
Chapter 5 Discussion and Conclusions

5.1 Summary of Shell Adze Sample

The SINM and OM shell adze samples collected from Solomon Islands demonstrated a wide range of morphological and metric variability. Most of the specimens were collected in Ontong Java, and were in complete condition. Only a small portion were fragmented (5.3%) or in a preform state (14.8%). The materials types used in the production of these implements included a range of molluscs belonging to the taxonomic families Tridacnidae, Cassidae, Terebridae and Strombidae. These included at least two giant clam shell species, T. maxima and T. gigas, and three large gastropods species, C. cornuta, C. rufa, and a species of Lambis, most probably L. lambis. Distinct morphological portions of these shell species were used to create the cutting-implements. The large majority (65%) were made from the very thick hinge region of T. gigas valves. The other shell portions identified included the sculptured dorsal region of T. maxima, the outer lips of C. cornuta and C. rufa, and part of the curved shell whorl of a Lambis species. For Terebra sp. adzes, the entire shell body was used.

The tools made from these shell portions were classified into five main adze varieties: hinge region adzes, dorsal region adzes, Cassis sp. adzes, Terebra sp. adzes and a lone Lambis sp. adze. Within these adze categories, finer variation between the specimens was distinguished by distinctive morphological appearances. Specifically, these finer adze varieties included 2 fold adze-gouges made from the folds of T. gigas and 9 beaked adzes made from the hinge region of T. gigas. Other cutting-implement types identified included 2 chisels, 2 gouges and 3 ‘waisted axes’ made from the hinge region of T. gigas, and 3 wedges most likely made from the outer lip of juvenile C. rufa shells.

Of the five main adze varieties, those made from the hinge region of T. gigas demonstrated by far the most morphological and metric variation. These adzes typically appeared well-ground and noticeably thick, and were described in this study according to differences in their distinct cutting edge and bevel shapes. The most common variety of hinge region adze had a wide curved cutting edge and flat bevel. The remaining varieties included adzes with U-curved cutting edges which possessed either flat or concave bevels, adzes with beaked and concave bevels, and adzes with straight cutting edges and flat bevels.
The remaining four main adze varieties were more restricted in their morphological and metric variation. Dorsal region adzes made from *T. maxima* generally appeared small, slim and either triangular or trapezoidal with sides divergent towards a straight cutting edge. *Cassis* sp. adzes included two varieties both made from detached outer lips. *C. cornuta* adzes generally appeared longer, more curved and tapered slightly from a narrow poll towards a wider cutting edge. In contrast, *C. rufa* adzes appeared shorter, straighter and relatively consistent in width from poll to cutting edge. *Terebra* sp. adzes were characterised by their distinctive cone shape, layered shell body exterior and interior columella structure. The cutting edge of this variety was distinctly U-shaped and concave. The individual *Lambis* sp. adze appeared triangular in plan with sides divergent towards a U-shaped and concave bevel. Similar to the fold adze-gouges, the *Lambis* sp. adze had a distinctly curved cross section.

### 5.2 Technological, Ecological and Functional Implications

Descriptive analysis of museum collections of shell adzes which lack provenance has been demonstrated in the past to be valuable for examining spatial relationships between prehistoric island societies and regional variability of shell adze forms (Rosendahl, 1969; Emory, 1975; Craib, 1977). However, these collections hold little value for assessing chronological changes or temporal sequences of the artefact class. Therefore, this study has demonstrated that shell adze assemblages which lack stratigraphic control may be of more use to archaeologists for learning about the prehistoric tool-making technology and inter-island interaction if analysed with a multifaceted approach. Such an approach should aim to incorporate technological, functional and ecological issues in the descriptions of the adzes as opposed to focusing solely on morphological variation of adze types.

**Technology**

The technological issues examined in this study included manufacturing techniques of Tridacna adzes, manufacturing and grinding sequences of *Cassis* sp. adzes, and butt modification. As no shell debitage and few preforms were available in the sample, investigating what techniques were used in the making of the Tridacna adzes was restricted mostly to analysing evidence of direct percussion and grinding of finished adzes. The results indicated that initial shaping of the adze blank generally involved a mixture of coarse and light chipping of the edges of the preform. Evidence of chipping
appeared unidirectional with percussive force being applied to the face of the adze formed by the exterior surface of the valve. Flaking from the exterior valve surface downwards appears relatively common in Oceanic shell working processes, at least in Melanesia, having been observed by Kirch and Yen in their analysis of Tikopia shell adzes (1982: 210) and Wickler in his study of shell adzes from Buka Island (2001: 194). Bruising or the dulling down of sculptured valve surfaces was also apparent among some of the preforms and appeared to be an important stage in their manufacturing process. Although, this was difficult to substantiate given that evidence of bruising and chipping were usually untraceable from extensive grinding. Overall, this process from roughing out to final grinding reflected practices of Tridacna adze working that have been widely observed in prehistoric Pacific assemblages (Kirch and Rosendahl, 1973: 68; Rosendahl, 1987: 105), and which are well documented in archaeological literature (Szabo, 2004, 2008; Smith and Allen, 1999).

Manufacturing processes of Cassis sp. adzes have not been as well described in shell adze literature. Emory (1975) analysed one of the largest recorded samples in the Pacific of C. rufa adzes in his study of Tuamotu Archipelago. He identified a manufacturing pattern among this adze variety, arguing that once detached from the shell, the broken surface of the outer lip would be ground to form the front of the tool while the cutting edge would be ground on the opposite face and “always at the same end of the lip – the apex” (Emory, 1975: 110) (Figure 2, Chp. 2). This contrasted to the manufacturing sequences of C. rufa and C. cornuta adzes in this sample. These Ontong Java adzes were consistently manufactured with the broken surface of the outer lip forming the back of the adze, and with the anterior end (opposite to the apex) forming the bevel end of the adze. Interestingly, this pattern has been observed on specimens from Western Marianas (Craib, 1977: Fig. 12a) and Utrok Atoll in Marshall Islands (Weisler 2001: Fig. 6.6a) (Figure 41). The similarity between these manufacturing sequences has some implication for reinforcing well-established linguistic and archaeological evidence for widespread cultural interaction between prehistoric societies in the western Pacific region (Alkire, 1965; Kirch, 1991; Rehg, 1995; among others). Inter-island interaction in this region was particularly noteworthy between Ontong Java and other Polynesian Outliers (Hogbin, 1941; Bayliss-Smith, 1975; Bayard, 1976; Kirch, 1984). Adzes have also been manufactured from the inner lip of Cassis shells. This variety has appeared less frequently in prehistoric assemblages,
although has a recorded distribution as wide as those manufactured from outer lip portions (Rosendahl, 1969; Davidson, 1971; Emory, 1975; Kirch and Yen, 1982).

**Figure 41.** *C. rufa* adze (left) from Marshall Islands (Weisler, 2001: 92) and Type 3 *C. cornuta* adze (right) from Western Marianas region (Craib, 1977: 66). Both ground in similar pattern to Ontong Java *Cassis* sp. adzes.

Butt modification of shell adzes, specifically evidence of notched sides and frontal or lateral reduction of the butt, has received little archaeological attention. Australian archaeologist Mark Rawson examined four shell adzes “showing concave notches or waists” from a collection of 334 shell adzes in the Australian Museum collected from Banks Islands (1988: 17). He argued that shell adzes showing waisting or butt modification as hafting aids are rarely featured in western Pacific assemblages, or have generally been overlooked in previous archaeological studies (Rawson, 1988: 17). Some examples include a hinge region adze from Nukuoro showing stepped reduction or bevelling of the front of the butt (Davidson, 1971: Fig. 26a), a laterally flaked dorsal region adze from Anuta (Kirch and Rosendahl, 1973: 21d), and tanged shell adzes from Tuamotu (Emory, 1975: Fig. 88). Apart from the tanged shell adzes which are unique to the Tuamotu assemblage, the hinge region adzes from Ontong Java analysed in this study showed similar features of butt modification. Specifically, some of the beaked adzes with bevelled butts appeared identical to Davidson’s finding on Nukuoro (Figure 42). The ‘shouldered’ hinge region adze analysed in this sample has not featured in other shell adze study and appears localised to the Ontong Java collection (Figure 40, Chp. 4). Shell adzes showing butt reduction and other modifications accounted for less than 1% of this sample. However, these traits usually appeared very distinctive and
have potential significance for assessing spatial and cultural interactions between prehistoric societies.

Figure 42. Beaked adze from Nukuoro showing stepped reduction (Davidson, 1971: 60).

Ecology
The ecological issues included in this analysis were the influence of morphological properties and biological development of *T. gigas* and *T. maxima* on the manufacturing processes of the Tridacna adzes. The drastic difference in growth of these two species was a determining factor in the range of stylistic variation the prehistoric tool-makers were able to produce. Adzes made from the dorsal region of the smaller *T. maxima* were demonstrated to be relatively limited in their form. No adzes were positively identified as being made from the hinge region of *T. maxima* in this sample, however, those that have been observed in other assemblages have demonstrated a slightly higher range of variation (Kirch and Rosendahl, 1973; Kirch and Yen, 1982; Kirch, 1983; Davidson, 1971). In contrast, the greater thickness and morphological plasticity of *T. gigas* valves provided adze-makers with, what Weisler (2001: 86) fittingly described, a virtual “open slate” for manufacture. This was exemplified by the hinge region adzes exhibiting the highest degree of variation among the adze varieties. The unique morphological and anatomic features of these species were also demonstrated to be crucial to the process of classifying and differentiating between the adze varieties.
Barbara Moir (1986) has emphasised the importance of acknowledging ecological issues in shell adze study. Using data from available archaeological literature, she proposed an ecologically based model useful for the comparative analyses of assemblages between island groups and across marine habitats. She demonstrated that closed atolls are more likely to have adzes of *T. maxima*, open atolls are more likely to have adzes of *T. gigas* and raised coral islands tend to have a more even distribution of adzes from these two species (Moir, 1986: 104-106). Due to the limited size of regional samples of shell adzes described in this study and my specific focus on systematising descriptive methodology, her model of adze distribution was not tested. However, it holds potentially significant culture historical implications for investigation of the artefact class, and I recommend that it be applied in future studies.

**Function**

One of the functional issues examined in this study included the correlation between the angle of attack and shape of the cutting edges and bevels of the hinge region adzes. Comparing these variables did not indicate any substantial differences between the adze varieties, however, the results did reflect upon common archaeological interpretations of distinct functions of shell adze cutting edges. Straight edged, flat bevelled adzes have been described as suitable for planing, dressing and often finishing flat surfaces (Davidson, 1971: 67; Osborne, 1979: 23; Leach and Davidson, 2008: 306). Tools with curved and concave cutting edges, on-the-other-hand, have commonly been associated with hollowing out tasks such as removing “the inside pieces of wood in canoe or drum making” (Garanger, 1982: 105). Douglas Osborne has argued that “a straight bitted adze, when hewing with the grain of the wood, has a strong tendency to split the timber” (Osborne, 1979: 21). A curved blade is more conducive to this task, however, “because all its cutting edge does not lie in one plane” (Osborne, 1979: 21). Beaked adzes have been commonly described as “grooving” instruments, due to the V cross-sectioned cut they would produce on a working surface (Craib, 1977; Osborne, 1979). U-shaped, concave cutting edges have usually been associated with *Terebra* sp. adzes and lighter wood-working tasks (Davidson, 1971; Craib, 1977;). The U-shaped hinge region adzes examined in this sample, which were typically characterised by striking angles below 30 degrees, may well have been hafted and used as chisels in the action of shaving or skimming working surfaces.
Figure 43. Largest and smallest (micro-adze) hinge region adzes analysed in this sample.

Distinctions in overall size of the shell adzes in this sample, particularly among the highly variable hinge region adzes, were demonstrated to have likely had functional significance (Figure 43). Micro-adzes, which in this sample only one was identified and originated from Mono Island, have been interpreted as a distinct variety of shell adze used for “fine carving work” (Kirch and Yen, 1982: 230) or “decorative carving on items such as wooden bowls and paddles” (Leach and Davidson, 2008: 307). Extraordinarily large adzes made from the hinge line of *T. gigas* valves have been commonly affiliated with having important ceremonial functions in western Pacific societies (Firth, 1959; Moir, 1989). In this sample, several of the Ontong Java hinge region adzes appeared strikingly similar to ceremonial adze types recorded on Takuu atoll (Moir, 1989: 362-413) (Figure 44). In particular, hinge region adzes judged as preforms in this sample, and which were manufactured with the ligament buttress forming the butt end of the adze, showed many similar characteristics (Figure 21, Chp. 4). It is arguable then that some of these Ontong Java specimens described as being in a preform state due to their unground bevels were in fact finished and served as “sociocultural goods” as Moir found on Takuu. This is supported by her argument that some of the finished Takuu adze types, “to the archaeologist’s eye, would constitute an
adze blank rather than a finished form” (Moir, 1989: 377). Therefore, it is important in shell adze analysis that the potential social significance of shell adzes, particularly large *T. gigas* hinge region adzes, be acknowledged. It would be limiting to perceive morphological variation of these adzes as being attributable only to functional or stylistic differences.

Figure 44. Adze type used for brideprice on Takuu Atoll (Moir, 1989: Fig. 36).

5.3 Methodology in Shell Adze Analysis

Methodological approaches archaeologists have taken to analysing and describing shell adzes have been demonstrated in this study to be hindered by several issues. Most shell adze studies have not been explicit in the selection and recording of criteria used to analyse the tools. This is problematic as it makes it almost impossible for researchers to replicate analytical methods or reproduce results. In the few cases where archaeologists have specified the criteria they used (Craib, 1977; Kirch and Yen, 1982; Weisler, 2001; Wickler, 2001), these criteria have varied considerably due to having been designed to accommodate variation of their specific shell adze assemblages. The criteria utilised in this methodology has drawn upon these studies and provided a revised set of variables and attributes that can be used to guide a systematic method of cataloguing and
describing the artefact class. It has also been designed to account for a wider range of morphological variation seen among Oceanic shell adzes.

Another issue in shell adze methodology has been ambiguity and vagueness in terminology used in the description of these shell tools. In most instances, this has been the result of a lack of understanding of Tridacna valve anatomy and their morphological distinction from most Bivalvia (i.e. hinge is ventral and thinner sculptured region is dorsal). The Tridacna valve terminology utilised in this study has addressed this issue. It provided an illustrative diagram of giant clam valves highlighting anatomic features commonly used in Tridacna adze-making and defined important descriptive terms used in shell adze literature.

This study also demonstrated that difficulty in distinguishing between different classes of cutting-implements has resulted in terminological discrepancies. For example, some archaeologists have resorted to regarding all cutting-implement classes as adzes (Kirch and Rosendahl, 1973: 68; Rosendahl, 1987: 104), while others have combined different tool types into “adze-gouges” (Garanger, 1982) or “adze/chisels” (Weisler, 2001). An important source of this terminological inconsistency is that conventionally used definitions of these cutting-implements are primarily based upon different hafting methods (Buck et al. 1930). When only blades are available to be analysed, as it often the case with archaeological samples, these definitions can be difficult to apply. The definitions of shell cutting-implements utilised in this study have sought to alleviate this issue by emphasising other differentiating characteristics of these tools such symmetry of the cutting edge and angle of attack.

It was also highlighted that dorsal region adzes made from T. maxima have been observed by archaeologists to have been traditionally hafted in either a reversed or normal manner (Crosby, 1973; Davidson, 1971; Firth, 1959). This has resulted in some terminological contradictions, for example archaeologists describing shell adze blades as possessing the bevel on the front of the adze (Kennedy, 1931: 290). To refrain from causing terminological confusion in shell adze description, the adze terminology utilised in this study followed standard conventions, specifically the definition that the bevel is always located on the back of the adze.
Apart from some exceptions (Kirch and Yen, 1984; Moir, 1989; Weisler, 2001), shell adze studies have given almost exclusive attention to describing typological variation within a culture historical framework. This has been demonstrated to be an issue in methodology as it has resulted in the neglect of a wider range of issues that can have positive outcomes for broadening archaeological understandings of this prehistoric shell tool technology. Particularly for museum, surface and ethnographic collections of shell adzes which lack stratigraphic control, undertaking a multifaceted approach that incorporates these issues can add greater value and depth to their description. This was demonstrated by the results and discussion of the manufacturing processes, functional characteristics and ecological variables of this shell adze sample.

**Problems and Recommendations**

In addition to difficulties in differentiating between Tridacna species described in Chapter 3, an important issue in this methodology concerned the use of maximum thickness as a metric attribute. Measuring maximum thickness of the adze demonstrated to be effective for assessing the variation of thickness of dorsal region adzes as they were regularly thickest at the midpoint of the adze. This variable was problematic, however, when measuring hinge region adzes as some were thickest towards the cutting edge of the adze while others were thickest at the poll. It is recommended that rather than only recording maximum thickness of the adzes, which vary, it would be more effective to record thickness of single points of the adze, specifically midpoint thickness and poll thickness.

Another recommendation to further advance methodology used in descriptive analysis of shell adzes is that depth of hollowness of bevels be included as a metric attribute. Adding this feature, as has been done so already and proven constructive in technological study of stone adzes (Best, 1977), would enable more detailed investigation of the functional differences between concave and flat bevelled shell adzes. In addition, it may prove valuable to test the correlation between the degree of concavity of bevels and other attributes such as angle of attack to examine the possible functional purposes of fold adze-gouges and other significantly concave shell adze varieties.
5.4 Conclusion

This dissertation has provided a critical review of methodology used in descriptive analysis of Oceanic shell adzes. It has argued that shell adzes have received far less attention by archaeologists compared to stone adzes. This is despite their extensive distribution throughout the archaeological record in the Pacific and tremendous value for broadening our understanding of the role and importance of shell cutting-implement technology in prehistory.

It has highlighted strengths and weaknesses in the way archaeologists have described and analysed the artefact class, and expanded upon these to construct a revised methodological approach. The research aims originally set out in Chapter 1 have been demonstrated to have been achieved. First, the set of criteria constructed in this study adequately accommodated the wide range of variation of the OM and SINM samples of shell adzes. In addition, having improved upon variables and attributes selected in previous major shell adze studies, this revised set can also be easily reapplied in future research to accommodate a more comprehensive range of variation seen among Oceanic shell adzes. Second, ambiguities in shell adze nomenclature have been reviewed, and revised descriptive and anatomical terms suggested. Third, conventional practice of describing morphological and metric variation of the shell adzes was followed. However, a multifaceted approach was also applied to place greater analytical and descriptive emphasis on other issues including technology, function and ecology.

The revised methodology and terminology defined in this study offers an important development towards systematising descriptive analysis of shell adzes. This has been demonstrated through the application of this methodology to studying a Solomon Islands collection of shell adzes. In addition, the multifaceted approach taken in this study has demonstrated the descriptive and interpretive value of incorporating a wider range of issues, rather than focusing solely on typological variation. Problems that arose during the analytical process and faults in this methodology have been acknowledged, and recommendations for further improvements suggested.
Bibliography


Kennedy, D. G. (1931) *Field Notes on the Culture of Vaitupu, Ellice Islands.* New Plymouth: Thomas Avery & Sons Ltd.


85


Appendix

Appendix 1. John Craib's (1977: 43) flow chart demonstrating his process of type formation for western Micronesian shell adzes.

---

**Fig. 6. Process of Type Formation.**
Appendix 2

Patrick Kirch and Douglas Yen's (1982: 222) typology of Tikopia shell adzes.
Appendix 3. Criteria used in previous shell adze studies that were drawn upon in the formation of the revised methodology.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Discrete Attributes (Provenance)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Site</td>
<td>Taxon (<em>T. maxima</em>, <em>T. gigas</em>, <em>C. cornuta</em>, <em>Cypraecassis rufa</em>, <em>Lambis</em> sp., or <em>Conus</em> sp.)</td>
<td>Site/Area</td>
</tr>
<tr>
<td>Source Material (basalt, andesite, tridacna, terebra, or cassis)</td>
<td>Layer</td>
<td>Artefact Number</td>
<td>Unit</td>
</tr>
<tr>
<td>[Blank]</td>
<td>Stratigraphic Zone</td>
<td>[Blank]</td>
<td>Layer/Level</td>
</tr>
<tr>
<td>[Blank]</td>
<td>Phase</td>
<td>[Blank]</td>
<td>[Blank]</td>
</tr>
<tr>
<td><strong>Discrete Attributes (Morphology)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cutting Edge (straight, wide curve, u-curve or pointed)</td>
<td>Status (whole, bevel, butt, other)</td>
<td>Portion (e.g. whole, mid+edge, butt+mid, edge, or butt)</td>
<td>Status (finished or preform)</td>
</tr>
<tr>
<td>Cross Section (oval, circular, quadrangular, triangular, plano-convex or elliptical)</td>
<td>Material (Tridacna, Cassis, or Conus)</td>
<td>Butt Shape (blunt, rounded or pointed)</td>
<td>Species (<em>T. maxima</em> or <em>T. crocea</em>)</td>
</tr>
<tr>
<td>Body (amount and placement of grinding – all surfaces, back only, front only, unaltered/only bevel)</td>
<td>Shell Morphology (dorsal, hinge, lip, whorl)</td>
<td>Shell Region (right valve, left valve, fold, dorsal region, hinge, lip or whorl)</td>
<td>Grinding (scale 1-4)</td>
</tr>
<tr>
<td>Poll (round, square, pointed or broken)</td>
<td>Degree of Grinding (scale 1-4)</td>
<td>Grinding Location (combinations of front, back or side)</td>
<td>Cross Section (plano-convex, elliptical/oval, or quadrangular/rectilinear)</td>
</tr>
<tr>
<td>Sides (square, round, square/round or unaltered)</td>
<td>Transverse Section (plano-convex, elliptical-oval, quadrangular)</td>
<td>Grinding % (0, 0-50 or 0-100)</td>
<td>Side Angle (parallel sides, angled from bevel to butt, or one sight straight, one angled.</td>
</tr>
<tr>
<td>Bevel (determined by the number of ground, angled surfaces on both sides of the cutting edge – single or double)</td>
<td>Bevel Edge (straight, curved)</td>
<td>Cutting Edge in Plan (straight, slightly curved or curved)</td>
<td>Bevel Edge (straight, curved or pointed (arc covers less than half of length))</td>
</tr>
<tr>
<td>[Blank]</td>
<td>Bevel Transverse Section (convex, concave)</td>
<td>Bevel (flat or concave)</td>
<td>Butt Morphology (blunt, rounded, or pointed)</td>
</tr>
<tr>
<td>-----------------</td>
<td>---------------------------------------------</td>
<td>-------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>[Blank]</td>
<td>Butt Morphology (blunt, rounded, pointed, bevelled)</td>
<td>[Blank]</td>
<td>[Blank]</td>
</tr>
</tbody>
</table>

**Metric Attributes**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (mm)</td>
<td>Maximum Length (mm)</td>
</tr>
<tr>
<td>Maximum Thickness (mm)</td>
<td>Midpoint Width (mm)</td>
</tr>
<tr>
<td>Max width (mm)</td>
<td>Poll Width (mm)</td>
</tr>
<tr>
<td>Poll width (mm)</td>
<td>Cutting Edge Width (mm)</td>
</tr>
<tr>
<td>Cutting edge width (mm)</td>
<td>Thickness (mm)</td>
</tr>
<tr>
<td>Outline (geometrical shape as determined by shape index – rectangular, trapezoid or triangular)</td>
<td>Angle of Bevel (*)</td>
</tr>
<tr>
<td>- Rectangular (&gt;2.39)</td>
<td>Weight (g)</td>
</tr>
<tr>
<td>- Trapezoid (1.7-2.39)</td>
<td>Thickness of Butt (mm)</td>
</tr>
<tr>
<td>- Triangular (&lt;1.7)</td>
<td>Weight (g)</td>
</tr>
<tr>
<td>Thickness/Width Index</td>
<td>Angle of Cutting Edge (*)</td>
</tr>
<tr>
<td>Width/Length Index</td>
<td>Midpoint Width/Thickness Ratio</td>
</tr>
<tr>
<td>Bevel Angle (*)</td>
<td>Thickness/Length Index</td>
</tr>
<tr>
<td>Taper Index</td>
<td>Midpoint Thickness/Length Ratio</td>
</tr>
<tr>
<td>[Blank]</td>
<td>Taper (Midpoint Width/Poll Width Ratio)</td>
</tr>
</tbody>
</table>

*Bevel Angle (*)

*Midpoint Width/Length Ratio
Appendix 4. Methods for measuring bevel angle and angle of attack

Bevel Angle

Recording this feature involved using a universal bevel protractor that was modified with an attached ruler. The first step involved adjusting the bevel protractor to the correct position (see below). The second step involved inserting the adze into the measuring area always with the bevel touching the ruler surface (see below). The third step involved sliding the bevel along the ruler until the cutting edge fit snuggly between it and the rotating steel rod, from which the measurement could be taken.

Angle of Attack
Recording this feature involved using four materials: 1) standard 360° plastic protractor, 2) blue tack, 3) a piece of A4 paper and 4) pieces of paper shaped according to different ranges of striking angle (materials 1 and 4 in image below).

These materials were used to set up an angle of attack ‘recording station’. Setting up the station involved attaching the plastic protractor to the edge of the working table or desk using blue tack (see image below). The protractor had to be attached with the 0 to 180 degree plane running parallel across the flat surface of the desk. A piece of paper would then be laid down adjacent to the protractor to act as the working surface. The adze would then be slid with the cutting edge brushing against the paper until it ‘bit’ into and creased it. The angle at which the adze bit into the paper would be judged at eye level, and then double checked using the angle-measuring coloured triangles.