

# ON THE ASTRONOMICAL KNOWLEDGE AND TRADITIONS OF ABORIGINAL AUSTRALIANS

By

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A THESIS SUBMITTED IN FULFILMENT OF THE REQUIREMENTS  
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Except where acknowledged in the customary manner, the material presented in this thesis is, to the best of my knowledge, original and has not been submitted in whole or part for a degree in any university.

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# Contents

<b>Dedication</b>	<b>xiii</b>
<b>Acknowledgements</b>	<b>xv</b>
<b>Abstract</b>	<b>xvii</b>
<b>Preface</b>	<b>xix</b>
<b>List of Publications</b>	<b>xxiii</b>
<b>List of Figures</b>	<b>xxv</b>
<b>List of Tables</b>	<b>xxix</b>
<b>1 Introduction</b>	<b>1</b>
1.1 Hypotheses . . . . .	1
1.2 Aims . . . . .	4
1.3 Objectives . . . . .	5
1.4 Structure . . . . .	5
<b>2 Discipline, Theory, &amp; Methodology</b>	<b>7</b>
2.1 Cultural Astronomy . . . . .	7
2.1.1 Archaeoastronomy & Ethnoastronomy . . . . .	8
2.1.2 Historical Astronomy . . . . .	9

2.1.3	Geomythology . . . . .	9
2.2	Theory . . . . .	10
2.3	Methodology . . . . .	13
2.4	Rigour . . . . .	16
<b>3</b>	<b>Indigenous History &amp; Culture</b>	<b>23</b>
3.1	Human Migration to Australia . . . . .	23
3.2	Language & The Dreaming . . . . .	28
3.3	Indigeneity & Self-Identification . . . . .	31
3.4	Researching Indigenous Knowledge . . . . .	34
<b>4</b>	<b>Review of Aboriginal Astronomy</b>	<b>41</b>
4.1	What is Aboriginal Astronomy? . . . . .	41
4.2	Why Study Aboriginal Astronomy? . . . . .	42
4.3	Literature on Aboriginal Astronomy . . . . .	45
4.4	Examples of Aboriginal Astronomy . . . . .	46
4.4.1	Timekeeping & Written Records . . . . .	47
4.4.2	Observations of Planetary Motions . . . . .	48
4.4.3	Astronomy in Stone Arrangements & Rock Art . . . . .	51
<b>5</b>	<b>Dating Techniques</b>	<b>55</b>
5.1	Introduction . . . . .	55
5.2	Techniques for Dating Aboriginal Astronomy . . . . .	56
5.3	Technique 1: Archaeological Dating . . . . .	58
5.4	Technique 2: Dating Natural Events . . . . .	58
5.5	Positional Astronomy: Background Theory . . . . .	59
5.5.1	The Celestial Sphere . . . . .	61
5.5.2	Effect 1: Precession . . . . .	65
5.5.3	Effect 2: Stellar Proper Motion & Radial Velocity . . . . .	66
5.5.4	Effect 3: Stellar Magnitude & Variability . . . . .	68
5.6	Technique 3: Testing Connections . . . . .	70

5.6.1	Coalsack Nebula . . . . .	71
5.6.2	Arcturus . . . . .	76
5.6.3	Capella & The Beehive Cluster . . . . .	78
5.6.4	Fomalhaut . . . . .	79
5.6.5	Pleiades . . . . .	82
5.6.6	Vega . . . . .	84
5.6.7	Summary . . . . .	86
5.7	Technique 3: Constellation Pattern–Matching . . . . .	86
5.8	Technique 4: Using Oral Traditions . . . . .	94
5.9	Conclusion . . . . .	95
<b>6</b>	<b>Eta Carinae</b>	<b>97</b>
6.1	Introduction . . . . .	98
6.2	William E. Stanbridge: Biographical Details . . . . .	100
6.3	Identification of Boorong Celestial Objects . . . . .	101
6.4	Identification of Eta Carinae . . . . .	110
6.5	About Eta Carinae . . . . .	114
6.6	Other Attempts to Identify Collongullouric War . . . . .	117
6.7	Eta Carinae Previously in Boorong Culture? . . . . .	119
6.8	Celestial Phenomena in Oral Traditions . . . . .	120
6.9	Other Indigenous Records of Eta Carinae . . . . .	122
6.10	Conclusions . . . . .	124
<b>7</b>	<b>Eclipses</b>	<b>125</b>
7.1	Introduction . . . . .	126
7.2	Science of the Earth–Moon–Sun System . . . . .	126
7.2.1	Lunar Phases . . . . .	126
7.2.2	Eclipses . . . . .	127
7.3	Aboriginal Stories of the Sun and Moon . . . . .	129
7.4	Aboriginal Reactions to Eclipses . . . . .	132
7.4.1	Solar Eclipses . . . . .	132

7.4.2	Lunar Eclipses . . . . .	135
7.5	Causes of Eclipses: An Aboriginal Perspective . . . . .	137
7.5.1	Solar Eclipses . . . . .	137
7.5.2	Lunar Eclipses . . . . .	140
7.6	Dating Oral Traditions from Historic Eclipses . . . . .	141
7.7	Predicting Eclipses . . . . .	144
7.8	Representations of Eclipses in Rock Art . . . . .	145
7.9	Discussion . . . . .	147
<b>8</b>	<b>Comets</b>	<b>153</b>
8.1	Introduction . . . . .	154
8.2	Comets . . . . .	154
8.3	Methodology & Results . . . . .	156
8.4	Aboriginal Perceptions of Comets . . . . .	157
8.5	Historic Visible Comets . . . . .	160
8.5.1	C/1843 D1 (Great March Comet of 1843) . . . . .	160
8.5.2	C/1844 Y2 (Great Comet of 1844) . . . . .	162
8.5.3	C/1861 N1 (Comet Tebbutt) . . . . .	163
8.5.4	C/1901 G1 (Comet Viscara) . . . . .	164
8.5.5	C/1910 A1 (Great Daylight Comet of 1910) . . . . .	166
8.5.6	C/1927 X1 (Comet Skjellerup–Maristany) . . . . .	167
8.6	Discussion & Conclusion . . . . .	169
<b>9</b>	<b>Meteors</b>	<b>175</b>
9.1	Introduction . . . . .	176
9.2	Terminology . . . . .	177
9.3	Methodology . . . . .	178
9.4	Results & Analysis . . . . .	179
9.4.1	Meteors as Benevolent Spirits . . . . .	179
9.4.2	Meteors as Malevolent Spirits . . . . .	181
9.4.3	Meteors and Evil Magic . . . . .	184

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9.4.4	Meteors as Omens . . . . .	185
9.4.5	Meteors and War . . . . .	187
9.4.6	Meteors in Ritual & Ceremony . . . . .	188
9.4.7	Other Views of Meteors . . . . .	193
9.4.8	Meteor Showers . . . . .	194
9.5	Discussion . . . . .	196
9.5.1	Perceptions of Meteoritic Phenomena . . . . .	197
9.5.2	Witness of Cosmic Impacts . . . . .	198
9.5.3	Researcher & Discipline Bias . . . . .	199
9.6	Conclusion . . . . .	201
<b>10</b>	<b>Meteorite Falls &amp; Cosmic Impacts</b>	<b>205</b>
10.1	Introduction . . . . .	206
10.2	Australian Impact Craters . . . . .	207
10.3	Geomythology . . . . .	210
10.4	Known Australian Impact Craters . . . . .	213
10.4.1	Gosse's Bluff . . . . .	213
10.4.2	Wolfe Creek . . . . .	214
10.4.3	Henbury . . . . .	216
10.4.4	Veevers . . . . .	217
10.4.5	Boxhole . . . . .	218
10.4.6	Other Craters . . . . .	218
10.4.7	Summary of the Evidence from Known Impact Craters . . . . .	218
10.5	Other Impact Sites . . . . .	219
10.5.1	New South Wales . . . . .	220
10.5.2	Northern Territory . . . . .	223
10.5.3	Western & South Australia . . . . .	226
10.5.4	Tasmania . . . . .	229
10.5.5	Queensland & Victoria . . . . .	229
10.6	Meteorites Falls & Finds . . . . .	233

10.6.1	Aboriginal Discovery of Meteorites & Impact Craters . . . . .	236
10.6.2	Aboriginal Use of Meteoritic Material . . . . .	236
10.7	Statistics of Meteorite Falls & Impacts . . . . .	237
10.7.1	Meteoroid Influx Rate . . . . .	237
10.7.2	Probability of Being Struck by a Meteorite . . . . .	239
10.7.3	Probability of Death or Injury from Cosmic Impacts . . . . .	240
10.8	Discussion . . . . .	243
10.8.1	A Tsunami in the Gulf of Carpentaria? . . . . .	252
10.9	Conclusion . . . . .	252
<b>11</b>	<b>Orientations of Linear Stone Arrangements</b>	<b>255</b>
11.1	Introduction . . . . .	255
11.1.1	Cardinal Directions in Aboriginal Languages . . . . .	256
11.1.2	Stone Arrangements . . . . .	257
11.2	Methodology . . . . .	259
11.2.1	Archaeological Site Cards . . . . .	259
11.2.2	Site Card Measurements . . . . .	263
11.2.3	Field Survey Methods . . . . .	263
11.2.4	Error Analysis . . . . .	266
11.3	Results & Statistical Analysis . . . . .	269
11.3.1	Site Cards . . . . .	269
11.3.2	Field Survey Measurements . . . . .	270
11.4	Discussion & Conclusion . . . . .	272
<b>12</b>	<b>Summary &amp; Conclusion</b>	<b>277</b>
12.0.1	Dating Techniques . . . . .	278
12.0.2	Eta Carinae . . . . .	279
12.0.3	Eclipses . . . . .	279
12.0.4	Comets . . . . .	279
12.0.5	Meteors . . . . .	280
12.0.6	Cosmic Impacts . . . . .	280



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12.0.7 Stone Arrangements . . . . .	281
12.1 Conclusion . . . . .	282
12.2 Communication & Education . . . . .	283
<b>A The Life &amp; Legacy of William E. Stanbridge</b>	<b>285</b>
A.1 Introduction . . . . .	285
A.2 Personal Life . . . . .	286
A.3 Academic Life . . . . .	288
A.4 Politics & Philanthropy . . . . .	291
A.5 Legacy . . . . .	294
<b>References</b>	<b>297</b>
<b>About the Candidate</b>	<b>359</b>
<b>About the Advisors</b>	<b>361</b>



# Dedication

For my grandparents – Mary & Philip Isaacson. RIP.

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This thesis is dedicated to the generations of Indigenous Australians whose language, culture, land, and lives were damaged or destroyed by British colonisation.

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I would like to acknowledge the Wallumattagal people (the Traditional Custodians of the land on which Macquarie University is situated) both past and present.

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### **Note to Aboriginal and Torres Strait Islander Readers**

This thesis contains the names and images of people that have passed away.

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# Abstract

Historian of science David Pingree defines science in a broad context as as the process of systematically explaining perceived or imaginary phenomena. Although Westerners tend to think of science being restricted to Western culture, I argue in this thesis that astronomical scientific knowledge is found in Aboriginal traditions. Although research into the astronomical traditions of Aboriginal Australians stretches back for more than 150 years, it is relatively scant in the literature. We do know that the sun, moon, and night sky have been an important and inseparable component of the landscape to hundreds of Australian Aboriginal groups for thousands (perhaps tens-of-thousands) of years. The literature reveals that astronomical knowledge was used for time-keeping, denoting seasonal change and the availability of food sources, navigation, and tidal prediction. It was also important for rituals and ceremonies, birth totems, marriage systems, cultural mnemonics, and folklore. Despite this, the field remains relatively unresearched considering the diversity of Aboriginal cultures and the length of time people have inhabited Australia (well over 40,000 years). Additionally, very little research investigating the nature and role of transient celestial phenomena has been conducted, leaving our understanding of Indigenous astronomical knowledge grossly incomplete.

This thesis is an attempt to overcome this deficiency, with a specific focus on transient celestial phenomena. My research, situated in the field of *cultural astronomy*, draws from the sub-disciplines of archaeoastronomy, ethnoastronomy, historical astronomy, and geomythology. This approach incorporates the methodologies and theories

of disciplines in the natural sciences, social sciences, and humanities. This thesis, by publication, makes use of archaeological, ethnographic, and historical records, astronomical software packages, and geographic programs to better understand the ages of astronomical traditions and the role and nature of eclipses, comets, meteors, impact events, and certain variable stars. I also test the hypothesis that certain types of stone arrangements have preferred orientations that probably relate to astronomical phenomena.

This research shows that Aboriginal astronomical traditions explain the motions of celestial bodies and the relationship between events in the sky and events on Earth. I explore how Aboriginal people perceived and made use of particular astronomical phenomena, such as meteors and comets, and show that Aboriginal people made careful observations of the motions of celestial bodies. I provide evidence that Aboriginal people noticed the change in brightness of particular stars, described the kinematics of eclipses, explained how lunar phases are related to ocean tides, and acknowledged the relationship between meteors, meteorites, impact events, and impact craters. I then show that linear stone arrangements in New South Wales have a preferred orientation to the cardinal points and explore astronomical reasons for this. In the Appendix, I include biographical details of William Edward Stanbridge, one of the first people to write in depth about Aboriginal astronomical traditions, that were compiled from historic records.



# Preface

This thesis is the culmination of three years work at Macquarie University, seeking to understand how astronomical knowledge is encoded in various Aboriginal cultures of Australia. During the course of this research, I have had the opportunity to work with many of the top people in cultural astronomy and present my work to audiences around the world, including France, Peru, Singapore, South Africa, the United States, and Australia.

Cultural Astronomy is a highly interdisciplinary field that draws from the social sciences, humanities, and the natural, physical, and mathematical sciences. Although I incorporate methods and techniques from these fields in my research, I must acknowledge that this work is from the perspective and background of an astrophysicist and not a social scientist (my bachelors and masters degrees are in physics and astronomy with some background in archaeology). My work was completed in the Dept of Indigenous Studies at Macquarie and was incorporated into the Research Centre for Astronomy, Astrophysics & Astrophotonics at Macquarie towards the end of my candidature. My thesis advisors were Prof Ray Norris (an astrophysicist), Dr Kristina Everett (a cultural anthropologist), and John Clegg (an archaeologist). Towards the end of my candidature, Dr Michelle Trudgett (an Indigenous educator) became an official co-advisor. The highly interdisciplinary nature of my work and my advisory team is illustrated nicely by PHD cartoonist Jorge Cham (following page).

I also worked closely with Dr David Frew (an astrophysicist in the Dept of Physics & Astronomy) and Dr Craig O'Neill (a geophysicist in the Dept of Earth & Planetary



Science), both at Macquarie. Robert (Bob) Fuller (a trained archaeologist and President of the Northern Sydney Astronomical Society) was a very helpful field assistant and provided his personal vehicle and time for the field surveys. Bob's interest in this project led to him enrolling in an MPhil program at Macquarie, where he studies the astronomy of the Kamilaroi people of north-central New South Wales.

The main chapters of this thesis (Chapters 6–11) were published as one or more papers in peer-reviewed journals and much of the background material in Chapter 4 was published in refereed conference proceedings. Many of the references in each paper also appear in other papers, so I opted not to include a reference list at the end of each chapter, but instead supply a single bibliography at the end of the thesis (despite this, most newspaper citations are given as footnotes as many of the authors are anonymous). Chapter 3 was developed in close collaboration with Kristina Everett. Chapter 6 was a joint venture between myself and David Frew. David first proposed the idea of this

project to me, but we put in equal work: all aspects of the paper were researched by us both, and we came together and discussed our findings, which were nearly identical. Chapters 5, 7, 8, and 9 were solely my own work, with comments and suggestions from Ray Norris. Ray's contribution to Chapter 10 was more substantial, particularly regarding aspects of the analysis. Fieldwork in Chapter 11 involved the assistance of Robert Fuller. Ray Norris provided comments and the Monte Carlo simulations. John Clegg is responsible for teaching me how to identify, survey, and record rock art sites, for which I am extremely grateful.

Appendix A is a brief biography of William E. Stanbridge that developed out of my research in Chapter 6 and is entirely my own work. Very little was published about Stanbridge, so I set out to collect as much information as possible from the resources available to me (library and newspaper archives). I was able to piece together a rough biography from this material. I contacted the Daylesford Historical Society and discovered that they have a rather large folder of information on Stanbridge that has not been published. Future work will involve an historical project to collate and analyse this information to produce a full biography.



Participants of *Ilgarjiri - things belonging in the sky* – a symposium on Australian Indigenous Astronomy held on 29 November 2009 at AIATSIS in Canberra.

# List of Publications

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Ray P. Norris & Duane W. Hamacher (2011). Astronomical Symbolism in Australian Aboriginal Rock Art. *Rock Art Research*, Vol. 28(1), pp. 99–106.

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# List of Figures

2.1	Proceedings of Oxford I . . . . .	12
2.2	Crescent Engraving: Moon or Boomerang? . . . . .	20
3.1	Map of Human Migration . . . . .	25
3.2	Sea Level over the last 140,000 Years . . . . .	26
3.3	Map of Sunda and Sahul . . . . .	27
3.4	Map of Australian Aboriginal Languages . . . . .	29
4.1	Torres Strait & Aboriginal Flags . . . . .	44
4.2	Message Stick showing phases of the moon . . . . .	48
4.3	A Yolngu Morning Star Pole . . . . .	49
4.4	The cycles of Venus . . . . .	50
4.5	Wurdi Youang . . . . .	52
4.6	The Llama in the Sky . . . . .	54
5.1	Chaco Canyon Pictogram . . . . .	60
5.2	The Celestial Dome . . . . .	62
5.3	The Celestial Sphere . . . . .	63
5.4	Path of Precession . . . . .	65
5.5	Proper Motion Components . . . . .	67
5.6	Proper Motion and Radial Velocity of a Star . . . . .	68
5.7	$\Delta V_{\text{mag}}$ of Stars over 40k years . . . . .	69

5.8	Emu in the Sky . . . . .	72
5.9	Emu in the Sky Engraving . . . . .	73
5.10	Emu in the Sky Egg . . . . .	74
5.11	Azimuth of the Coalsack at Sunset . . . . .	75
5.12	<i>Eleocharis dulcis</i> . . . . .	77
5.13	Beehive Cluster, Castor, Pollux & Capella . . . . .	79
5.14	Mean Monthly Temperature at Bendigo . . . . .	80
5.15	Mean Monthly Rainfall in Adelaide . . . . .	81
5.16	The Autumn Rising of Fomalhaut . . . . .	81
5.17	The Pleiades . . . . .	83
5.18	Maximum Altitude of Vega . . . . .	85
5.19	Mallee Fowl . . . . .	86
5.20	Crux and The Pointers . . . . .	88
5.21	A Wedge-Tailed Eagle . . . . .	89
5.22	Proper Motions of Stars in Crux . . . . .	90
5.23	Geometry of Crux and an Eagle Footprint . . . . .	92
5.24	Crux today and 25,000 years ago . . . . .	93
6.1	Map of Victoria . . . . .	99
6.2	Excerpt from Stanbridge (1858) . . . . .	111
6.3	Robur Carolinum . . . . .	112
6.4	Excerpt from Halley (1679) . . . . .	113
6.5	Excerpt from La Caille (1763) . . . . .	114
6.6	Eta Carinae Light Curve . . . . .	115
6.7	Eta Carinae . . . . .	116
6.8	Eta Carinae Light Curve 1830–1900 . . . . .	118
7.1	Lunar Phases . . . . .	127
7.2	Tidal Range Over a Lunar Month . . . . .	132
7.3	Merlpal Maru Pathanu . . . . .	142
7.4	Total Solar Eclipse of 1793 . . . . .	144



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7.5	Basin Track Engravings . . . . .	148
7.6	Basin Engravings and Eclipse . . . . .	149
7.7	Tree Leaves Projecting Solar Eclipse . . . . .	150
8.1	Comet Rock . . . . .	159
8.2	Great Comet of 1843 . . . . .	162
8.3	Nearly Total Solar Eclipses 1846–1864 . . . . .	163
8.4	Great Comet of 1861 . . . . .	164
8.5	Great Comet of 1901 . . . . .	165
8.6	Great Comet of 1910 . . . . .	167
8.7	Great Comet of 1927 . . . . .	168
8.8	Bulgandry . . . . .	171
9.1	Namorrorddo . . . . .	182
9.2	Nulla Nulla . . . . .	188
9.3	Namorrorddo with a Miyarrul . . . . .	189
9.4	Arungquilta Punishment . . . . .	192
9.5	A Waratah . . . . .	194
9.6	Great Leonid Meteor Shower of 1833 . . . . .	196
10.1	Terrestrial Impact Craters in Australia . . . . .	208
10.2	Corona Australis . . . . .	214
10.3	Wolfe Creek Crater and the Rainbow Serpent. . . . .	215
10.4	Henbury Crater Field . . . . .	217
10.5	Kulu – The Meteorite . . . . .	225
10.6	Locations of Cosmic Impacts in Oral Traditions . . . . .	233
10.7	Asteroid Impact Frequency on Earth . . . . .	242
10.8	Submarine Impact Craters in Australia . . . . .	250
10.9	Chevron Dunes in the Gulf of Carpentaria . . . . .	251
11.1	Stone Arrangements in NSW . . . . .	260
11.2	Sketches of Stone Arrangements . . . . .	262

11.3 Stone Arrangements Studied . . . . .	265
11.4 Orientations of Stone Rows from Site Card Data . . . . .	270
11.5 Orientations of Stone Rows . . . . .	272
A.1 North View from Daylesford . . . . .	287
A.2 Grave of W.E. Stanbridge . . . . .	289
A.3 William E. Stanbridge . . . . .	293
A.4 Christ Church, Daylesford . . . . .	296

## List of Tables

5.1	Positions of Coalsack over 15,600 years . . . . .	75
5.2	Data for Objects discussed in Section 5.6 . . . . .	87
5.3	Positional Data for Crux . . . . .	91
6.1	Stars Identified from Stanbridge . . . . .	105
6.2	Boorong Stars . . . . .	106
6.3	Stars in Victorian Aboriginal Languages . . . . .	108
6.4	Brightness of Stars in Stanbridge . . . . .	121
7.1	Frequency of Eclipses in Australia . . . . .	129
7.2	Table of Historic Eclipses . . . . .	152
8.1	Aboriginal Terms for Comets . . . . .	172
8.2	Great Comets of the 1800s . . . . .	173
9.1	Aboriginal Names of Meteors . . . . .	202
10.1	Australian Impact Craters . . . . .	209
10.2	Coordinates of Cosmic Impacts in Oral Traditions . . . . .	232
10.3	Meteorite Influx Rate . . . . .	238
10.4	Impact Events Predicted . . . . .	246
10.5	Holocene Impacts . . . . .	248
10.6	Submarine Impact Craters near Australia . . . . .	249

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11.1	Locations of Stone Rows in NSW . . . . .	261
11.2	Selected Linear Stone Arrangements . . . . .	264
11.3	Accessibility of Sites . . . . .	267
11.4	Stone Row Survey Data . . . . .	271
A.1	Stanbridge Timeline . . . . .	295

# 1

## Introduction

*“Long dismissed as children’s stories or ‘myths’ by Westerners, Australian Aboriginal stories have only recently begun to be taken seriously for what they are: the longest continuous record of historic events and spirituality in the world.”*

— Karl-Erik Sveiby & Tex Skuthorpe (2006)

### 1.1 Hypotheses

The Merriam-Webster Dictionary defines (Western) science as either *“knowledge or a system of knowledge covering general truths or the operation of general laws especially as obtained and tested through scientific method”* or *“such knowledge or such a*

*system of knowledge concerned with the physical world and its phenomena*<sup>1</sup>. Scientists and philosophers have debated the definition of science for decades and different schools of thought take different philosophical approaches (e.g. Popper, 1959 vs. Kuhn, 1962). Although there is no universal consensus on a definition of Western science, it is generally regarded as a systematic enterprise of explaining the natural world through empirical observation, prediction, falsification, and the testing of hypotheses using the language of mathematics (Nola & Irzik, 2005: 185-206). The term “science” is often used to denote a structured, systematic quest for knowledge, such as library science, political science, or social science, but science generally refers to disciplines of the natural and physical sciences, such as physics, astronomy, chemistry, geology, and biology<sup>2</sup>.

Astronomy is considered the oldest of the natural sciences and is generally defined as the branch of science that deals with everything outside of the earth’s atmosphere: celestial objects and phenomena, space, and the universe as a whole. Science is derived from the Latin word *scientia*, meaning *knowledge*. From its origins in the Near East, modern science was established in Greek philosophy and developed in Western Europe from the 12th Century through to the Enlightenment of the 18th century (Aaboe, 1974; Neugebauer, 1975; Heilbron, 2003: vii). The Scientific Revolution was spawned from the publication of works by Nicolaus Copernicus (1473–1543) and Andreas Vesalius (1514–1564) in 1543. This was followed by works from a number of scholars, including Tycho Brahe (1546–1601), Johannes Kepler (1571–1630), and Isaac Newton (1642–1727), who pioneered the development of Western science (Kuhn, 1962; Westfall, 1971; Heilbron, 2003).

In a broader context, several definitions of science have been proposed. Dampier-Whetham (1911) defines science as “*ordered knowledge of natural phenomena and of the relationship between them*”. Lloyd & Sivin (2002: 4) elaborate that the mark of science “*lies in the aims of the investigation and the bid to comprehend aspects of the physical world*”. McCluskey (2011) notes that other science historians do not limit the

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<sup>1</sup><http://www.merriam-webster.com/dictionary/science>

<sup>2</sup>An entire doctoral thesis could be written on the definition and development of science and still only scratch the surface of the topic. It is not my intent to dive into this area, but only to briefly discuss the basic tenets of science.

scope of science to the natural world. For example, Pingree (1992: 559) argues that “*science is a systematic explanation of perceived or imaginary phenomena, or else is based on such an explanation.*”

Although Westerners tend to think of science as being restricted to Western philosophy, do we find evidence of science developing in non-Western cultures, such as the Aboriginal cultures of Australia? If so, what symbolic language is used to describe science? How far back in time can this knowledge be found? This thesis attempts to answer these questions with respect to astronomical science, or *astronomy*. Do Aboriginal knowledge systems provide explanations of natural objects and phenomena and their relationship to events on earth? For example, did Aboriginal people have explanations regarding the link between lunar phases and ocean tides? (Galileo didn’t!). Do Aboriginal skywatchers provide an explanation of eclipses relating the the relative positions of the sun and moon? Or the link between meteors, meteorites, and impact craters? Did Aboriginal people build structures that aligned with celestial objects for practical or ceremonial purposes?

In this thesis, I hypothesise that (astronomical) science, as defined by Pingree, is not unique to Western philosophy, but can be found in Australian Aboriginal cultures as well. To test this hypothesis, I explore the astronomical knowledge of various Aboriginal cultures in Australia to see if this knowledge meets the definition of science. I also use this knowledge to identify the language in which astronomical scientific knowledge is encoded and attempt to see how far back in time this knowledge is found.

Aboriginal people have been in Australia for over 40,000 years and had little contact with the rest of the world prior to colonisation by the British in 1788. Therefore, everything ever written about Aboriginal culture occurred *after* colonisation, and a majority of that was done by Westerners, namely anthropologists and missionaries. Some anthropologists and researchers subscribed to (now antiquated) views that Aboriginal people were inferior to Europeans both culturally and biologically (Howard-Wagner, 2007; McGregor, 2002). In addition, missionaries were primarily concerned with converting Aboriginal people to Christianity. This involved banning Aboriginal languages,

customs, laws, and traditions in favour of Western culture and language. This large-scale destruction of “traditional” (pre-contact) ways had a significantly negative impact on Aboriginal people and culture.

Since Aboriginal people did not possess a structured written language (Walsh, 1991: 45), everything ever written about Aboriginal culture is biased or influenced by Western culture. Because of this, there is no clear distinction between “pre-contact” and “post-contact” astronomical knowledge. As I discuss throughout this thesis, Aboriginal knowledge was not static in time; it was dynamic and changing. Many examples in this thesis cite knowledge that was generated after colonisation, such as the main argument of Chapter 6. Because of this changing knowledge system, coupled with the effects of colonisation, we cannot clearly discriminate between pre- and post-contact astronomical knowledge. In addition, knowledge ownership and transmission is linked to Aboriginal (self) identity. In Section 3.4, I discuss the concept of Indigenous self-identity, highlighting the problems with defining Aboriginality and show that the concept is political in nature and a topic of ongoing contention.

## 1.2 Aims

In this thesis, I place an emphasis on understanding Aboriginal knowledge relating to transient celestial phenomena and stone structures with astronomical orientations. Previous studies have addressed obstinate astronomical objects (such as stars and the Milky Way) and their role in Aboriginal cultures but have paid little attention to transient phenomena (such as variable stars, eclipses, comets, meteors, and cosmic impacts). Material culture, such as rock art with astronomical symbolism and stone structures with astronomical alignments have not been explored in any depth until recently (see Norris & Hamacher, 2010; Norris et al., 2012).

In summary, the aims of this thesis are as follows:

1. To determine if astronomical scientific knowledge is found in the Aboriginal cultures;



2. If so, to identify in what symbolic language was this knowledge was stored and transmitted;
3. To determine how long this knowledge has been passed down though the millennia.

## 1.3 Objectives

While achieving these aims, I attempt to answer the following questions:

- How did Aboriginal people make practical use of the sun, moon, and stars?
- How did Aboriginal people perceive transient celestial phenomena?
- What role did these phenomena play in the social structure of the community?
- Were there common trends in these views among different Aboriginal groups or were they all completely different?
- Do particular events in oral traditions or artistic forms correspond to historic events reported in the literature?
- Do stone arrangements contain astronomical alignments or have a preference to cardinal orientations?

## 1.4 Structure

This thesis is divided into 12 chapters, one appendix, and a single references section. The first four chapters, including this one, are intended to set the stage for the thesis, present the argument, aims, and goals, and provide the reader with the background information necessary to contextualise and critique the thesis. Below, I highlight the nature and goals of each chapter.

- Chapter 2 introduces the reader to the academic discipline of Cultural Astronomy, including its history and development. I then discuss the theoretical framework,

context, and methodology of the discipline and highlight the rigour I take in this work.

- Chapter 3 provides a brief overview of the history of human migration to Australia and provide the reader with a brief background on Aboriginal languages, culture, and issues of Indigenous self-identification.
- Chapter 4 explores the literature of Cultural Astronomy in Australia (termed *Aboriginal astronomy*), citing examples and explaining why the study of Aboriginal astronomy is relevant and important.
- Chapter 5 explores techniques for estimating the age of astronomical knowledge and to test the hypothesis that astronomical knowledge dates back to first human migration to Australia (this topic is also touched upon in the remaining chapters). This chapter makes heavy use of the methods and techniques of positional astronomy.
- Chapters 6–10 address knowledge and traditions related to transient celestial phenomena, specifically Eta Carinae, eclipses, comets, meteors, and cosmic impacts.
- Chapter 11 reports on an archaeological survey of linear stone arrangements in New South Wales to show they have preferred cardinal alignments, which may be based on the positions of astronomical bodies.
- Chapter 12 summarises my findings and conclusions and discusses the importance of outreach and education.
- Appendix A is a brief historical biography of William Edward Stanbridge, one of the first people to write about Aboriginal sky knowledge in detail, which I wrote based on collected historical and newspaper documents. To date, no biography of W.E. Stanbridge has ever been published.

# 2

## Discipline, Theory, & Methodology

*“One of the most endearing characteristics of archaeoastronomy is its capacity to set academics in different disciplines at loggerheads with each other.”*

— Clive Ruggles (2000: 65)

### 2.1 Cultural Astronomy

Cultural astronomy is the discipline that seeks to understand the role of astronomy in culture. It is sometimes called the “anthropology of astronomy” (Platt, 1991) and incorporates the sub-disciplines of archaeoastronomy, ethnoastronomy, and historical astronomy. It is highly interdisciplinary, drawing from the social sciences, humanities,

and natural, physical, and mathematical sciences<sup>1</sup>.

### 2.1.1 Archaeoastronomy & Ethnoastronomy

*Archaeoastronomy* is the study of the astronomical knowledge and traditions of past cultures and societies, while *ethnoastronomy* applies to current cultures and societies. The term archaeoastronomy was coined by Elizabeth Baity in 1973 and was suggested as the preferred term by Euan MacKie (Sinclair, 2006). Specific definitions vary and have been the topic of contentious debate over the last 30 years when archaeoastronomers from around the world were brought together at the first Symposium on Archaeoastronomy at Oxford University (Ruggles, 1993).

Early terms such as astro-archaeology (Hawkins, 1966) and ancient astronomy (Thom, 1967) were used in place of archaeoastronomy. Ruggles (1999: 155) argues that the term Ancient Astronomy is misleading since modern astronomy is a (Western) scientific discipline, while archaeoastronomy considers the symbolically rich cultural interpretations of phenomena in the sky. The term Ancient Astronomy assumes that astronomy, as it is practised today, was identically practiced in the distant past among multiple cultures.

Sinclair (2006) defines archaeoastronomy as the study of how people in the past understood and utilised phenomena in the sky and seeks to understand the role the sky played in their culture. This definition fails to properly recognise how the night sky constitutes part of the social experience (Moyano, 2011). Iwanisewski (2009) accounts for this by defining cultural astronomy as the discipline that “studies the mechanisms by which people come to understand astronomical phenomena. It analyses their systems of conceptualisation and representation and correlates social connections, social processes

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<sup>1</sup>Researchers in the field come from a diverse range of academic backgrounds although most post-graduate theses are completed in social science or humanities departments. According to a study of 79 master and doctoral theses in Cultural Astronomy, McCluskey (2004) found that only a few (3) were completed in a physical sciences department (astronomy and astrophysics). The rest were attributed to archaeology (20), cultural anthropology (15), history (31, including period history, history of science, religion, and art), religious studies (2), fine arts (2), literature (2), and folklore (4).

and sets of ideas about social life” (paraphrased by Moyano, 2011: 96).

In the context of this thesis, I draw upon archaeological and ethnographic data sources from both past and current Aboriginal cultures. Therefore, I use both archaeoastronomical and ethnoastronomical approaches.

### 2.1.2 Historical Astronomy

Closely associated with archaeoastronomy and ethnoastronomy is the sub-discipline of *historical astronomy*, which uses historical records of celestial events to gain perspectives about the culture that witnessed the event. Information from these events can be used to test the science of the event. For example, dated historical records can reveal the day and time a particular supernova was visible, which is sometimes difficult to determine using purely scientific methods. The position of a passing comet with respect to the background stars can be used to calculate its orbital characteristics, which is how Edmond Halley identified the comet that now bears his name in his 1705 publication *Synopsis Astronomia Cometicæ*.

This thesis includes several examples of historical astronomy, most notably Chapter 6, which uses an ethnographic record describing a particular star, which David Frew<sup>2</sup> and myself showed was a reference to the 1843 eruption of the hyper-giant variable star Eta Carinae. In Chapters 7, 8, 9, and 10, I use historic ethnographic records of eclipses, comets, meteors, and cosmic impacts to learn more about Aboriginal perceptions of these phenomena and understand how Aboriginal people explained their motion and nature. I also use these records in an attempt to date oral traditions and learn more about the meteoroid influx rate.

### 2.1.3 Geomythology

In a similar vein to historical astronomy, geomythology deals with culture and geological, atmospheric, and oceanographic objects, features, and phenomena. The term,

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<sup>2</sup>Dr. David Frew is a Research Fellow in the Department of Physics & Astronomy at Macquarie University. In addition to his research interests in planetary nebulae and variable stars, he has a particular interest in the historical light curve of Eta Carinae.

coined by Indiana University geologist Dorothy Vitaliano (1968), seeks to extract information about the nature and origin of past events (real or alleged) from oral traditions. These include the origin and nature of fossils, earthquakes, tsunamis, and volcanic eruptions, but can also incorporate astronomical phenomena such as comets, eclipses, meteors, meteorites, cosmic impacts, and aurorae. The core claim of geomythology is that natural events are often recorded in oral traditions, which may contain “genuine and perceptive knowledge” based on careful observation of the natural world. Vitaliano (1973) argues that there are two kinds of geologic folklore: (1) a description of a geologic feature or phenomenon that inspired a folklore explanation, and (2) a garbled explanation of some actual geologic event, usually a natural catastrophe. Thus, oral histories/folklore may be used to learn more about particular events or to identify evidence of events that are currently unknown to science, such as a previously unidentified meteorite or impact crater.

I apply this hypothesis to several chapters of this thesis and show that known astronomical events are encoded in oral tradition, including solar and lunar eclipses, comets, variable stars, and impact events. In Chapter 10, I show that if oral traditions that describe impact events are based on eyewitness accounts, they suggest a higher meteoroid influx rate than current scientific models predict. I also show that the great number of impact events described in oral traditions indicate that previously unknown impact craters could be found using the description.

## 2.2 Theory

*“For a long time I have believed that such diversity [in cultural astronomy] requires the invention of some all-embracing theory. I think I was very naïve in thinking that such a thing was ever possible.”*

— Stanislaw Iwaniszewski (2003: 7)

Over the course of the 1980s and 1990s the approach to doing archaeoastronomy was divergent and based on the availability and sources of “data”, which were primarily

archaeological in nature. As the discipline evolved it no longer relied on purely archaeological techniques. Historic, ethnographic, linguistic, and artistic data sources were becoming more commonplace. In 1981 the first global symposium on archaeoastronomy brought together two different schools of thought (and approaches) on the subject. In the Old World, where little or no historical or ethnographic records existed regarding the astronomical practices of ancient peoples, archaeoastronomers were restricted to gaining insight through the archaeological record. This relied heavily upon statistical studies of structural alignments. Perhaps the most notable (and famous) example was Stonehenge. This method was pioneered by scholars such as Norman Lockyer (1909), Gerald Hawkins (1966), and Alexander Thom (1967) and continues to be an area of intensive research today.

In the New World, European colonists had recorded the traditional knowledge and customs of the various indigenous groups with which they came into contact. These records, coupled with a material/archaeological record, gave direct insight into the culture of Indigenous peoples and the focus they placed on particular celestial objects or phenomena. This provided far more direct information regarding astronomical knowledge and practices of these cultures (Aveni, 1982). The Old World and New World approaches became known as Green and Brown archaeoastronomy, respectively, reflecting the colours of the conference proceedings in which they were published (Figure 2.2; see Heggie, 1982; Aveni, 1982).

The division between pure Brown and Green approaches to archaeoastronomy is now obsolete, as is the term archaeoastronomy itself (albeit a bit more slowly than the Brown/Green division). The preferred term is ‘cultural astronomy’, which embraces a wide range of data sources, methods, and techniques from diverse academic backgrounds, most notably archaeology, anthropology, and history. But there exists no universal methodology or theoretical framework for cultural astronomy, although the adaptation of social theory is recognised as essential for any research in the discipline (Iwaniszewski, 1989). The IAU 278/Oxford IV Symposium on Archaeoastronomy & Astronomy in Culture held in Lima, Peru in January 2011 had a particular focus on determining the role and identity of cultural astronomy in the broader context of



FIGURE 2.1: Proceedings of the 1981 Oxford I Symposium on Archaeoastronomy. The proceedings were divided into two volumes: **Left** – Archaeoastronomy in the Old World (Heggie, 1982), from which Green Archaeoastronomy takes its name, and **Right** – Archaeoastronomy in the New World (Aveni, 1982), from which Brown Archaeoastronomy takes its name.

academia (Ruggles, 2011a). Part I of these proceedings addressed this need, especially Iwaniszewski (2011).

Australia is an ideal place in which to pursue studies in cultural astronomy. Material archaeological culture relating to the night sky, such as stone arrangements, rock art, message sticks, and artistic motifs exist along with ethnographic and historic records regarding their use and purpose. In some areas of the country, modern Aboriginal people are far removed from their traditional ways of living (including their language, customs, and knowledge, although fragments still survive). But in other areas, such as Arnhem Land, the traditional ways are still very much a part of everyday life and many of these communities are willing to share their knowledge with ethnographers. While all of Indigenous Australia has been affected by colonisation, the effects are less severe in Arnhem Land than in urban areas, where colonisation has been more complete. In



many remote (and even some urban) communities, the language is still spoken and the customs and traditions are either still practised or are being rejuvenated. In other areas they have disappeared altogether.

In fields such as ethnography (which I discuss in the next section), and particularly in this thesis, it is important to deconstruct certain aspects of Western viewpoints (Ruggles, 2011b). No culture will view the natural world in the exact same way as another, nor will basic ideas or perceptions be universal. It is not the goal of Western science to disprove oral traditions or Indigenous views of the cosmos. The goal is to understand the role, origin, and evolution of astronomical knowledge and practices in all cultures of the world. To do so gives valuable insight into the human mind and provides a context for the evolution of thought and knowledge in various cultures living under different geographic and environmental conditions. In this case, it also provides a deeper appreciation for the intellectual feats of Australian Aboriginal cultures, which have been repressed, subjugated, and falsely dubbed as intellectually inferior to the dominating culture. In Chapter 4, I discuss the goal of this research in an Indigenous context and show why this knowledge is important and how it is useful in practice.

## 2.3 Methodology

Since cultural astronomy does not yet possess its own unique theoretical and methodological framework, research in this interdisciplinary relies upon the theories and methods of the disciplines from which it draws (i.e. sociology, anthropology, history, archaeology, etc). This is a thesis by publication with each chapter comprising one or more peer-reviewed papers on a common theme in Aboriginal Astronomy, which is primarily related to transient celestial phenomena. Although each chapter has an independent methodology, this thesis draws from three general sources of information: ethnographic, historical, and archaeological data. The analyses for each chapter rely heavily on astronomical and geographic tools and software packages. I outline each of these below.

Ethnography, from Greek ‘*ethnos*’ meaning ‘*folk/people*’ and ‘*grapho*’ meaning ‘*to write*’, is a method that uses a qualitative approach to learn and understand cultural

phenomena that reflect the knowledge and system of meanings guiding the life of a cultural group (Geertz, 1973). Ethnography is a major component in several disciplines, such as cultural/social anthropology, sociology, philosophy, history, and linguistics. An ethnography is a written observational activity that provides an account of a particular culture, society, or community, which ethnographers study and interpret. To accomplish this, ethnographers conduct fieldwork that usually involves spending a period of time (often a year or more) living with the local people in a particular society, learning about their ways of life. By taking part in the culture they are studying, the ethnographer is better able to understand local customs, language, and behaviour. Ethnographies are highly rigorous but are conducted through the cultural lens of the ethnographer.

The ethnographic fieldwork from which this research draws was not conducted by me but was taken from ethnographies published by others between British colonisation and today. These ethnographers possessed a range of academic training and/or experience. Some amateur ethnographers, such as Daisy Bates (1859–1951), lived long periods of time with local communities and whose records are generally considered of value, despite her lack of formal academic training (de Vries, 2008)<sup>3</sup>. Others, such as W.E.H. Stanner, were considered top quality researchers and were held in high regard (Hinkson et al., 2008). The interested reader is referred to Fredrick (2008), who provides an overview of the academic credentials and field methods of twelve major contributors to the field of Aboriginal astronomy: William Stanbridge, William Ridley, James Dawson, Alfred Howitt, Katherine Parker, Walter Spencer, Francis Gillen, Carl Strehlow, Daisy Bates, Norman Tindale, Charles Mountford, and Brian Maegraith.

Ethnographic, historical, and archaeological sources included books, journal papers, conference proceedings, abstracts, newspapers, magazines, book reviews, personal letters and journals, field notes, legal documents, archaeological site cards, published and unpublished reports and manuscripts, media sources (video and audio recordings), artwork, linguistic databases, reputable websites on Indigenous culture (e.g. ABC, SBS,

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<sup>3</sup>There have been well publicised cases of deliberate deception by Bates, which casts doubt on some of her work.

and Australian Geographic), and documentary films. The reliability of these sources varies significantly as not all of them have been published as academic works. The initial databases I used were developed by Serena Fredrick (2008) for her MPhil research and Ray Norris (2008) for his private research. I utilised online databases, such as JSTOR, Trove, ADS, Google Books/Scholar, and other searchable library databases for particular topics, keywords, and phrases. I also scoured the Macquarie University library for books, manuscripts, and journal papers on Aboriginal culture and scanned the indexes for keywords and topics. Sources were also drawn from the Australian Institute for Aboriginal & Torres Strait Islander Studies (AIATSIS) in Canberra, the Mitchell Library in Sydney, and the Museum of South Australia in Adelaide.

I submit that not every possible source on Aboriginal culture was thoroughly surveyed for astronomical knowledge, as literally tens-of-thousands of books and journal articles have been written about Aboriginal people and culture. I was unable to obtain some of the sources and manuscripts I sought, as they were either not in print, contained restricted content, or were simply unavailable to me during the period of my research.

Some of the archaeological data was taken from first-hand fieldwork. This involved surveying and recording rock art sites and stone arrangements, the latter of which is outlined in Chapter 11. Much of the geographic research used for Chapters 10 and 11 was conducted with the help of Google Earth and Google Maps. These programs provided valuable information about the landscape, terrain features, topography, distance scales, and the high-resolution imagery was extremely beneficial when scanning the landscape for meteorite impacts or locating archaeological sites from less-than-accurate site card records. Geographical programs developed by the U.S. Geological Survey and the Australian Government were also used in Chapter 11 for making various measurements, such as estimating the variation of magnetic declination. These also are described in their relevant chapters.

For astronomical analyses, I used software packages such as Starry Night Pro, Stellarium, and reputable online programs. These packages are ideal for conducting research in positional astronomy, where it is necessary to determine the positions of

celestial objects in the sky at any given time of day at any year ( $\pm 25,000$  years) at any place on earth. These programs account for a range of dynamic and atmospheric effects including precession, stellar proper motion, radial velocity, atmospheric refraction, and lunar light pollution. In the relevant chapters, I highlight the specific programs I used and discuss their benefits and limitations. Various databases on historical comets, meteor showers, and eclipses were also used, which are all described in their relevant chapters.

Before continuing, it must be noted that particular Aboriginal groups are represented more than others. This is due to the information available in the published literature. Particular groups have been studied in more detail than others, and my research reflects this preference.

## 2.4 Rigour

*“Archaeoastronomy is a field with academic work of high quality at one end but uncontrolled speculation bordering on lunacy at the other.”*

— Clive Ruggles<sup>4</sup>

Any subject that crosses disciplines is prey to individuals who promote a range of unsupported personal interpretations, exaggerated claims, or wild speculation, frequently in opposition to the available evidence or the laws of nature. Cultural astronomy, especially the sub-discipline of archaeoastronomy, is certainly no exception. From the “ancient astronaut” claims of Erich Von Däniken and Zecharia Sitchin to the supposed doomsday clock surrounding the Mayan calendar, baseless speculation, pseudo-science, New Age mysticism, and conspiracy theories have plagued the discipline since its inception. Cultural astronomers have fought vehemently to legitimise their subject in the eyes of the general public and wider academia, while maintaining respectful and

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<sup>4</sup>AR315 (Archaeoastronomy) Lecture Notes, School of Archaeology & Ancient History, University of Leicester: <http://www.le.ac.uk/archaeology/rug/AR315/>

helpful collaboration with Indigenous communities (Ruggles, 2009). Even today, cultural astronomy is sometimes considered by some to be a fringe science, despite the high level of rigour involved (Ruggles, 1999: 3-6). This is a combination of several factors, primarily driven by unsubstantiated claims published by researchers who do not use an appropriate level of academic scholarship in their work (such as Sitchin and Von Däniken) and the media attention these ideas receive<sup>5</sup>. It is here that I explicitly demonstrate that this research is rigorous and scholarly.

It is fairly straightforward to quantify the reliability of scientific data, such as physical properties of archaeological artefacts, the predictive motions of celestial bodies, or scientifically derived environmental data. But how does one place an error bar on an oral tradition? How do we know the accuracy of second hand, non-Indigenous accounts? In general, I give more credibility to Indigenous authors (primary sources) than non-Indigenous researchers (secondary sources), and non-Indigenous writers with appropriate academic training are considered more reliable than those without proper training. However, I do acknowledge that this is subjective. Not all accounts are of equal reliability, especially second or third generation sources. I present each account or view as it is reported in the literature or directly from the informant, giving full citation. However, I do not weigh each of these according to reliability. While this could be a worthwhile exercise in the long run, with nearly a thousand sources, this is not a practical task for a project that must be completed in just three years. A detailed survey of each source with an estimate of its reliability is the subject of future work, although Fredrick (2008: her Chapter 3) investigated the reliability of some of the major contributors to Aboriginal astronomy.

I have found accounts from researchers that would be given relatively high levels of reliability that have really “gotten it wrong”. A Dreaming story about the asterism of Orion’s Belt from an Aboriginal community near Ooldea, South Australia recorded in the early 20th century seemed to describe the variability of Betelgeuse. Daisy Bates

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<sup>5</sup>See the History Channel and Discovery Channel for a range of shows on the paranormal, astrology, UFOs, ancient astronauts, Mayan doomsday calendars, and other pseudo-science: <http://www.skepticblog.org/2012/01/25/science-tv-sell-out/>

(1904/1912) identifies the stars that constitute Orion as *Nyeeruna*, a cowardly womaniser that chases the women of the Pleiades (*Yugarilya*). According to Bates, Nyeeruna's right hand is represented by the star Betelgeuse ( $\alpha$  Orionis), which holds a club he endeavours to fill with fire-magic to hurl at *Kambugudha*, the eldest sister of the *Yugarilya* (represented by the V-shape of the brighter stars of the Hyades in Taurus), who prevents Nyeeruna from ever reaching the *Yugarilya*, thus humiliating him. In his rage, Nyeeruna reddens with fire and lust, but Kambugudha's magic and humiliation causes his fire magic to die out, becoming faint. After some time, his magic comes back and his brightness increases. This is of interest to cultural astronomy, as Betelgeuse is a red super-giant with noted semi-regular variability that ranges by nearly 1 mag and has a duration of several months to a year. These variations, first described by Herschel (1840), would be noticed by a careful naked eye observer<sup>6</sup>. However, after obtaining Bates' original notes and manuscripts from the South Australian Museum, it was clear that she had changed small but significant details in the story and seemed to confuse the identity of the bright stars in Orion (referring to Rigel, a clearly blue star, as "shining reddly"). The project had to be scrapped because of this. The uncertainty in Bates' account was simply too high to argue a definitive connection while maintaining an appropriate level of rigour. Several projects have been either scrapped or shelved until further investigation can be properly conducted.

Given the nature of the subject, there are places where hard answers are not able to be found, solid conclusions cannot be made, and speculation is appropriate. Where this occurs, it is clearly stated in the text. To make unfounded claims or to press conclusions that are contradictory to the available evidence is damaging to the field, to the researcher, and ultimately, to the Indigenous community, as their culture is not being accurately or properly represented. Speculation is fine, so long as it is clearly labeled as such, is founded on reliable evidence, and is physically possible. It is highly unethical to feed false information back into a community, even if the researcher has the best of intentions. To avoid this issue, I use primary sources wherever possible, speculation is kept to a minimum and is clearly labeled as such, methods are clear and

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<sup>6</sup>This idea was first suggested by Fredrick (2008).

consistent, and only those projects that maintain a high level of rigour are found in this thesis.

As an astronomer, it is easy to be biased toward astronomical interpretations. For example, while an archaeologist may see a crescent rock engraving as a boomerang or a wind-break, it looks to an astronomer like a crescent moon. Unusual motifs in artistic forms could represent just about anything if there is no supporting ethnographic evidence or first-hand Indigenous accounts to tell us what it means. For example, some astronomers have argued that abstract motifs could represent supernovae, despite the lack of supporting evidence (e.g. Murdin, 1981). When searching for alignments in stone arrangements, it is desirable to the astronomer to seek results that are consistent with astronomical phenomena. Such an expectation is a reflection of our own bias as researchers, thus illustrating the importance of rigour. As Ruggles (2011b: 7) noted, cultural astronomers should not be demotivated by results that produce non-astronomical answers.

In this context, Ruggles (2011a) illustrates many of the issues presented when interpreting astronomical events or symbolism in Indigenous cultures. When searching for astronomical symbolism in rock art, do objects need to be representative of their physical characteristics? Do brighter stars need to be shown as larger motifs or should the angular distance between stars be accurately scaled in rock art? Cairns (1993) suggests that small, circular cup-like depressions on rock platforms north of Sydney are representations of constellations or stellar asterisms. He may be correct. But how does one demonstrate this in the absence of ethnographic or historic evidence? There are so many stars in the night sky that they form a myriad combination of designs — given this, one could find almost any statistical correlation between star patterns among the thousands of cup marks on the rock platforms. It may be true that these depressions represent stars, but it is difficult to demonstrate this statistically. Tucker et al. (2011) applied this technique to similar engraved cups in rock art from Argentina, showing a high degree of similarity between patterns of cup marks and particular star patterns. However, they admit that this is a working hypothesis and do not claim certainty in their results (not to mention that those cup-like engravings are few in number).



FIGURE 2.2: **Left** – A crescent petroglyph from Calga Springs, NSW. **Middle** – the crescent Moon, and **Right** – a boomerang. Image from Norris & Hamacher (2011).

I had started a similar project during my candidature where I sought to determine if crescent engravings in the region north of Sydney more closely resembled the geometry of crescent moons than a boomerang. I shelved the project because the base assumptions were flimsy. Is there any reason a boomerang (or similar object) should be drawn exactly to scale? Is it possible to know the identity of two similar shapes with no cultural context to support either claim? Engravings of human figures do not look like photographic images of people, but can be identified as human by the fact that they have a head, body, and limbs. It is not important that they are drawn to scale. Therefore, whether the crescent engravings accurately portray a particular object with accuracy is not important. We do not know the context of the engravings with any certainty and our interpretations are speculative. For these reasons, I shelved that project<sup>7</sup>.

<sup>7</sup>While this thesis was being examined, I supervised Trevor Leaman, a vacation research scholar, through a project to measure the orientations of crescent engravings in Sydney rock art. Using published reports, he found that the orientations of these motifs had a clear preference for the cardinal directions and that Dreaming stories across Australia describe a connection between boomerangs and the crescent moon. This project has since been “un-shelved”.



Similarly, one must be careful when interpreting a site where only some information is known. For example, the Wurdi Youang stone arrangement indicates the position of the setting sun at the solstices and equinoxes, as noted above. We are careful not to label this an “astronomical observatory” as we do not know the cultural context of the site, why it was used, or what these alignments meant to the people who built the arrangement. The alignments may be deliberate, but the solar connection could be peripheral to the overall purpose of the site, or serve some minor role. We simply do not know. To claim anything more at this point would be disingenuous.

I have described some of the inherent bias I have as an astronomer. I actively fight this bias by considering all interpretations and not favouring an astronomical one over others, but I acknowledge that this bias is present. I also realise that as a non-Indigenous researcher (and a non-Australian), there are other biases and limitations to my understanding of Aboriginal culture. In Section 3.4, I explore the limitations of this work and of myself and other researchers as non-Indigenous people researching Aboriginal culture.

In the next chapter, I review and discuss aspects of the history of Indigenous peoples, which are relevant to this thesis, from first human migration to Australia to modern ideas of Indigenous identity.



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# 3

## Indigenous History & Culture

*“The Dreamings are our ancestors, no matter if they are fish, birds, men women, animals, wind or rain. It was these Dreamings that made our Law...and our Law is not like European Law, which is always changing... our law cannot change. All things in our country have Law, they have ceremony and song, and they have people who are related to them...”*

— Mussolini Harvey  
(Rose, 1996: 27)

### 3.1 Human Migration to Australia

The scientific approach to understanding human presence in Australia is to first acknowledge that all humans, no matter how they are classified by geography or culture,

are, at the core, biologically the same. We are *Homo sapiens sapiens* – a species of the genus *Homo* — bipedal hominids of the great ape family. The current evidence-based consensus is that anatomically modern humans evolved from archaic *Homo sapiens* in Africa in the Middle Palaeolithic ( $\sim 250,000$  years before present, hereafter BP). Around 70,000 years BP, humans began migrating out of Africa (Figure 3.1), replacing earlier hominids (who were driven to extinction partially by humans and partially because of their inability to adapt to changing climactic conditions) or breeding with them (e.g. Green et al., 2010). Archaeological and genetic evidence shows that by at least 40,000 years BP, humans had colonised Eurasia, Australia, and Oceania, and by 14,500 years BP, they had reached the New World (Americas), living as hunter/gatherers until  $\sim 10,000$  years BP, when humans began rudimentary agriculture (see Flood, 1983; McHenry, 2009). The islands of the Pacific Ocean have only been inhabited over the last 2,000 years with New Zealand (Aotearoa) being one of the last habitable places on earth to be settled by humans (Murray-McIntosh et al., 1998). Recent research (Rasmussen et al., 2011) using genetic data shows that Aboriginal Australians are from the first group of humans to migrate out of Africa some 62,000–75,000 years BP, representing one of the oldest continuous populations outside of Africa.

The spread of our species was dependant on a number of factors, including climatic conditions, our ability to adapt to new environments, and the accessibility of new land and resources (e.g. Diamond, 1997). Climatic change produced variable sea levels over the earth's history that guided the paths of human migration. The last time the sea level was as high as it is now was some 120,000 years BP<sup>1</sup>. Since then, the sea level has varried by as much as 120 m below current levels, with the lowest levels occurring approximately 18,000 and 37,000 years BP. 40,000–50,000 years BP, the sea level was  $\sim 80$  m below that of today, creating a single land-mass that incorporates the current land-masses of Tasmania, mainland Australia, and New Guinea, called Sahul, with much of southeast Asia comprising the land-mass of Sunda. The major land-masses were separated by a deep ocean waterway that exceeded 90 km in width, known as the Webber Line. This suggests that migrating humans possessed sea faring skills.

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<sup>1</sup>Glacial & Interglacial Scale, NOAA: [www.ncdc.noaa.gov/paleo/ctl/clisci100k.html](http://www.ncdc.noaa.gov/paleo/ctl/clisci100k.html)

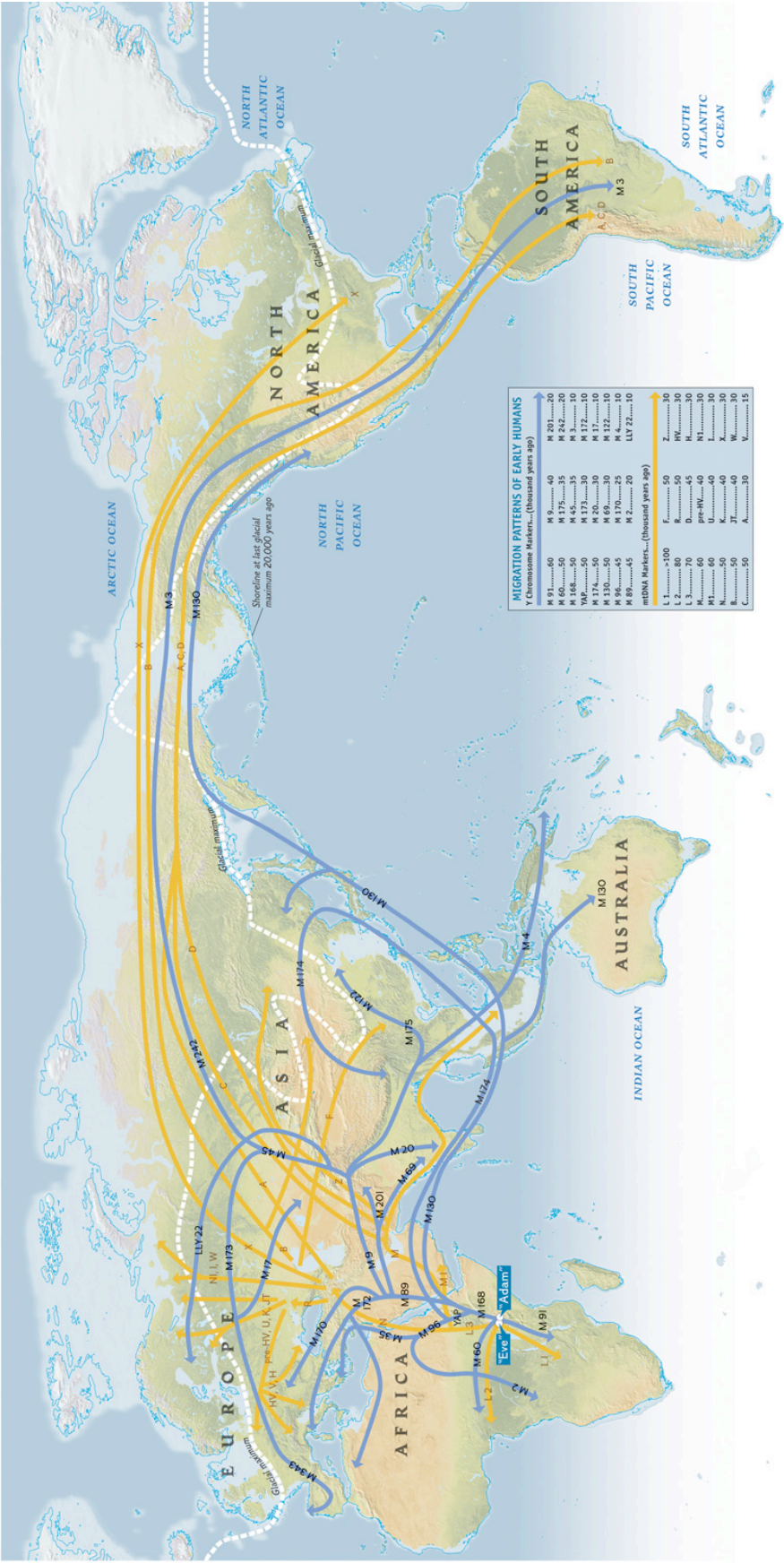


FIGURE 3.1: Map showing the paths of human migration. Image from [www.geneticarchaeology.com](http://www.geneticarchaeology.com)



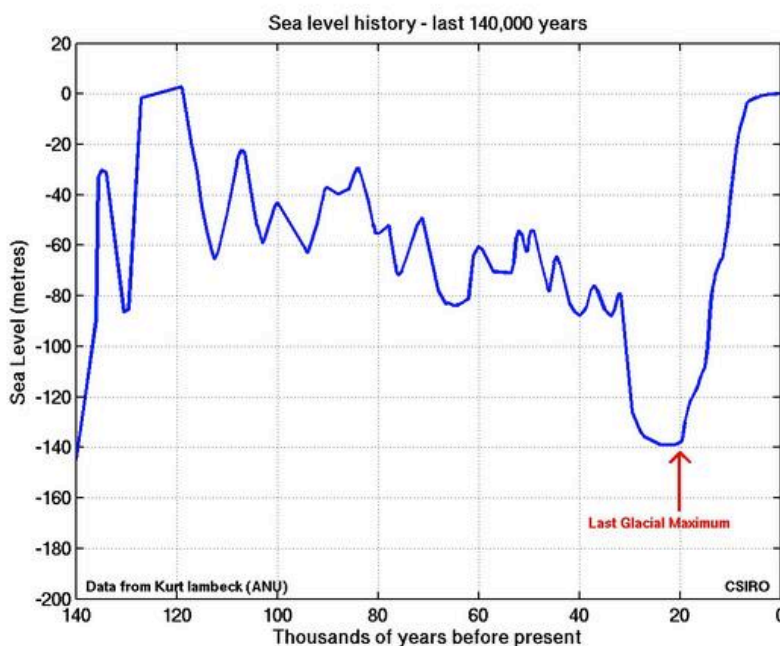


FIGURE 3.2: Sea Level over the last 140,000 Years. Image from CSIRO ([http://www.cmar.csiro.au/sealevel/sl\\_hist\\_intro.html](http://www.cmar.csiro.au/sealevel/sl_hist_intro.html)).

The arrival period of humans to Australia is found from two major sources of evidence: genetic and archaeological. Several models of human migration have been proposed in the past (see van Holst Pellekaan, 2008 for a treatise on the subject), many of which suggested that multiple waves of early humans had migrated to Sahul. Recent genetic studies using Y chromosomes and mitochondrial DNA<sup>2</sup> suggest that humans migrated to Australia in a single wave, as opposed to multiple waves (Hudjashov et al., 2007). The study showed that the Indigenous people of Australia and New Guinea share several ancient genetic lineages, indicating that both are descended from a single founding population (Figure 3.1). Archaeological evidence comes from sites that have been dated using a number of techniques. Most reliable methods show that people have inhabited Australia for between 40,000 and 50,000 years (see O'Connell & Allen 2004, Bowler et al., 2003, Gillespie & Roberts, 2000, and Bird et al., 2002), with higher estimates exceeding 60,000 years (see Thorne et al., 1999, Roberts et al., 1990, and

<sup>2</sup>Y Chromosomes are found only in males and indicate the father's genetic history. Mitochondrial DNA is passed down through the mother only.



FIGURE 3.3: A map showing the land-masses of Sunda and Sahul, showing the coastline at the last glacial maximum. The ecozone boundaries are identified as Wallace, Webber, and Lydekker Lines. Image by Maximilian Dörrbecker.

Fullagar et al., 1996).

In summary, evidence shows that humans migrated out of Africa some 75,000 years BP and migrated to Australia over 40,000 years ago, with some estimates exceeding 60,000 years. This would make Indigenous Australians among the oldest continuous cultures in the world (see Head, 2002: 97; McNiven & Russell, 2005: 205–208).<sup>3</sup>

<sup>3</sup>By continuous, we mean that they were not colonised until the arrival of Europeans.

## 3.2 Language & The Dreaming

*“In the language are our ideas and we need them, the world needs them.”*

— Bruce Pascoe<sup>4</sup>

Before the European colonisation of Australia, there were estimated to be over 300 distinct language groups with nearly 750 dialects (Walsh, 1991, see Figure 3.4). Each language group possessed a unique culture, customs, laws, religious practices, and traditions (see Figure 3.4). While adjacent groups had a similar (but different) language and culture, such as Spanish and Portuguese, others were as different as Japanese and Zulu. Because Australia had few domesticable animals or crops, full-blown agriculture never took a foothold (Diamond, 1997). Indigenous Australians lived largely as nomadic hunter/gatherers, meaning that each group of people, or community, moved to new food sources within their land boundaries, which were often denoted by natural landmarks such as mountains and rivers, throughout the year. In some areas, such as Western Victoria, abundant food marine sources were available most of the year, leading to a semi-sedentary lifestyle (Coutts et al., 1978; Clarke, 1991, 1994) that led to the building of stone huts and “villages”.

Aboriginal Australians lived for over 40,000 years or more with little contact from the outside world. Areas in the north of Australia were visited by Macassan fishermen (from Sulawesi) between 1700 CE and 1907 (MacKnight, 1976), but it was not until British colonisation that the lives and cultures of Indigenous Australians were radically altered by outside cultures.

A formal written language never developed in Australia, as was the case with many hunter/gatherer cultures across the world<sup>5</sup>. In most regions, adjacent communities spoke different languages or dialects and many Aboriginal people were multi-lingual. Some information was recorded in written form, such as message sticks that were taken by messengers to distant communities to inform them of events such as initiation

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<sup>4</sup>‘Do more’ challenge for us all. *Koori Mail*, Vol. 441, p. 40.

<sup>5</sup>Written language is the product of an agrarian society, which first developed in Sumer (Mesopotamia) ~ 6,000 years ago in the form of Cuneiform (Robinson, 2003).



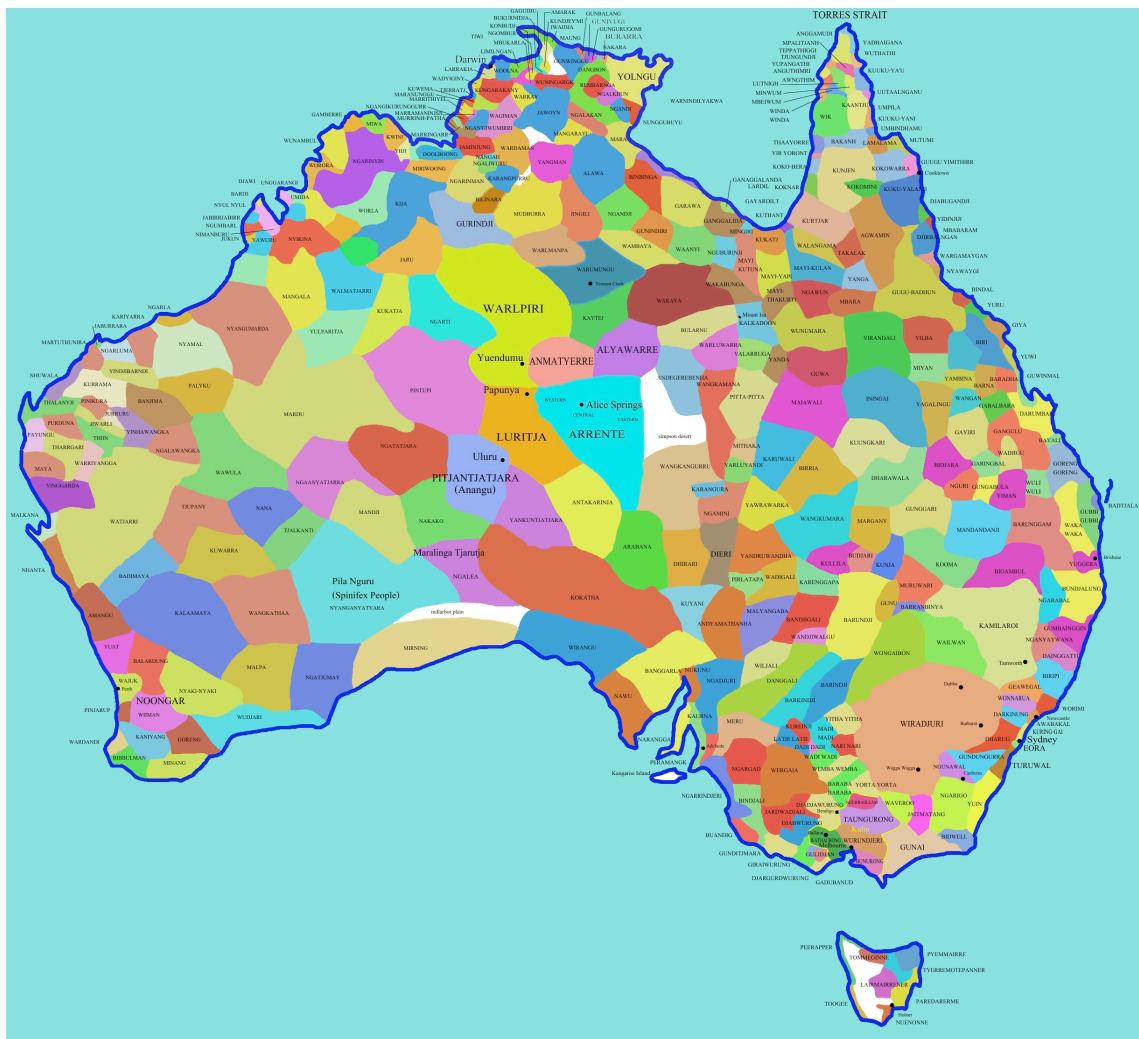


FIGURE 3.4: Map of Australian Aboriginal Languages. Each coloured patch shows the approximate area of each of the main Aboriginal language groups. Taken from the Australian Institute for Aboriginal and Torres Strait Islander Studies (AIATSIS), Canberra: [www.aiatsis.gov.au](http://www.aiatsis.gov.au)

ceremonies. Artistic motifs, such as bark paintings, rock art, sand drawings, and culturally modified trees (tree carvings), contained information in written form, but was not used phonetically. Given the lack of a written language, strong oral traditions developed as a mental record of the history, laws, customs, and religious traditions of each community. As the Yolngu teacher Yalmay Yunupingu explained<sup>6</sup>:

*“Our language is our power, our foundation, our root and everything that holds us together. [It] gives us strength; language is our identity, who we*

<sup>6</sup>NT Govt accused of endangering culture. *Koori Mail*, Vol. 439, p. 8.

*are. Our language gives us pride. Language is our law and justice.”*

Oral traditions, recounted through story, song, dance, and art, were handed down through successive generations and typically contained a moral charter. When young people reached their mid-teens, they were taught the laws, customs, histories, and oral traditions (e.g. Rumsey, 1994). They were then subject to a ceremonial rite-of-passage, in which they had to prove their knowledge and bravery, commonly called “initiation”. Knowledge that was considered sacred and secret was restricted by gender, initiation, totem, or blood/skin groups (see Michaels, 1985; Ross, 1986).

In 1896, Francis Gillen coined the term “The Dreaming” to refer to the period in the religious mythologies<sup>7</sup> of the Northern Arrernte people of Central Australia (Dean, 1996). The term was adopted by Spencer & Gillen (1899) and has been adopted by most Aboriginal groups of Australia in modern times. The Dreaming is the embodiment of Aboriginal culture. It contains the cosmology, laws, customs, traditions, stories, songs, and religion. It is both a body of knowledge and a place and time. Time is not necessarily linear and the place is not necessarily in our physical world. The Dreaming is home to ancestral spirits. It may represent a future, past, or concurrent reality parallel to our own. During ritual ceremonies, it is believed the past can become the present, so the oft quoted term *The Dreamtime* is not entirely accurate, as it denotes a linear timeline, separating past, present, and future. To understand Aboriginal culture and to learn about the laws, customs and traditions, it is essential to understand the Dreaming<sup>8</sup>. The Dreaming is sacred and it is passed to new generations through carefully constructed ceremonies via oral tradition. The Dreaming contains the collective knowledge of the community. It is here where we must search to find scientific knowledge.

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<sup>7</sup>As I discuss in Section 10.3, the word *mythology* is derived from the Greek *mythos*, meaning ‘story’ (or in some cases ‘word’) and *logos*, meaning ‘word’ in the form of speech. Thus, “mythology” means “spoken stories”. The modern misappropriation of the term *myth* to denote something that is false or untrue is incorrect and problematic.

<sup>8</sup>The reader is referred to Dean (1996) for a more in depth analysis and discussion of the Dreaming.

### 3.3 Indigeneity & Self-Identification

Colonisation of Australia by the British was a major turning point in the lives and cultures of Indigenous Australians. With the British came disease, introduced pests (e.g. rats and foxes), racist perceptions, stolen land, and oppressive governmental policies (McGregor, 2002). In many regions, missionaries banned Aboriginal languages and customs and attempted to convert Aboriginal people to Christianity. The loss of country, culture, and language combined with 200 years of oppression, racism, poverty, and intermarriage with non-Aboriginal people led to complex identity issues that are a major focus of reconciliation and Indigenous self-identification today (e.g. Keen, 1988; Dodson, 1994; Dunn et al., 2004).

According to the Merriam-Webster dictionary, the term “indigenous” comes from Late Latin *indigenus*, Latin *indigena*, and Old Latin *indu*, meaning “native”. Synonyms include “*autochthonous*” (Greek meaning “sprung from the earth”), “*aboriginal*”, or “*natural*”. More general definitions claim that “indigenous”, in the context of humans, refers to a group of people who were the first inhabitants of a land or region. “The first inhabitants” is a rather subjective phrase, as every group of people on earth united by language, culture and/or society have distinct and different views of “the first”, and these views are often argued and challenged within these groups. For example, who were the “indigenous” inhabitants of Europe or Africa? Within the context of each culture, views regarding this will vary significantly.

In Australia the term most commonly used to refer to the First Australians is “Aboriginal”. This term is used to denote the people living in Australia prior to European colonisation. It does not, however, refer to Torres Strait Islanders, who are of Melanesian extraction and are culturally different from Aboriginal Australians. The term Indigenous Australian is generally used to include both Aboriginal and Torres Strait Islander people. The main question in this context is how “Aboriginal” is defined in Australia. While researching over 700 pieces of legislation in Australia, McCorquodale (1986) found no less than 67 different definitions of “Aboriginal people” and these definitions were far reaching in their classification and labeling of someone deemed

“indigenous”. At the time of colonisation, the definition was considered rather straight forward; either you were Aboriginal or European. It was not until these two groups began merging, biologically and culturally, that the definition became more ambiguous in the eyes of both groups. How did one classify a person whose mother was Aboriginal and father was European, or vice-versa? Did this depend on genetic traits that were more apparent (light or dark skin, for example) or was it based on culture?

Early colonial definitions of “aboriginal” focused on an ever-changing set of criteria, originally referring to a person’s particular place of habitation, but later changing to refer to that person’s “blood classification”: i.e. classifying people by the degree of “indigenous” blood in their genetic makeup. Australian legislation used the concept of “blood classification” well into the 1950s, which affected the rights, benefits, and land ownership of anyone in Australia who had any “indigenous blood” in their genes. These inconsistencies produced serious problems to anyone who did not fall into a clear-cut category, as illustrated by Read (1998):

*“In 1935 a fair-skinned Australian of part-indigenous descent was ejected from a hotel for being an Aboriginal. He returned to his home on the mission station to find himself refused entry because he was not “an Aboriginal”. He tried to remove his children but was told he could not because they were Aboriginal. He walked to the next town where he was arrested for being an Aboriginal vagrant and placed on the local reserve. During the Second World War he tried to enlist but was told he could not because he was Aboriginal. He went interstate and joined up as a non-Aboriginal. After the war he could not acquire a passport without permission because he was Aboriginal. He received exemption from the Aborigines Protection Act and was told that he could no longer visit his relations on the reserve because he was not an Aboriginal. He was denied permission to enter the Returned Servicemen’s Club because he was.”*

State sponsored racism became policy with the passing of laws and acts that separated and isolated people of Aboriginal heritage from mainstream Anglo-Celtic society.

While examples are seemingly endless, the *Commonwealth Franchise Act (1902)*, which prevented Aboriginal people from voting, stands out. It was not until the *Commonwealth Act of 1949* that Aboriginal Australians had the right to vote under federal law, although it was not generally recognized by the states until 1962, when Aboriginal people gained the right to vote in Western Australia, and Queensland in 1965. It is a common misconception that the 1967 referendum gave Aboriginal people the right to vote. Instead, it gave the Commonwealth powers to make laws with respect to the Aboriginal people and counted them in the Census (Reynolds, 1997). While these examples highlight the complications in perceiving someone as “indigenous” or “aboriginal”, they take us no closer to defining these terms.

The term “indigenous” is only applicable in the context of a dominating society from a different cultural and/or genetic background. “Aboriginal” meant nothing until colonisation, as prior to that there was no basis for comparison. It is not until a distinctly different group of people arrived that one could discriminate between the two. Race is meaningless from a scientific perspective and only has meaning in a political/cultural context (Sowell, 1995; Gates, 1997; Farber, 2009) and classifications and definitions of Aboriginality are largely political in nature (e.g. Keen, 1988; Hodge, 1990; Hollinsworth, 1992; Bourke, 1993; Holland, 1996; Morton, 1998; Bauman, 2006; Read et al., 2008). Historically, the Australian state has battled with the definition and classification of Aboriginality. Since the land was taken from the Indigenous population under *Terra Nullius* (land belonging to no one), Aboriginality or Indigeneity is a threat to state sovereignty (e.g. Stokes, 1997; Peterson & Sanders, 1998; Weiner, 1999; French, 2003). Therefore, it has been an Australian state policy to control these terms, which cannot be accomplished until they are defined<sup>9</sup>.

Since colonisation, Aboriginal knowledge has been inextricably linked to identity. In regards to this thesis, we do not know how much of the knowledge recorded about Aboriginal cultures is pre- or post-colonial. We can reasonably assume there are various degrees of “cultural influence” — that is, Western knowledge that influenced Aboriginal

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<sup>9</sup>I use the capitalised term “Aboriginal” in lieu of “Indigenous” as I only address Aboriginal (mainland Australian and Tasmanian) cultures and not Torres Strait Islander cultures.

knowledge. It is certain that this occurred, especially in areas under the control of Christian missionaries whose goal was the eradication of traditional language, laws, and customs in favour of Christianity and Western “civilisation”. For example, note in Section 10.5.2 how Christian mythology was incorporated into the Aboriginal stories of local land features in the Central Desert.

Examples of (non-European) cultural influence are found among the Yolngu of Arnhem Land, where Macassan (Indonesian) fisherman traded with Aboriginal people prior to, and during, European colonisation. “*The cultural imprint on the Yolngu people of this contact is everywhere: in their language, in their art, in their stories, in their cuisine,*” (Ganter, 2005: 3). This influence includes Indonesian words that have been incorporated into local Aboriginal languages, such as *rupiah* (money), *jama* (work), and *balanda* (white person) (Macknight, 1986).

This thesis provides examples of Western knowledge influencing, or being incorporated into, Aboriginal culture. The degree of cultural influence in Indigenous knowledge systems is not always clear and any attempt to quantify it is problematic. Therefore, the knowledge presented in this thesis cannot be discriminated between pre- and post-colonial knowledge; it is a mixture of the two, as we have no way of clearly making this distinction.

### 3.4 Researching Indigenous Knowledge

*“Education is the antidote to the tide of intolerance that infects the modern mind. By sharing ancient knowledge with our youth, we are giving them the chance to empathise and engage with our Aboriginal heritage.”*

— Jonathan Hill<sup>10</sup>

Indigenous knowledge has no clear definition (Sillitoe et al., 2005), but involves interpretations of the world that have been generated by Indigenous people over the course of human history (*ibid*). Oral tradition, laws, artistic forms, dance, and song all

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<sup>10</sup>‘Practical reconciliation’, readers letter. *Koori Mail*, Vol. 482, p. 23.

contain expressions of knowledge. As I show throughout this thesis, this knowledge is progressing. It incorporates new information, new perspectives, new events, new experiences, and new ideas. This is one of the reasons why distinguishing between pre- and post-colonial knowledge is so problematic. This thesis attempts to better understand Indigenous knowledge related to the sky by primarily using ethno-historic documents and archaeological evidence<sup>11</sup>. The arguments in this thesis use an evidence-based approach. This thesis is ultimately a work of Western science that simultaneously respects Indigenous perspectives (c.f. Ruggles, 2009). Being a non-Indigenous researcher, especially one with an academic background in the physical sciences, there are limitations to this work.

Much of the literature from which this thesis draws is based upon ethnographic work undertaken by mostly Western anthropologists and researchers, not all of whom had formal training (and would therefore be considered “amateur ethnographers”). As with the collection of any ethnographic information, the conditions under which the process is conducted are never ideal (LeCompte & Goetz, 1982; Sim, 1999). Data collection in classical ethnography primarily involves participant observation. This firsthand experience allows the ethnographer to gain a close and intimate familiarity with a community and their practices through intensive involvement with people in their natural environment (DeWalt et al., 1998). In addition to participant observation, ethnography is a delicate process of translating language, meaning, intent, and purpose. This creates an inherent bias that is difficult to quantify, but certainly exists. The information shared with researchers depends upon several factors, including gender, age, and status, but relies most heavily upon their relationship with the community and knowledge custodians, their reputation, and their willingness to engross themselves within the community. It is rare for an Aboriginal elder to simply reveal all of their knowledge to a researcher, in the researcher’s mother tongue. Ethnographers have found, both in Australia and around the world, that as time progressed and their trust

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<sup>11</sup>The best approach, of course, would be to talk directly with Aboriginal people (ethnography). The reason this approach is not taken in this thesis is simply because of the time constraints required for a proper ethnography in the timeline of a PhD, as well as my lack of formal ethnographic training.

and rapport with the community matured, their informants opened up and shared more (and in some cases different) knowledge (e.g. Bednarik, n.d.; Russell, 2005; Archer, 2002; Greenhill & Dix, 2008). Robert Bednarik<sup>12</sup> highlights the view of some Aboriginal elders by a comment from an Aboriginal custodian that said:

*“It took me 60 years to become an Aboriginal, so how could a young balanda (European) straight from university learn much in a matter of a few months or years?!”<sup>13</sup>.*

In many cases, Aboriginal people choose not to reveal sacred knowledge. In some instances, the knowledge revealed to the researcher was done so in confidence and was not to be shared. Walter (2005: 28) discusses how some Western researchers in the late 19th and early 20th centuries, specifically citing Norman Tindale, had a tendency to treat their research subjects as “scientific specimens, stripping away their human dignity in the research process”, which led to much resentment and suspicion among Aboriginal people regarding any research of their people and culture. There have been numerous cases in which Aboriginal Elders have revealed sacred information to researchers under the condition that the information not appear in print or be revealed to anyone else, but this request was often ignored, despite it being a gross breach of confidence and ethics (Neate, 1982; Tuhiwai-Smith, 2001). Fortunately, this is a rare occurrence these days.

One highly visible case, *Foster vs. Mountford & Rigby, Limited* (1976)<sup>14</sup>, involved

<sup>12</sup>Website: [mc2.vicnet.net.au/home/interpret/web/ethno.html](http://mc2.vicnet.net.au/home/interpret/web/ethno.html)

<sup>13</sup>It is here that I must make a point clear, as illustrated by the preceding quote. I understand the context of the term ‘expert’ when working in academia and when dealing with the media to mean someone with extensive knowledge or ability based on research, experience, or occupation and in a particular area of study. Despite this, I do not consider myself an expert in Indigenous culture. In many cases, this term is used by others to describe my role in this research, but I feel it disingenuous to claim expertise on a culture, or on the hundreds of distinct Aboriginal cultures in this country, simply because I spent a few years in a library and at rock art sites. I do not speak an Aboriginal language, I do not live in an Aboriginal community or have Aboriginal heritage, nor have I been initiated into any Aboriginal community.

<sup>14</sup>Australian Law Reports, Vol. 71(14), p. 73.



a breach of confidence regarding the sharing of secret knowledge. In his once-banned book, *Nomads of the Australian Desert* (1976), Charles Mountford published ethnographic studies of Aboriginal groups in central Australia during the 1940s. Pitjantjatjarra Elders revealed sacred information to Mountford in confidence, with an understanding that it not be published. Mountford, however, chose to include this information in his book, believing that it was necessary to do so, because of his conviction that Aboriginal cultures were a “dying race” on the brink of extinction. The Aboriginal plaintiff in the case sought an injunction to prohibit the publication of the book within the Northern Territory. The Justice for the case noted that “photographs, drawings, and descriptions of persons, places and ceremonies have deep religious and cultural significance to the plaintiffs” and found that “some of the matters hitherto secret are revealed in the book, and that this has caused dismay, concern and anger”. He further noted the plaintiff’s concern that “the revelation of the secrets to their women, children and uninitiated men may undermine the social and religious stability of their hard-pressed community. Despite Dr. Mountford’s prognosis that their life and beliefs ‘are so quickly vanishing’, there was still an urgent desire in these people to preserve those things, their land and their identity” (*ibid*).

The considerations noted above must be addressed when analysing published material based on ethnographic studies or other research conducted by non-Aboriginal researchers. This is true today, but perhaps especially during the 19th and 20th centuries. Data taken from the published literature are interpreted and analyzed with an understanding and acknowledgment of these limitations. This thesis is a balance between the knowledge provided by Indigenous elders, the translated and analysed information provided by ethnographers, and my findings and analyses based on empirical research. Secret or deeply sacred knowledge is not presented in this thesis out of respect for the Traditional Owners.

Indigenous astronomical knowledge and traditions are carried and maintained by a range of Indigenous people, from fully initiated senior custodians, responsible for carrying and preserving the knowledge and traditions of the community, to people that are far removed, both genetically and culturally, from their own pre-contact knowledge

and ways of life. However, people of the latter category may still possess knowledge that has been passed to them by their own family or community oral histories. Many Indigenous people are now sharing their information directly with the public and I have drawn from this growing body of literature and have been guided by Indigenous stake-holders and researchers over the course of my research.

Given the changing views and knowledge of the cosmos by various Aboriginal cultures (and indeed all cultures, including Western astronomy), the data presented in this thesis does not necessarily represent modern Aboriginal views of celestial objects or phenomena, nor do the views expressed in this work necessarily represent all members of that particular group at all times. Indigenous knowledge and perceptions can change over time, so the “data” presented here must consider these facts.

Finally, many Aboriginal communities have seen little or no benefit from providing access to their knowledge, traditions, and land. In fact, many racist governmental policies were born out of Aboriginal people sharing their culture. It seems the benefactor is almost always the researcher or government agency. Greenhill & Dix (2008) highlight this problem, as recounted by Sandra Bailey at the first National Aboriginal and Islander Mental Health Conference held in Sydney in 1993:

*“It’s peculiar to say the least that as one of the most consulted and researched people in the country, we are the least listened to. We have to go continually to the Government with cap in hand, bowing, scraping and proving that we’re here, justifying our existence and our numbers and our needs, of course. As Kooris, we are born into a situation according to which our communities are in isolation. We’re subjected to a constant procession of academics, researchers, government agents, anthropologists, archaeologists, and sociologists, perhaps psychologists, who come to our door requiring information. As sure as one leaves, another arrives. We rarely see the report and often too late. We sometimes get quoted out of context or not at all, usually to our detriment. There are no improvements in our conditions and no improvements — and that’s a deliberate mistake there that I’ve repeated those three words — there are no improvements in our conditions or benefits*

*for our efforts. They, on the other hand, have either tidied up their files, made a decision on our behalf, made a scientific breakthrough, attained doctoral status, published their opinions, become experts in the field, provided a consultant's report, moved on to another theory, gained a new prestigious portfolio, attracted lucrative publicity, gained political kudos, offered legislation, made an impressive speech, attacked our credibility, denied our Aboriginality, advised us as to what we should be doing, or created another problem for us on which we will soon be consulted."*

As a non-Indigenous (and non-Australian) researcher, this is a consideration of which I must be especially aware. I ensure that I take no personal monetary advantage of being given this information, always giving credit where it is due, and sharing this with the public. A direct benefit to the Aboriginal community is essential to working with Aboriginal people, maintaining respectful ties with the Aboriginal communities, and in helping to mend the wounds of 200 years of oppressive policies. Our work must be mutually beneficial to Aboriginal communities and in cases where appropriate we include Aboriginal custodians as coauthors on published papers and books.

In the next chapter, I explore Aboriginal astronomy as a discipline, noting the research definitions, goals of the discipline, and highlight recent advances in the field.



Wardaman Senior Custodian and Aboriginal Astronomer, Bill 'Yidumduma' Harney.

# 4

## Review of Aboriginal Astronomy

*“The Aboriginal knowledge of astronomy greatly exceeds that of the majority of civilized folk, and the reason is very evident: the knowledge is of vast importance to him in his night journeys and in his computation of time; and such knowledge, with its accompaniment myth, is carefully preserved in the minds of the elders and karajis, and imparted with exceeding care in to the initiates of the Bora ceremony.”*

— W.A. Squire (1897: 47).

### 4.1 What is Aboriginal Astronomy?

In a broad context, “Aboriginal astronomy” is simply cultural astronomy as applied to Aboriginal cultures. This involves understanding how Aboriginal people used and

understood the sun, moon and stars. In the context of this thesis, “Aboriginal astronomy” does not simply refer to stories related to the sky or the naming of celestial objects. It implies an intellectual quest to gain a deeper understanding of the nature and motions of celestial objects and phenomena, their relationship to events on the earth, their origin and composition, and the ways they can be used for practical purposes. Did Aboriginal people make predictions based on observations of the sky and land? Or are the oral traditions and artistic forms related to the night sky simply a reflection of abstract beauty that contain nothing of practical importance?

## 4.2 Why Study Aboriginal Astronomy?

*“Because of the respect that astronomical knowledge engenders both in the academic world and among the public, studies in ethnoastronomy have a huge potential for raising awareness of and promoting minority groups.”*

— Alejandro Martin Lopez (2011: 42)

There are several reasons to study the astronomical knowledge of Aboriginal Australians. One reason is to better understand and respect the intellectual accomplishments of Aboriginal Australians (Norris, 2010). Many of the accomplishments of Aboriginal Australians are unknown to most non-Indigenous Australians and this ignorance fuels negative perceptions of Aboriginal people (e.g. Hudson, 2010).

Astronomy is a good way to generate interest in Indigenous culture among the public (Fienberg & Beatty, 2005). A survey by the New York Times found that astronomers and physicists have the 5th most prestigious occupation in America (West, 2009) and astronomy is a subject I have personally found very useful to highlight the intellectual achievements of Aboriginal people. Many people react positively and show genuine interest and curiosity when learning about Aboriginal astronomy. In my experience, very few react with cynicism. Thus, astronomy seems to be a good way to educate the public about Aboriginal knowledge and culture. This can lead to a more positive

public perception of Aboriginal people, which is an important step in the reconciliation process (e.g. Gomersall et al, 2000).

Another reason is to better understand how astronomical knowledge was used by different cultures in various geographical locations. The night sky was useful for practical and cultural purposes (e.g. Stanbridge, 1861 and Tindale, 2005). Different environmental conditions at different geographical locations means that the specific application of astronomy in one area may have little or no practical use to cultures in another area. For example, Polaris ( $\alpha$  Ursa Minor) is an efficient celestial tool for navigation in the northern hemisphere, as it lies very close to the north celestial pole. There is no such pole star in the southern hemisphere, which forces southern hemisphere cultures to develop alternate navigational techniques. The climate and weather patterns and their relationship to the motions of celestial bodies visible from Mesopotamia, Canada, or Greenland have little or no application to people in Arnhem Land, Fiji, or South Africa. Stars near the north celestial pole are invisible to most places in the Southern Hemisphere (depending on latitude) and vice-versa. Therefore, in order to obtain a complete and accurate picture of the use and context of astronomy by peoples around the world, it is important to understand the application of astronomy to each culture in a separate context, taking these variables into account. For instance, navigation is such an important aspect of Torres Strait Islander culture that the symbol of a navigational star was incorporated into their national flag (Figure 4.1–Right). Similarly, the sun is important as a provider and protector to Aboriginal cultures and was similarly incorporated into the national Aboriginal flag (Figure 4.1–Left).

What applies to agricultural societies in Europe may have little application to the hunter/gatherer cultures of Australia. The failure of colonists over the last 200 years to acknowledge the usefulness and insightfulness of Indigenous knowledge led to many environmental problems, including misuse of natural resources, introduced pests, fauna extinction, and environmental destruction (e.g. Garden, 2005). Understanding the ways Indigenous Australians utilised the night sky can have a practical application, especially when connected with climactic and environmental factors. Many Indigenous Australians used the appearance or disappearance of particular star patterns to denote

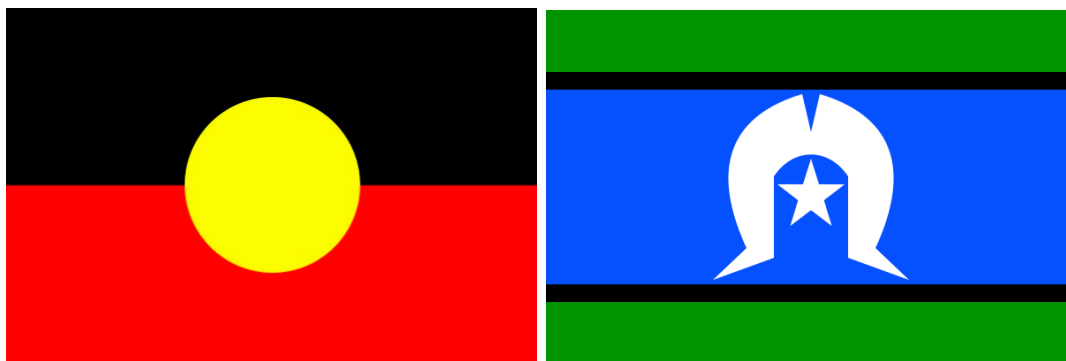


FIGURE 4.1: **Left** – The Aboriginal flag of Australia, signifying the sun (yellow), the earth (red) and the people (black), created by Harold Thomas in 1971. **Right** – The Torres Strait Islander flag signifying the land (green), the sea (blue), the people that live between the two (black), peace (white), the Dherri head-dress, and a five pointed star that represents the five major language/island groups and a navigational star, created by Bernard Namok in 1992.

the availability of particular food sources (e.g. Stanbridge, 1858), when weather patterns were about to change (e.g. Sharp, 1993), or when Macassan (Indonesian) fisherman would soon arrive in Arnhem Land (Norris & Hamacher, 2009). These connections apply as much today as they did prior to colonisation (as discussed in Chapter 5). Some forms of rock art, such as petroglyphs and stone arrangements, contain astronomical symbolism or alignments that are used for practical and ceremonial purposes among Aboriginal Australians (see Cairns & Harney, 2003; Norris & Hamacher, 2011), as well as many Indigenous groups across the world (see Poss, 2005; Ruggles, 2005).

Colonisation and the combined affects of disease, genocide, reduced access to resources, relocation and poverty on Aboriginal people meant that many Aboriginal cultures suffered a high degree of damage, nearly disappearing altogether in some cases (Rowley, 1970; Chauncy, 1973; Davies, 1974; Halloran, 2004). In the context of rock art, little is known about the traditional use or meaning of some of the sites. Even some Aboriginal custodians are only able to contribute fragmented information at best, since their language and traditions were banned by Christina missionaries in many places. If we are able to determine, at least to some degree, the purpose or meaning behind some of these sites, some knowledge may be jointly generated with Indigenous custodians for the on-going benefit and use of the Traditional Owners. For example, Chapter 11



addresses the hypothesis that Aboriginal stone arrangements are oriented to the cardinal points. If the results of this study confirm this, then a fragment of information regarding the use or purpose of these sites can be returned to the respective Aboriginal communities.

### 4.3 Literature on Aboriginal Astronomy

The literature on Aboriginal Astronomy is extensive. My review of the literature revealed that many works related to Aboriginal culture contain some element of astronomical knowledge. Aboriginal Australians are sometimes considered the most studied people on the planet (Attwood, 2008), and the literary works relating to Aboriginal people and culture number well into the thousands. It is therefore difficult to list every single source that has some reference to Aboriginal astronomical knowledge. However, a number of works have been dedicated to, or contain a major significant amount of, Aboriginal astronomy.

The first published work to include references to the astronomical knowledge or traditions of Aboriginal Australians was by Tench (1789) and referred to the Aboriginal people of Sydney. The first publication dedicated to the topic was Stanbridge (1858), who was taught the astronomical traditions of the Boorong clan near Lake Tyrrell in northwestern Victoria. His four-page paper forms the basis of Chapter 6. Over the next 150 years, several papers and book chapters were dedicated to Aboriginal astronomical knowledge, such as MacPherson (1881), Mathews (1904), Parker (1905), Griffin (1923), Maegraith (1932), Massola (1968a), and Mountford (1958, 1976) to name a few. To date, the most detailed record of the astronomical knowledge of any individual group is that of the Wardaman people from the Northern Territory, entitled *Dark Sparklers: Yidumduma's Aboriginal Astronomy* (Cairns & Harney, 2003). Many other works describing the in-depth sky knowledge of particular groups have been published, but they do not contain the sheer volume of information as *Dark Sparklers*. A few postgraduate theses have included a component on Aboriginal astronomy, including Love (1988, MA) and Clarke (1994, PhD), while Morieson (1996, MA) and Fredrick

(2008, MPhil) were wholly dedicated to the subject.

A majority of these publications deal with particular Aboriginal groups. It was not until the latter part of the 20th century that researchers began to really look at the subject in a cross-cultural context and compare the astronomy of Indigenous groups across the continent and across the globe, such as Haynes (1992), Clarke (1997), Johnson (1998), and Norris & Norris (2008). In addition to the papers cited here and the references contained within, the interested reader is referred to the following sources for literature on Aboriginal Astronomy:

- The “Further Readings for the Dedicated Researcher” section of the Aboriginal Astronomy Project website ([www.emudreaming.com](http://www.emudreaming.com)) contains an extensive list of publications on Aboriginal astronomy and rock art.
- Bhathal (2010) provides a selection of documents related to Aboriginal astronomy that were published prior to 1940.

A full database of literature on Aboriginal Astronomy is currently being collated and will be ready in the near future.

## 4.4 Examples of Aboriginal Astronomy

*“The land speaks to us and we speak to the land.”*

— Neparrnya Gumbula (1997).

Aboriginal people consider the sky to be part of the landscape; an inseparable component of the natural world. Everything on the earth is reflected in the sky (Mowaljarlai & Malnic, 1993), indicated by the numerous oral traditions that discuss beings originating on Earth and then making some sort of voyage to the sky (Johnson, 1998). The message from Neparrnya Gumbula is repeated throughout Australia – the land speaks to us. As part of the landscape, the sky also speaks to us. It tells us when the seasons change, when the tides come and go, when new food sources are ready...

even how to find our way at night. It is essential for the survival of any culture to understand the sky, be it agrarian or hunter/gatherer (e.g. Aveni, 1989, 2003; Bauer & Dearborn, 1998; Ruggles & Barclay, 2000; Urton, 1981; Zeilik, 1985). In this section, I will highlight a few examples of how the sky was carefully observed and used for various purposes that I do not discuss later in this thesis. The remainder of this thesis addresses this question in depth, dealing primarily with transient phenomena and finishing with stone structures.

#### 4.4.1 Timekeeping & Written Records

There are a number of ways celestial objects can be used to record the passage of time. In Aboriginal cultures, the moon is widely used. Hahn (1964: 130) notes that Aboriginal people of the Hahndorf area in the Adelaide Hills were observed making notches in their digging sticks upon the appearance of each New Moon<sup>1</sup> to mark their own age. Message sticks consist of pictograms used to communicate particular information to distant communities, which Howitt (1889: 314) called “Blackfellow’s letters”. For example, Mathews (1897: 293) explains how the pictograms on a message stick (Figure 4.2) represent information about the location and time of a corroboree to be held in the future. The message stick states that “Nanee (a) sent the message from the Bokhara river (b), by the hand of Imball (c), via the Birie (d), the Culgoa (e), and Cudnappa (f) rivers, to Belay (g); that the stick was dispatched at new moon (h), and Belay and his tribe are expected to be at Cudnappa river (f) at full moon (i); (j) represents a corroboree ground, and Belay understands from it that Nanee and his tribe are corroboreeing at the Bokhara river, which is their taorai, and, further, that on the meeting of the two tribes at full moon on the Cudnappa river a big corroboree will be held.”

This particular message stick reveals pictograms representing the moon at different phases (“new” and “full”). The new moon, which in this context represents a crescent, is depicted in the lower-left of Frame 1, labelled as (h) while the full moon is the full

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<sup>1</sup>The term New Moon is often used by non-astronomers to indicate the first appearance of the waxing crescent moon.

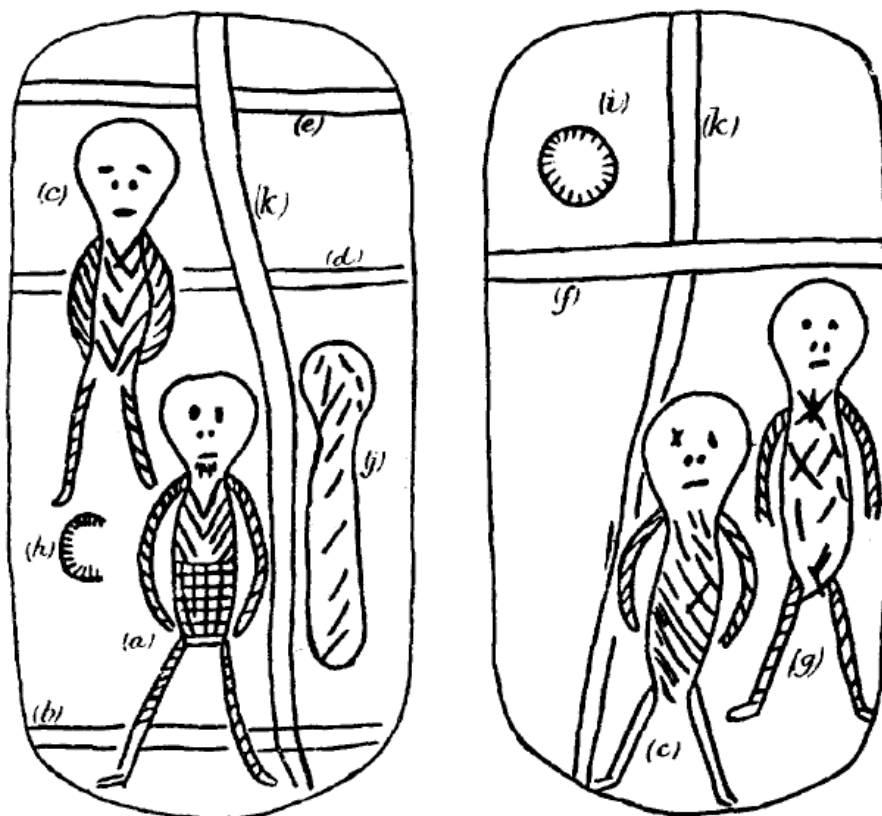


FIGURE 4.2: A message stick, taken from Mathews (1897: 292), depicting information including time, denoted by the phase of the moon.

circle depicted in the upper-left of Frame 2, labelled as (i). Given that the cusps of the moon point toward the right, this stick seems to represent a waxing crescent moon, which is prominent in the early evening. Lunar phases were a common method of determining time in message sticks (e.g. Howitt, 1889: 317).

#### 4.4.2 Observations of Planetary Motions

Yolngu people call the planet Venus *Banumbirr*, and tell how she came across the sea from the east in the Dreaming, naming and creating animals and lands as she crossed the shoreline, and continued traveling westwards across the country, leaving as her legacy one of the songlines, which are important in Aboriginal cultures (Norris & Norris, 2008).



FIGURE 4.3: A morning star pole, made by Yolngu artist Richard Garrawurra from Elcho Island. The tuft of Magpie-goose feathers at the top represents Banumbirr, and also represents a waterlily. The patterns are traditional clan designs. The other tufts of feathers on pandanus strings represent other stars, and other clans. From Norris & Norris (2008)

During the Morning Star Ceremony, Yolngu people communicate with their ancestors on *Baralku*, the island of the dead, with the help of Banumbirr and the Morning Star Pole (Figure 4.3). The ceremony starts at dusk and continues through the night, reaching a climax when Banumbirr rises a few hours before dawn. She is said to trail a faint rope behind her along which messages are sent, and which prevents her from ever moving away from the Sun. This faint line in the sky may be *zodiacal light*, which is caused by interplanetary dust in the plane of the solar system. When Norris & Norris (2008) asked a Yolngu elder how he knows when Venus will rise, he replied “we count the days, silly”.

This ceremony reveals that Yolngu people noticed that Venus never strays far from the Sun, which they explain in terms of the rope binding the two bodies together. The other is that the Morning-Star ceremony has to be planned well in advance, since

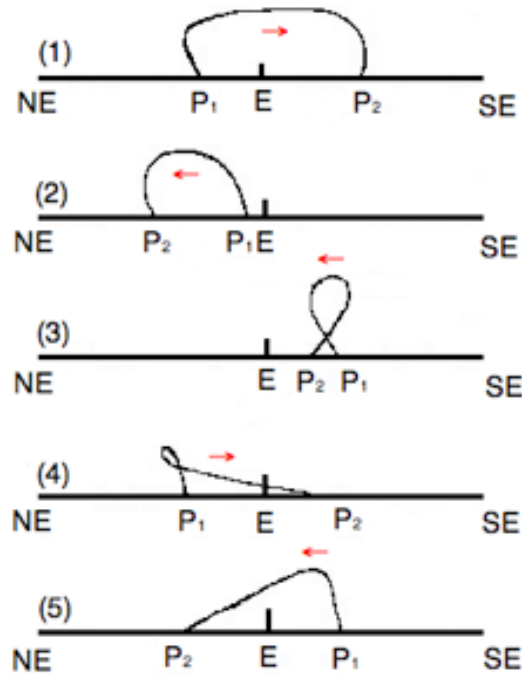


FIGURE 4.4: Five cycles of Venus' orbital path plotted at 05:00 each day from Darwin, Australia. Azimuths are given as northeast (NE), east (E) and southeast (SE).  $P_1$  is the point where Venus first rises at 05:00 and  $P_2$  is the last day it rises at this time. The durations of each cycle are (1) 152 days, (2) 116 days, (3) 144 days, (4) 164 days, and (5) 135 days. The red arrow shows the direction of the orbital path. Image by D.W. Hamacher calculated using Starry Night Pro software using data from September 1999 to June 2014.

Venus rises a few hours before dawn only at certain times of the year, which vary from year to year. Therefore, the Yolngu people also track the complex motion of Venus well enough to predict when to hold the Morning Star Ceremony.

To understand the periodicity of Venus as observed from Arnhem Land, one needs to observe its position in the sky every day from the first time it rises, say, at 05:00 ( $P_1$ ) to the last day it rises at 05:00 ( $P_2$ ). If these positions are plotted, it is clear that Venus makes five distinct cyclic patterns, each with a different 'duration' (the total number of days Venus is above the horizon at 05:00, see Figure 4.4). Each cycle has the same period and repeats every eight years. This gives 2,922 days between the start of each new cycle, although the cycles show that Venus rises before the sun at dawn roughly once every 1.5 years. This occurs because Earth is in roughly 8:13 resonance with Venus, which means the orbits of Earth and Venus arrive at nearly

the same configuration after eight Earth years and 13 Venus years. The actual ratio is 0.61518624, which is only a 0.032% deviation from 8:13 (0.61538462). After eight years, the orbits are mismatched by  $1.5^\circ$  of Venus' orbital movement. This change results in Venus and the Earth being in opposite relative orientation to the original match every 120 such cycles, which is 960 earth years. This means that over the last 40,000 years, Venus has been in opposite relative orientation  $\sim 42$  times. On timescales of thousands of years or more, the relative position of the Earth-Venus system is effectively random. Thus, the cycle of Venus cannot be predicted accurately over periods exceeding a few hundred years, showing that knowledge relating to the cycles of Venus must change over time and Aboriginal people would have needed to make careful observations over time to know when to hold the ceremony.

We do not yet know with certainty whether each cycle was known in detail, or the general 1.5 year cycle of Venus rising in the east at dawn. By knowing the dates of the last several ceremonies, the answer may become more clear. Future work with the Yolngu is necessary.

### 4.4.3 Astronomy in Stone Arrangements & Rock Art

Do forms of material culture, such as rock art or stone arrangements, contain astronomical symbolism or alignments that have a practical purpose? In this section, I will explore two examples that do not form a major component of this thesis. The first is the Wurdi Youang stone arrangement in Victoria that is oriented to the position of the setting sun at the solstices and equinoxes (Norris, et al., 2012) and the second is the now-famous Emu in the Sky engraving north of Sydney, which I briefly discuss in Section 5.6.1.

Wurdi Youang is an egg-shaped stone arrangement in Victoria built by the Wathaurung people before European colonisation. The arrangement consists of about 100 basalt stones forming a closed egg-shaped loop,  $\sim 50$  m in diameter along its major axis. The arrangement is oriented along an east-west axis, with three prominent stones at the western apex. When viewed from the eastern apex, the two straight sides mark the solstices and the three stones at the western apex mark the equinoxes (Figure 4.5

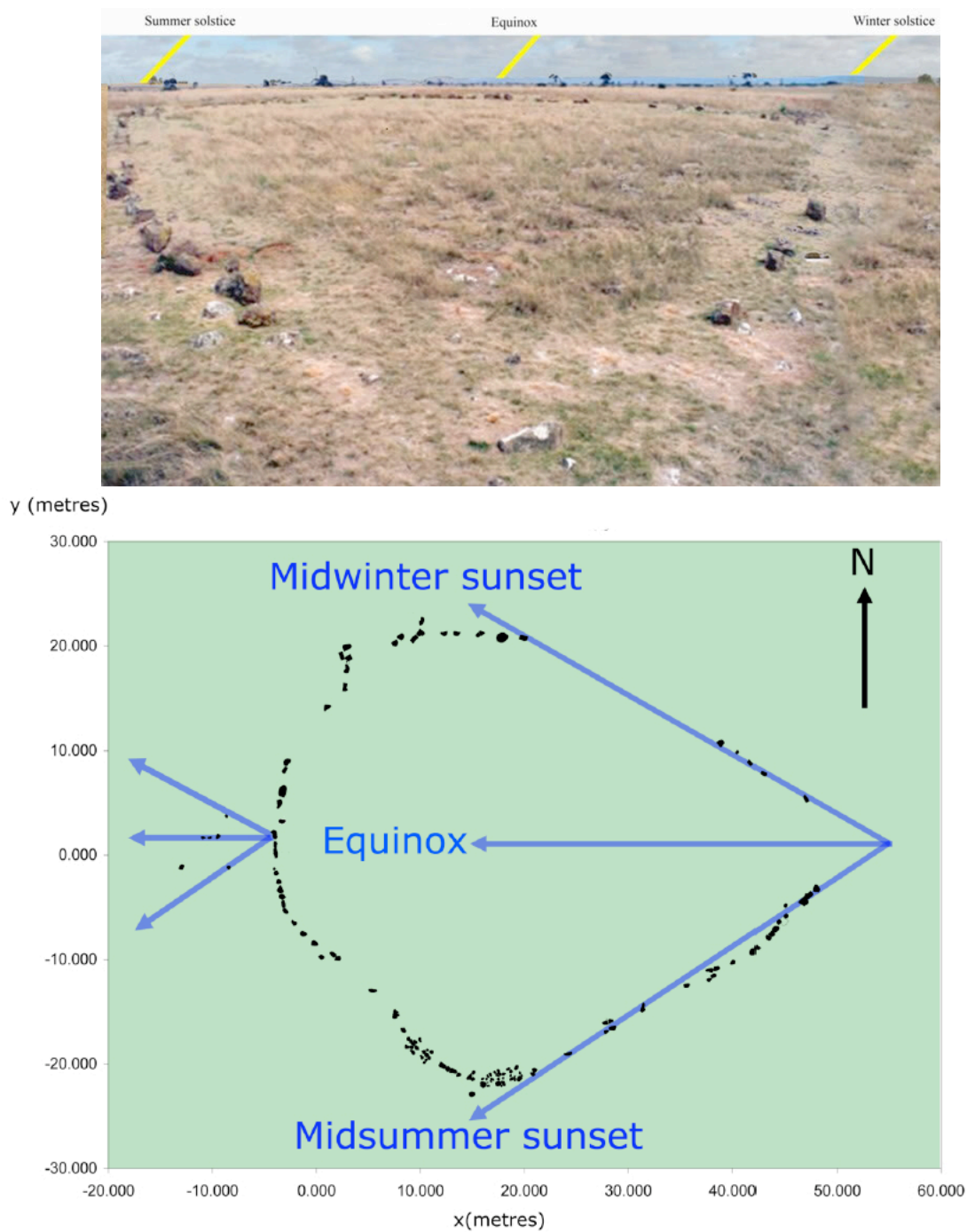


FIGURE 4.5: The Wurdi Youang stone arrangement in Victoria, of which the Wathaurong people are the Traditional Owners. Top image shows the alignments of the arrangement if standing at the eastern apex looking west. The bottom image shows the overall layout of the arrangement. Taken from Norris et al. (2011).



– Top). Similarly, outlier stones west of the western apex also indicate the equinoxes and solstices (Figure 4.5 – Bottom). Monte Carlo simulations by Norris et al. (2012) show that these alignments are not the result of chance, but were deliberately placed in these positions. The age of the site is unknown, but dating it is a high priority. The purpose of the site is unknown and the solar alignments may be peripheral to the main purpose of the site, but these alignments reveal that the solar points probably played a practical role regarding the role of timekeeping in that culture. Are there other structures that have a preferred orientation to cardinal directions? I explore this in Chapter 11.

The plane of our Milky Way galaxy stretches across the winter evening sky in the Southern Hemisphere. The plane is rich in stars, star clusters, and dark dust lanes, caused by cool gas and dust obscuring background stars. The most famous of these dark patches is the Coalsack, a dark nebula bordering the Southern Cross (Crux). The Coalsack closely resembles the head of an emu, with a 5.3 magnitude star, BZ Crucis, in a position that it closely resembles like the emu’s eye. The celestial emu, seen in profile, stretches down the galactic plane, through the Pointers ( $\alpha$  &  $\beta$  Centauri) to the galactic bulge, where the dark dust lanes trace out the shape of the emu’s body and legs (this is discussed further in Section 5.6.1). This asterism is found across Australia (Norris & Hamacher, 2009). In fact, a similar asterism is found South America. The Inca of the Andes saw this asterism as the outline of the celestial llama, an animal they revered (Bauer & Dearborn, 1998; Figure 4.6). To the Tupi–Guarani of the upper Chaco in Bolivia, this asterism represents an ostrich (Pereira, 2004).

A petroglyph (rock engraving) at Elvina Track in Kuringai Chase National Park north of Sydney may have a connection to the night sky. The site is believed to be male initiation (Bora) site. Towards the north end of the rock platform is an engraving of an emu and a culture hero believed to be Daramulan, the son of the sky deity Baiame (Stanbury & Clegg, 1990). The emu engraving shows her feet pointed behind her, as if she were flying (which, of course, emus cannot do). It was proposed by Cairns (1996) that this may represent the Emu in the Sky. Norris & Norris (2008) discovered that the emu aligns to her image in the night sky at the time of year that emus are laying their



FIGURE 4.6: The Llama in the Sky, as seen by the Inca of the Peruvian Andes. Painting by Cusco artist Miguel Cartagena.

eggs (late May and early June, Section 5.6.1. This is discussed further in Section 5). Emu eggs were an important food source for Aboriginal people, and the engraving features an egg within the emu herself. Large circular depressions found in the area, commonly called snames (Higgs & Clegg, 2004), are believed to be fire pits used for illuminating the ceremonial site at night. One such sname lies very close to the emu engraving, indicating that the site was used at night. These connections suggest a close association with the night sky. More solid examples are reported from communities where astronomical traditions are well known and practised by Elders, such as Bill Yidumduma Harney, the last fully initiated custodian of the Wardaman people in the Northern Territory, whose astronomical knowledge is extensive (see Cairns & Harney, 2003). If it were not for his knowledge, the interpretations of the astronomical sites for which he is a custodian would be open to interpretation, as a connection is not obvious to the untrained and uninitiated Wardaman eye.

# 5

## Dating Techniques

*“Aboriginal beliefs of the sky have been handed down through oral tradition for some 40,000 years and hence they show us, as no other existing culture can, how natural phenomena beyond human control can be assimilated and understood without recourse to measurement of time, distance, or quantity.”*

— Roslynn D. Haynes (1992: 127)

### 5.1 Introduction

One of the three components of my hypothesis is that Aboriginal astronomical knowledge has existed since humans first migrated to Australia. Astronomical knowledge is encoded in the traditions related to the sky, which generally involves material and oral culture. Material culture may involve sites with an astronomical link for which

archaeological techniques can be used, such as a stone arrangement that aligns to the rising or setting position of the sun at the solstices. Or it may refer to astronomically-related rock art that can be dated. Oral culture involves the use of stories, songs, and dance to transmit knowledge that may describe the coincidental connection between a celestial event and an event on the Earth, such as the heliacal rising of the sun and a changing season or the availability of a particular food source. Or it may describe celestial events that can be dated, such as a supernova, eclipse, or meteorite impact.

Because all Aboriginal traditions were recorded after colonisation, it is difficult to know when they first arose. If they describe an event that can be dated, then we could know the age of the tradition (I examine this extensively in the next five chapters). However, if the tradition does not provide information about a dateable event, we cannot know when it first arrived, only a *limit* to the age, or the *terminus post quem* — the earliest point from which it could have occurred. It is certain that astronomical traditions existed well before colonisation and we have no reason to believe they did not exist when humans first settled Australia. But we can only be certain of the *terminus ante quem* — the latest period in which something must have occurred. This applies to all astronomical traditions described in this thesis. For example, in Section 7.6, I cite an oral tradition that Norman Tindale suggests is a story about a solar eclipse that occurred on 12 March 1793 near Parachilna, South Australia. This provides the *terminus ante quem* for that particular story, although traditions about eclipses may very well go back much further. Thus, the uncertainty in the age of many astronomical traditions is quite large — thousands of years in some cases, as I will show in this chapter.

## 5.2 Techniques for Dating Aboriginal Astronomy

To determine how far back in time astronomical knowledge can be found, we must identify the first uses of “astronomy”. There are two general approaches to accomplishing this: direct and indirect. Direct methods can be broken into two general types: dating material culture and dating oral culture.

**Technique 1** involves dating material culture with astronomical significance, such as a stone arrangement that has solar or lunar alignments or a petroglyph or pictogram that contains astronomical symbolism. In this case, dating methods such as radiometric or thermoluminescence dating could be utilised. **Technique 2** involves dating an oral tradition that contains a description of a celestial event, such as a supernova or meteorite impact. Both techniques have their limitations and involve making core assumptions. For example, without supporting ethnographic evidence from Indigenous sources, astronomical interpretations of rock art motifs are speculative. In the case of an astronomical event, identifying the age of a tradition from an eclipse or planetary conjunction is problematic, as these phenomena occur at periodic intervals.

The indirect approaches do not provide “absolute ages” of astronomical traditions, but instead provide an age limit, or the *terminus post quem*. Because the positions of the stars change over time due to the effects of precession and stellar proper motion, connections between astronomical events and terrestrial events, such as the heliacal rising of a particular star signaling the start of a season, will change over time. Similarly, the appearance of particular star patterns (what we normally think of as “constellations” in the Greek tradition) will also change. **Technique 3** involves calculating the age limits of these connections and star-patterns given the observational data of the component stars and accounting for precession and stellar proper motion<sup>1</sup>. A similar method was used by Alexander Thom (1967) to calculate the construction date of particular stone alignments in the UK based on the position of the rising or setting moon relative to the landscape horizon<sup>2</sup>.

In a similar vein, **Technique 4** investigates oral traditions that describe the positions of the stars as being different to what we see today. An example would be an oral tradition that describes a bright star near the south celestial pole. No bright stars (zero or first order magnitude) are found in this region of the sky today, but because

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<sup>1</sup>This idea was proposed to me by Klaus Kieneswenger, an astronomy student at the University of Vienna who completed his senior thesis on Aboriginal Astronomy (see Kieneswenger, 2011).

<sup>2</sup>Thom’s exercise was dependant on whether the stone arrangements were intended to align to astronomical objects in the first place. This adds an element of uncertainty that must be taken into account.

of precession bright stars such as Achernar and Canopus were near the south celestial pole at points in the distant past (3,500 years ago and 12,000 years ago, respectively).

The theme of dating astronomical traditions is discussed and applied throughout this thesis, in particular Techniques 1 and 2. In this chapter, I discuss each of these techniques. Techniques 2 and 3 are dependent on the changing positions of the stars over time, so I will discuss the basic background theory of positional astronomy. I will then apply Technique 3 to a set of six connections and one star pattern and apply Technique 4 to a single oral tradition to determine the age limits of each.

### 5.3 Technique 1: Archaeological Dating

To set a solid date for the earliest confirmed uses of astronomy in Australia, we are limited to the techniques of archaeology (e.g. Penrose, 1893, 1897; Lockyer & Penrose, 1901–1902; Steele, 2003). Material culture, such as an artefact or stone arrangement that has clear astronomical symbolism or alignments can be dated using a range of established techniques, such as radiometric, thermoluminescence, or archaeomagnetic dating. The Wurdi Youang stone arrangement mentioned in the previous chapter (Norris et al., 2012) is a good example. Various archaeological techniques could be used to date the site, such as excavating material under the stones and determining when it was last exposed to sunlight (thermoluminescence). Another technique is to find a buried midden or hearth, either within the arrangement or nearby, and use radiocarbon techniques to date it. If multiple techniques reveal a similar age, they provide a confident age estimate.

### 5.4 Technique 2: Dating Natural Events

Oral traditions often contain descriptions about natural events, be it a comet, meteorite impact, eclipse, or supernovae. Some oral traditions also contain descriptions of geologic events, such as earthquakes, volcanic eruptions, and tsunamis (see Section 10.3). Because some events occur rather frequently (such as a lunar eclipse), it would be hard

to identify a particular one unless we were given a date. Rare events, like supernovae or meteorite impacts, can be dated using scientific methods. This technique is used in several chapters of this thesis, especially Chapter 10.

Rock art might also contain depictions of astronomical events that can be dated. However, without ethnographic evidence to support these claims, the interpretations are speculative. A good example is the Chaco Canyon pictogram in Arizona that some believe represents the 1054 CE supernova (e.g. Miller, 1955; Brandt & Williamson, 1979; Figure 5.1–Left). The supernova, which reached a maximum visual magnitude of  $-6$ , was recorded by Chinese and Arab astronomers (Collins et al., 1999; Brandt & Williamson, 1979) and almost certainly was witnessed by Anasazi astronomers. Historical records and astrophysical dating techniques of the remnant confirm the event was first witnessed from Earth in 1054 CE, with some Chinese accounts suggesting it was first recorded on 4 July 1054 (Collins et al., 1999). On this day, the crescent moon was in close proximity to the supernova (Figure 5.1), suggesting a link to the Chaco Canyon pictogram. However, the lack of ethnographic records prevent a direct link between the rock art and the supernova event and scholars have shown that this pictogram probably represents the crescent moon and evening star, Venus (e.g. Williamson, 1987: 77).

## 5.5 Positional Astronomy: Background Theory

The position and brightness of the stars and other celestial objects change over time because of precession, stellar proper motion, and radial velocity. Given the precise observational data of the brightest stars, combined with the laws of celestial mechanics, one can calculate the positions and brightness of stars with relatively good precision up to tens-of-thousands of years into the past. This allows us to place age limits on a number of terrestrial/celestial connections, such as the appearance of a particular star at a certain time of the year and its connection to terrestrial events, including the availability of a particular food source or the changing of seasons. For example, if the Heliacal rising of the Pleiades corresponds to the start of winter in the Central Desert, we can determine how far into the past this connection would have been applicable.



FIGURE 5.1: **Left** – the Chaco Canyon pictogram, which some researchers speculate is a representation of the 1054 CE supernova. **Right** – The view of the sky on 4 July 1054 from Chaco Canyon, showing the moon and Crab Nebula, generated from Starry Night Pro.

These connections are coincidental in nature and should not be confused with astrological ideas that the positions of celestial objects have any direct influence or impact on physical terrestrial events. I use the term “connection” for cases of a coincidental relationship between a terrestrial event (e.g. seasonal change, animal breeding season) and the positions of celestial objects (e.g. heliacal rising or setting).

We can also estimate an upper age limit to patterns of Aboriginal constellations that use a connect-the-dots approach. These are rare, as most Aboriginal groups generally attributed characters to individual stars and not patterns of stars, although some examples of connect-the-dots constellations exist. For example, the Southern Cross is the footprint of an eagle to some Aboriginal groups of the Central Desert. However, the effects of stellar proper motion and radial velocity dictate that the stars of the Southern Cross would have looked different in the past and will look different in the future. This change depends on the magnitude of the stars’ proper motions. This can be calculated to see if the effect is significant, which I will do later in this chapter.

I begin by discussing the celestial sphere and define the terms used in the Western science of Positional Astronomy (from Smart & Green, 1977). I then describe the



effects that cause a gradual change in the positions and brightness of celestial objects over time. The first is the gradual shift of the celestial sphere about the ecliptic, called *precession of the equinoxes*. The second is the movement of individual stars through space, the transverse component of which is called *stellar proper motion*, while the line of sight change is called *radial velocity*. The third effect is that of a star's change in apparent brightness. I then test a selection of terrestrial/celestial connections and pattern matching to estimate connection age-limits. Testing the age of oral traditions based on natural events is a theme that will be discussed in the remaining chapters.

For this study, I use the Starry Night Pro astronomical software package, which accounts for many of the effects I will describe below, including precession and stellar proper motion<sup>3</sup>. The software uses the old Julian calendar for all dates before 15 October 1582, and the Gregorian calendar for all dates after this. The dates 5–14 October 1582 do not exist in Starry Night, which accounts for the ten days which were skipped when the new calendar was introduced. Star data for the nearest two million stars, including magnitude, position, and proper motion, comes from the Hipparcos/Tycho-2 catalogue and is automatically updated when the catalogue is updated. The software also accounts for the refraction of light through the Earth's atmosphere for rising and setting times of celestial objects by lowering the horizon by  $\sim 0.5^\circ$ .

### 5.5.1 The Celestial Sphere

To an earth-bound observer the heavens appear as a celestial dome covering the ground (Figure 5.2), with the point directly above the observer denoted as the *zenith* and the point directly below the observer as the *nadir*. The *meridian* is the great circle passing through the zenith and celestial poles at a particular point on the Earth. In positional or spherical astronomy, the celestial realm is treated as an imaginary sphere concentric to the Earth, rotating about the same axis as the Earth. The projection of the Earth's poles toward the sphere define the celestial poles and similarly with the Earth's equator projecting the celestial equator. This projection is useful for positional astronomy,

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<sup>3</sup>The 2008 version of the user manual covers all of the information discussed in this paragraph.

which applies the techniques of spherical trigonometry to determine the positions of objects against the celestial sphere.

The position of an object in the sky from an Earthbound observer (looking outward onto the celestial sphere) can be described as a two dimensional vector in terms of *azimuth* and *altitude* (Figure 5.2). The azimuth, sometimes called a *bearing* (expressed in degrees), is the angle between the due north ( $0^\circ$ ) and the perpendicular projection of the star down onto the horizon (E =  $90^\circ$ , S =  $180^\circ$ , etc). In positional astronomy, altitude is the vertical angle of an object with respect to the horizon. Objects above the horizon have a positive altitude, while objects below the horizon have a negative altitude. While altitude and azimuth define the relative position of a celestial object to an Earthbound observer, it is completely dependent on the latitude, longitude, and elevation (height above sea level) of the observer.

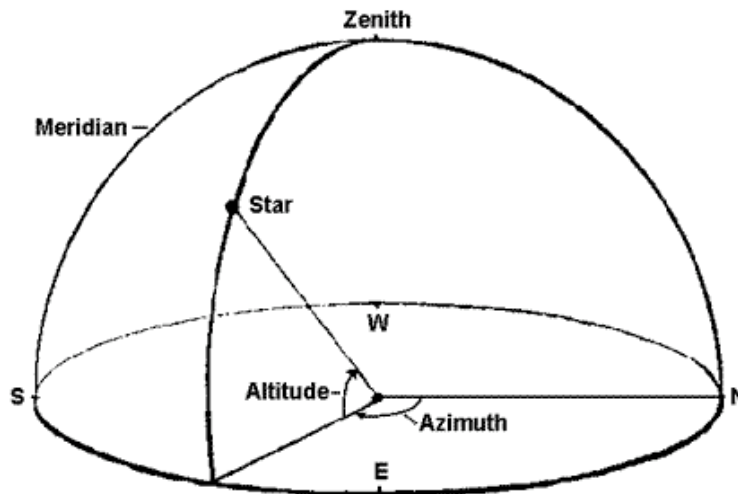


FIGURE 5.2: The celestial dome with North representing an azimuth of  $0^\circ$ , E =  $90^\circ$ , S =  $180^\circ$ , and West =  $270^\circ$ . The altitude is  $0^\circ$  on the horizon and  $+90^\circ$  at zenith. Image credit: Department of Astronomy, University of Michigan.

The absolute (non-relative) position of an object on the celestial sphere uses a similar coordinate system to what we see on a globe of the Earth, which is expressed as latitude and longitude. Right ascension, often denoted as RA or  $\alpha$ , is similar to longitude, with an origin at the celestial projection of the prime meridian, termed the *first point of Aries*, where the sun crosses the equator at the Vernal equinox (for

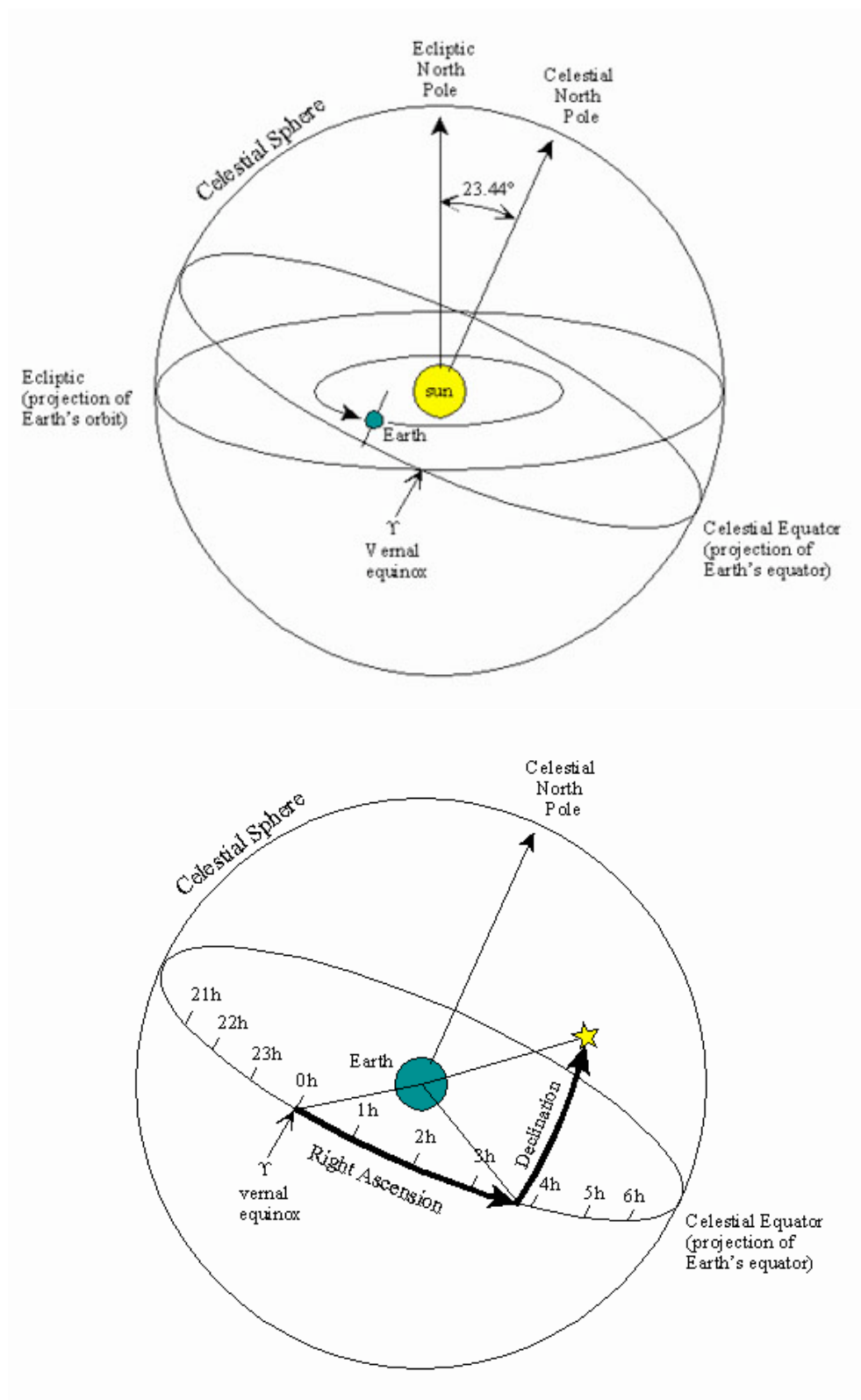


FIGURE 5.3: The celestial sphere, noting the celestial and ecliptic poles, equator, axial tilt, and equinox (top) and right ascension/ declination (bottom). Images credit: National Atmospheric & Oceanic Administration.

northern hemisphere observers). Right ascension is typically expressed in terms of hours (<sup>hr</sup>), minutes (<sup>m</sup>), and seconds (<sup>s</sup>). This is because one complete rotation of the Earth covers a full circle, which happens in approximately 24 hours. Declination, often denoted as DEC or  $\delta$ , is similar to latitude and separates the celestial sphere into two domes, joined at the celestial equator. Declination ranges from  $0^\circ$  at the equator to  $90^\circ$  at the poles (Figure 5.3). Declinations to the north of the celestial equator ( $\phi$ ) are considered positive, while those south of the celestial equator are considered negative. Declination is expressed in terms of degrees ( $^\circ$ ), arc minutes ( $'$ ), and arc seconds ( $''$ ). When the declination of an object is at the zenith of an observer, it corresponds to the observer's latitude (within  $0.01^\circ$ , because of small geometric effects that account for geodetic projection).

The geometric plane containing the mean orbit of the Earth and Sun is called the *ecliptic plane*. The imaginary line, or great circle, the Sun makes as it travels across the sky is simply called the *ecliptic* (Figure 5.3). The ecliptic is the projection of Earth's orbit on the sky and takes its name from the fact that eclipses occur when the full or new moon crosses the ecliptic, either when it lies directly between the Earth and sun (solar eclipse) or directly opposite the sun (lunar eclipse). The positions of objects with respect to the ecliptic are measured as ecliptic longitude ( $0^\circ < \lambda < 360^\circ$ ) and ecliptic latitude ( $+90^\circ < \beta < -90^\circ$ ). The moon and planets orbit the sun in roughly the same plane, so they appear near the ecliptic as they travel across the sky. For example, the orbital plane of the moon is tilted  $5.145^\circ$  from the ecliptic.

The ecliptic and the celestial equator are not parallel, but intersect with a separation angle of approximately  $23^\circ 26'$  ( $23.44^\circ$ ), also known as axial tilt or *obliquity of the ecliptic* (Figure 5.3). As mentioned above, the diametrically opposite points where these two planes intersect denotes the equinoxes. The sun passes from South to North through the vernal equinox/first point of Aries. The region  $9^\circ$  on either side of the ecliptic denotes the *Zodiac*, representing 12 constellations the sun appears to travel through during the course of a year, which are each divided in to equal zones of celestial longitude.

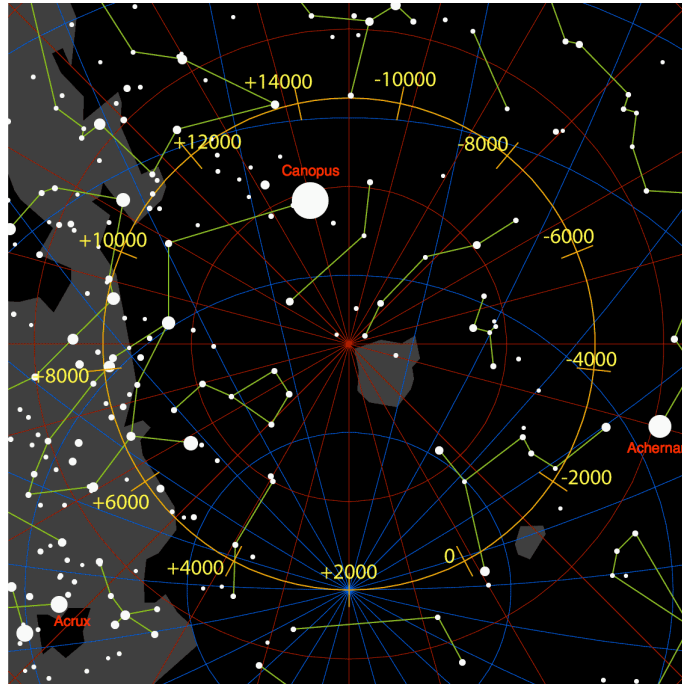


FIGURE 5.4: The path of the celestial pole due to precession in the Southern Hemisphere, giving the reference year 2000 CE as 0. Canopus (visual magnitude =  $-0.72$ ), Achernar ( $0.45$ ) and Acrux ( $0.77$ ) are labeled in red, with the diameters of the stars in the image corresponding to their brightness (larger circle = brighter star). Image reproduced using Wikimedia Commons License.

### 5.5.2 Effect 1: Precession

The axial tilt of the Earth and the gravitational torque of the sun, moon, and planets, cause the axial poles of the earth to change position with respect to the background stars over time. This is called *precession*, which is similar to the wobble of a spinning top. It causes the earth's polar axes to shift over time in a circular-pattern, completing a loop once every  $\sim 25,772$  years (at the current rate). This means that the vernal equinox regresses along the ecliptic by  $\sim 50''$  per year (or  $1^\circ$  every 72 years). Thus, the celestial poles shift over time (see Figure 5.4). This rate, however, is not constant over time. Tidal forces caused by the gravitational influence of the planets varies the rate of precession. The ecliptic rotates about node lines at the current rate of  $\sim 47''$  per century, called *nutation*. Other forces, such as polar motion, also attribute a similar variation, but we can safely neglect these effects for the purpose of this study as they are quite small.

### 5.5.3 Effect 2: Stellar Proper Motion & Radial Velocity

All stars are moving through space, which we see in three components representing three dimensions:

1. the change in a star's right ascension ( $\Delta\alpha$ ),
2. the change in a star's declination ( $\Delta\delta$ ),
3. the change in a star's distance from the Earth ( $\Delta d$ ).

The two dimensional angular change in a star's position with respect to the centre of mass of the solar system (along right ascension and declination) is referred to as *proper motion*. This value is given in terms of the annual angular change in right ascension ( $\mu_\alpha$ ) and declination ( $\mu_\delta$ ), using units of arc-seconds per year ("/year). This vector ( $\mu$ ) accounts for the magnitude of the star's proper motion and the position angle ( $\theta$ ), which indicates the direction of the proper motion on the celestial sphere. The position angle is given in degrees, where  $0^\circ$  is due north,  $90^\circ$  is due east, etc.

To illustrate, lets say a star has the coordinates  $(\alpha_0, \delta_0)$  today and  $(\alpha_f, \delta_f)$  one year from now. The proper motion is simply the difference between the two vectors, given as (Smart & Green, 1977: 252):

$$\begin{aligned}\mu_\alpha &= \alpha_f - \alpha_0 \\ \mu_\delta &= \delta_f - \delta_0\end{aligned}\tag{5.1}$$

Therefore, the magnitude of the proper motion ( $\mu$ ) is given by adding the vector components:

$$\mu^2 = \mu_\delta^2 + \mu_\alpha^2 \cdot \cos^2 \delta\tag{5.2}$$

where the position angle ( $\theta$ ) is related to the proper motion by:

$$\begin{aligned}\mu_\delta &= \mu \cos \theta \\ \mu_\alpha \cos \delta &= \mu \sin \theta\end{aligned}\tag{5.3}$$

The factor  $\cos \delta$  shows the decreasing effect in motion right ascension has on the magnitude of the proper motion for stars nearer the celestial pole, being zero at the poles (Newcomb, 1904: 287–288). See Figure 5.5 for a visual interpretation of these components.

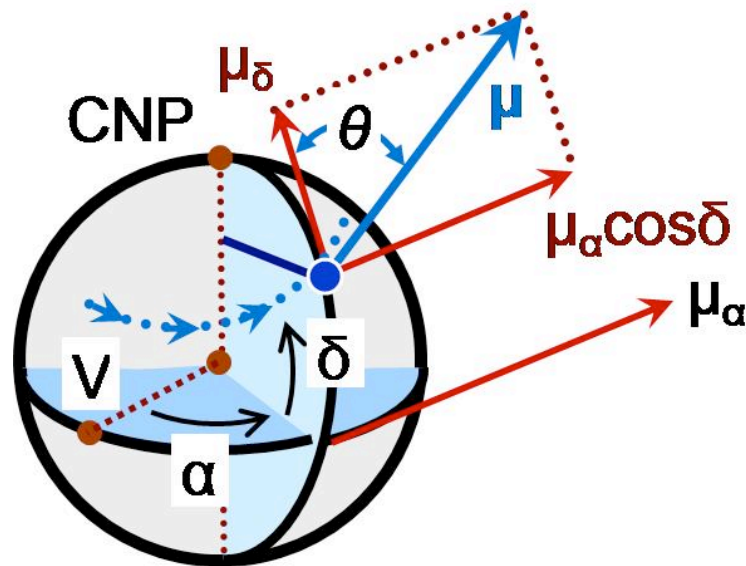


FIGURE 5.5: The geometric components of a star's proper motion as viewed from the Earth. CNP is the celestial north pole, V is the Vernal equinox,  $\alpha$  is the right ascension,  $\delta$  is the declination,  $\mu$  is the vector of the proper motion,  $\theta$  is the position angle, and the path of the star on the celestial sphere is indicated by the blue arrows. Image by Brews O'Hare, used under Wikimedia Commons License.

The movement of the star along the observer's line of sight is the *radial velocity* ( $V_r$ ), given in km/s. A negative value means the star is moving towards the Earth. These combined values give the velocity vector of the star in space (see Figure 5.6).

In the next section, I discuss the various effects of stellar variability, including the long-term change in apparent magnitude due to the changing distance of the star from the earth.

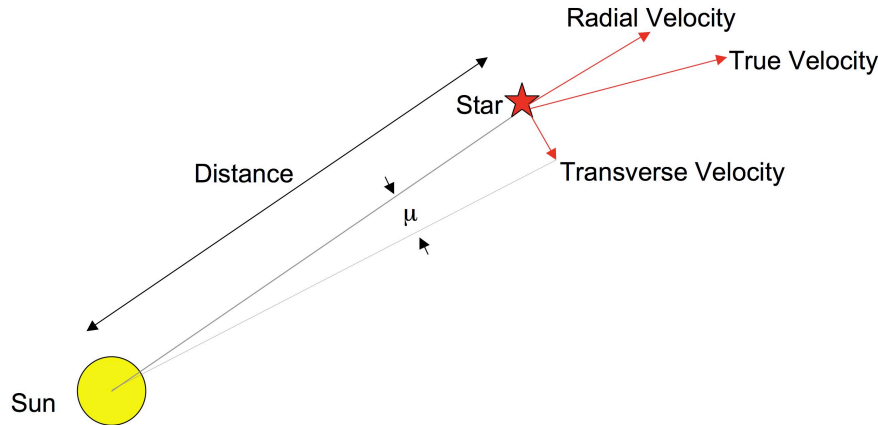


FIGURE 5.6: The geometric components of proper motion ( $\mu$ ) and radial velocity of a star as viewed from the centre of mass of our solar system. Image by D.W. Hamacher.

#### 5.5.4 Effect 3: Stellar Magnitude & Variability

A number of effects can alter the apparent visual magnitude ( $V_{mag}$ ) of a star over time. Stars that change in brightness over time are considered variable stars, which are classified into two types:

- **Intrinsic:** Stars whose luminosity changes. Examples include stars that swell and shrink over time (pulsating variables), stars that go through occasional eruptions (eruptive variables), or stars near the end of their lives that go through a cataclysmic change, such as nova or supernova (cataclysmic);
- **Extrinsic:** Stars whose light reaching earth is changed. Examples include eclipsing binaries or stars that exhibit large sunspots, dubbed rotating variables.

Except for the rare eruptive or cataclysmic variable events, there are only a handful of bright ( $V_{mag} < 2$ ) variable stars that produce a change in brightness over short periods of time ( $t < 1$  year) that are visible to the naked eye (Good, 2003). The primary effect of a star's apparent magnitude over long observable time periods (hundreds to thousands of years) is the change in the star's distance from Earth. It is this effect for which we are concerned and must correct for this study.



The apparent magnitude of a star ( $m$ ) from an Earth-bound observer is dependent on the absolute magnitude<sup>4</sup> of the star ( $M$ ) and the distance to the star ( $d$ , in parsecs<sup>5</sup>), given as:

$$m = M + 5 \cdot \log (d/10) \quad (5.4)$$

Galactic extinction (the fraction of light that is lost due to extinction, which is caused by the absorption or scattering of light by the interstellar medium) is neglected here as the effect for most bright stars is negligible since these stars are in the relatively local galactic neighbourhood (the 50 brightest stars in the sky are all within 1,800 ly from Earth, 94% of which are within 800 ly and 66% are within 400 ly).

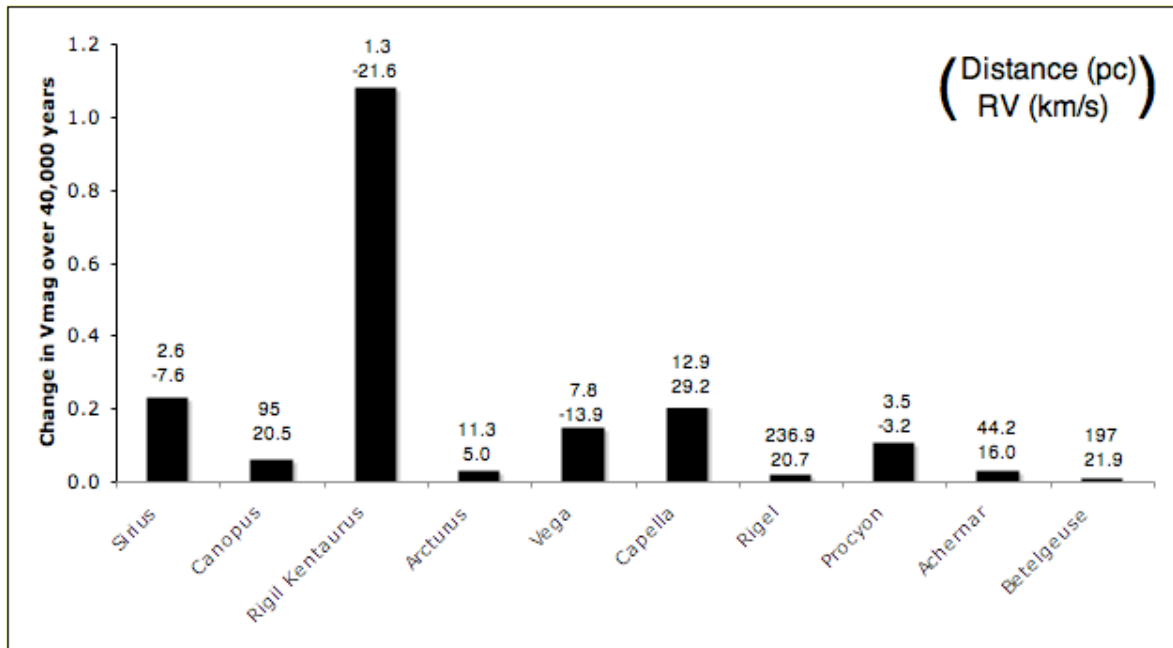


FIGURE 5.7: The change in the visual magnitude ( $V_{\text{mag}}$ ) of the 10 brightest stars in the southern skies between now and 40,000 years ago by accounting for their change in distance from the Earth (neglecting intrinsic variability). These values assume a constant radial velocity, showing that over astronomically-short time scales, the  $V_{\text{mag}}$  does not change significantly, except in the case of Rigil Kentaurus ( $\alpha$  Centauri) which changes by nearly a factor of three since it is the closest star to our solar system. The numbers above each star are the distance and radial velocity as shown in the middle-right of the figure.

<sup>4</sup>Absolute Magnitude is a measure of a star's intrinsic brightness. It equals the apparent magnitude a star would have if it were 10 parsecs away from the observer, assuming no galactic extinction.

<sup>5</sup>A parsec is  $\sim 3.26$  light years or  $\sim 3.1 \times 10^{13}$  km.

Other factors can change the apparent magnitude of a star including intrinsic variability or variability due to a star's position relative to another, such as with eclipsing and contact binary stars. In some cases the intrinsic variability is periodic or semi-periodic, while some are variable because of stellar instability as it is with novae or supernovae. These alter the absolute magnitude of a star and thus its apparent magnitude.

The radial velocity of stars will affect the distance to the star, and thus the apparent magnitude. The effect of radial velocity, however, is rather low over a period of 40,000 years, typically on the order of 1/10th of a magnitude (see Figure 5.7), except for  $\alpha$  Centauri, which has a high radial velocity and was a factor of three fainter 40,000 years ago. Therefore, radial velocity will not have a significant effect on the brightness of the stars and we neglect the change in  $V_{\text{mag}}$  for the purpose of this particular study.

## 5.6 Technique 3: Testing Connections

Many terrestrial/celestial connections are denoted by the heliacal rising of a particular star or cluster, which signifies things such as seasonal change or the availability of a new food source. *Heliacal rising* is when a celestial object is first visible above the eastern horizon just before sunrise when it has been invisible for a period of time. The visibility of a star at dawn depends on its brightness relative to the background glow of the sun (from Aveni, 2001: 112). For 1st magnitude stars, the sun needs to have an altitude of  $-10^\circ$  for the star to be visible. For 2nd magnitude stars, the sun's altitude needs to be approximately  $-14^\circ$ . For 3rd magnitude stars, such as those that comprise the Pleiades, the sun's altitude needs to be approximately  $-16^\circ$  to  $-17^\circ$ . For example, to an observer at Lake Tyrrell, Victoria in the year 2000, the heliacal rising of the Pleiades occurred on 13 June. On this day, the Pleiades rose at 06:01:14 AM and were visible for 13 minutes before the sun reached an altitude of  $> -16^\circ$  at 06:14:13 and drowned out the light of the Pleiades. Similarly, *heliacal setting* occurs when a star is just visible before it sets just behind the sun on the western horizon. For a 1st order magnitude star to be first visible just before setting, the sun must be at altitude

$-7^\circ$  and  $-10^\circ$  for 2nd magnitude stars.

Other factors must be taken into consideration when estimating the heliacal rising with accuracy, including refraction of the starlight and sunlight through the Earth’s atmosphere, atmospheric conditions and extinction, visual acuity of the observer, visibility of the horizon (e.g. vegetation, local topography), and the elevation and altitude of the horizon from the observer<sup>6</sup>. It is not required that the heliacal rising be determined with a high degree of accuracy for this study, as the gradual changes due to precession or stellar proper motion are slow.

I now determine the age limits of six terrestrial/celestial connections including the appearance of the Coalsack in the evening and its connection to the emu breeding season, the heliacal rising of Arcturus and the availability of the corms of the spike-rush, Capella and the start of summer, the heliacal rising of Fomalhaut and the start of Autumn, the the heliacal rising of Pleiades and the start of Winter, and the appearance/disappearance of Vega and the breeding cycles of the Mallee Fowl. Although many more examples exist, these six are representative of a diverse range of objects and connections. The technique can also be applied to other connections and navigational stars. In Table 5.2 I present astrometric data for each of these objects.

### 5.6.1 Coalsack Nebula

The “Emu in the Sky” is an asterism common to many Aboriginal groups across Australia (Fredrick, 2008). Although variations exist, it is generally regarded as representing an emu outlined by the dust lanes of the Milky Way, from the Coalsack (the emu’s head) to the galactic bulge in Scorpius (the emu’s body, see Figure 5.8). In some cases, the emu is simply denoted by the Coalsack with no reference to the body. *Tchingal* in the Wergaia language and *Torong* in the Mara language, both of Victoria (Stanbridge, 1858; Dawson, 1881) are examples, although this asterism is found among regionally-diverse groups such as the Kamilaroi and Guringai of NSW (Ridley, 1873a; Norris & Norris, 2008) and the Larrakia near Darwin in the Northern Territory (Basedow, 1925).

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<sup>6</sup>Starry Night Pro corrects for refraction and elevation can be input by the user, which is taken from Google Earth data.

Coincidentally, the appearance of the asterism in the evening sky is the same as the start of the emu breeding season. Emus form breeding pairs during the summer months of December and January and hens can begin laying eggs in mid to late April but most clutches appear in May and June, although hens can lay eggs well into October.



FIGURE 5.8: A profile of an emu (left) and the Emu in the Sky (right). Emu image by [www.australiananimallearningzone.com](http://www.australiananimallearningzone.com), galaxy image by Alec Kennedy.

While the Southern Cross and Coalsack are circumpolar at the latitudes south of Sydney and Perth, the Coalsack first appears in the evening skies in February, but is low on the horizon until April, when it appears  $\sim 30^\circ$  above the horizon about an hour after sunset (from Sydney). The full asterism, including the “body” (galactic bulge near the tail of Scorpius) appears an hour after sunset by the first of June. The “emu” rises earlier each night until it lies parallel to the southern horizon an hour after sunset in late July and early August when the bulk of clutches, laid in May and June, begin hatching.

A petroglyph at Elvina Track in Kuringai Chase National Park north of Sydney is believed to represent the Emu in the Sky (Cairns, 1996; Norris & Hamacher, 2009; see Section 5.9 for more). The engraving of an emu (a flightless bird) appears to be in flight as the legs are curved behind the animal instead of below it. The orientation of

the engraving is such that it aligns to the Emu in the Sky asterism in late May and early June about an hour after sunset. To support this hypothesis, the emu engraving contains an egg inside the emu (see Figure 5.10). While we do not know with certainty that the engraving represents the asterism, we assume for the sake of this calculation that it does.

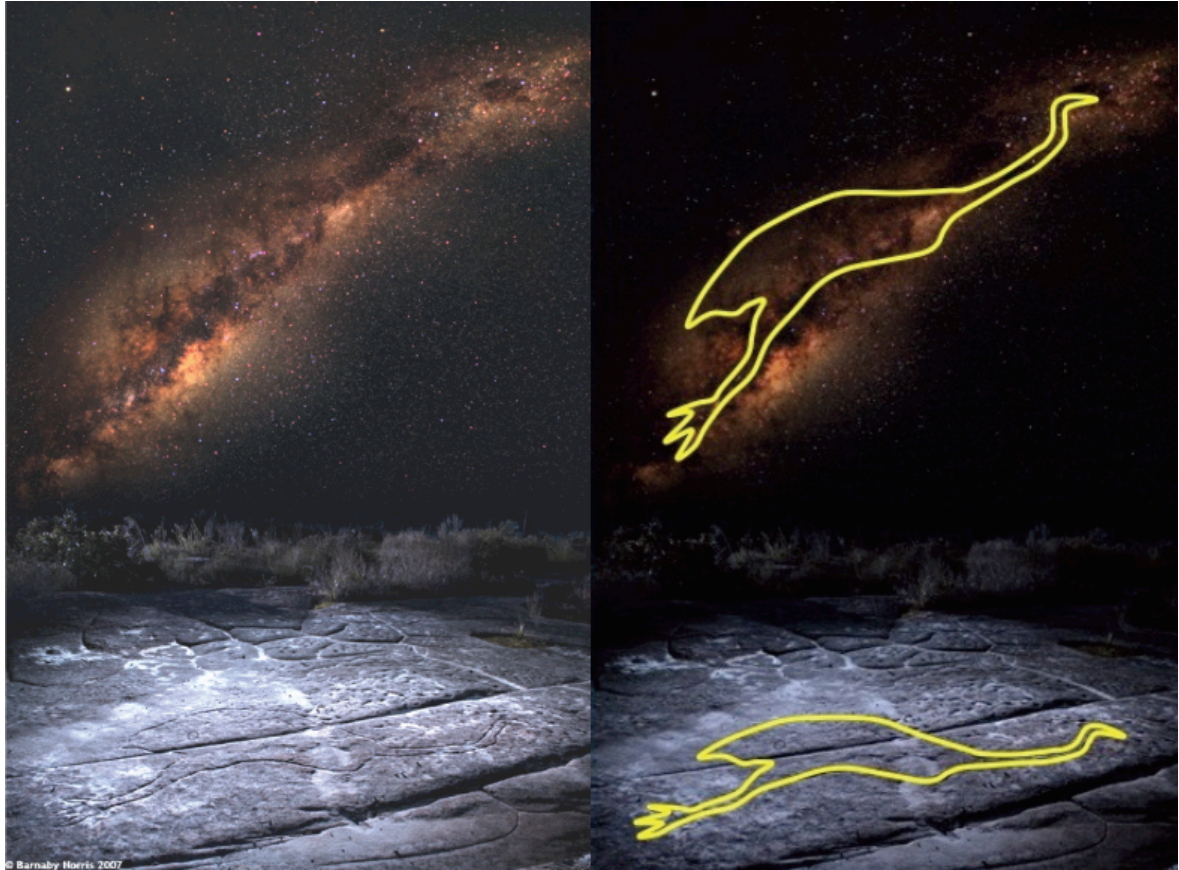


FIGURE 5.9: The *Emu in the Sky* engraving, as seen from Elvina Track, Kuringai Chase National Park, north of Sydney. Image by Barnaby Norris. A larger version can be found at the end of this chapter.

The appearance of the emu in the sky and the peak of the emu egg-laying season correspond to late May and early June. We are looking at the dust lanes and not individual stars in this case, so the effects of stellar proper motion or their relative brightness are ignored; precession is the primary driving force behind determining the age of this connection. Given the Coalsack's circumpolar nature as seen from Sydney (excluding  $\gamma$  Crucis, which briefly sets below the horizon), it appears at due south at



dusk in mid-December today. At sunset on 15 April, the mean start time of the emu breeding season, the Coalsack appears  $\sim 30^\circ$  above the horizon (from Sydney). As we extrapolate backwards in time on 15 April each year at sunset we find that the Coalsack moves toward the east with an increasing altitude. By 600 CE, the Coalsack is no longer circumpolar and first rises in late November.



FIGURE 5.10: An engraving of an egg in the emu engraving at Elvina Track, highlighted by a red circle. Image by Ray and Barnaby Norris © 2007.

If we set the limit of this connection as the date when the rising of the Coalsack precedes the typical start of the emu breeding season (mid-April), then we would be able to go back well over 12,000 years as the Coalsack still rises at roughly the same

time of year, albeit at a more northerly azimuth (see Table 5.1 and Figure 5.11). The asterism, however, has rotated into its current position. In 5000 BCE it was nearly vertical at sunset in early June whereas it appeared upside-down by 10000 BCE. None of this information is conclusive in determining when this asterism would have first denoted the breeding season of emus assuming the time of the year of their breeding has not changed significantly over the last 40,000 years. This does, however, provide a reasonable age limit of  $\sim 10,000$  years for this asterism connection.

TABLE 5.1: The dates the Coalsack rises at sunset between 2000 BCE and 16000 BCE (all years are given as BCE), when it is no longer circumpolar as seen from Sydney, also showing the azimuth (Az), where  $Az = 0^\circ$  is North,  $Az = 180^\circ$  is South.

Date	Year	Az ( $^\circ$ )	—	Date	Year	Az ( $^\circ$ )
12-Dec	2000	163.3		09-Jan	10000	125.5
02-Jan	4000	144.5		05-Jan	12000	127.0
08-Jan	6000	133.6		27-Dec	14000	136.3
11-Jan	8000	127.3		12-Dec	16000	149.5

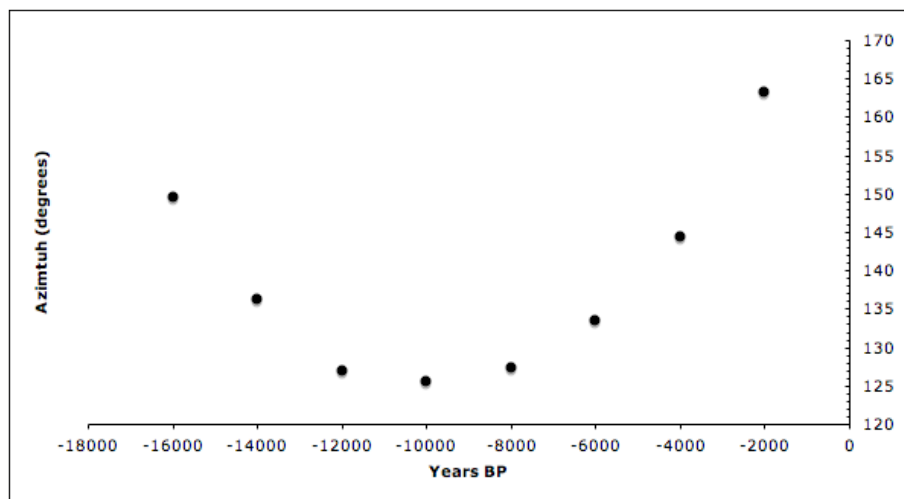


FIGURE 5.11: The azimuth of the Coalsack rising at sunset in 2,000-year intervals during the period when it was not circumpolar as seen from Sydney. The parabolic shape of the curve is a visualisation of the wobbling-motion caused by precession. Years are given as years before present (BP), using 2000 CE as a reference for simplicity. Data from Table 5.1.

### 5.6.2 Arcturus

According to Mountford (1956), the Yolngu of Arnhem Land begin harvesting the corms of the spike-rush when Arcturus ( $\alpha$  Boötis,  $V_{\text{mag}} = -0.04$ ) appears in the dawn sky. The spike-rush (*Eleocharis dulcis*), also called the *rakia*, *water chestnut* or *gulach* (Figure 5.12), is a grass-like sedge with an edible tuber, which can grow to a height of over 1.5 m and is found across northern Australia. The plant had numerous uses for Aboriginal people, which included making baskets or fish-traps from the grass-reeds or eating the carbohydrate-rich tubers. The growth rate of the spike-rush is dependent on the level of rainfall, with the tubers growing when the water saturates the top several centimeters of soil (Frith & Davies, 1961). Because Arnhem Land has a monsoonal climate with wet and dry seasons, the tubers are generally harvested during the wet season when the rains have provided sufficient rain for the growth of the tubers. Approximately 90% of the annual rainfall in northern Australia ( $\sim 0.9$ – $1.2$  m) occurs during the summer months of November to April (Braithwaite & Estbergs, 1985; Taylor & Tulloch, 1985). Given this information, we expect that the tubers of the spike-rush to be harvested after the start of the wet season. The amount of rain varies from year to year, but the starting time and duration of the wet season is rather consistent (*ibid*). Therefore, the time to harvest the tubers should correspond roughly to late November.

Arcturus currently rises  $10^\circ$  above the eastern horizon at dawn around 20 November from northern Australia, in agreement with the prediction that the tubers should be harvested in late-November after the start of the wet season. This also meets the requirement that 1st magnitude stars are visible only if the sun is at least  $10^\circ$  below the horizon. If we extrapolate back in time, this connection is more difficult to calculate since Arcturus does not significantly increase in altitude. Looking at its altitude at sunrise on 20 November over the last 7,000 years we find that it reaches a peak of just over  $23^\circ$ . Arcturus, however, moves in a gradual northerly direction as we extrapolate backwards in time, from an azimuth of  $\sim 67^\circ$  today to  $\sim 33^\circ$  some 4,000 years ago. Around 7,700 years ago, Arcturus would have risen at  $\sim 02:30$  AM and would have been  $\sim 17.5^\circ$  above the horizon in the direction of due north at sunrise ( $Az = 0^\circ$ ), which would not make for a useful heliacal rising star. It is hard to determine at what





FIGURE 5.12: An illustration of *Eleocharis dulcis*, a plant found in the swampy areas of northern Australia. Image by Francisco Manuel Blanco, ca. 1880. Image from Wikipedia commons.

point the star would not have been a useful indicator over the last 7,700 years, but this value can be used as an upper limit. However, we see that from  $\sim 700$  CE to  $\sim 4000$  BCE, the bright star Antares ( $\alpha$  Scorpii,  $V_{\text{mag}} = 1.09$ ) would have made a good indicator as it appeared between  $10^\circ$  and  $30^\circ$  above the eastern horizon at sunrise during this time.

According to Stanbridge (1858: 138) the Boorong people of northwestern Victoria called Arcturus *Marpeankurrk*, the mother of *Djuir* (Antares) and *Weekurrk* (Muphris, see Section 6.3). When Arcturus was north in the evening sky, the larvae of the wood ants (called *bittur*) were coming into season. The larvae were an essential food source during the winter months of August and September. Stanbridge claimed that when Arcturus sets with the sun, the larvae are gone and summer (Cotchi) begins. Arcturus is  $\sim 30^\circ$  above the northern horizon at sunset in this region at the beginning of August (with an average maximum temperature of  $12^\circ$  C) and sets with the sun by the first of October (with an average temperature of  $15^\circ$  C), corresponding to the beginning of the summer months (where the mean temperature is  $16.5^\circ$  C, taken from the Bureau

of Meteorology, Victoria).

The northerly position of Arcturus means that it remains relatively low in the sky, never exceeding an altitude of  $33^\circ$  as viewed from Victoria over the last several thousand years. This also means it will rise and set over the course of 10 hours, less than a full winter's night. While it reaches this peak altitude around the 5th of August today, as we go backwards in time its altitude gradually decreases until it appears just on the horizon ( $\sim 16^\circ$  west of north) at sunset  $\sim 5300$  BCE. This gives us an absolute age limit for this connection of  $\sim 7,300$  years.

### 5.6.3 Capella & The Beehive Cluster

To the Wotjobaluk people of north-central Victoria (Massola, 1968a: 111), the Beehive Cluster<sup>7</sup> represented the smoke of a fire (*Coomartoorung*) that was used by the hunters *Turree* and *Wanjel* (Castor and Pollux<sup>8</sup>) to cook the kangaroo, *Purra* (Capella,  $\alpha$  Aurigae,  $V_{\text{mag}} = 0.91$ ). When the Beehive set it signalled the start of autumn, while the setting of Capella signified the beginning of summer (Cotchi, called the “Great Heat”). These objects all form a linear pattern across the sky towards the north (see Figure 5.13). Massola uses earlier records, such as those by Stanbridge (1858), but does not define in what terms the star or cluster “went out of the sky”. Based on the importance of the heliacal appearance or disappearance of particular stars, I assume this is a reference to heliacal setting of these objects. A look at the setting times of these objects from north-central Victoria confirms this.

Using temperature data from Bendigo, Victoria (Figure 5.14), we see that December and January are the hottest months, where the daily high can exceed  $40^\circ$  C. Capella, which is already very low on the northern horizon, sets at dawn in early November, corresponding to the star of summer. As we extrapolate back in time, the heliacal setting of Capella would have precessed back to late September by 6000 BCE. By assuming constant climatic conditions and setting the beginning of October as a boundary for denoting the start of summer, we limit this connection to  $\sim 7,000$  years BP. Capella

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<sup>7</sup>This open cluster is also known as Praesepe with catalogue names M44 and NGC 2632.  $V_{\text{mag}} = 3.7$ .

<sup>8</sup> $\alpha$  Geminorum ( $V_{\text{mag}} = 1.58$ ) and  $\beta$  Geminorum ( $V_{\text{mag}} = 1.15$ ), respectively.

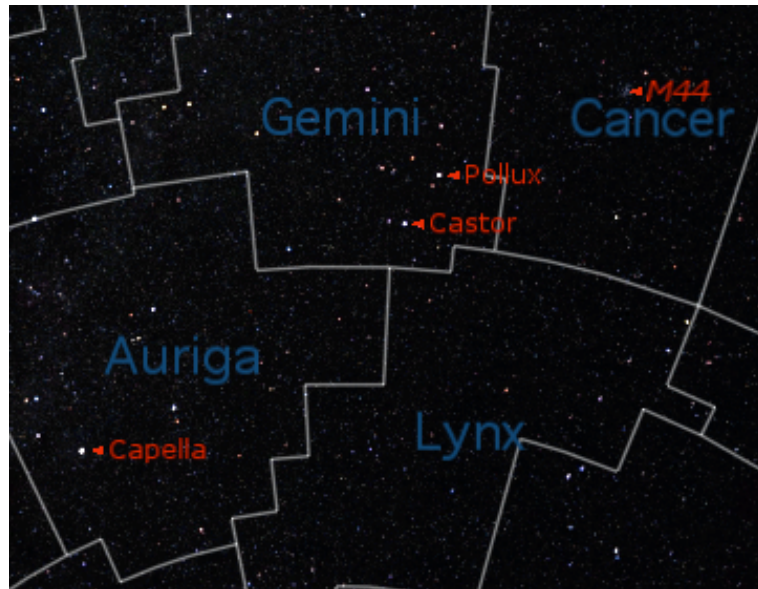


FIGURE 5.13: The Beehive Cluster (M44), Castor, Pollux, and Capella in the northern sky, making a roughly linear pattern. Image from Starry Night Pro.

never rises more than  $8^\circ$  above the horizon today. Extrapolating backward in time, the altitude of Capella increases to a maximum of  $\sim 53^\circ$  around 10000 BCE before reducing again to today's level by  $\sim 22000$  BCE. A similar situation arises with the Beehive Cluster.

#### 5.6.4 Fomalhaut

In the region of the Adelaide plains the arrival of autumn was denoted by the heliacal rising of a star called *Parna*, which warned Aboriginal people that the annual autumn rains would soon arrive and that they needed to build large, waterproof huts (Gell, 1842; Taplin, 1879: 126). A hilltop campsite south of Adelaide was named *Parnangga*, which meant “autumn rains” and referred to the appearance of Parna in the morning sky (Taplin, 1879: 126; Cooper, 1952: 22). Parna has not previously been identified, but the autumn rains occur around the end of March and beginning of April. According to the Bureau of Meteorology (2010)<sup>9</sup>, the average monthly rainfall in the period from 1977

<sup>9</sup>Climate statistics for Australian locations, Monthly climate statistics, Period 1977-2010, Summary statistics Adelaide (Kent Town).

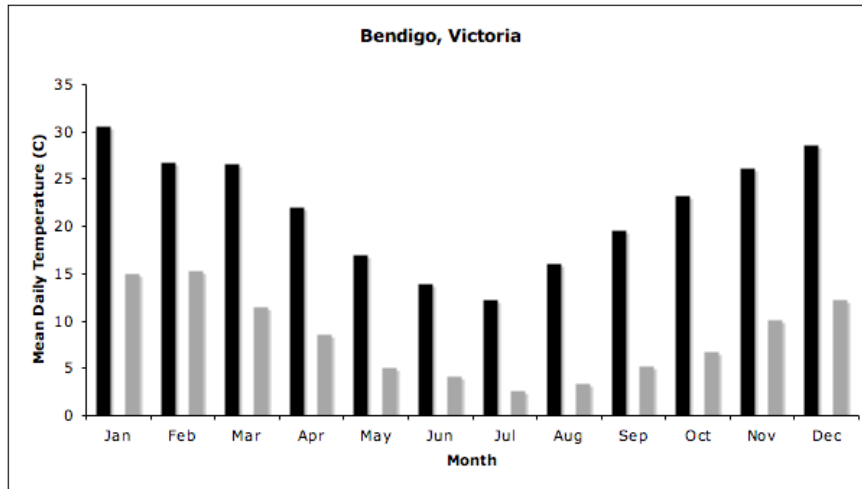


FIGURE 5.14: The daily maximum (black) and minimum (grey) mean temperatures from Bendigo, Victoria. Data taken from the Weather Zone website, Fairfax Digital Media. [www.weatherzone.com.au](http://www.weatherzone.com.au)

to 2010 increased from an average of 19.9 mm during the summer months (December–February) to 40.9 in April, after which it surpasses the monthly average of 45 mm and increases throughout the winter to reach a peak of 79.7 mm in June (see Figure 5.15). The March average (24.9 mm) is just above the summer average (19.9 mm), showing that the increase in rainfall during April rises significantly (64%) from that in March. Thus, my search for a corresponding star indicates that it would have a heliacal rising in mid-March.

Additional information regarding the identification of Parna comes from the Yaraldi term for autumn (*marangalkadi*), which means “autumn, time of the crow” (February–April). The crow is a prominent figure in Yaraldi Dreamings (Meyer, 1843: 78; Berndt et al., 1993: 21, 76, 240–242). In Yaraldi culture, the “autumn stars” are low in the southeastern sky because the crow spirit entered the skyworld to the southeast of the Lower Murray (towards Mount Gambier). Therefore, Parna is most likely a bright star (probably 1st or 2nd-order magnitude) that rises just prior to sunrise in mid-March to the southeast. This leaves only one obvious candidate.

The 2nd-order magnitude star Fomalhaut ( $\alpha$  Piscis Austrini,  $V_{\text{mag}} = 1.16$ ) rises at dawn on 15 March. At sunrise, it is  $\sim 22^\circ$  above the horizon at an azimuth of  $\sim 112^\circ$ , corresponding to the southeasterly direction. I identify Parna as the star Fomalhaut

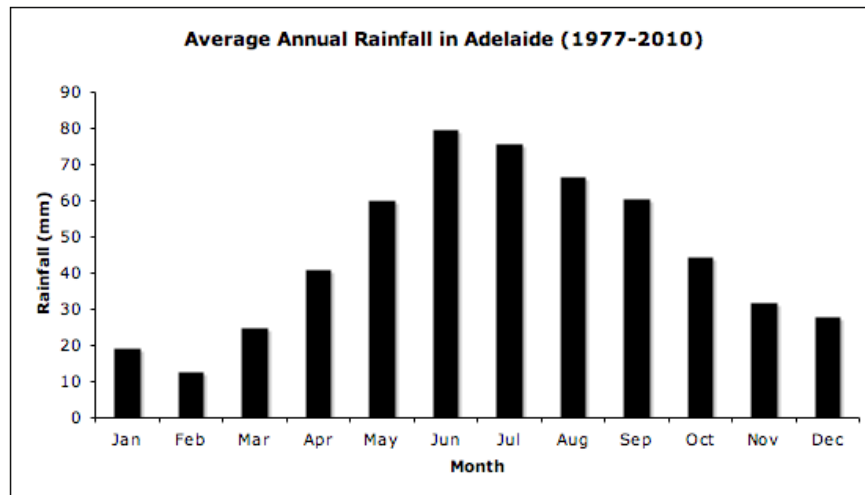


FIGURE 5.15: The Average annual rainfall in Adelaide between the years 1977-2010, showing the sharp rise in autumn from March–May, corresponding to the autumn rains. The monthly average is  $\sim 45$  mm.

because it meets the criteria set out and is the only bright star in that region of the sky visible at sunrise (see Figure 5.16). In southeastern Victoria and parts of far southeastern NSW, Fomalhaut is represented by the senior male ancestor *Bunjil*, who is also associated with the eagle-hawk (Howitt, 1884: 452).



FIGURE 5.16: The position of Fomalhaut (labeled in red) in mid-March just before sunrise from Adelaide, South Australia (using a simulated landscape and clouds). Image taken from Starry Night Pro.

By using mid-February as the earliest starting point of Autumn (a fairly liberal estimate), we find a connection date of  $\sim 50$  BCE. Of course, climactic changes over the

last 2,000 years would have had an effect on the arrival time (or presence of) the autumn rains, but this extrapolation reveals a sufficient first-order approximation of the age of this particular connection. Assuming the autumn rains began after mid-March over the past several hundred years, Fomalhaut would have only been a reasonable indicator for this event over the last 2,000 years or so. Prior to this it would have been a poor indicator of the coming autumn rains.

### 5.6.5 Pleiades

The Pleiades (M45) is the most famous star cluster in the night sky and is found in the traditions of almost every group of people in the world. The cluster is  $\sim 2^\circ$  wide in the constellation of Taurus, lying 440 light years from earth with an overall  $V_{\text{mag}} = 1.16$ . The cluster contains some 1000 statistically confirmed stars, of which 14 are visible to the naked eye under the best conditions (Adams et al, 2001). Despite this, only seven are easily visible, with a further three or four apparent to the keen observer. As with many cultures around the world, the Pleiades in Aboriginal astronomical traditions are often associated with a group of young women, typically seven in number (Johnson, 1998, 2000; Fredrick, 2008).

The cluster is prominent in many Aboriginal traditions, being one of the most widespread astronomical objects in Aboriginal oral traditions after the sun and moon (Johnson, 1998; Fredrick, 2008). Because of this, connections between the rising and setting of this star cluster and various food sources, and seasons were common. The heliacal rising of the Pleiades, for example, tell the Pitjantjatjara of the Central Desert that the dingo-breeding season has begun (Mountford, 1976). The breeding season is roughly between March and May (although some sources quote April to June) with a gestation period of 61–69 days (Sillero-Zubiri et al., 2004: 228). Aboriginal people of the Central Desert used the pups as a food source and performed fertility ceremonies during the breeding season (Tindale & George, 1971: 48–49). This relationship is found in oral traditions relating the Pleiades and dingoes from the Mann Ranges (Mountford, 1976: 463–465). As of the year 2000 CE, the Pleiades are visible  $1^\circ$  above the horizon when the sun is at altitude  $-16^\circ$  on 8 June, using Anthony Aveni's visibility limit



FIGURE 5.17: The Pleiades star cluster. The hue is a reflection nebulae caused from the stars of the cluster as it passes through a dusty region of the interstellar medium. Because the cluster is dominated by hot Spectral Class B stars, they appear blue. Image from NASA/ESA (2004).

discussed in Section 5.6. Dingoes begin giving birth to their puppies in early to mid June, corresponding to the heliacal rising of the cluster. This also corresponds to the beginning of winter according to the Pitjantjatjara (Clarke, 2003).

Dingoes were estimated to have arrived in Australia  $\sim 4,000$  years BP (Savolainen et al., 2004), although new research suggests this date goes back to 18,000 years BP (Oskarsson et al., 2011). As with Fomalhaut, the Pleiades have risen later each year over the past few thousand years. I set the heliacal rising criteria of the Pleiades as being visible  $1^\circ$  above the horizon when the sun has an altitude of  $-16^\circ$ . I give a day limit of 1 May (1 March + 61 days for the shortest gestation period). Earlier than  $\sim 1850$  BCE, the heliacal rising of the Pleiades occurs prior to 1 May, giving a connection age of  $\sim 3,850$  years. This age limit corresponds to a time long after dingoes were estimated to have arrived in Australia (18,000 years BP), showing that this connection is fairly recent (less than  $\sim 10\%$  of the time humans have been in Australia).

The ethnographic records (e.g. Mathews, 1900; Parker, 1905; Strehlow, 1907; Mountford, 1939, 1976) describe the cluster being visible for a brief time before sunrise, signaling the arrival of winter (June–August). This link explains why the Pleiades

were believed to represent ice or frost to many Aboriginal groups. Given that the temperature in many parts of Australia during June and July can dip below freezing, with the lowest temperatures usually occurring just after sunrise<sup>10</sup>, frost most often occurs when the Pleiades are just visible above the dawn horizon. As demonstrated with the dingo breeding season, the heliacal rising of the Pleiades as a seasonal indicator is ineffective as we extrapolate backwards more than a few thousand years. Therefore, this connection cannot be more than a few thousand years old.

### 5.6.6 Vega

Stanbridge (1858) noted the connection between the appearance of the star Vega and the breeding season of the Mallee fowl (*Leipoa ocellata*) to the Boorong people of Victoria. According to Stanbridge, the star Vega ( $\alpha$  Lyrae,  $V_{\text{mag}} = 0.03$ , which he actually identifies as the constellation Lyra) is called *Neilloan*, the mallee fowl and the mother of *Totyarguil* (Aquila). He states that (*ibid*: 39)

*“when the loan [Mallee Fowl] eggs are coming into season on earth, they are going out of season with her. When she sits with the sun the loan eggs are in season.”*

Like Arcturus, Vega is a northerly star (just over  $28^\circ$  from the north celestial pole), never rising more than  $16^\circ$  above the horizon as seen from Lake Tyrell and reaching its maximum altitude while passing an azimuth of due north ( $0^\circ$ ), see Figure 5.18.

Mallee fowls are mostly land-dwelling and highly camouflaged endangered birds that are about the size of a chicken (Figure 5.19). They build large mounds (up to 20 m in circumference) in which they incubate their eggs, which number  $\sim 18$  per clutch on average. The birds use moist rotting compost as the base of the mound, which generates heat. The eggs are laid on this heap and covered by an insulating layer of sand that is maintained by the birds to keep an internal temperature of  $\sim 33^\circ$  C. During

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<sup>10</sup>The coldest time of the day is usually just after sunrise, as the earth continues to lose heat into space (for clear skies) while the atmosphere in the distance absorbs the sun’s heat before it reaches the observers locale.





FIGURE 5.18: The star Vega at maximum altitude as it crosses due north (azimuth =  $0^\circ$ ) as seen from Lake Tyrell, Victoria just before sunrise in early April. Image generated from Starry Night Pro.

a typical year the birds will begin digging the egg chamber in August (when Vega rises at dusk). The birds begin laying their eggs in September, which have a typical incubation period of 60 days, although the incubation period is heavily dependant on the temperature maintained in the mound (Benshemesh, 2007). The sun and Vega set together in November, which roughly corresponds to the time the eggs are ready to be collected.

Because of Vega's northerly position, it will remain a low altitude star moving across the northern horizon for several thousand years into the past from the latitude of northern Victoria. The effects of precession, however, cause Vega to decrease in altitude at a (non-constant) rate of a few degrees per millennium, appearing below the horizon by 6000 BCE. As the altitude decreased, the time between when Vega rose and set in the sky decreased, thus affecting the corresponding dates. Prior to 4000 BCE, Vega would have begun to rise just after sunset (on August 13th) but would have set just four hours later, never exceeding an altitude of  $3.5^\circ$ . As time recedes, Vega rises at dusk later in the month of August but sets in late October instead of mid-November. By 5000 BCE Vega sets with the sun in early-mid October and barely moves above the horizon after sunset in late August ( $\text{Alt} < 1.3^\circ$ ). By this point, any connection between the mallee fowls' breeding cycle and the rising and setting of Vega is effectively gone. By  $\sim 5500$  BCE Vega was no longer visible from central Victoria, thus, the connection



FIGURE 5.19: A Victorian Mallee Fowl (*Leipoa ocellata*) on an egg-laying mound. Image by Ian McCann, Museum Victoria, Melbourne.

between Vega and the birds' breeding cycle cannot exceed an age of  $\sim 7,500$  years, assuming the birds followed the same breeding patterns then as they do today.

### 5.6.7 Summary

This technique provides an age limit to terrestrial/celestial connections among astronomical traditions of Aboriginal Australians. The six examples I used above demonstrate that the age limits of the connections are  $< 10,000$  years, with most of them being  $< 7,500$  years old (Table 5.2). Together, they provide evidence that oral traditions and Dreamings changed over time to accommodate the changing celestial cycles. We would expect earlier Aboriginal groups ( $> 10,000$  years ago) to have had different astronomical oral traditions and connections to the ones we see today.

## 5.7 Technique 3: Constellation Pattern–Matching

My in-depth review of the literature on Aboriginal astronomy revealed that most Aboriginal groups attributed characters in astronomical traditions to particular stars or celestial objects and only rarely employed a connect-the-dots approach to constellations. In this section, I examine one such case from the Central Desert (Mountford,

TABLE 5.2: Data on the stars with connections tested in Section 5.6, including Bayer designation (or Messier ID for the two star clusters), the common name, coordinates,  $V_{\text{mag}}$ , radial velocity ( $\Delta r$ ), proper motion ( $\Delta\alpha, \Delta\delta$ ), parallax ( $P$ , both in terms of milli-arc seconds), distance ( $r$ ), and the approximate age limit of the connection ( $A_L$ ) in years before present (BP). Star data from SIMBAD Catalogue. Cluster data from van Leeuwen (2009). The age given for the Pleiades connection is based on the rising of the cluster only.

Bayer/Messier	Common	$V_{\text{mag}}$	$r$	$\alpha$	$\delta$	$\Delta r$	$\Delta\alpha$	$\Delta\delta$	$P$	$A_L$
Designation	Name		(ly)	(J2000)	(J2000)	(km/s)	(mas/yr)	(mas/yr)	(mas)	(yrs BP)
$\alpha$ Crucis	Acrux	0.79	320	12 <sup>hr</sup> 26 <sup>m</sup> 35.9 <sup>s</sup>	-63° 05' 57"	-11.2	-35.83	-14.86	10.17	10,000
$\alpha$ Aurigae	Capella	0.08	42	05 <sup>hr</sup> 16 <sup>m</sup> 41.4 <sup>s</sup>	45° 59' 53"	29.2	75.52	-427.11	77.29	7,000
$\alpha$ Boötis	Arcturus	-0.04	37	14 <sup>hr</sup> 15 <sup>m</sup> 39.7 <sup>s</sup>	19° 10' 56"	5.0	-1093.45	-1999.40	88.98	7,300
$\alpha$ Lyrae	Vega	0.03	25	18 <sup>hr</sup> 36 <sup>m</sup> 56.3 <sup>s</sup>	38° 47' 01"	-13.9	201.03	287.47	128.93	7,500
$\alpha$ Piscis Austrini	Fomalhaut	1.16	25	22 <sup>hr</sup> 57 <sup>m</sup> 39.0 <sup>s</sup>	-29° 37' 20"	6.5	329.22	-164.22	130.58	500
M45	Pleiades	1.60	392	03 <sup>hr</sup> 47 <sup>m</sup> 24.0 <sup>s</sup>	24° 07' 00"	5.7	20.10	45.39	8.32	4,000
M44	Beehive	3.70	577	08 <sup>hr</sup> 40 <sup>m</sup> 24.0 <sup>s</sup>	19° 41' 00"	33.6	-35.81	-12.85	5.49	7,000



FIGURE 5.20: The Pointers, Coalsack, and the Southern Cross. Image by Roger Groom.

1976: 451): the Southern Cross, which is attributed to the footprint of the wedge-tailed eagle. Similarly, the False Cross is the footprint of a hawk and the same technique could be applied to this asterism. In this section, I will use the effects of stellar proper motion and radial velocity to determine if the Southern Cross would have appeared significantly different in the past to the way it does today, to the extent that it no longer resembled the footprint of a predatory bird. The point where the asterism no longer resembles its earthly counterpart is the age limit we can set for this tradition.

The constellation of Crux, known as the Southern Cross, is the smallest of the 88 standard Western constellations, but arguably the most famous in the Southern Hemisphere. It features prominently on the national flags of several Southern Hemisphere countries, including Australia, Brazil, New Zealand, Samoa, and Papua New Guinea, as well as many Australian commonwealth state and territory flags. The four brightest stars of the Southern Cross decrease in brightness clockwise from the bottom ( $\alpha$  Crucis,  $\beta$  Crucis,  $\gamma$  Crucis, and  $\delta$  Crucis), which borders the Coalsack, a dark absorption nebula near  $\alpha$  Crucis and  $\beta$  Crucis (Figure 5.20). The nearby bright stars  $\alpha$  Centauri and  $\beta$  Centauri are referred to as the Pointers, as they roughly point towards  $\gamma$  Crucis at the top of the Southern Cross.



FIGURE 5.21: A wedge-tailed eagle, *Aquila audax*, the largest raptor in Australia. Photo from [www.freewildlifepictures.com](http://www.freewildlifepictures.com).

Crux, the Coalsack, and the Pointers are prominent in many Aboriginal traditions and are commonly associated with one another. Some Aboriginal groups in the Central Desert referred to the Coalsack as the nest of the wedge-tailed eagle (*Aquila audax*, Figure 5.21), the Southern Cross was his footprint, and the Pointers represented his throwing stick (Mountford, 1976: 451).

I attempt to estimate a rough age limit of this stellar association by looking at the relative positions of these stars and their brightness in the past. The stars move relative to one another due to stellar proper motion, so the overall positions of the stars move with respect to each other in addition to precession (albeit rather slowly) and the radial velocity of the stars (indicating that they change in apparent magnitude) showing that this asterism would have looked different in the past. Using astrometric and observational data and the laws of positional astronomy, we can determine if there was a point in the past where this asterism would have looked so different to today's pattern as to be unrecognisable as the footprint of a predatory bird. Additionally, since two of the stars that make up the Pointers and Southern Cross are relatively close to the Earth ( $\alpha$  Centauri and  $\gamma$  Crucis), their proper motion will be relatively large and have a greater effect on the shape of the overall asterism.



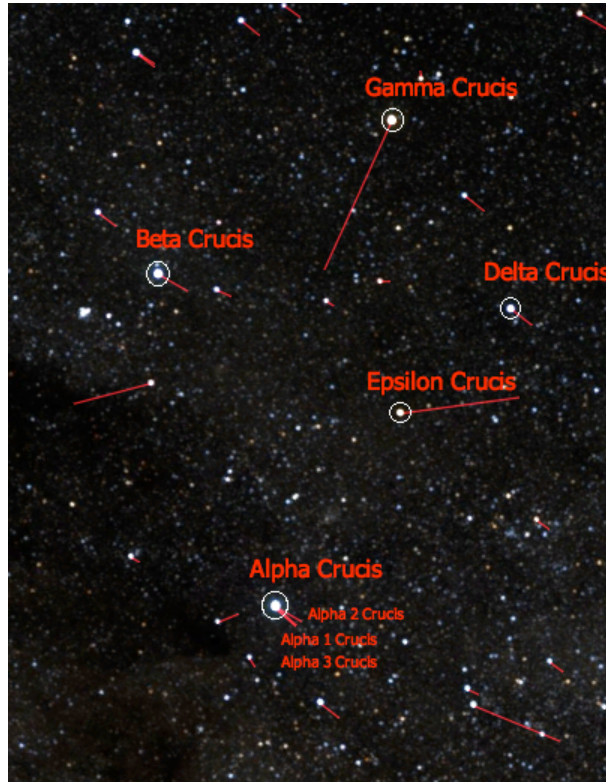


FIGURE 5.22: The projected proper motions vectors of the brightest stars in Crux, shown as red lines (these are only used to illustrate their RV). White circles are around the five brightest stars in Crux.  $\alpha^1$  Crucis and  $\alpha^3$  Crucis share a nearly identical proper motion. Image credit: Starry Night Pro.

I first investigate the proper motions and radial velocity of the Pointers and the four brightest stars of the Southern Cross. The positional data of the four brightest stars in Crux are given in Table 5.3. These data show that  $\alpha$  Crucis,  $\beta$  Crucis, and  $\delta$  Crucis all have similar proper motions, while the proper motion of  $\gamma$  Crucis is quite different from the other three (Figure 5.22).

To determine how far back in time Crux would have resembled an eagle's footprint, I draw a line connecting  $\alpha$  Crucis with  $\gamma$  Crucis, then a line connecting  $\beta$  Crucis with  $\delta$  Crucis. I measure the angular distance between the intersection point of the two lines (which I denote as the origin point) and each star, given as  $R_A$  (origin to  $\alpha$  Crucis),  $R_B$  (origin to  $\beta$  Crucis),  $R_G$  (origin to  $\gamma$  Crucis) and  $R_D$  (origin to  $\delta$  Crucis), as shown in Figure 5.23 – Left. I do the same with an eagle's footprint, where I measure points from the cuticle of the four talons, from which the footprint takes its shape (see Figure 5.23

TABLE 5.3: Positional data for the four brightest stars in Crux, giving the right ascension ( $\alpha$ ), declination ( $\delta$ ), Stellar Proper Motion ( $\Delta\alpha$ ,  $\Delta\delta$ ) in arc seconds per year, radial velocity, distance, the apparent visual magnitude and the absolute visual magnitude for an epoch of J2000. Below is the corresponding data for these stars 40,000 years ago, which also includes the change in the distance due to radial velocity ( $\Delta D$ ), the approximate distance to the stars at that time ( $D$ ), and the change in the apparent magnitude due to radial velocity ( $\Delta V_{\text{mag}}$ ).

Star (J2000)	$\alpha$ ( $^{\circ}$ )	$\delta$ ( $^{\circ}$ )	$\Delta\alpha$ (mas/yr)	$\Delta\delta$ (mas/yr)	RV (ly/yr)	D (ly)	$V_{\text{mag}}$ (app)	$V_{\text{mag}}$ (abs)
$\alpha$ Crucis	186.64960	-63.09917	-0.03583	-0.01486	-0.000034	320	0.79	-4.14
$\beta$ Crucis	191.93000	-59.68861	-0.04824	-0.01282	+0.000052	350	1.30	-3.92
$\gamma$ Crucis	187.79130	-57.11333	+0.02794	-0.26433	+0.000069	88	1.59	-0.56
$\delta$ Crucis	183.78625	-58.74889	-0.03668	-0.01072	+0.000074	360	2.78	-2.47
Star (-40,000)	$\alpha$ ( $^{\circ}$ )	$\delta$ ( $^{\circ}$ )	$\Delta\alpha$ (mas/yr)	$\Delta\delta$ (mas/yr)	$\Delta D$ (ly)	D (ly)	$V_{\text{mag}}$ (app)	$\Delta V_{\text{mag}}$ (app)
$\alpha$ Crucis	46.80675	-37.00897	-0.398	-0.165	+1.4	319	0.81	+0.02
$\beta$ Crucis	44.30200	-33.23588	-0.536	-0.142	-2.1	352	1.25	-0.05
$\gamma$ Crucis	36.88750	-33.65045	+0.310	-2.937	-2.8	91	1.66	-0.07
$\delta$ Crucis	41.13575	-36.81248	-0.408	-0.119	-3.0	363	2.76	-0.02

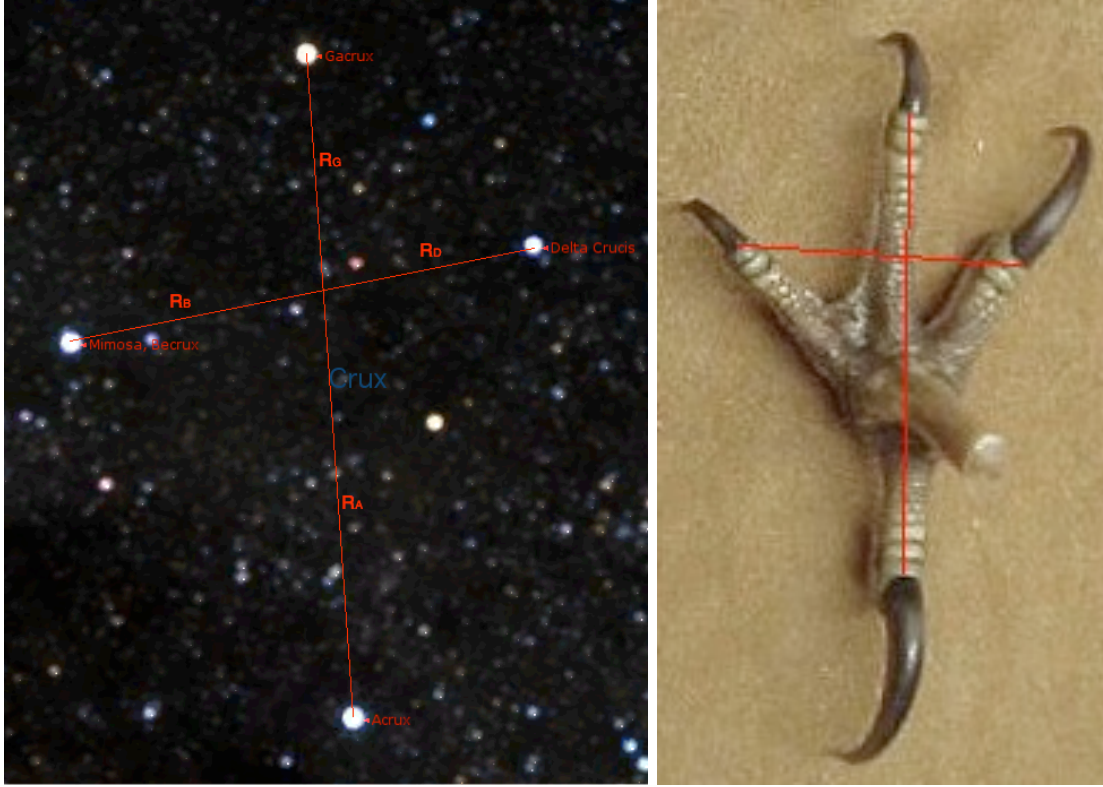


FIGURE 5.23: **Left** – The radial distances between each star and the point where the two lines forming the cross intersect are labeled corresponding to their name:  $R_A$ ,  $R_B$ ,  $R_G$ , and  $R_D$ . Configuration is shown as of 2000 CE, taken from Starry Night Pro. **Right** – The foot of an eagle. Because the talons curve upward, they are less likely to leave a clear shape in the soil/sand. Therefore, I use the cuticle of the talon as the basis for measurement.

– Right). I then compare the ratios of these values along each axis for both Crux and the eagle's foot now and at some time in the past when they no longer resemble each other. For this comparison, the ratio  $R_B/R_D = R_1$  and  $R_A/R_G = R_2$  for Crux and the foot.  $R_1^{\text{Crux}} = 1.2$  and  $R_2^{\text{Crux}} = 1.8$ . From this, we see that  $\alpha$  Crucis is two-thirds as far from the origin point than  $\gamma$  Crucis. A similar test using the eagle foot shows  $R_1^{\text{Foot}} = 1.3$  and  $R_2^{\text{Foot}} = 2.1$ . I determine the geometric similarity of Crux and the foot by using the following formula:

$$R_{eN} = \frac{R_N^{\text{Foot}} - R_N^{\text{Crux}}}{R_N^{\text{Foot}}} \quad (5.5)$$

In order to classify Crux and the eagle footprint as geometrically similar, I set  $R_{eN} < 0.50$ . Today, we can say that the Southern Cross and an eagle footprint are



geometrically similar ( $R_{e1} = 0.076$  and  $R_{e2} = 0.142$ ). To determine when they are no longer geometrically similar, the value of either  $R_{e1}^{\text{Crux}}$  or  $R_{e2}^{\text{Crux}}$  must be  $> 0.5$ .  $\alpha$  Crucis,  $\beta$  Crucis, and  $\delta$  Crucis are all have similar proper motion vectors and are all of a similar distance from earth; 320, 350 and 360 ly, respectively. Therefore, we do not expect them to move significantly relative to each other over the course of time. However,  $\gamma$  Crucis is fairly close to the Earth (88 ly) with a relatively high proper motion, moving in a direction different to the other three stars. For this reason, we expect Crux to change significantly in appearance over time based on the relative position of  $\gamma$  Crucis.



FIGURE 5.24: The four brightest stars of Crux as they appear today (in red circles) and as they would have appeared 25,000 years ago (labeled). It is clear that the high proper motion of  $\gamma$  Crucis would have greatly affected the appearance of the asterism in the night sky. This shows that 25,000 years ago Crux would not have reasonably resembled an eagle's footprint, placing an age limit on this asterism. Image generated using Starry Night Pro.

By taking measurements of the lines connecting the bright stars of Crux 25,000 years ago, we find that Crux was much different geometrically that what it is today, as we would expect (Figure 5.24). The value of  $R_1^{\text{Crux}}$  changed by 0.4, but not as significantly as  $R_2^{\text{Crux}}$ . With a value of 1.09, the change in  $R_2^{\text{Crux}}$  between now and 25,000 years ago was 0.71. This gave  $R_{e2} \approx 0.50$ , no longer meeting the criterion for geometric similarity. This tells us that Crux resembling an eagle's footprint is  $< 25,000$  years old and would have been unrecognisable as an eagle's footprint prior to that date.

Oral traditions relating the Pointers (seen as as a throwing stick) to Crux would probably have been more recent, as  $\alpha$  Centauri has a relatively high proper motion and radial velocity. Around 25,000 years ago,  $\alpha$  Centauri would have been two times fainter and in the constellation Ara – over  $20^\circ$  from its current position in Centaurus.

## 5.8 Technique 4: Using Oral Traditions

The fourth example is the possibility of dating an oral tradition based on the description of celestial objects in the sky. For example, an oral narrative entitled *The Beginning Island*, which was recorded in the 1830s (McKay et al., 2001: 39-40), describes the formation of Tasmania. When the sun (*Parnuen*) and his lunar wife (*Vena*) came into being they dropped seashells to the small island (called *Troweena*, which became Tasmania). Their first child (*Moinee*), a strong, shining baby, was born on that day. His parents placed him high above the icy lands to the south of the island becoming the “*Great South Star*”. The next day Parnuen and Vena had another child (*Dromerdene*), which they placed in the sky midway between themselves and Moinee. The next day, twins (*Beegerer* and *Piminer*) were born and became the stars Sirius and Betelgeuse. Moinee was angry from his loneliness in the south, so his parents sent two spirits (*Une*, lightning and *Bura*, thunder) to live with him above the “Great South Land”. At the time, icebergs floated around the island and Vena would sometimes set over an iceberg. One day an iceberg melted and Vena sank. This made her only visible at night, which we see as the moon. The sun, in his anger, melted all the icebergs and gave the island to his son, Moinee, who has watched over it since.

This story is ambiguous and attempts to identify the star are problematic: the identity of the Great Southern Star is unknown but could be a reference to an unknown supernova. Or it may represent a star from a time when one of the brighter stars in the sky was closer to the south celestial pole than it is today. The story describes icebergs around the island, which suggests a colder period of the Earth's recent geologic history. Perhaps the Great Southern Star was a reference to the bright star Achernar ( $\alpha$  Eridani,  $V_{\text{mag}} = 0.5$ ), which would have appeared within  $7^\circ$  of the south celestial pole  $\sim 5,000$  years ago or, perhaps (see Figure 5.4 in Section 5.5.2), when the bright star Canopus ( $\alpha$  Carinae,  $V_{\text{mag}} = -0.72$ ) was within  $11^\circ$  of the south celestial pole some 14,000 years ago, at the end of the Pleistocene when glacial retreat began (called the Holocene epoch), which is consistent with the subsequent warming and melting icebergs.

This explanation presents a number of new challenges, including the question of whether an oral tradition can survive for thousands of years (which will be discussed in Chapter 10). Any connection between this story and Canopus or Achernar is speculative. The story is too ambiguous to make any definitive or reputable claims regarding a relationship to particular celestial objects at a known point in time, but similar stories may exist with sufficient details that could be useful for dating the narrative.

## 5.9 Conclusion

From this study, I provide an age limit to oral traditions based on the connection between terrestrial events and the positions of particular stars in the sky. The traditions tested must generally be  $< 7,500$  years old, with one of the six tested being  $< 10,000$  years old. This does not give us an actual age, but does provide us with a *terminus post quem*. This reveals an enormous uncertainty in estimating the ages of astronomical traditions using oral culture that do not cite a particular datable event. If we assume that astronomical traditions are on the order of tens-of-thousands of years old, this shows that astronomical traditions changed to incorporate new information as the positions of stars gradually changed over time.

Precession is the dominating effect altering terrestrial/celestial connections. The

effects of precession shows that the positions of the stars would have appeared  $\sim 25,800$  years ago much as they do today. A majority of the visible stars would not have deviated significantly from their current positions due to their relatively low stellar proper motion and radial velocity. A small number of stars, namely those that are close to the earth with higher proper motions, such as  $\alpha$  Centauri, would have changed more dramatically from their current positions over the last 25,800 years. Therefore, the maximum positional change of the stars in the sky from their current positions (as seen from earth) occurred approximately 13,000 years ago, effectively altering or nullifying almost any terrestrial/celestial connection.

The technique of using stellar proper motion and radial velocity to estimate the age limit of a particular asterism reveals even larger uncertainties, showing the traditions could be tens-of-thousands of years old. The example using Crux shows that this particular asterism must have developed long after humans first arrived in Australia, not before. For that example, stellar proper motion is the dominating effect since precession has no affect on the relative positions of stars.

This study shows that astronomical traditions that relate to the connection of star positions and terrestrial events must be less than 10,000 years old, while particular asterisms may be tens-of-thousands of years old, such as Crux representing an eagle's footprint, which provides a *terminus post quem* of 22,000 years.

# 6

## Eta Carinae

*“The Boorong pride themselves upon knowing more of astronomy than any other tribe.”*

— William Edward Stanbridge (1858: 137).

The first major subject explored as part of the analysis of astronomical phenomena in this thesis involves the identification of variable stars, specifically novae and supernovae. In this chapter, evidence is presented that the Boorong people of northwestern Victoria recorded the “Great Eruption” of Eta ( $\eta$ ) Carinae in the nineteenth century and incorporated it into their oral traditions. The eruption of this star is considered a “supernova–impostor” event and not a proper supernova (as the eruption did not destroy the star). This work was a joint venture between myself and David Frew, who brought the link between the Stanbridge account and Eta Carinae to my attention.

We both researched every aspect of this chapter, so no part of this is strictly my work or his work – it was a joint effort. I therefore use the word “we” instead of “I” in this chapter.

The star in the Aboriginal account is identified, as well as others not specifically identified by name, using descriptive material presented in the 1858 paper by William Edward Stanbridge in conjunction with early southern star catalogues. This identification of a transient astronomical event supports the argument that Aboriginal oral traditions are dynamic and not static. This is the only definitive indigenous record anywhere in the world of  $\eta$  Carinae’s outburst identified in the literature to date.

## 6.1 Introduction

The first detailed publication on Aboriginal astronomy in the literature was by William Edward Stanbridge, who described the astronomy and mythology of the Boorong clan of the Wergaia language from the dry Mallee country near Lake Tyrrell in northwest Victoria (Stanbridge, 1858; 1861, see Figure 6.1). The Boorong word for Tyrrell<sup>1</sup> (*tyrille*) meant “sky” or “heavens” and they prided themselves on knowing more astronomy than any other Aboriginal community (Stanbridge, 1858: 137; 1861: 301). Stanbridge read his seminal paper to the Philosophical Institute of Victoria on 30 September 1857. He wrote:

*“I beg to lay before your honorable Institute the accompanying paper on the Astronomy and Mythology of the Aborigines, and in doing so I am sensitive of its imperfectness, but as it is now six years since I made any additions to it, and as my occupation does not lead me to that part of the country where I should be able to make further additions, I have presumed to present it to your society, hoping that it may be a means of assisting with others to gather further traces of the people that are so fast passing away.*

*This statement of the Astronomy and Mythology of the Aborigines is, as nearly as language will allow, word for word as they have repeatedly during*

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<sup>1</sup>Sometimes “tyrrell” is spelt “tyrell”.

*some years stated it to me. It is in the language of, and has been gleaned from, the Booroung Tribe, who claim and inhabit the Mallee country in the neighbourhood of Lake Tyrill, and who pride themselves upon knowing more of Astronomy than any other tribe.” (Stanbridge, 1858: 137).*

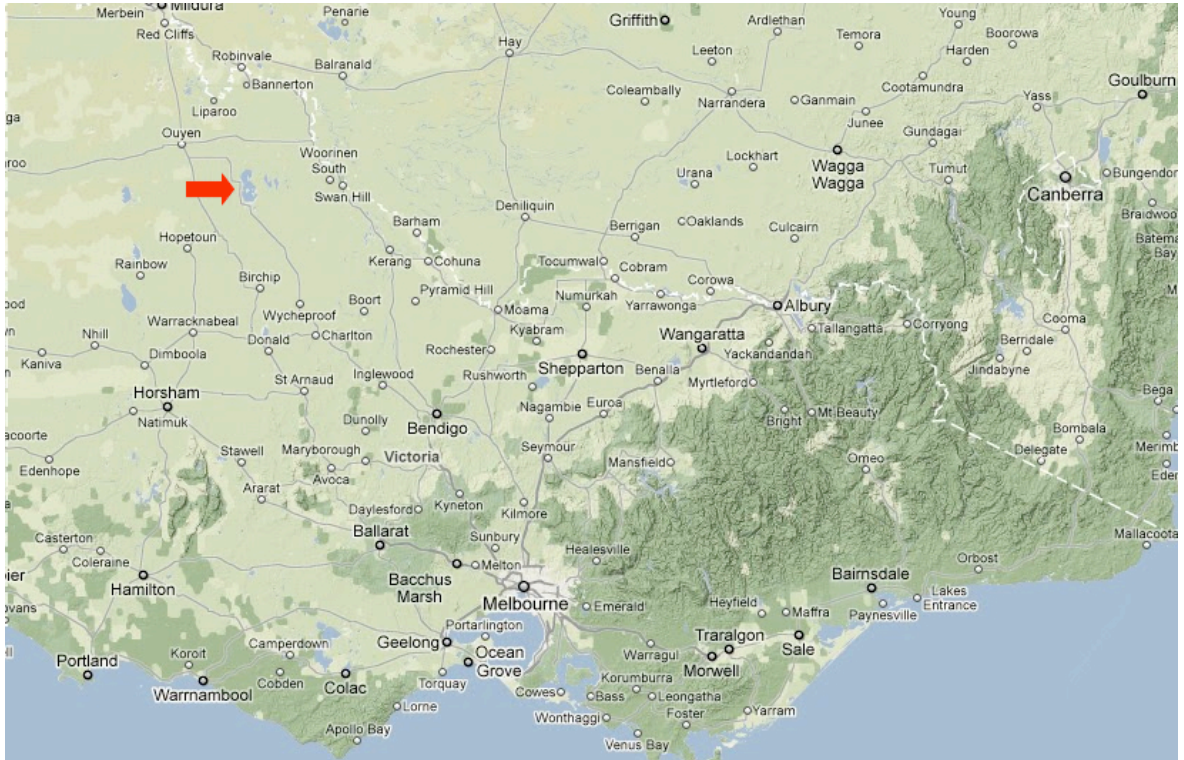


FIGURE 6.1: A map of Victoria (south-eastern Australia). Lake Tyrill, where Stanbridge acquired his knowledge of Booroung astronomy, is indicated by the red arrow, and Tyrell Downs is just to the east of Lake Tyrill (image taken from Google Maps).

Stanbridge’s work describes Booroung views of various celestial objects and phenomena, including the Sun, Moon, Jupiter, Venus, numerous individual stars, the Pleiades and Coma Berenices open star clusters, two compact constellations (Delphinus and Corona Australis), the Magellanic Clouds, the Coalsack Nebula, the Milky Way, meteors, and the seasons. These celestial objects are represented by characters in oral traditions that are typically represented by animals or beings, and occasionally their spouses. In some cases, Stanbridge identified the star by name, while in other cases it is identified only by a general description, which typically includes its brightness, constellation, and proximity to particular stars. Stanbridge’s work was later re-analysed

by MacPherson (1881) and Morieson (1996).

In this chapter, one of Stanbridge’s Boorong descriptions is identified as the outburst of the super-massive binary system Eta ( $\eta$ ) Carinae. A brief biographical account of William Stanbridge is provided in Section 6.2, with an extended biography in Appendix A, while all the celestial objects described in Stanbridge (1858) are identified in Section 6.3. In Section 6.4 the evidence is summarised that indicates the Boorong observed  $\eta$  Carinae during its Great Eruption in the nineteenth century and incorporated it into their oral traditions, while we discuss  $\eta$  Carinae itself in Section 6.5. In Section 6.6, previous attempts to identify the wife of War (the crow) are discussed, while in Section 6.7 this is used as an exemplar to show that the Boorong incorporated  $\eta$  Carinae into their oral traditions during the nineteenth century period of outburst and not before. In Section 6.8 we explain how transient astronomical phenomena are often incorporated into oral traditions and show that sky knowledge is dynamic and changing, while in Section 6.9 a search is conducted for other indigenous records of  $\eta$  Carinae before summarising the conclusions in Section 6.10.

## 6.2 William E. Stanbridge: Biographical Details

William Edward Stanbridge<sup>2</sup> (Esq, M.L.C., J.P.) was born on 1 December 1816 in the village of Astley in Warwickshire, England. In November 1841, Stanbridge arrived in Port Phillip, Victoria and moved around Victoria and South Australia over the next several years, finally settling near Daylesford, Victoria. Soon after his arrival in Daylesford, Stanbridge purchased the Holcombe run and later Wombat run, both north of Daylesford. He was issued a pastoral license for Tyrrell Station from September 1847 to January 1873 and was the first non-Indigenous person to do so.

On 8 July 1862 Stanbridge was appointed “honorary correspondent for the Upper Loddon district, of the control board for watching over the interests of the aborigines”. Stanbridge became a member of the Philosophical Institute of Victoria, the Royal Society of Victoria, and was a Fellow of the Anthropological Institute, London. He

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<sup>2</sup>A full biography of Stanbridge, including all references, can be found in Appendix A.



presented his paper on Boorong astronomy to the Philosophical Institute of Victoria in Melbourne on 30 September 1857 (which was published in their 1858 proceedings). A second, longer paper was later published in 1861 and included all the essential astronomical information from the original 1858 manuscript, the original of which was apparently destroyed in a fire. Stanbridge claimed to have gained his information on Boorong astronomy from two members of a Boorong family who had the reputation of having the best astronomical knowledge in the community. He stated that his first fieldwork experience was conducted by a small campfire under the stars, located on a large plain near Lake Tyrrell. In his original 1857 address, Stanbridge said that he had not made any additions to the paper in the previous six years, implying that he did the bulk of his astronomical fieldwork between being issued a pastoral license at Tyrell Downs (ca. 1848) and 1851, with the latter date being better constrained.

His education and training in astronomy is unclear, but his written papers show that he had an acceptable knowledge of astronomy and navigation. It is also uncertain what astronomy references he had at his disposal while conducting his fieldwork, but the most widespread contemporary star catalogue was the “British Association Catalogue” (Baily, 1845). Other possibilities include the Parramatta or ‘Brisbane’ catalogue (Richardson, 1835), the complete edition of La Cailles catalogue of 9,766 stars (Henderson & Baily, 1847), or the earlier La Caille (1763) catalogue of 1,942 southern stars, which will be discussed further in Section 6.4.

## 6.3 Identification of Boorong Celestial Objects

Stanbridge (1858, 1861) provides equivalent western names for the majority of stars identified by the Boorong, which were repeated in Smyth (1878: 432–434). As part of this re-analysis of Stanbridge’s work, these stars will be independently identified, as well as all the stars he did not specifically name. Since the Boorong clan apparently no longer exists as an entity and much of their traditional knowledge has been lost (Morieson, 1996), Stanbridge’s papers are the only primary source of Boorong ethnoastronomy. Stanbridge (1858) is used to identify all stellar objects that are not

identified by name, which are presented in Table 6.1. A complete list of all the Boorong celestial objects and seasons identified by Stanbridge and this analysis is provided in Table 6.2, including visual magnitudes for all stars.

Some of the proposed object identifications need additional clarification. The Boorong object called *Totyarguil* is the bright star Altair rather than the whole constellation of Aquila, since Stanbridge (1858: 139) specifically noted that “the stars on either side are his two wives”. This comment certainly refers to  $\beta$  Aql and  $\gamma$  Aql, which flank Altair prominently in the sky; MacPherson (1881: 76) came to a similar conclusion. Similarly, *Neilloan* (a flying Loan or Mallee Fowl) is identified by Stanbridge with an object called Lyra. Stanbridge’s description does not suggest that Neilloan refers to a group of stars. We note that prior to the late nineteenth century, Vega was commonly called ‘Lyra’ or ‘Lucida Lyrae’ in the literature (e.g. Herschel, 1847: 334), so we match Neilloan to the bright, zero-magnitude star Vega, as distinct from the whole constellation of Lyra<sup>3</sup>. In agreement with our conclusion, MacPherson (1881) also identified Neilloan to be the star Vega.

The explicit mention of the relatively inconspicuous star  $\sigma$  Canis Majoris (CMa) by Stanbridge is noted. Perhaps it was pointed out to Stanbridge because it lies between the bright stars Wezen ( $\delta$  CMa) and Adhara ( $\epsilon$  CMa) on an approximate straight line (an apparent positional preference of the Boorong noted by MacPherson, discussed below). Alternatively, and less likely, the Boorong may have noticed that it varies in brightness. This reddish star ( $V = +3.45$ ,  $B-V = 1.72$ ; spectral class M0–Ib) is a known irregular variable star with a small amplitude of  $\sim 0.1$  mag (Samus et al., 2010). There is a suggestion of larger amplitude variability in the past (J.E. Gore, quoted by Chambers, 1875), but this has not been confirmed by modern observations. Even so, there is a small possibility that the star may have been substantially brighter in the

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<sup>3</sup>Many of the characters observed by the Boorong, which were identified as bright stars by Stanbridge (1858), have been considered by Morieson (1996, 2002) to represent patterns of stars, which sometimes include very dim stars. Since Aboriginal clans in southeast Australia generally avoided using a connect-the-dots approach to grouping constellations (see Fredrick, 2008; Johnson, 1998; Massola, 1968a), instead attributing individual stars to specific characters in their oral traditions, it seems unlikely that Morieson’s proposed constellation patterns were recorded or used by the Boorong.

nineteenth century.

As shown in Table 6.2, the Boorong created a reasonably good list of the brightest stars visible from northwestern Victoria. The only first magnitude stars omitted by Stanbridge were (with the  $V_{\text{mag}}$  in parentheses): Procyon (+0.40), Betelgeuse (+0.50, variable), Spica (+0.96), Fomalhaut (+1.14), Deneb (+1.26), and Regulus (+1.35). MacPherson (1881: 72-75) speculates that the reason these stars are omitted is because the Boorong (and other clan and language groups of the region) preferred to systematically group stars. He proposes that characters represented by stars of a particular family are either:

- Grouped based upon their arrangement in the sky, specifically grouping three stars (or clusters) in a linear pattern;
- Grouped into four linear arrangements that are roughly parallel to each other; or
- Arranged roughly parallel to the horizon as they rise in the evening sky in their respective seasons at the latitude of the region ( $36^\circ$  S).

Examples of this linear grouping include Orion's Belt, Aldebaran, and the Pleiades (Group 1), Vega, Altair, and  $\alpha$  Capricorni (Group 2), Antares, Arcturus, Shaula, and Lesath (Group 3). In these cases (except for Shaula and Lesath), the characters represented by these stars are of a particular family. MacPherson asserts that because Procyon, Betelgeuse, Spica, Fomalhaut, Deneb, and Regulus do not fall into this systematic mechanical grouping, despite their brightness, the Boorong did not include them. The interested reader is referred to MacPherson (1881) for a more detailed, in-depth explanation of this systematic grouping of stars. One must also remember that Stanbridge's source was apparently two members of a single Boorong family (Stanbridge, 1861: 301), and particular bright stars may have been omitted by either Stanbridge or by his Boorong informants for unknown reasons.

Massola (1968a: 106-112) highlights the oral traditions of various Aboriginal groups of Victoria, including the Wotjobaluk, Mara, Kulin, Kurnai, Bidwel, Yaitmathang, and Murray River communities (but does not specify Boorong oral traditions). The Wotjobaluk and Boorong are both clans of the Wergaia language. He claims to have obtained his information from fieldwork over a period of 10 years, as well as “the scant published material” (*ibid*: x). Massola (*ibid*: 105) states that “*beliefs of the Victorian Aborigines regarding the world appear to have been much the same amongst all tribes*”. On page 109 he cites stars in Wotjobaluk and Mara traditions not included in those of the Boorong, specifically Fomalhaut, which he describes as an eaglehawk ancestor (as mentioned in the previous chapter), to which unspecified Murray River communities attribute to the planet Mars. As discussed in Section 6.6, some of Massola’s descriptions of Wotjobaluk sky knowledge appear to have been adopted directly from Stanbridge’s paper. Additionally, the Moporr (Mara) people included Betelgeuse in their sky knowledge, as opposed to the Boorong or Wotjobaluk (Dawson, 1881: 100-101). Betelgeuse is rare in the oral traditions of other Aboriginal groups across Australia (see Fredrick, 2008), so it is unclear if MacPherson’s hypothesis applies only to Wergaia oral traditions or if the Boorong simply did not tell Stanbridge about certain stars for whatever reason. In Table 6.3 we present a comparison of Boorong, Wotjobaluk, Mara/Moporr, and Kulin star names.

Several studies have shown that many Aboriginal groups gave significance to the brightest individual stars, their nearby companion stars, naked-eye double stars, small distinctive asterisms or clusters, and the dark dust clouds silhouetted along the Southern Milky Way (e.g. Fredrick, 2008; Johnson, 1998). Several Aboriginal groups noted compact but distinctive groups of relatively faint stars: for example, Mountford (1956: 479) and Haynes (1992, 2000: 58-59) have related how the Aboriginal people of Groote Eylandt gave the name of *Unwala* (the Crab) to the compact group of third and fourth magnitude stars that comprise the head of Hydra, midway between the first-magnitude stars Procyon and Regulus, the latter two of which are apparently not considered significant. In contrast, Peter Beveridge, reporting to the Select Committee of the Legislative Council of Victoria, stated that “[the Aboriginal Victorians] *have a name and*

TABLE 6.1: Stars in Stanbridge (1858) not identified by name. \*Also known as  $\eta$  Robur or  $\eta$  Argo

Boorong	Stanbridge's Description	Object Name	Designation
Karik Karik	The two stars in the end of the tail of Scorpius	Lesath	$\nu$ Scorpii
Bermbermgle	The two large stars in the forelegs of Centaurus	Rigil Kent Hadar	$\alpha$ Centauri $\beta$ Centauri
Tchingal	The dark space between the forelegs of Centaurus & Crux	Coal Sack	–
Bunya	Star in the head of Crux	Gacrux	$\gamma$ Crucis
Kulkunbulla	Stars in the Belt and Scabbard of Orion	Alnilam Alnitak Mintaka Trapezium Hatsya	$\epsilon$ Orionis $\zeta$ Orionis $\delta$ Orionis $\theta^{1,2}$ Orionis $\iota$ Orionis
Weetkurrk	Star in Bootes, west of Arcturus	Muphrid	$\eta$ Bootis
Collowgullouric War	Large red star in Rober Carol, marked 966		$\eta$ Carinae*
Collenbitchick	Double Star in the head of Capricornus	Prima Giedi Secunda Giedi	$\alpha^1$ Capricorni $\alpha^2$ Capricorni
Unurgunite	Star marked 5 <sup>th</sup> mag 22 between two larger ones in the body of Canis Major	–	$\sigma$ Canis Major
Wives of Unurgunite	The stars on either side of Unurgunite are his two wives	Adhara Wezen	$\epsilon$ Canis Major $\delta$ Canis Major
Wives of Totyarguil	Two stars on either side of Aquilla (Altair)	Tarazed Alshain	$\gamma$ Aquilae $\beta$ Aquilae

TABLE 6.2: Stars and celestial objects identified by Stanbridge in both Western and Boorong terms. Stars are ordered by magnitude, from brightest to faintest. \*Approximate magnitude in 1850. \*\*Combined magnitude of individual components. \*\*\*Given as Cornua Berenices [sic] in Stanbridge (1858: 139) and Coma Berenices in Stanbridge (1861: 302).

Western	Boorong	$V_{\text{mag}}$	Constellation
Sirius	Warepil	-1.46	Canis Major
Canopus	War	-0.72	Carina
$\eta$ Carinae	Collowgullouric War	-0.4*	Carina
Rigil Kent	Bermbermgle	-0.28	Centaurus
Arcturus	Marpeankurk	-0.03	Boötes
Vega (Lyra)	Neilloan	0.03	Lyra
Capella	Purra	0.08	Auriga
Rigel	Collowgullouric Warepil	0.15	Orion
Achernar	Yerrerdetkurk	0.45	Eridanus
Hadar	Bermbermgle	0.61	Centaurus
Acrux	(spear in neck) Tchingal	0.75	Crux
Altair	Totyarguil	0.76	Aquila
Aldebaran	Gellarlec	0.86	Taurus
Antares	Djuit	0.98	Scorpius
Pollux	Wanjel	1.16	Gemini
Becrux	(spear in rump) Tchingal	1.25	Crux
Adhara	Wife of Unurgnnite	1.50	Canis Major
Castor	Yurree	1.58	Gemini
Gacrux	Bunya	1.62	Crux
Shaula	Karik Karik	1.64	Scorpius
Alnilam	Kulkunbulla	1.70	Orion
Alnitak	Kulkunbulla	1.74	Orion
Wezen	Wife of Unurgunite	1.82	Canis Major
Mintaka	Kulkunbulla	2.23	Orion
Muphrid	Weetkurk	2.65	Boötes
Lesath	Karik Karik	2.69	Scorpius

$\gamma$ Aquilae	Wife of Totyarguil	2.72	Aquila
$\iota$ Orionis	Kulkunbulla	2.77	Orion
$\tau$ Scorpii	Wife of Djuit	2.82	Scorpius
$\sigma$ Scorpii	Wife of Djuit	2.90	Scorpius
$\sigma$ Canis Maj	Unurgunite	3.47	Canis Major
$\alpha^2$ Capricorni	Collenbitchick	3.56	Capricornus
$\beta$ Aquilae	Wife of Totyarguil	3.71	Aquila
$\delta^{1,2}$ Orionis	Kulkunbulla	3.9**	Orion
$\alpha^1$ Capricorni	Collenbitchick	4.24	Capricornus
Sun	Gnowee		
Moon	Mityan		
Jupiter	Ginabongbearp		
Venus	Chargee Gnowee		
Meteor	Porkelongtoute		
Space	Tyrille		
Star	Tourte		
Milky Way	Warring		
Magellanic Clouds	Kourtchin		
Coal Sack	Tchingal		
Delphinus	Otehocut		
Cornua Berenices***	Tourtchinboionggera		
Pleiades	Larnankurk		
Corona Borealis	Won		
Autumn	Weeit		
Summer	Cotchi		
Winter	Myer		
Spring	Gnallew		

TABLE 6.3: Comparative names of celestial bodies taken from Massola (1968a) for the Wotjobaluk and Kulin groups of Victoria. Mara and Moporr names are taken from Massola (1968a) and Dawson (1881)\*, respectively. All objects are listed alphabetically. \*\*Massola (1968a: 8) refers to Dok (the frog) as the mother of the Bram-bram-bult (the Pointers), represented by a star in Crux closest to the Pointers, referring to  $\beta$  Crucis. However, on page 108, he claims Duk [sic] is the west star of Crux, referring to  $\delta$  Crucis, and that  $\alpha$  and  $\beta$  Crucis are represented by spears thrown by the Bram-bram-bult that pierced the emu (Tchingal – Coalsack). Both accounts are apparently taken from the Wotjobaluk clan.

Object	Wotjobaluk	Mara/Moporr	Kulin
Aldebaran	Gallerlec	—	—
$\beta$ Aquilae	Wife of Totyarguil	—	Kunnawarra
$\gamma$ Aquilae	Wife of Totyarguil	—	Kunnawarra
Altair	Totyerguil	—	Bunjil
Antares	Djuitt	Butt Kuee tuukuung*	Balayang
Arcturus	Marpean-kurrk	—	—
Betelgeuse	—	Moroitch*	—
$\alpha^{1,2}$ Capricorni	Collenbitchik	—	—
$\alpha$ Centauri	Purt-mayel	—	Djurt–djurt
$\beta$ Centauri	Bram-bram	—	Thara
$\delta$ Canis Majoris	Urnugunite	—	—
Canopus	War	Waa*	Lo-an-tuka
Capella	Purra	—	—
$\eta$ Carinae	Collow-collouricwar	—	—
Castor	Yurree	—	—
$\delta$ Crucis	Dok**	—	—
$\gamma$ Crucis	Bunya	—	—
Fomalhaut	[recorded, no name]	Buunjill*	—
Muphrid	Weet-kurrk	—	—
Pollux	Wanjel	—	—
Rigel	Warepil	Yerrerdetkurrk*	—
2 stars in Sagittarius	—	—	Tadjeri, Tarnung
$\lambda$ , $\nu$ Scorpii	Karik Karik	Kummim bieetch*	—
Sirius	Warepil	Gneeanggar*	Lo-an
Tarazed	Wives of Totyarguil	—	Kunnawarra
Vega	Neil-loan	—	—
Yellow Star in Orion	—	Kuupartakil*	—



<b>Star Groups</b>	<b>Wotjobaluk</b>	<b>Mara/Moporr</b>	<b>Kulin</b>
Beehive Cluster	Coomartoorung	—	—
Orion's Belt	Kulkunbulla	Kuppiheear*	—
Pleiades	Larnan-kurrk	Kuurokeheear*	Karatgurk
Pointers	Bram-bram-bult	Tuulirmp*	—
<b>Constellations</b>	<b>Wotjobaluk</b>	<b>Mara/Moporr</b>	<b>Kulin</b>
Coma Berenices	Tourtchimboiongherra	—	—
Corona Australis	Wom	—	—
Crux	—	Torong (or)	—
	—	Kunkun Tuuromballank*	—
Delphinus	Otchout	—	—
Hydra (head?)	—	Barrukill*	—
<b>Galaxies &amp;</b>			
<b>Nebulae</b>	<b>Wotjobaluk</b>	<b>Mara/Moporr</b>	<b>Kulin</b>
Milky Way	[smoke, name not given]	Barnk*	—
Coalsack	Tchingal	Torong*	—
LMC	[recorded, male]	Kuurn Kuuron*	—
SMC	[recorded, female]	Gnaerang Kuuron*	—
<b>Solar System</b>	<b>Wotjobaluk</b>	<b>Mara/Moporr</b>	<b>Kulin</b>
Comet	—	Puurt Kuurnuuk*	—
Jupiter	Ginabonbearp	Burtit Tuung Tirng*	—
Mars	—	Parrupum*	—
Meteor	—	Gnummae waar*	—
Moon	Mityan	Meeheearong	Menyan
		Kuurtaruung*	
Sun	Gnowee	Tirng*	—
Venus	Chargee gnowee	Wang'uul* <i>or</i>	—
		Paapee Neowee*	

*legend for every planet and constellation visible in the heavens*” (Ridley, 1873b: 278), although this may have been a generalised statement that was not deeply researched by Beveridge.

These same general trends are also seen in the oral traditions of the Boorong, who identified all but five of the 21 first-magnitude stars, and a total of over 30 individual stars, plus Delphinus, Coma Berenices, the Magellanic Clouds, Venus, and Jupiter. There remains some confusion in the literature over the identity of the Boorong object called *Won*, identified simply as “Corona” by Stanbridge (1858), representing the boomerang thrown by *Totyarguil* (Altair). We note that Corona Australis has nearly the same right ascension as Altair and is relatively near to it on the sky, so we identify *Won* as Corona Australis rather than Corona Borealis (cf. Massola, 1968a; Johnson, 1998). Of the two constellations, Corona Australis has the more geometrically symmetric pattern, and is rather like a boomerang, representing the only apparent instance where a ‘connect-the-dots’ star pattern is applied by the Boorong. Corona Australis is quite distinctive under a dark sky, despite the relative faintness of its component stars.

## 6.4 Identification of Eta Carinae

Stanbridge (1858: 140) describes a bright star called *Collowgullouric War* as a female crow, the wife of *War* (Canopus). He labels it as “*a large red star in Rober Carol [sic]*”, and gives the identification number “966”; an extract is reproduced in Figure 6.2. We deduce that Collowgullouric War is referring to  $\eta$  Carinae in outburst, during the period of Stanbridge’s fieldwork, c. 1848 to 1851, which coincides with the years during which  $\eta$  Carinae was at its brightest (Smith & Frew, 2011), and that this outburst was incorporated into Boorong oral traditions. We expand on the reasoning underpinning this identification below.

“Rober Carol” refers to the now-defunct constellation of Robur Carolinum (Latin

140                      *On the Astronomy of the Aborigines.*

Won (Corona), a boomerang thrown by Totyarguil.  
 Weetkurrk (Star in Bootes, west of Arcturus), daughter of  
 Marpeankurrk.  
 War (Male Crow) (Canopus), the brother of Warepil, and the  
 first to bring down fire from (tyrille) space, and give it to the  
 aborigines, before which they were without fire.  
 Collowgullouric War (large red star in Rober Carol, marked  
 966) (Female Crow), wife of War. All the small stars around  
 her are her children.

FIGURE 6.2: An excerpt from Stanbridge (1858: 140) describing War (Canopus) and his wife, Collowgullouric War (bottom).

for “Charles’ Oak”) created by Sir Edmond Halley<sup>4</sup> in 1679, after observing the southern sky from St. Helena in 1677 (Halley, 1679; Baily, 1843). This new constellation was appropriated from the classical star group of Argo Navis (also now defunct), and constituted stars now located in eastern Carina and Vela, and western Centaurus (see Figure 6.3). Halley (1679) recorded  $\eta$  Carinae as a fourth magnitude star (see Figure 6.4), and Frew (2004) showed its magnitude at that time was  $V = +3.3 \pm 0.3$  on a modern photometric scale.

Stanbridge cites the simple designation ‘966’. This refers to a designation from La Caille’s pioneering catalogue of 1,942 southern stars (La Caille, 1763). The reader is referred to Frew (2004: 9) for the cross-identifications of stars in this region of the sky, taken from old catalogues. We further note that the correct designation for  $\eta$  Carinae from La Caille’s catalogue is ‘968 Argus’, but the surrounding Carina Nebula (NGC 3372) received the designation ‘966 Argus’, even though it is an extended, non-stellar object. This small discrepancy in the designation is probably the result of a transcription error by Stanbridge (see Figure 6.5), but we can deduce from this designation alone that Stanbridge was referring to a bright red star associated with the Carina nebula, i.e.  $\eta$  Carinae itself.

<sup>4</sup>This constellation (Charles’ Oak) was named in honor of King Charles II who is claimed to have hidden in an oak tree for a full day, during his defeat by Oliver Cromwell in the Battle of Worcester in 1651 (see Ridpath, 1989: 147).

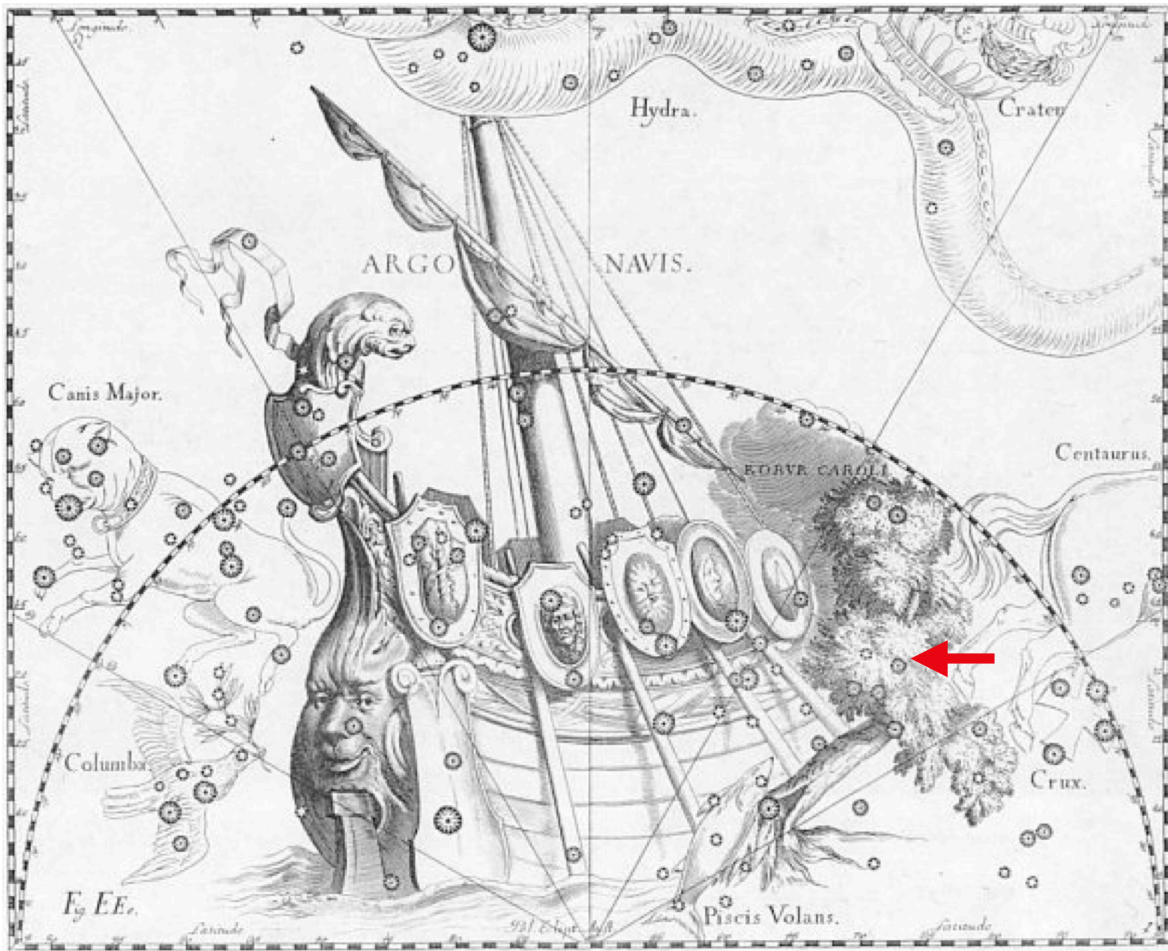


FIGURE 6.3: A star chart featuring Robur Carolinum from the star atlas of Jan Hevelius, who utilized the data from Halley (1679). The image is adapted from the modern facsimile of this atlas by Sheglov (1968: 53).  $\eta$  Carinae has been marked with a red arrow.

It seems unlikely that Stanbridge had a copy of La Caille's (1763) catalogue, which is a very rare work.  $\eta$  Carinae was not cross-referenced with La Caille (1763) in the British Association Catalogue, but was instead listed as Lac 4457 from the complete edition of La Caille's catalogue of 9,766 stars. However, the Paramatta or Brisbane catalogue does cross reference  $\eta$  Argus as Lac 968, listing it as a second magnitude star. However, this catalogue names it as  $\eta$  Argus. Perhaps Stanbridge had access to Johann Bode's Uranographia atlas (Bode, 1801), which shows the outline of Robur Carolinum, marked as Robor Caroli. In summary, it is unclear exactly what atlas and catalogue Stanbridge used to make his identifications. Nonetheless, this lack of knowledge does not affect the conclusions.

<i>Robur Carolinum.</i> <i>In perpetuam sub illius latebris servati Caroli II.</i> <i>Magnæ Britanniae &amp;c. Regis memoriam in cælum</i> <i>merito translatum.</i>				
143	1. Quæ ad radicem . . . . .	2	♄ 27 25	A. 72 15½ 848
144	2. In summo trunco . . . . .	3	24 37½	62 10 964
145	3. In ramis præcedentibus, de quatuor borea . . .	5	13 19	59 55 935
146	4. Sequens . . . . .	4	17 36½	58 57 968
147	5. Præcedens . . . . .	4	15 32	62 37 922
148	6. Media . . . . .	4	18 30½	61 27½ 943
149	7. In ramis sequentibus, duarum borea . . . . .	4	29 59½	56 49 1025
150	8. Austrina . . . . .	5	♍ 6 27	58 32 1037
151	9. In summâ arbore, duarum præcedens . . . . .	4	♄ 2 54	51 4½ 949
152	10. Sequens . . . . .	3	5 59½	51 6½ 970
153	11. Informium ad truncum præcedens . . . . .	4	18 21	67 30½ 894
154	12. Sequens . . . . .	4	♍ 2 51	67 23½ 920
155	13. Præcedens in triquetro . . . . .	3	♄ 3 33	31 31 1020
156	14. Media . . . . .	4	6 43	33 22 1029

FIGURE 6.4: An excerpt from Halley’s (1679) Catalogue of Southern Stars, taken from the more accessible edition of Baily (1843: 173). Entry 146 (Sequens) refers to the coordinates of  $\eta$  Carinae, with the designation 968 taken from Lacaille (1763). Halley noted  $\eta$  Carinae as a fourth magnitude star, which was shown by Frew (2004) to be equal to  $V = +3.3 \pm 0.3$  on the modern scale.

In the two decades prior to the publication of Stanbridge’s paper,  $\eta$  Carinae was one of the brightest stars in the sky and would have demanded attention from even a casual skywatcher (Frew, 2004). Contemporary accounts commonly referred to its colour as orange or reddish during the Great Eruption (e.g. Smyth, 1845; Jacob, 1847; Gilliss, 1855, 1856; Moesta, 1856; Abbott, 1861; Powell, 1862; Tebbutt, 1866; see Smith & Frew, 2011), consistent with Stanbridge’s depiction of it as “a large red star”. A cursory view of this region of sky with the unaided eye shows this to be one of the richest regions of stars in the southern Milky Way (called *Warring* in the Boorong language). Several third to fifth magnitude stars are located within a few degrees of  $\eta$  Carinae and are very likely the “small stars” (children) referred to in Stanbridge’s account.

There is only one other star in Robur Carolinum that is reddish or orange in hue

	Chamaeleontis. . . . .	6	158	20	30	73	11	39
	Chamaeleontis. . . . .	6	158	22	0	73	51	14
	Argus. . . . .	6	158	30	43	59	16	23
	Argus. . . . .	6	158	31	36	63	5	23
965	Argus. . . . .	E neb.	158	35	24	58	48	23
→	Argus. . . . .	Æ ne.	158	39	15	58	11	46
	Argus. . . . .	6	158	46	50	62	39	18
→	Argus. . . . .	2	158	51	30	58	22	37
	Argus. . . . .	6	158	52	37	41	52	25
970	Argus. . . . .	μ	159	1	12	48	6	16

FIGURE 6.5: Excerpt from La Caille (1763) showing the entry for the Carina Nebula (966), described as “ne.” or nebulous, and  $\eta$  Carinae (968), listed as a second magnitude star with the designation  $\eta$ . These entries are highlighted with a red arrow.

and is brighter than the fourth magnitude, which is q Carinae ( $V = +3.32$ , spectral type K3–Ib). Of the 34 stars positively identified in Stanbridge’s study (see Table 6.3), only three were below third magnitude ( $V > +3.5$ ), of which two are components of a conspicuous naked eye double star ( $\alpha^{1,2}$  Capricorni). It is unlikely that q Carinae is the star recorded by Stanbridge, but is more likely to be one of the “children”. Furthermore, this star is rather too faint for its colour to be obvious to unaided vision. While the naked eye limit for human foveal (direct) vision is  $V \approx +4.1$  (Schaefer, 1993) or perhaps a little fainter (Schaefer, 1996), stars much fainter than  $V \approx +3.0$  fall in the domain of mesopic vision, where colour perception is quite poor (Malin & Frew, 1995: 86). This is further evidence that the “large red star”, recorded by Stanbridge (and by extension the Boorong) was  $\eta$  Carinae, and not q Carinae or some other fainter star.

Given the brightness and colour of  $\eta$  Carinae during the years of Stanbridge’s field-work, its location in Robur Carolinum, and considering its designation in La Caille’s (1763) catalogue and those catalogues that cross-references La Caille, we determine that Collowgullouric War is a Boorong record of  $\eta$  Carinae during its period of outburst in the 1840s.

## 6.5 About Eta Carinae

$\eta$  Carinae is a luminous hypergiant at a distance of  $2,350 \pm 50$  pc from the Sun (Smith, 2006) in the constellation Carina (J2000,  $\alpha$ :  $10^{\text{hr}} 45^{\text{m}} 04.0^{\text{s}}$ ,  $\delta$ :  $-59^\circ 41' 04''$ ). It is a

massive binary system with a combined mass exceeding 100 times that of the Sun. The current visual magnitude is  $V \approx +4.6$  (Fernández-Lajús et al., 2009; Verveer & Frew, 2009). The dominant member of the binary system is an eruptive luminous blue variable star, with a luminosity of approximately four million times that of the sun (Davidson & Humphreys, 1997).

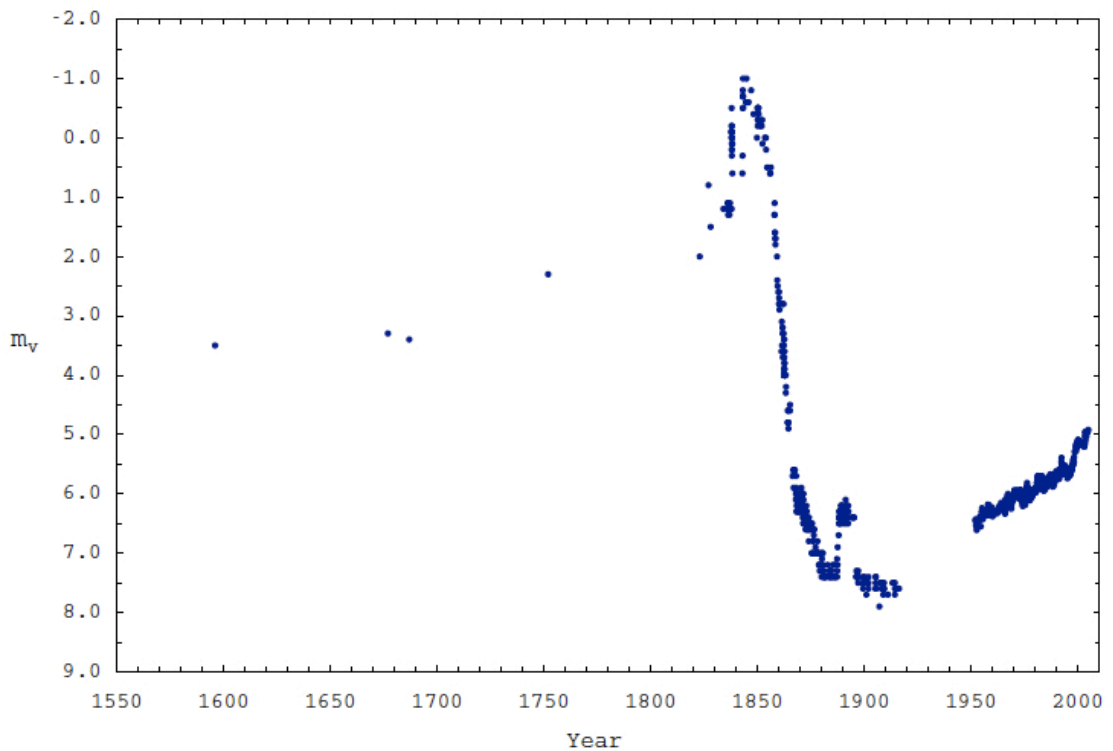


FIGURE 6.6: The visual light curve of Eta Carinae from 1596 to 2000, covering the period of the Great Eruption that extended from 1837 to 1857, taken from Frew (2004: 12).

The brightness of  $\eta$  Carinae has varied markedly since its first recorded observation over four centuries ago (Figure 6.6). It was a first or second magnitude star at the beginning of the nineteenth century, before John Herschel made the first detailed series of brightness measurements in the 1830s (Herschel, 1847). He noted that its brightness was relatively constant during this period ( $V = +1.2$  on the modern Pogson scale), before he observed it to rapidly brighten at the close of 1837 to be as bright as  $\alpha$  Centauri, before quickly fading again – this brightening is generally considered to be the start of the period of enhanced brightness known as the Great Eruption (Frew,



2004; Smith & Frew, 2011)<sup>5</sup>.  $\eta$  Carinae brightened markedly again during 1843; at its peak brightness in March of that year, and again in January 1845, it was the second brightest star in the sky after Sirius. The well-known Homunculus nebula is the ejected debris from this explosive event (e.g. Thackeray, 1949; Gaviola, 1950; Smith & Gehrz, 1998; Walborn et al., 1978; see Figure 6.7). The origin of this eruption, sometimes called a “supernova impostor” event, remains uncertain (e.g. Smith, 2008; Smith & Owocki, 2007). The star returned to its pre-outburst brightness in 1858, and continued to rapidly fade; by 1869, the star was invisible to the naked eye.

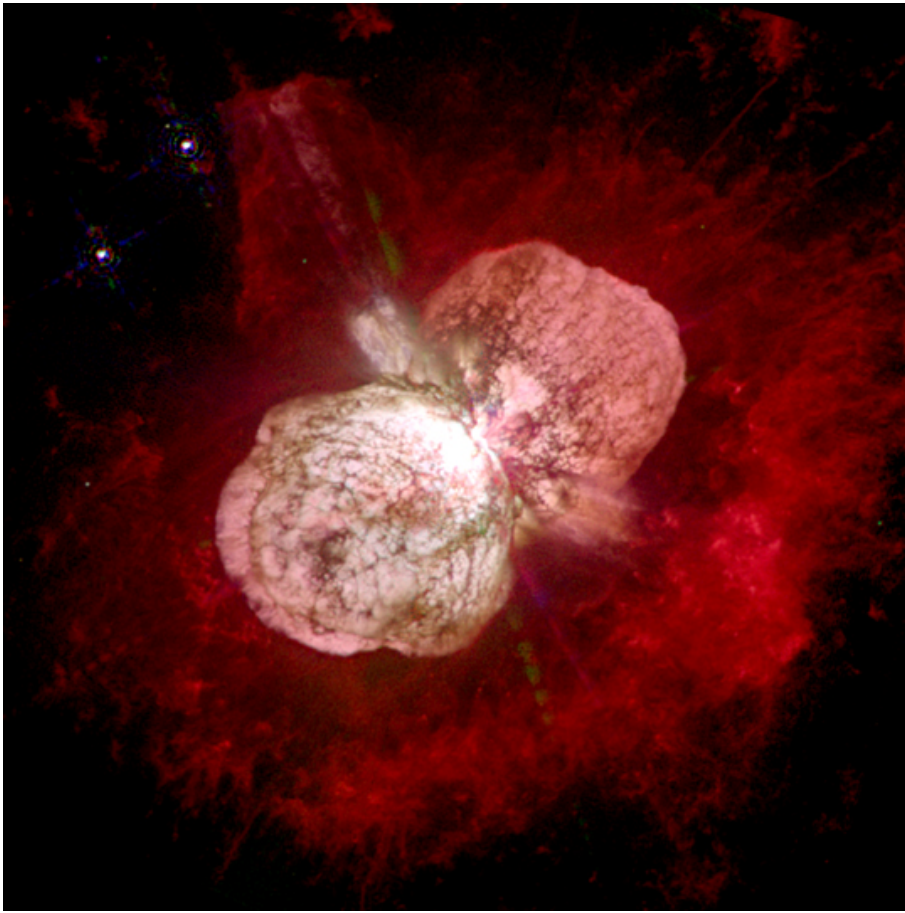


FIGURE 6.7: A NASA Hubble Space Telescope image of Eta Carinae and the surrounding Homunculus nebula by J. Morse and K. Davidson (6 September 1999).

<sup>5</sup>However,  $\eta$  Carinae appeared as bright as a first magnitude star as early as July 1827, when the naturalist William Burchell observed it to be “as large as a Crucis” (Herschel, 1847: 35; Frew, 2004: 24).



## 6.6 Other Attempts to Identify Collowgullouric War

MacPherson (1881: 73) explains that the female crow is the “small red star No. 966 in King Charles’ Oak [Robur Carol]”. It is interesting that he would describe this star as “small”, considering Stanbridge had specifically referred to it as “large”. However, by the 1880s,  $\eta$  Carinae was much fainter with an apparent magnitude of  $V = +7.4$  (see Figure 6.8), too faint to be discerned with the naked eye against the backdrop of the rich Carina nebula. In addition, Johnson (1998: 122), who cited MacPherson, described Collowgullouric War as “a small red star, probably Epsilon ( $\epsilon$ ) Carinae” ( $V = +1.86$ ), to which Haynes (2000: 75) also agrees. It is possible that MacPherson attributed Collowgullouric War to a “small” red star because of the faintness of  $\eta$  Carinae during the time he published his paper (see Figure 6.8). Both Johnson and Haynes may have been unaware of  $\eta$  Carinae’s variable past, and instead identified Collowgullouric War as  $\epsilon$  Carinae because of its current brightness and slightly orange tint.

Stanbridge (1861: 303) said that neighboring Aboriginal groups, from Swan Hill (near Tyrell Downs) to Mount Franklin (near Daylesford), share similar names and associations of the stars with the Boorong. A perusal of Massola (1968a) shows that the Wotjobaluk clan of the Wergaia language group, of which the Boorong is also a clan, has nearly identical views of the night sky as the Boorong. Although Stanbridge does not provide the details of stories associated with Boorong stars, Massola does concerning Wotjobaluk stars (*ibid*: 3–27). Massola identifies the crow (War) in Wotjobaluk traditions as Canopus and mentions that the largest star in “Rober Carol” is “Collowcollouricwar”, his wife (*ibid*: 109); a reference to what we identify as  $\eta$  Carinae. In this case it is likely that Massola referred directly to Stanbridge’s accounts, as most of the Wotjobaluk names as given by Massola are almost identical to the Boorong names recorded by Stanbridge. Furthermore, some descriptions are identical (e.g. Muphrid or Weetkurrk is described as a “star in Bootes, west of Arcturus” by both Stanbridge and Massola). Interestingly, Massola noted some celestial objects not mentioned by Stanbridge that have significance to the Wotjobaluk, such as Fomalhaut and the Beehive cluster (a conspicuous naked-eye star cluster, also called M44 or NGC 2632), although

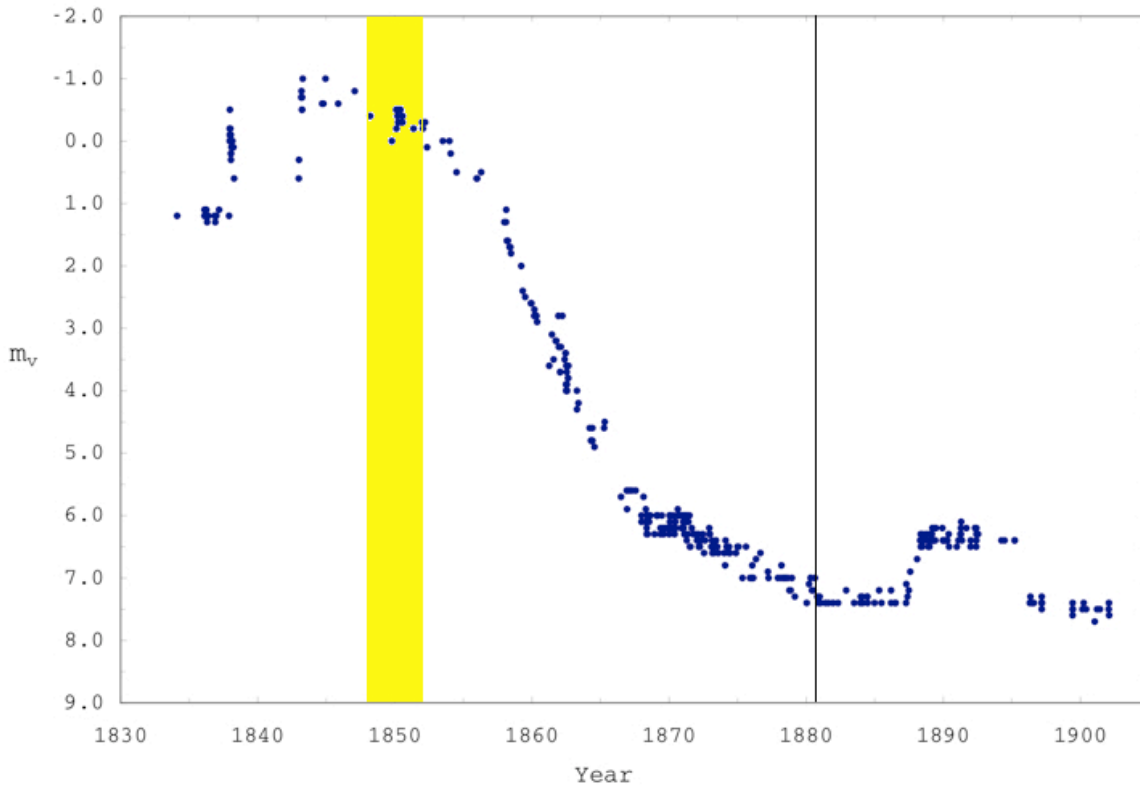


FIGURE 6.8: The visual light curve between 1830 and 1900, covering the period of the Great Eruption that extended from c. 1837 to 1857 (from Frew, 2004). The time period in which Stanbridge was likely to have conducted his fieldwork (approximately 1847 to 1851) is denoted by the yellow bar. The year in which MacPherson described  $\eta$  Carinae as a “small red star” (1881) is highlighted by the vertical line

the reason for their exclusion in Boorong astronomy is unclear. It is worth mentioning that although Massola (*ibid*: 109) mentions Collow-collouricwar as the wife of War, he does not include any mention of Collowgullouric War in the Wotjobaluk stories (*ibid*: 3–27).

In his unpublished Master of Arts thesis, Morieson (1996: 74) identified Collowgullouric War as  $\eta$  Carinae, but did not give his reasoning for this. He suggests that other nearby red stars, including R Carinae, S Carinae, and a fifth magnitude star near the open cluster NGC 2516, may also be Collowgullouric War (but excludes this possibility in later publications). We can rule these out as candidates, since they do not match Stanbridge’s description as “large” (bright). Furthermore, R and S Carinae are both large-amplitude, Mira-type variable stars, spending most of their time below

naked-eye visibility. And as mentioned earlier, stars of these magnitudes do not show apparent colour to the unaided eye. Finally, R Carinae, S Carinae, and NGC 2516 are not labeled ‘966’ in any star catalogues, leaving no alternative star to identify as Collongullouric War.

In summary, we consider the evidence for a Boorong identification of  $\eta$  Carinae during its Great Eruption to be unambiguous, as there are no alternative bright red stars nearby in the sky from which to choose, nor any others labeled 966.

## 6.7 Eta Carinae Previously in Boorong Culture?

We further argue that  $\eta$  Carinae was probably not in the oral traditions of the Boorong prior to its outburst, and propose that this transient “supernova imposter” event was significant enough to be included in their oral traditions during the 1830s or early 1840s. In Stanbridge’s account, the Boorong associate Warepil, Collongullouric Warepil, and War with some of the brightest stars in the sky (namely Sirius:  $V = -1.46$ , Rigel:  $V = +0.15$ , and Canopus:  $V = -0.72$ , respectively). This suggests the Boorong chose  $\eta$  Carinae to represent Collongullouric War given it was of similar magnitude during its Great Eruption ( $0 > V > -1.0$ ).

Prior to its major outburst (i.e. before 1820),  $\eta$  Carinae was a second or third magnitude star in a region of the sky densely populated with stars of similar or brighter magnitudes, such as  $\beta$  Carinae ( $V = +1.68$ ),  $\epsilon$  Carinae ( $V = +1.86$ ),  $\delta$  Velorum ( $V = +1.94$ ),  $\iota$  Carinae ( $V = +2.25$ ) and  $\kappa$  Velorum ( $V = +2.50$ ). We emphasise that Stanbridge recorded none of these conspicuous stars.

An interesting trend regarding the magnitude of particular stars and their celestial spouses is apparent in Boorong traditions. Masculine stars with a single wife are both represented by objects of comparable brightness and are always in the same region of the night sky (see Table 6.4). If a character has two spouses, they are of different magnitudes, usually being fainter than the main character, except in the case of Unurgunite where his wives are brighter. Additionally, the trio of spouses are found to be in a fairly straight line (see Djuit, Totyarguil, and Unurgunite). Such a linear

preference in grouping stars was described by MacPherson (1881: 73–75), as discussed before.

The bright southern portion of the Milky Way in the vicinity of  $\eta$  Carinae is especially rich in moderately bright naked eye stars, but the only first magnitude stars in that region belong to Crux. Considering the magnitude of Canopus (War), we would expect to find his wife represented by a star of similar magnitude relatively nearby in the sky. We know that during its nineteenth century outburst,  $\eta$  Carinae was comparable in brightness with Canopus and is in the same general region of the sky. Therefore, it seems it was deliberately chosen to be War’s wife, with its brightness as a key factor. There is no obvious reason why  $\eta$  Carinae before its outburst would have been incorporated into celestial oral traditions so closely associated with the brightest stars in the night sky. Prior to the early 1800s,  $\eta$  Carinae was a second or third magnitude star (see Figure 6.8) in a region of the sky full of stars of similar magnitudes. It was only during the 20-year period between 1837 and 1857 that it became one of the brightest stars in the night sky before fading from view by the 1870s.

## 6.8 Celestial Phenomena in Oral Traditions

As shown throughout this thesis, it is not uncommon for special events to serve as the foundation for new oral traditions or to be incorporated into pre-existing oral traditions. Many Aboriginal oral traditions are not static, but rather dynamic. While Aboriginal oral traditions in most cases serve to illustrate and record a particular moral charter and to preserve the social structure of the community, specific mnemonics can change over time. Several examples of transient celestial mnemonics, including comets, meteors and meteorite falls, being incorporated into pre-existing oral traditions or serving as the foundation of others can be found throughout the literature, a few of which we discuss below.

The fall of a meteorite near Jupiter Well, Western Australia was incorporated into a new oral tradition (Poirier, 2005: 237–238), as was an apparent meteorite fall witnessed by Aboriginal people and described to Barker (1964: 109–110). The Aboriginal

TABLE 6.4: Comparative brightness between celestial objects representing husbands and those representing their wife or wives. LMC and SMC are the Large and Small Magellanic Clouds. Some of the star listed are variables, noted with an asterix. Thus, the magnitude quoted is at peak brightness.  $\delta$  Canis Majoris is also called “22 Canis Majoris”, identified as such by Stanbridge. \*Maximum Brightness

Husband	Object	$V_{\text{mag}}$	Spouse(s)	$V_{\text{mag}}$
Warepil	Sirius	−1.46	Rigel	0.15
Ginabongbearp	Jupiter	−2.9*	Venus	−4.6*
War	Canopus	−0.72	$\eta$ Carinae	−1.0*
Kourt-chin	LMC	0.4	SMC	2.30
Djuit	Antares	0.98	$\tau$ Scorpii	2.82
			$\delta$ Scorpii	2.90
Totyarguil	Altair	0.76	$\beta$ Aquilae	3.71
			$\gamma$ Aquilae	2.72
Unurgunite	$\delta$ Can Maj	3.47	$\epsilon$ Can Maj	1.50
			$\delta$ Can Maj	1.82

informant’s description provided enough details to leave little doubt in Barker’s mind that they had witnessed the fall. But since the meteorite was used as a source for sacred stories, the informants would not reveal its location to Barker or the other white Australians (for more examples, see Chapter 10). In the 1800s, the Western Arrernte people of Ntaria (Hermannsburg, NT) incorporated Christian mythology into their pre-existing oral traditions during their period of conversion by Lutheran missionaries (see Austin–Broos, 1994). Some of these traditions were related to celestial phenomena, including a story of a falling star and rock art that depicted the sun, moon and stars (*ibid*).

In some cases, the appearance of a comet coincided with a natural disaster or catastrophic event. For example, the appearance of bright comets in Australian skies coincided with droughts (Parker, 1905: 99), disease epidemics (Spencer & Gillen, 1899: 549), war (Morrill, 1864: 61) or natural disasters (Mowaljarlai & Malnic, 1993: 194), prompting Aboriginal people to view the phenomenon with fear and apprehension

(which is consistent with many cultures around the world). These views were carried through successive generations via oral traditions. Even solar eclipses, which are rare occurrences from any given place on earth, have been incorporated into oral traditions (see Chapter 7). Therefore, the idea that significant celestial events were incorporated into oral tradition is supported by the literature.

Without Stanbridge’s description of Collogullouric War’s location and the catalogue designation he quoted, it would be difficult to argue that the Boorong were describing  $\eta$  Carinae. We have no records prior to 1857 regarding Boorong astronomy, and indeed none since Stanbridge. The Boorong clan no longer exists as an entity, but their descendants still live in the region as members of the Kulin nations (Clark, 1939). It would be of interest to know how the oral traditions regarding these stars changed, if at all, as  $\eta$  Carinae faded to invisibility just a decade after Stanbridge’s publication.

## 6.9 Other Indigenous Records of Eta Carinae

There are no unambiguous records of  $\eta$  Carinae from antiquity, and the earliest observations are derived from Dutch explorers at the close of the sixteenth century (Frew, 2004). The presence of faint nebulous ejecta exterior to the Homunculus nebula suggests that  $\eta$  Carinae underwent a putative earlier outburst that occurred several centuries before the Great Eruption (Walborn et al., 1978; Walborn & Blanco, 1988; Smith & Morse, 2004), perhaps around 1000 C.E.

We have shown that the Boorong recorded Carinae during its outburst in the nineteenth century, when it became the second brightest star in the night sky. Indeed, the long duration ( $\geq 20$  yrs) of the Great Eruption, far longer than any supernova event, and its sheer brightness compared to neighbouring stars, suggest it would have been widely observed by most, if not all, indigenous peoples of the southern hemisphere. Hence, we have examined a number of accounts summarising the ethnoastronomy of Australian Indigenous groups that post-date Stanbridge’s work, but nevertheless we have found no clear evidence for any other accounts that refer to an unidentified red star in Carina (e.g. Beveridge, 1889; Dawson, 1881; Howitt, 1904; Maegraith, 1932;

Massola, 1968a; Manning, 1882; Mathews, 1904; Mountford, 1956; 1958; Palmer, 1884; 1886; Parker, 1905; Piddington, 1930; Ridley, 1873a; Stone, 1911; and Tindale, 1937a,b, amongst other sources). Since the fieldwork for these studies dates from ca. 1870 to 1950, the simplest explanation is that as the star faded below naked-eye visibility in the 1860s, any oral traditions based on  $\eta$  Carinae that were authored during the Great Eruption were possibly lost, or seen to be no longer important.

In addition, we must ask if there are any archaeological records of the putative earlier outburst of  $\eta$  Carinae. Teames (2002) cites three stone artifacts from the pre-Incan Tiahuanacan culture (ca. 1000 C.E.) near the southern end of Lake Titicaca, Bolivia that may depict the 1000 C.E. outburst. While her evidence is highly intriguing, it is too open to interpretation to be definitive. Interestingly, Orchiston (2000; 2002) and Green & Orchiston (2004) have identified a reference in Best (1922) to a possible transient source in the southern Milky Way, recorded by the Maori of New Zealand or their Polynesian ancestors. The object is called *Mahutonga*, which Best (1922: 46) records as “a star of the south that remains invisible”. This reference in turn derives from Stowell (1911: 202–203) who described *Maahu* (Mahu) as the star of the south, which “has left its place in pursuit of a female. When it secures the female, it will come back again to its true home”. Stowell (1911: 209) further states that “Maahu–Tonga is invisible”. Based on this description, Green & Orchiston (2004) claim a transient event occurred in the region of Mahu or Mahutonga, Maori terms associated with the region of Crux and the Coalsack Nebula (Crux is the chamber of Maahu–Tonga; Stowell, 1911: 209), and identify it as a potential supernova. While they were unable to identify a particular supernova event, they highlighted the possibility of it being a transient observed in 185 C.E., which is generally, but not universally, understood to be a supernova (Martocchia & Polcaro, 2009; Schaefer, 1995; Stephenson & Green, 2002; Zhao et al., 2006). Its position (J2000,  $\alpha$ :  $14^{\text{h}} 43^{\text{m}}$ ,  $\delta$ :  $-62^{\circ} 27.7'$ ), lies close to  $\alpha$  Centauri near the border of Centaurus and Circinus.

However, the identification of Mahutonga with SN 185 would indicate that the account originated in Polynesia, over eight centuries before humans settled in New Zealand ( $\sim 1000$  CE). Stowell’s description might be taken to describe a star that

appears, disappears, and is expected to reappear again, suggesting a recurrent variable star as opposed to a supernova event that suddenly appears before fading on a timescale of months (Stephenson & Green, 2002). Given that  $\eta$  Carinae's brightness fluctuated significantly over several decades during the nineteenth century, it is possible that Mahutonga may be a reference to this. Since  $\eta$  Carinae is at a comparable angular separation to Crux as SN 185,  $\eta$  Carinae remains a possible, albeit speculative, candidate for Mahutonga.

## 6.10 Conclusions

We conclude that the Boorong people observed the outburst of  $\eta$  Carinae in the nineteenth century, which we identify using Stanbridge's description of its position in Robur Carolinum, its colour and brightness, its designation (966 Lac, implying it is associated with the Carina nebula), and the relationship between stellar brightness and positions of characters in Boorong oral traditions. This event was incorporated into Boorong oral traditions. This supports the assertion that Aboriginal sky knowledge is dynamic and shows that Aboriginal people were careful observers of the night sky. The observations by the Boorong represent the first and only definitive indigenous record of the Great Eruption of  $\eta$  Carinae identified in the literature to date.



# 7

## Eclipses

*“We are to witness an eclipse of the sun next month. Strange! All the natives know about it; how, we can’t imagine.”*

— Ada Janet Peggs (1903: 358).

The analysis of astronomical phenomena in Aboriginal cultures continues with eclipses. In this chapter, approximately 50 Australian Aboriginal perceptions and accounts of lunar and solar eclipses found in the literature are explored. This is done in order to determine how Aboriginal groups viewed and understood eclipses and to answer the question as to whether or not Aboriginal people attributed a solar eclipse to the superposition of the sun and moon, or lunar eclipses to the opposition of the sun and moon. The continued attempt to date oral traditions and rock art is applied by identifying historical eclipses in Aboriginal traditions.

## 7.1 Introduction

In this chapter, I examine five aspects of traditional Aboriginal knowledge regarding eclipses: (1) Aboriginal perceptions and reactions to eclipses, (2) Aboriginal explanations regarding the causes of eclipses, (3) dating oral traditions using historic eclipses, (4) predicting eclipses, and (5) representations of eclipses in Aboriginal rock art. I begin by discussing the science of lunar phases, tides and eclipses. If the account describes or is attributed to a known historic eclipse, it is given an ‘Event #’, with the details of each event listed in Table 7.2 (solar and lunar eclipse data was calculated using Espenak & O’Byrne, 2007a and 2007b, respectively).

## 7.2 Science of the Earth–Moon–Sun System

### 7.2.1 Lunar Phases

As the Moon orbits the earth, an Earth-bound observer will see a different percentage of the Moon illuminated by the Sun throughout a lunar month, which are referred to as lunar phases. These phases are divided into *new moon*, *first quarter*, *full moon*, *last quarter*, and back to new moon (Figure 7.1). When the Moon is between the Earth and Sun, appearing near the Sun in the sky from an Earthbound perspective, it is essentially invisible to us for about three days, which we call the new moon. As the Moon moves towards solar opposition, more of the surface is illuminated by the Sun. When less than half of the Moon is illuminated, it is called *crescent*, while more than half illuminated is called *gibbous*. As more of the Moon’s surface becomes progressively illuminated, we deem it *waxing*. When the Moon is at solar opposition, the entire hemisphere of the Moon facing the Earth is illuminated, revealing a *full moon*. As the Moon fades, it is deemed *waning*. The Moon rises at dawn during new moon and dusk during full moon, with the first quarter moon rising at midday and the last quarter moon rising at midnight.

To understand the causes of eclipses, it is essential to understand the relative motions of the Sun and Moon, which cause lunar phases. By examining Aboriginal oral

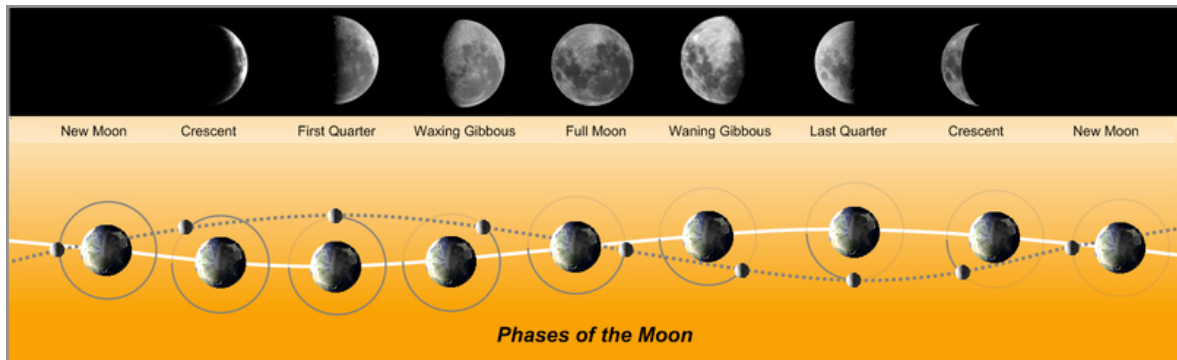


FIGURE 7.1: Lunar phases as seen from the Earth (top) and from above Earth (bottom), with the Sun to the left. This image corrected from the original for observers in the Southern Hemisphere. Image reproduced under Wikimedia commons licence agreement.

traditions, we can determine how Aboriginal people in traditional times understood the relative motions of the Moon–Sun system and their connection to events on the Earth, such as tides.

### 7.2.2 Eclipses

In the Earth–Moon–Sun system, there are two general types of eclipses: solar and lunar. When the Moon passes between the Earth and Sun, an observer in the area on the Earth that falls into the Moon’s shadow sees a solar eclipse. During a total solar eclipse, the Sun is completely blocked and day turns completely into night (called *totality*). During totality, the Sun’s faint corona as well as prominences may be observed. The shape and intensity of the corona depend on the presence of sunspots, which relate to the 11-year solar cycle (c.f. Aschwanden, 2004). Total solar eclipses are rare, and can be seen on average from a given point on the Earth’s surface only once every 410 years, while total solar eclipses in the Southern Hemisphere are even more rare, occurring only once every 540 years (Steel, 1999: 351). If only part of the Sun is covered, we see a partial solar eclipse. While total eclipses are quite rare, partial eclipses are far more frequent, with  $> 30$  such events occurring every century. If the Moon eclipses the Sun during apogee (due to its eccentric orbit), the Moon will completely fit within the disc of the Sun, leaving a ring of the solar disc visible, called the *annulus*. Thus, this is referred to as an *annular* eclipse.

When the Moon passes through the shadow of the Earth, we witness a lunar eclipse. Because the Earth's shadow darkens the entire moon, lunar eclipses are far more frequent than solar eclipses, often occurring 2–3 times per year. During a total lunar eclipse, longer wavelengths of light from the Sun are refracted through the Earth's atmosphere, causing the Moon to take on a ruddy appearance, although the colour varies from red to orange, pink or copper. This phenomenon was noted by some Aboriginal groups in various oral traditions.

There has been some debate regarding the visibility of partial eclipses. Chou (1981) and Marsh (1982) claim that even when 99% of the Sun is eclipsed, the remaining 1% is bright enough to cause retinal damage if viewed directly with the naked eye. There have been no studies that limit the magnitude required for people to notice a partial eclipse, but Stephenson & Clark (1978: 39) claims that partial eclipses that cover 98% of the Sun's surface could go by unnoticed, unless they were known in advance, used an observing aide, or were low on the horizon and/or the light intensity was reduced by the presence of clouds (e.g. Newton, 1979: 101). Mostert (1989) claims that no unambiguous hard evidence exists that a partial solar eclipse has been observed with the naked eye, although Ray Norris (personal communication) claimed to see a partial eclipse as a child in the UK on 15 February 1961 that he did not know about beforehand. This eclipse only covered 80% of the Sun but Norris still noted the dimming of light. I personally noticed the dimming of an otherwise clear sky during a partial solar eclipse on 26 February 1998 while driving in Jefferson City, Missouri. I had forgotten that an eclipse was predicted for that day, but the dimming was significant enough that I stopped and looked up at the sun, which visibly darkened an otherwise bright, clear sky. It seems, based on personal experience, that the argument that partial solar eclipses are not visible to the naked eye are false. In support of my conclusion, accounts presented in this paper are of partial eclipses that were noted by people with no special equipment, eye protection, or prior knowledge of the event (e.g. Morrill, 1864).

Given the rarity of solar eclipses, how many accounts of this phenomenon would we expect to find oral traditions? The frequency of total solar eclipses over a 1000-year period from 900–1900 C.E. for 11 locations across Australia is given in Table 7.1. An

TABLE 7.1: The frequency of total solar eclipses as seen from eleven different locations across Australia between CE 900–1900. Information includes the name of the observation location, the number of total eclipse events ( $N_e$ ) and the years those eclipses were observed. Data are taken from Espenak & O’Byrne (2007a).

City/Town	State	$N_e$	Years of Total Eclipses (CE)
Alice Springs	Northern Territory	0	
Adelaide	South Australia	5	1033, 1339, 1517, 1728, 1802
Brisbane	Queensland	4	1134, 1308, 1554, 1831
Canberra	Australian Capital Territory	1	1247
Darwin	Northern Territory	3	1191, 1242, 1256
Hobart	Tasmania	3	909, 1064, 1728
Melbourne	Victoria	2	1008, 1782
Perth	Western Australia	1	1310
Cairns	Queensland	0	
Broome	Western Australia	2	1712, 1737
Cobar	New South Wales	4	1308, 1336, 1547, 1608

average rate of 2.36 observed total eclipses from any given point in Australia over a 1000-year period is roughly consistent with the estimate of Steel (1999), or approximately one every 400–500 years. Assuming an average lifespan of 35 years (Prokopec et al., 1994), a total solar eclipse would be seen once in about every 14 lifetimes. Given this statistic, we would expect to find very few accounts of solar eclipses, either partial or total.

## 7.3 Aboriginal Stories of the Sun and Moon

In most Aboriginal cultures, the Sun is female and the Moon is male (Haynes, 1992: 130; Johnson, 1998), although this is not universal (e.g. see Meyer, 1846: 11–12). While the specific details vary between groups, many Aboriginal communities describe a dynamic between the Sun and Moon, typically involving one pursuing the other across the sky from day to day, occasionally meeting during an eclipse (Johnson, 1998:

129; Parker, 1905: 139–140; see next Section). Many stories explain why the Moon gets progressively ‘fatter’ as it waxes from new moon to full moon, then fades away to nothing as it wanes back to new moon. For example, the full moon is a fat, lazy man called Ngalindi to the Yolngu of Arnhem Land. His wives punish his laziness (or, in some versions, his breaking of taboos) by chopping off bits of him with their axes, causing the waning Moon. He manages to escape by climbing a tall tree to follow the Sun, but is mortally wounded, and dies (new moon). After remaining dead for three days, he rises again, growing fat and round (waxing Moon), until his wives attack him again in a cycle that repeats to this day (Hulley & Roberts, 1996: 53–56).

Because the lunar month is roughly the same length as the menstrual cycle, the Moon is sometimes associated with fertility, sexual intercourse, and child-bearing. In some communities, young women were warned about gazing at the Moon for fear of becoming pregnant (Haynes, 1997: 107). The Ngarrindjeri of Encounter Bay, South Australia, saw the Moon as a promiscuous woman (Meyer, 1846: 11–12) who became thin and wasted away (waning Moon) as a result of her numerous sexual encounters. When she became very thin (crescent moon), the creator being Nurrunderi ordered her to be driven away. She was gone for a short while (new moon), but began to eat nourishing roots, causing her to fatten again (waxing moon). A similar account is given by the nearby Jaralde people, except the waxing Moon represents the Moon-woman coming to term in pregnancy (Berndt et al., 1993: 232–233). Several other Aboriginal groups associate the Moon with love, fertility and intercourse, including the Kuku-Yalangi of the Bloomfield River, Queensland (McConnell, 1931) and the Lardil people of Mornington Island in the Gulf of Carpentaria (Isaacs, 1980: 163–166; Roughsey, 1971: 82–84; also see Johnson, 1998 and Fredrick, 2008: 102–104 for more examples).

The Moon and the Sun have a gravitational influence on the ocean, causing tides. Higher tides than normal (spring tides) occur when the Sun and Moon are aligned or opposed while lower tides than normal (neap tides) occur when the Sun and Moon are at 90° to the Earth, damping each other’s gravitational influence. Many coastal groups acknowledged the relationship between lunar phases and the ocean tides, including the connection between the spring tide and full moon. According to the Yolngu of Arnhem

Land and the Anindilyakwa of Groote Eylandt (Hulley, 1996), when the tides are high, the water fills the Moon as it rises at dawn and dusk (full and new moon, respectively). As the tides drop, the Moon empties (crescent) until the Moon is high in the sky during dusk or dawn, at which time the tides fall and the Moon runs out of water (first and last quarter). Warner (1937: 368) claims that

*“The Murngin [another name for the Yolngu of Arnhem Land] have a most accurate knowledge of the locational, seasonal, and daily variation of the tides. Anyone who has taken a canoe trip with them along the seacoast quickly learns that this knowledge is immense in detail, well organised, and held by all the men.”*

Warner subsequently describes the important role of the tides, Moon, and Sun in the Yolngu ceremonies and rituals. Tidal data from Milner Bay (Groote Eylandt) and Gove Harbour (Arnhem Land) show that semi-diurnal ranges reach their maximum during the period of full and new moon in coastal areas of the Northern Territory (see Figure 7.2).

In addition to describing the lunar phases and their relationship to tides, some Aboriginal groups identified that the Earth was finite in expanse. The Yolngu tell how the Sun–woman, Walu, lights a small fire each morning, which we see as the dawn (Wells, 1964). She decorates herself with red ochre, some of which spills onto the clouds, creating the red sunrise. She then lights her torch, made from a stringy–bark tree, and carries it across the sky from east to west, creating daylight. Upon reaching the western horizon, she extinguishes her torch and starts the long journey underground back to the morning camp in the east. When asked about this journey, a Yolngu man told Warner (1937: 328) that *“the Sun goes clear around the world”* and then illustrated this by “putting his hand over a box and under it and around again.” Smith (1970: 93) notes that some Aboriginal elders who studied the motions and positions of celestial objects seemed to know that the Earth was round, as a particular reference to a ‘day’ meant *“the Earth has turned itself about”*, although the degree of cultural influence by Westerners, if any, is uncertain.

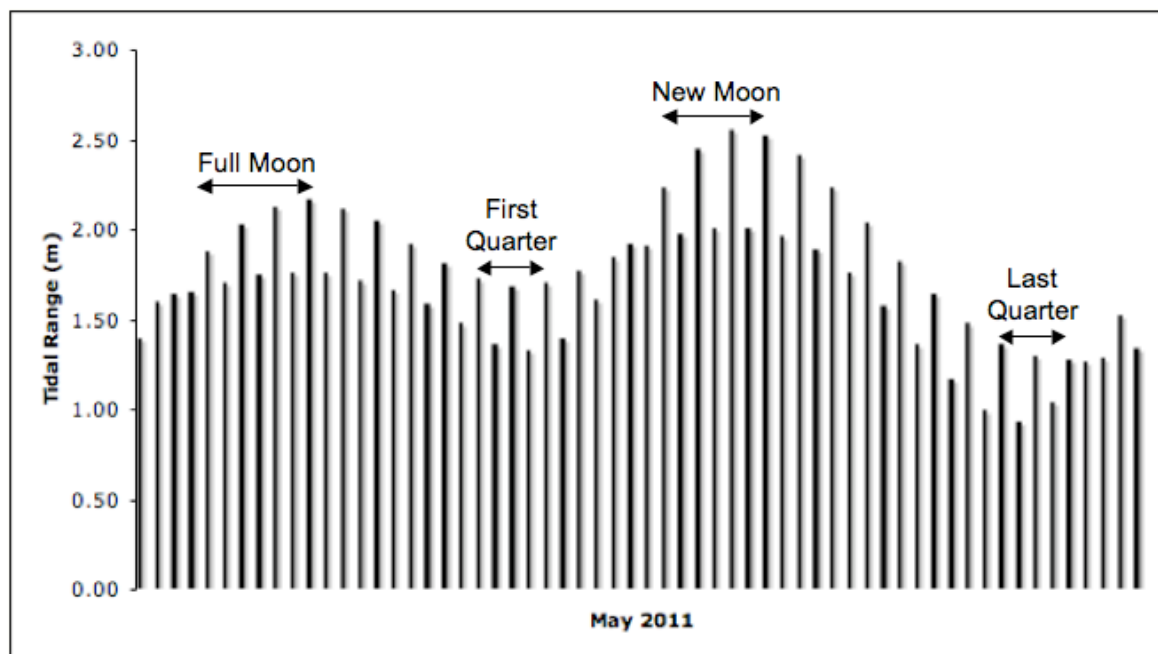


FIGURE 7.2: The tidal range (difference between high and low tide) over the course of May 2011 in Gove Harbour, eastern Arnhem Land, showing the data range that corresponds to particular lunar phases (indicating the day of and two days following). Data taken from Northern Territory Transport Group: Monthly tidal predictions for Northern Territory ports (2011): [www.nt.gov.au/transport/safety/marine/tides/ntports.shtml](http://www.nt.gov.au/transport/safety/marine/tides/ntports.shtml).

These accounts reveal that Aboriginal people were well aware of the motions of the Sun and Moon, and some coastal groups were aware of their connection with ocean tides. Understanding this relationship is a step towards determining the causes of eclipses.

## 7.4 Aboriginal Reactions to Eclipses

### 7.4.1 Solar Eclipses

Much like other transient celestial phenomena, such as comets and meteors (see the next three chapters), many Aboriginal groups held a negative view of solar eclipses. They could be a warning of a terrible calamity, an omen of death and disease, or a sign that someone was working black magic (Mudrooroo, 1994: 59; Wood, 1870: 94). According to colonist accounts, solar eclipses caused reactions of fear and anxiety to



many Aboriginal people, including those living near Ooldea, South Australia (Bates, 1944: 211), the Euahlayi of New South Wales (Parker, 1905: 139–140), the Yircla Meening of Eucla, Western Australia (Curr, 1886: 400), the Bindel of Townsville, Queensland (Morrill, 1964: 61), the Wirangu of Ceduna, South Australia (Bates, 1944: 211), the Ngadjuri of the Flinders Ranges, South Australia (Tindale, 1937b: 149–151), the Arrernte and Luritja of the Central Desert (Spencer & Gillen, 1899: 566; Strehlow, 1907: 19), the Kurnai of southeast Victoria (Massola, 1968a: 162), the people of Roebuck Bay, Western Australia (Peggs, 1903: 358, 360) and Erldunda, Northern Territory (Hill, 2002: 88). One colonist noted seeing Aboriginal people run under the cover of bushes in a fearful panic upon a solar eclipse (Curr, 1886: 400). In 1934, Aboriginal informants of the Mandjindja language in the Western Desert told Tindale (2005: 361–362) that they called a solar eclipse *Tindu korari*, an event they claim to have only seen once. They were struck with great fear at first, but were relieved when the eclipse passed with no harm having come to anyone. Tindale attributed this to an annular eclipse that occurred on 30 July 1916 (Event #1). The most recent annular eclipse visible from this region occurred 246 years earlier, while the most recent total solar eclipse occurred 1,082 years earlier, although four partial eclipses that covered more than 80% of the Sun's area were visible from this region between 1900 and 1934 (in 1900, 1905, 1915 and 1922). The specific eclipse the Mandjindja witnessed is uncertain, but the partial eclipse of 1916 is the best candidate, as it covered 89% of the Sun's surface.

To some Aboriginal communities of southeast Australia, the sky world was suspended above the heads of the people by trees, ropes, spirits, or magical means. In Euahlayi oral traditions, the Sun is a woman named *Yhi* who falls in love with the Moon man, *Bahloo* and pursues him across the sky. Bahloo has no interest in Yhi and constantly tries to avoid her. As the Sun and Moon move across the sky over the lunar cycle, Yhi chases Bahloo telling the spirits who hold the sky up that if they let him escape, she will cast down the spirit who sits in the sky holding the ends of the ropes and the sky-world will fall, hurling the world into everlasting darkness (Parker, 1905: 139–140).

To combat this omen of evil, some communities employed a brave and well-respected member of the community, such as a Clever Man or Elder, to use magical means to fight the evil of the eclipse. This typically included throwing sacred objects at the Sun whilst chanting a particular song or set of words. This practice was common to Aboriginal communities across Australia, including the Euahlayi, whose medicine men (*wirreenuns*) chanted a particular set of words (*ibid*) and the Ngadjuri who threw boomerangs in each cardinal direction to avert the evil (Tindale, 1937b: 149–151). Similarly, medicine men of Arrernte<sup>1</sup> and Pitjantjatjara communities would project sacred stones at the eclipsing Sun whilst chanting a particular song — always with success (Rose, 1957: 146–147; Spencer & Gillen, 1899: 566). The act of casting magical stones at the Sun strengthened the medicine man’s status in the community since he was always successful in bringing the Sun back from the darkness, averting the evil and saving the people. A nearly identical practice was performed in the event of a comet, which yielded the same result (see Chapter 8). Among the Wardaman of the Northern Territory, the head of the Sun-clan is a man named *Djinboon*. He can prevent or rescue the Earth from an eclipse of the Sun by magical means, or allow it to occur and frighten the people if laws are broken or if he does not receive the gifts he desires (Harney & Elkin, 1968: 167).

Hill (2002: 88) explains that the Aboriginal people near Erldunda, Northern Territory, reacted with a combination of fear and joy to a solar eclipse that occurred on 21 September 1922 (Event #2), with some calling out “*jackia jackia*” while others sang, in a fearful tone, the song “*You want to know what is my prize*”. However, not all Aboriginal communities viewed solar eclipses with fear, as the Aboriginal people of Beagle Bay, Western Australia, were apparently unafraid of solar eclipses (Peggs, 1903: 340–341).

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<sup>1</sup>Among the Arrernte (Anglicised as Aranda or Arunta), eclipses are caused by periodic visits of an evil spirit–magic called *Arungquilta* that takes up residence in the Sun. *Arungquilta* is also found in meteors and comets (see next two chapters).

### 7.4.2 Lunar Eclipses

Reactions to lunar eclipses are similar to those of solar eclipses. The Kurnai of Victoria saw a lunar eclipse as a signal that someone they knew on a journey had been killed (Massola, 1968a: 163). Similarly, Mudrooroo (1994: 58) explains that a lunar eclipse was an omen that someone on a journey had a serious accident, although he does not cite a specific Aboriginal group. The Ngarrindjeri near the mouth of the Murray River were fearful of the lunar eclipse of 13 August 1859 (Event #3), believing it to have been created by powerful Aboriginal sorcerers living beyond the European colonial areas (Clarke, 1997: 139; Taplin, 1859: 2 Sept 1859). Aboriginal people in the Wellington District of Queensland believed a lunar eclipse to be an omen of calamity to a distant relative and reacted with fear and sorrow (Lang, 1847: 460).

The perception that a lunar eclipse was an omen of death was shared by the Aboriginal people of Beagle Bay, Western Australia. During a lunar eclipse on 23 June 1899 (Event #4), an Aboriginal informant explained to Peggs (1903: 340–341) that the eclipse was an omen of death to a man — if the Moon is hungry and “wants to eat someone (a man)”, it becomes dark — but is uninterested in eating a woman<sup>2</sup>. On the same night, an Aboriginal man from a nearby community told Peggs that among his people, a lunar eclipse represented a man who had become sick.

A Wuradjeri account of a dying Clever Man is associated with what is possibly a partial lunar eclipse. As the man lay dying, 30 km away a corroboree was being held. When some of the people in the corroboree looked up at the Moon, they saw the man’s *warangun* (spirit) strike the Moon, followed by two dark patches that began to cover the Moon, which was high in the sky. The people in a corroboree stopped singing and dancing, realising that a lunar eclipse was an omen that someone had died. The next morning, they received the message that the Clever Man had died during the night. He had been lying on his back looking at the Moon when he died — at the exact moment the people in the corroboree saw the Moon go dark (Berndt, 1947/48: 83).

In western Queensland, a colonist at Wymullah Station on the Widgeewoggera

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<sup>2</sup>He also noted that if a child was born during a lunar eclipse, the child would be a boy.

River (McNeile, 1903) recounted a first-hand story about how he exploited a lunar eclipse to reclaim horses he believed were stolen by local Aboriginal people. One day, his horses disappeared and he had reason to believe it was a local group of Aboriginal people. After failing to locate the horses, McNeile approached an Aboriginal man named Jimmy, who requested a ransom of rum, tobacco and clothes in exchange for the location of the horses. Later that day, McNeile read in the local newspaper that a lunar eclipse was predicted to occur that night (20 December, year not given). Using the event to his advantage, McNeile told Jimmy that if he didn't reveal where the horses were, he would make the Moon disappear that night. And if they were not returned by the next morning, he would make the Sun disappear the next day — permanently. After being ignored by Jimmy, McNeile took a pair of bootjacks, went to the Aboriginal camp, and began dancing and chanting a song in Latin (which he improvised on the spot). As he did this, the people watched and laughed in amusement until the Moon began to go dark, which caused confusion and anxiety. As it reached full eclipse, panic struck the people at the camp and they began screaming and running into their huts. The next morning, he found his horses in a nearby small pen. Jimmy informed him that the “*Horses found themselves... You no put out big feller Sun now, boss? You leave 'm all right?*” (*ibid*: 68).

I attempted to identify a corresponding eclipse using Espenak & O’Byrne (2007b) from various vantage points across Queensland. I failed to identify any lunar eclipses on 20 December between 1800 and 1903 in any area of Queensland, suggesting the account was simply a fabricated story and not based on an actual event. The similarity of the eclipse story to Mark Twain’s novel “*A Connecticut Yankee in King Arthur’s Court*”, published just a few years earlier, in 1889, suggests that McNeile’s story is simply fiction<sup>3</sup>. Since the link seems fabricated, one may wonder why it is included at all? I include this as all accounts need to be recorded and analysed, even if they reveal themselves to be fiction.

Although many groups viewed lunar eclipses as bad omens, the Aboriginal people near Ooldea, South Australia, held no negative views of lunar eclipses, which they

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<sup>3</sup>Thanks to the anonymous reviewer of the published paper for making this connection.

called *pira korari*. They had witnessed one at Wynbring after colonists had built the Transcontinental Railway and paid little attention to it, according to Tindale (1934: 21–27). The Transcontinental (or Trans–Australian) Railway was completed in October 1917. In that year, there were three total lunar eclipses visible from this region, suggesting the men witnessed the eclipse on 28 December 1917, which was already eclipsing as it rose above the horizon (Event #5). The frequency of total lunar eclipses visible that year (on 8 January, 5 July, and 28 December) may explain why the event was downplayed by Tindale’s Aboriginal informants.

In hunter–gather societies, the sharing of food was essential for the survival of the community, and stealing or hoarding food is considered taboo. The Lardil of Mornington Island viewed the Moon as a greedy and selfish man who steals food and gorges, getting fatter (waxing Moon). As punishment for this action, he is cut into pieces, getting thinner (waning Moon) until he dies (new moon). The sudden and apparent “death” of the Moon during a lunar eclipse (McNight, 2005: xxii) served as a mnemonic and warning to younger generations about the Moon’s selfish nature, reinforcing the taboo of food theft and gluttony.

## 7.5 Causes of Eclipses: An Aboriginal Perspective

### 7.5.1 Solar Eclipses

The following accounts suggest that many Aboriginal groups had a firm understanding that during a solar eclipse, an object was covering the Sun, although many explanations were presented as to what that object was and why it covered the Sun. However, these explanations were dependent upon the person recording and translating these descriptions, who were nearly always non–Aboriginal people and were noted as a passing observation with little detail provided to the reader.

We first present cases where the people understood the Moon was the object covering the Sun. In Euahlayi culture, as discussed previously, the Sun woman, Yhi, is constantly pursuing the Moon man Bahloo, who has rejected her advances. Sometimes

Yhi eclipsed Bahloo, trying to kill him in a jealous rage. However, the spirits that held up the sky intervened and drove Yhi away from Bahloo (Parker, 1905: 139–140; Reed, 1965: 130). The Yolngu people of Elcho Island in Arnhem Land provided a similar, but less malevolent, explanation for a solar eclipse: it was an act of copulation between the Sun woman and Moon man (Warner, 1937: 538). The Wirangu of South Australia believed the solar eclipse on 21 September 1922 (Event #6) was caused by the hand of *maamu-waddi*, a spirit man that covered the Earth during the eclipse for the privacy of the Sun woman and Moon man while they were *guri-arra* — “husband and wife together” (Bates, 1944: 211). Near Eucla, South Australia, the Yircla Meening believed solar eclipses were caused by “the Meenings of the moon, who were sick, and in a bad frame of mind towards those of Yircla.” (Curr, 1886: 400)<sup>4</sup>. This account implies a link between the Moon and Sun during an eclipse, although the cause is not specifically stated. In these cases, it is clear the Aboriginal people understood that the Moon covered the Sun during the eclipse (except for the latter account which is ambiguous).

Such an understanding suggests that the Aboriginal group were aware of the Moon’s position in the sky through its various phases. Despite the fact that the Moon is essentially invisible for three days during the period of new moon, an observer who had been following the position of the Moon throughout the month would be able to predict its position during the new moon phase.

Among other communities, it is clear that the people understand *something* was covering the Sun during a solar eclipse, but attributed that “something” to various objects or actions, including a large black bird called tia by the Arrernte or spun possum fur by the Luritja (Strehlow, 1907: 19). To some Aboriginal groups in southwestern region of Western Australia, a solar eclipse is caused by *mulgarguttuk* (sorcerers) placing their *booka* (cloaks) over the Sun, while to some other groups they move hills and mountains to cover the Sun (Bates, 1985: 232). A similar view is held by Aboriginal people of the Central Desert who call a solar eclipse *bira waldurning* and claim it is made by a man (*waddingga*) covering the Sun with his hand or body (Bates, 1904–1912:

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<sup>4</sup>Yircla was the name of the community (Eucla) and also that of the Morning Star (Venus).

Notebook 6a, 74). During an eclipse of the Sun on 5 April 1856 (Event #7), a Bindel man told Morrill (1864: 61) that his son covered the Sun and caused the eclipse in order to frighten another person in the community. An earlier Arrernte account attributes a solar eclipse (*ilpuma*) to periodic visits of the evil spirit Arungquilta who takes up residence in the Sun, causing it to turn dark (Spencer & Gillen, 1899: 566). The Pitjantjatjara of the Central Desert believed that bad spirits made the Sun “dirty” during a solar eclipse (Rose, 1957: 146–147) while the Wardaman believed a solar eclipse was caused by an evil spirit swallowing the Sun (Harney & Elkin, 1968: 167). The Wheelman people of Bremer Bay, Western Australia, told Hassell & Davidson (1934: 234–236) a story about how one day the Sun and Moon fell, splitting the Earth in half. The lazy people were separated from the rest of the community to a place “on the other side of the Sun”. Sometimes they got bored and wanted to see what was happening back in this world. As they tipped the Sun on its side to have a peek, several of them would gather, blocking the Sun’s light, causing a solar eclipse. They only do this for a short time — just long enough for each of them to have a look, which explains why the eclipse does not last long. Hassell’s informant told her that “*Yhi (the sun) hide him face and Nunghar look down*” when storms come or the sky becomes dark in the daytime (solar eclipse). These accounts reveal an understanding that an object is covering the Sun during an eclipse, whether it is by natural or magical means, although the obscuration is not attributed to the Moon.

Not all causes of solar eclipses were attributed to an object covering the Sun. According to a community in Turner Point, Arnhem Land, a solar eclipse was caused when a sacred tree at a totemic site was damaged by fire or carelessness (Chaseling, 1957: 163). As such, sitting under the tree or even seeing it is reserved solely for initiated elders. One final account provides no insight to the cause of the eclipse, but provides an interesting example of how tangible and nearby some Aboriginal people thought the Sun to be. When astronomers in Goondiwindi, Queensland, were observing and recording the total solar eclipse of 21 September 1922 in order to test Einstein’s General Theory of Relativity, some Aboriginal people present thought the astronomers were trying to catch the Sun in a net (Menzel, 1949: 275, Event #8). Unfortunately,

Menzel gives no further information as to why the Aboriginal people thought this, or to their reactions during or after the eclipse.

### 7.5.2 Lunar Eclipses

I only found a few accounts describing the causes of lunar eclipses. Reed (1965: 130) describes the story (repeated by Johnson, 1998) that the Moon-man is constantly pursued by the Sun-woman and manages to avoid her advances most of the time. However, he is occasionally overtaken by the Sun-woman, signified by a lunar eclipse. Although Reed does not cite the Aboriginal group or location from which the story was taken, it is very similar to the Euahlayi account of a solar eclipse. The Arrernte believed a lunar eclipse was the result of the Moon man hiding his face behind the possum fur that he is constantly spinning, which is identical to the Luritja view of a solar eclipse (Strehlow, 1907). As with a solar eclipse, Aboriginal groups in the southwest region of Western Australia believe a lunar eclipse is caused by *mulgarguttuk* placing their cloaks or a hill or mountain over the Moon (Bates, 1985: 232). The Kayardild of Bentinck Island in the southern Gulf of Carpentaria believed the Moon was a man who used a net (halo of the Moon) to collect the souls of the recently-deceased during a lunar eclipse (*jawaaja*). As the net filled, the Moon-man would disappear, as if he himself had died, which prompted the people to hide under fig trees, fearful that the Moon would kill them. If the people did not seek shelter, they would be struck with *jiljawatha*, a sickness that induced crusted sores (Evans, 1995: 590–596). Róheim (1971: 53) suggests a Eucla Dreaming that describes a man ascending to the Milky Way who can only be seen when he “walks across the moon” may describe a lunar eclipse, showing an understanding that an ‘object’ (the earth’s shadow) covers the Moon during lunar eclipses.

The generally reddish colour of the Moon observed during a total lunar eclipse, as discussed in Section 7.2, is noted by some Aboriginal groups, including the Aboriginal people of the Clarence River, New South Wales, who thought a lunar eclipse revealed the Moon-man’s blood (Mathews, 1994: 60) and the Kurnai of Victoria who believed a red Moon signified that someone had been killed (Massola, 1968a: 162). The Lardil of



Mornington Island believe the Moon man's blood is visible during a total lunar eclipse, prompting elder people to shout out "*don't kill him!*" (McNight, 1999: 105). Strehlow (1907) notes that the Luritja believed the Moon sometimes goes into the graves of the recently dead and eats the entrails of the bodies. He then emerges into the sky, blood red in colour, so everyone can see what he has done. However, Strehlow claims this account has nothing to do with lunar eclipses but is instead referring to the new moon. The Moon can take on a reddish hue when it is low on the horizon, because the shorter wavelengths of light are reduced as they pass through the atmosphere at a low angle, allowing the longer wavelengths to dominate the colour.

In Ungarinyin culture of Western Australia an un-friendly medicine man causes the face of the Moon to be covered with blood, which greatly frightens the people (the text is unclear how this is done, but is presumably by some magical means). A friendly medicine man then ascends into the sky during a dream. Upon his return, he informs the people that he made the Moon "better" (Elkin, 1977: 126)<sup>5</sup>.

In the Maluililgal language of the western Torres Strait Islands, the term *Merlpal Mari Pathanu* means "*the ghost has taken the spirit of the moon*" (see Figure 7.3). It served as an omen of war, as told by Kallagawya artist David Bosun:

*"During this period, head-hunters prepared themselves for battle against their enemies, while the women in the other villages took their children and hid themselves in the bush away from their camps, safe from the attacking raiders."*

## 7.6 Dating Oral Traditions from Historic Eclipses

The age of a story that includes a description of a natural event may be estimated by identifying the date of that event. Tindale (1937b: 149–151) believed that a Ngadjuri story from Parachilna, South Australia, described a solar eclipse, which he dates to 1793. In the story, an elderly female being came from the northwest accompanied by

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<sup>5</sup>Although Elkin does not identify whether the heavenly object is the Sun or Moon, we interpret the account to refer to the Moon since the Moon turns red during a lunar eclipse.



FIGURE 7.3: *Merlpal Maru Pathanu*, a Torres Strait Islander interpretation of an eclipse. Painting by David Bosun (2007): [www.aboriginalartprints.com.au/works\\_enlargement.php?work\\_id=270](http://www.aboriginalartprints.com.au/works_enlargement.php?work_id=270).

two dingoes who behaved as men — one with reddish fur and the other with black fur. Two brothers, Wulkinara and Kudnu of the lizard totem, succeeded in killing the dingoes and burning the old woman. As a result, the Sun disappeared, causing fear among the people. Members of the community tried diligently to bring the Sun back from the darkness, but eventually collapsing, exhausted and in tears, and fell asleep. Kudnu awakened during the darkness and cast magic boomerangs into the sky in each of the cardinal directions. The first three — to the north, south, and west — failed, but the fourth, cast towards the east, was successful and the Sun appeared again.

Tindale attributes this event to a total solar eclipse that passed over Parachilna on 13 March 1793 (see Figure 7.4). Using Espenak & O’Byrne (2007a) and the Starry Night astronomical software package, I calculated that the solar eclipse that passed over Parachilna actually occurred a day earlier on 12 March 1793, and was a partial eclipse that covered  $\sim 93\%$  of the Sun’s area (Event #9a) with the path of totality passing over 200 km north of Parachilna, although Tindale may have considered what was visible from Parachilna as total. Tindale claims that any earlier (total) solar eclipses would have occurred prior to 1600. However, there was a total eclipse visible from Parachilna just eleven years earlier, on 7 October 1782 (Event #9b). Although there were no other total eclipses visible from Parachilna between 1701 and 1782, there were six other partial eclipses that covered 75% or more of the sun during that time. The most recent total solar eclipses prior to 1793, aside from the 1782 event and a few annular eclipses, were in 1608 and 1610. A better candidate for Tindale’s explanation would be the total solar eclipse in October 1782 that passed over Parachilna. As we are unclear of Tindale’s definition of a total eclipse, there will be some ambiguity in this interpretation. In areas where the 1793 total eclipse would have been visible, such as at Lake Eyre, the planet Mercury would have become clearly visible just  $1.5^\circ$  above the Sun during totality, but there is no mention of this in the account. However, the story described the woman as coming from the northwest and the 1793 eclipse was visible in the west–northwestern sky, while the 1782 eclipse was visible in the east–northeastern sky.

A problem arises with Tindale’s interpretation of this story as representing a solar eclipse: the story describes the people falling asleep while the Sun goes dark and waking sometime later with the Sun still dark. Under the best conditions, the Sun will remain in totality (completely covered) for no more than 7.5 minutes. The total duration of the 1782 eclipse was  $\sim 2.5$  hours, with totality lasting only  $\sim 2.5$  minutes. The people would have been in total darkness for only a couple of minutes — not long enough to exhaust oneself into sleep then wake sometime later with the world still in darkness. Another explanation would have been heavy cloud cover, although it seems unlikely people would react in such a fearful panic to mere clouds. In a later publication

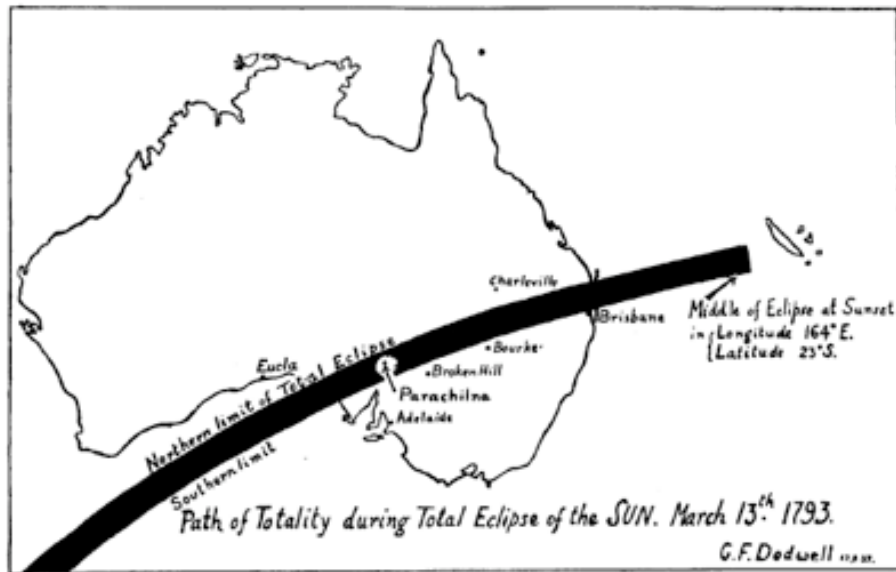


FIGURE 7.4: The path of a total solar eclipse that occurred on 12 March 1793 as calculated by Government Astronomer Mr. G.F. Dodwell that Norman Tindale believed was the source of an Aboriginal story about the sun becoming dark. In Tindale (1937b: 152), Dodwell's calculation was off by a day and the path of the total eclipse did not cover Parachilna but came close. A later account (Tindale & Lindsey, 1963: 96) cited the correct date of 13 March.

(Tindale & Lindsey, 1963: 96), he recounted the same story but with minor changes. In this account, the boomerangs were thrown one after the other with no rest-period. The boomerangs were thrown in each cardinal direction as mentioned above. When it was thrown to the east, the sunlight reemerged. This version is consistent with an eclipse (which also corrected the date of the event), but given these changes, it is uncertain how accurate it is to the original Aboriginal account.

## 7.7 Predicting Eclipses

To understand the cause of eclipses is to understand the relationship between the motions of the Sun and Moon over time. If these motions are understood with sufficient accuracy, an eclipse can be predicted in advance. However, the required accuracy is very high, requiring carefully-constructed instruments to make the required measurements. Eclipses can be reasonably predicted by understanding the Saros cycle, which is 223 synodic months long, or 6,585.3213 days (18 years 11 days). See Meeus (2004) for a

full description of the Saros cycle and the mechanics involved.

We found only one account that mentioned a prediction: Peggs (1903: 358, 360) presents letters written by her to C.J. Tabor whilst Peggs was living in Roebuck Bay, Western Australia, between 1898 and 1901. Peggs wrote “*We are to witness an eclipse of the sun next month. Strange! all the natives know about it; how, we cant imagine!*” (letter dated December 1899). Peggs asked a local Aboriginal woman named Mary about the eclipse, who responded “*Him go out all right*”. It is unclear from her account how she concluded that Mary had predicted the event — whether it was Mary’s comment or by some means not described in the letter. The comment by Mary, however, may have been misleading, as she may have merely been acknowledging what happens during an eclipse. Peggs later wrote:

*“The eclipse came off, to the fear of many of the natives. It was a glorious afternoon; I used smoked glasses, but could see with the naked eye quite distinctly. There seemed such a rosy hue surrounding the sun, at times changing to yellow. After a good deal of persuasion Jack convinced Mary to look through glasses, but she was half afraid.”*

Given that the letter was dated December 1899, I searched for any solar eclipses during this period. Between 1891 and 1900, only one solar eclipse was visible from this region, a partial eclipse that covered 76% of the Sun’s surface, which occurred on 22 November 1900 (Event #10).

Reasons for doubting the veracity of this story include the inconsistency in the dates and the lack of evidence that Aboriginal people made sub-arcminute precision measurements required for eclipse prediction (despite evidence elsewhere for Aboriginal astronomical alignments accurate to a few degrees, see Chapter 11).

## 7.8 Representations of Eclipses in Rock Art

Astronomical symbolism is found in Aboriginal rock art across Australia (see Norris & Hamacher, 2011). Ku-ring-gai Chase National Park, north of Sydney, is home to

a number of Aboriginal rock engravings, some of which depict crescent motifs (see Figure 7.5). Traditionally, archaeologists (e.g. McCarthy, 1983) refer to these motifs as boomerangs. However, it is possible that these shapes represent crescent Moons. An engraving at Basin Track in Ku-ring-gai Chase National Park depicts a man and woman, their arms and legs over-lapping, with a crescent shape above their heads. While other engravings depicting a man and woman partially superimposed are found in the region, with only their arms and legs intersecting (see McCarthy, 1983), the crescent above their heads is found only at Basin Track. In other cases, the male figure is holding a crescent in one hand and a fish or shield in the other and some engravings show a single figure with a crescent above the head. The meaning of these motifs is unclear, as few ethnographic records regarding these engravings and ceremonial sites exist. In the case of the Basin Track engraving, Norris & Norris (2008) speculated that the motif might represent the Moon-man obscuring the Sun-woman during a solar eclipse<sup>6</sup>. Near the man-woman is an engraving of a hermaphrodite figure, which could represent the Sun and Moon in full eclipse (John Clegg, personal communication, 2009).

If we speculate that this motif represents a solar eclipse as seen from that location in the direction of the engraving (i.e. a straight line from the feet of the figures through their heads and crescent, towards the horizon), the eclipse must occur near dawn, as the petroglyph faces  $55 \pm 5^\circ$  east of north. I examined solar eclipse events visible from the region in the nineteenth century using the Starry Night software package. One eclipse candidate occurred at dawn on 8 August 1831 ( $t_{start} = 06:45$ ,  $t_{max} = 07:03$ ,  $t_{end} = 08:13$ ), which covered  $\sim 85\%$  of the Sun's disk (Event #11). At mid-eclipse, the Sun closely resembles the crescent engraving, with the cusps of the crescent pointing downward (see Figure 7.6). The engraving aligns to the general direction the eclipse would have been visible from this location (between due east and  $45^\circ$  north-east). Unfortunately, we have no supporting ethnographic evidence and dating a rock engraving

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<sup>6</sup>While earlier illustrations of the engraving show the woman covering the man, the engraving itself is less clear. The engraving lines that comprise the arms and legs of the man and woman cross each other with no special reference to superposition.

is problematic, as engravings were typically re-grooved during ceremonies (Stanbury & Clegg, 1990). Therefore, this interpretation remains speculative.

## 7.9 Discussion

Given the low probability of witnessing a total solar eclipse in Australia, I expected to find very few accounts of total solar eclipses. And since a partial eclipse may pass without notice because of the Sun's intense brightness, we did not expect to find many accounts of partial eclipses, either. Of the four accounts that we can attribute to a specific solar eclipse, three of them are partial eclipses, with some obscuring as little as 75.7% of the sun's disk. I also find a number of Aboriginal words and descriptions of solar eclipses, despite our initial predictions. This shows that Aboriginal people did observe some total and partial eclipses and the memory of these events remained strong in many areas. I cannot attribute any partial eclipses that covered less than 75% of the sun's disk to oral traditions and would use this as an estimated lower limit to what people could reasonably notice, although observing the Sun even when 75% is eclipsed would still cause retinal damage. However, I acknowledge that other factors can reveal partial eclipses, such as image-projection by tree leaves acting as pinhole cameras (Figure 7.7), sufficient cloud-cover, or low-horizon partial eclipses where the intensity of the Sun's light is reduced.

The available data reveal that some Aboriginal groups explained the mechanics of the Sun–Earth–Moon system and the relationship of lunar phases to events on the Earth. The Yolngu people of Arnhem Land provide the most complete ethnographic evidence, in that their astronomical traditions explain that the Sun and Moon move in an east to west motion, the Moon goes through repeated phases that affect the ocean tides, the Earth is finite in space, and the Moon covers the Sun during a solar eclipse.

Particularly important are the accounts that Aboriginal people acknowledged that lunar eclipses were associated with the Sun (Johnson, 1998; Reed, 1965). It is not surprising that someone familiar with the relative motion of the Sun and Moon might notice that a solar eclipse occurs when the Moon is close to the Sun, and deduce that

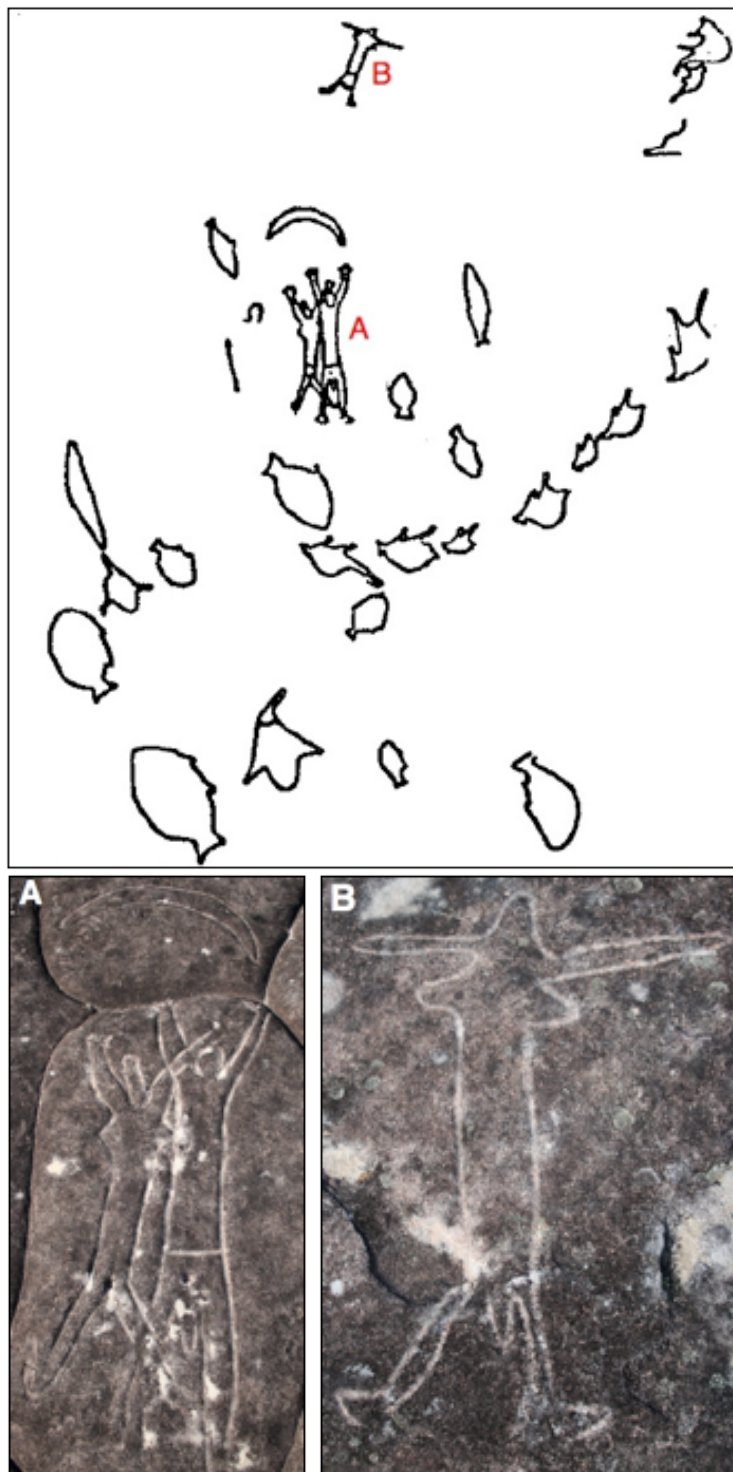


FIGURE 7.5: (A) Aboriginal rock engravings at the Basin Head Track, Kur-ring-gai Chase National Park, taken from Stanbury & Clegg (1990). (B) A photo of the man and woman engraving and (C) the hermaphrodite figure, by D.W. Hamacher (2010).



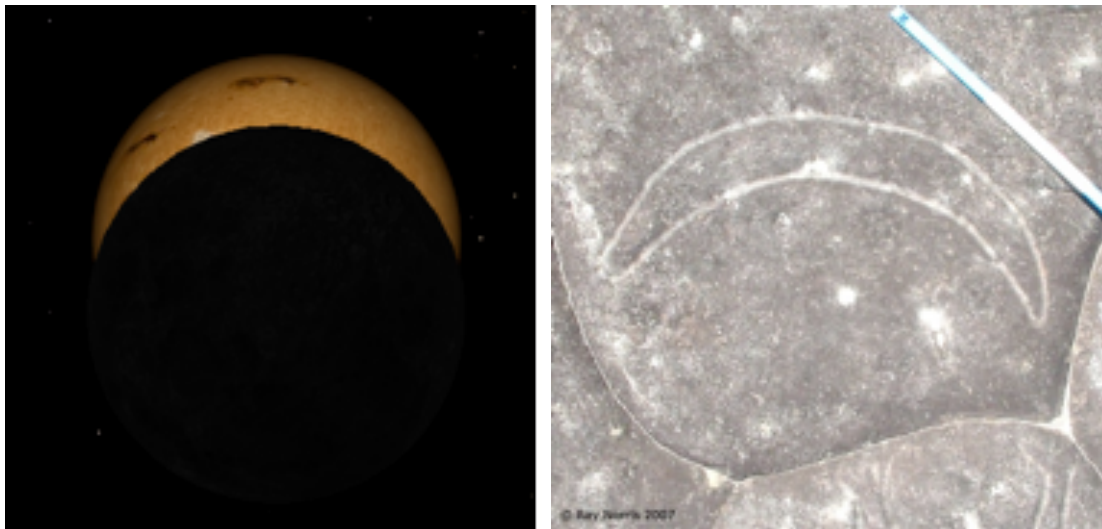


FIGURE 7.6: LEFT: A partial solar eclipse that occurred on 8 August 1831 as viewed from Kurring-gai Chase National Park just after 07:00 during mid-eclipse (Event #14). Image taken from Starry Night astronomical software package. RIGHT: The Basin Head Track engraving of a crescent shape above the heads of a man and woman who are partially superimposed, photo by Ray Norris (2007).

a solar eclipse was caused by the Moon. But it would be an impressive intellectual feat for an individual to recognise that a lunar eclipse was connected with the position of the Sun. It is therefore important to get further independent evidence of knowledge of this association from historical accounts, in order to corroborate the account by Reed.

While conducting ethnographic fieldwork in 2006, Norris & Norris (2008) were with a Yolngu ceremonial leader during a lunar eclipse. The leader (name withheld) told Norris that his clan had no oral tradition about the eclipse. However, it is possible that the leader did not want to share this information, as it may have been considered sacred and secret.

Overall, the cosmos is predictable, with most changes occurring gradually and slowly, such as the change in stellar positions over the night or throughout the year, the phases of the Moon, or the positions of the planets. The night sky served many important functions and roles within Aboriginal communities and unexpected transient phenomena, such as eclipses, are relatively rare. This is probably the reason that eclipses are met with reactions of fear and anxiety and why they are generally associated with negative attributes, such as death and disease — a reaction common to other



FIGURE 7.7: Tree leaves acting as pinholes on 3 October 2005 in St. Juliens, Malta, allowing one to observe a partial eclipse without looking directly at the Sun (image reproduced under Wikipedia Commons license).

unexpected transient phenomena, such as meteorite impacts, fireballs and comets (as will be shown in the following chapters).

Some interpretations presented in this chapter are solid examples of Aboriginal Astronomy in that they clearly display an understanding of the motions of the Sun and Moon and their relationship with eclipses, including those of the Yolngu, who had a clear understanding that the Moon covered the Sun during a solar eclipse. Other groups, such as the Wirangu and the Euahlayi, acknowledged that something was obscuring the Sun during a solar eclipse, although it is not clear whether they defined that object as the Moon.

Again, it is important to remember that many Aboriginal cultures were heavily damaged by colonisation, and a significant amount of pre-colonial knowledge about

celestial phenomena has been lost. Most of the records available in the literature are colonist accounts — few of which come from professional ethnographers. Given that Aboriginal societies are extremely complex and exist in a framework that is foreign to most Westerners, I acknowledge limitations in interpreting the available information, which is strongly influenced on the biases, interpretations, and legitimacy of the sources.

TABLE 7.2: Eclipses discussed in this paper are given in this table, which includes the event number (#), the date of the eclipse (DD/MM/YEAR), coordinates of the location where it was seen, the eclipse type T (S = solar, L = lunar) and sub-type ST (P = partial, T = total, A = annular), the percentage of the sun eclipsed (Obs, only for solar eclipses), and the time of maximum eclipse (t). Events 2, 6 and 8 are of the same eclipse seen from different locations. Times are calculated using Espenak & O’Byrne (2007a, 2007b) with the following time zone conversions: WA=UTC+8:00; NT/SA=UTC+9:00; QLD/NSW/VIC/TAS=UTC+10:00 (Eucla, WA=UTC+8:45). 9b – moon is rising during eclipse.

#	Date	Latitude	Longitude	T	ST	Obs	t
1	30/07/1916	27° 20' S	126° 10' E	S	A	89.1	09:46:19
2	21/09/1922	25° 11' S	133° 11' E	S	T	100	14:55:00
3	13/08/1859	34° 55' S	138° 35' E	L	T		02:04
4	23/06/1899	16° 58' S	122° 39' E	L	T		22:18
5	28/12/1917	30° 27' S	131° 50' E	L	T		18:46
6	21/09/1922	32° 07' S	133° 40' E	S	P	75.7	14:56:37
7	05/04/1856	19° 15' S	146° 49' E	S	P	91.9	17:05:31
8	21/09/1922	28° 33' S	150° 19' E	S	T	100	16:13:26
9 a	12/03/1793	31° 07' S	138° 23' E	S	P	92.9	15:58:26
b	07/10/1782	31° 07' S	138° 23' E	S	T	100	09:21:58
10	22/11/1900	18° 07' S	122° 16' E	S	P	0.76	17:13:47
11	08/08/1831	33° 52' S	151° 13' E	S	P	84.8	07:03:55
12	03/10/1819	13° 54' S	126° 18' E	L	T		23:13
13	12/05/1873	22° 20' S	131° 38' E	L	T		20:20
14	12/12/1871	18° 46' S	146° 33' E	S	P	79.1	15:12:53
15	28/09/1791	35° 10' S	117° 53' E	S	P	92.2	06:38:46

# 8

## Comets

*“He saw the comet, which he assured me was the harbinger of all kinds of calamities.”*

— Edward John Eyre (1845: 474–475).

In this chapter, I present 25 accounts of comets from 40 Australian Aboriginal communities, citing both supernatural perceptions of comets and historical accounts of Great Comets from various Aboriginal communities. Historical descriptions include the Great Comets of 1807, 1843, 1861, 1901, 1910, and 1927. I describe the perceptions of comets in Aboriginal societies and show that they are typically associated with fear, death, omens, malevolent spirits, and evil magic. I also provide a list of words for comets in 16 different Aboriginal languages on Table 8.1.

## 8.1 Introduction

*Cometography* is the study of comets from both from a scientific and historic perspective (Kronk, 2003). Recorded sightings of comets date back to the second century BCE, with the possibly earliest written recording of a comet by the Chinese in 1059 BCE (Yeomans & Kiang, 1981; Xu et al., 2000: 107–125). While historic accounts of comets and their role in mythology have been widely described in the literature (e.g. Baillie & McCafferty, 2005; Burnham, 2000; Donnelly, 2005; Kronk, 2003; Levy, 1994; Schechner, 1999), little research has been conducted regarding Aboriginal Australian accounts of comets. Ethnographic literature on Aboriginal communities reveals several perceptions of comets and accounts of historic comets. In some cases the comet is described but the author does not specify to which comet the account is referring (e.g. Morrill, 1864: 61; Roth, 1984: 8), although the description and dates provided allow us to identify the most probable comet to which the account is referring. In other cases, perceptions of a comet are described, but do not correspond to any particular one. The description of the object, combined with the dates of the event, allow us to identify the particular comet discussed, providing a more complete historical account.

This chapter analyses various Aboriginal perceptions of comets as well as descriptions of historic bright comets, including C/1843 D1, C/1844 Y1, C/1861 J1, C/1901 G1, 1P/1909 R1, C/1910 A1, and C/1927 X1. I begin by introducing the reader to basic information about comets as a celestial phenomenon. I then present my data collection methods and describe the various perceptions of comets, then dividing up identifiable comets by the date of the recorded account.

## 8.2 Comets

The term ‘*comet*’ comes from the Latin ‘*cometes*’, which is derived from the Greek word ‘*komē*’, meaning “hair of the head”. Comets, which consist of dust, ice, frozen gas, and rocky particles, range in size from a few kilometres to tens of kilometres, and orbit the Sun. Short period comets ( $P < 200$  years) are believed to originate in the

Kuiper Belt beyond the orbit of Neptune while long period comets ( $P < 200$  years) are believed to originate in the Oort cloud, a spherical region extending nearly a light-year into space. Far from the sun, a comet consists only of a solid body, called the nucleus, appearing much like an asteroid. As it nears the sun, solar radiation evaporates the ice and frozen gasses, ejecting them into the surrounding space. This creates a halo of heated gas called the coma, which is then blown by solar wind in the direction opposite the sun, creating a large dust tail. For large comets with a diameter larger than 50 km, the coma can be larger than the sun with a dust tail extending over 150 million km in length<sup>1</sup>. Short period comets typically orbit the sun until the nucleus has evaporated. About 90% of short period comets will evaporate after approximately 50 cycles (Whitman et al., 2006). Some comets break apart because of tidal forces from large solar system objects, such as planets or the sun, such as Comet Shoemaker-Levy which broke apart and struck Jupiter in 1994. Some long period comets may pass through the inner solar system only once before they are ejected into interstellar space. Comets can appear in the skies during the day or night, depending on their brightness, and may be visible from weeks to months. Brighter comets (greater than magnitude +2) are generally deemed “Great Comets”, although there is no official definition (see Table 8.2).

Comets and meteors are often conflated. For example, the Spanish words for comet and meteor are ‘*cometa*’ and ‘*meteoro*’, respectively. Despite this, the word *cometa* is preferred by rural Mexicans to describe both phenomena (Köhler, 1989: 289). In some Australian Aboriginal languages, the word for comet and meteor are reported to be the same, such as *nilgoolerburda* in the Bindel language of northern Queensland (Morrill, 1864: 61) and *binnar* in an unspecified Western Australian language (Moore, 1842: 126, 145). In some cases, the description of one seems to indicate the other. The Yolngu word for meteor, *ngarrpiya*, is also the word for octopus (Lowe, 2004: 116). Octopi do not generally resemble meteors, but do resemble multi-tailed comets. This is probably the result of the linguist or anthropologist confusing the two phenomena

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<sup>1</sup>D.K. Yeomans (2005). *Comet*. World Book Online Reference Center, World Book, Inc: [www.worldbookonline.com/wb/Article?id=ar125580](http://www.worldbookonline.com/wb/Article?id=ar125580)

or a language translation error<sup>2</sup>. Tindale (2005: 376) categorises comets and fireballs (bright meteors) together, despite them being different phenomena, though he only discusses the former. Haynes (2000: 86) describes comets as flaming spears hurled across the heavens by a celestial Pitjantjatjara being named *Wurluru*. Comets, unlike meteors, are not fiery and do not “fly” across the sky – they appear as “fuzzy stars” that slowly and gradually brighten, move across the sky, and fade away from night to night over a period of weeks to months. To some Arrernte clans, a comet was a sign that a person in a neighbouring community had died with the tail pointing to the direction of the deceased (Spencer & Gillen, 1899: 549). A nearly identical description is given by Piddington (1932: 394) about the Karadjeri of coastal Western Australia, but is attributed to the trajectory of meteors instead of the tails of comets. In this chapter, I note instances where confusion arises and identify the likely phenomenon that is being described.

### 8.3 Methodology & Results

The available literature was surveyed, as discussed in Section 2.3, for references to comets or descriptions that may refer to comets but do not explicitly identify them as such. 41 accounts were collected, including sixteen Aboriginal words for comets (see Table 8.1), representing 40 Aboriginal groups from all Australian states except Tasmania (eight each from Victoria, Queensland and the Northern Territory, seven from Western Australia, six from South Australia, and four from New South Wales).

Historically, visible comets are identified by the date and or description of the account. In some cases, the identification is clear, while in other cases, the identification is inferred and should not be considered definitive. We must stress that Indigenous views and accounts of comets are not homogeneous or unchanging over time. It is common for a particular celestial object or phenomena to have different views among members of the community, and these views are dynamic and changing. It is therefore essential to understand that the accounts provided in this paper simply reference the

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<sup>2</sup>There are cases, however, of multi-tailed meteors, so this conclusion is not definitive.



community from which they came, and do not imply that everyone within the same community or language group had the same view, reaction, or association with comets. Statements such as “The [Aboriginal group] saw comets as [...]” are used only to denote the Aboriginal group or geographic area from which the account was taken.

## 8.4 Aboriginal Perceptions of Comets

When Westerners began studying Aboriginal communities in the early 1800s, they noted that the Aboriginal people viewed extraordinary or unusual natural events with great dread (e.g. Eyre, 1845: 358–359; Palmer, 1884: 294). The unexpected arrival of a bright comet often triggered fear and was associated with death, spirits, or omens — a view held by various cultures around the world (e.g. Andrews, 2004; Bobrowsky & Rickman, 2007; McCafferty & Baillie, 2005). Such views include those of the Tanganekald of South Australia who perceived comets as omens of sickness and death (Tindale, n.d.), the Mycoolon of Queensland who greeted comets with fear (Palmer, 1884: 294), the Kaurna of Adelaide who believed that the Sun father, called Teendo Yerle, had a pair of evil celestial sisters who were “long” and probably represented comets (Clarke, 1997: 129; Schurmann, 1839) and the Euahlayi of New South Wales saw comets as evil spirits that drank the rain–clouds causing drought<sup>3</sup>, with the cometary tail representing a large thirsty family that drew the river into the clouds (Parker, 1905: 99). The Moporr clan of Victoria described a comet as *Puurt Kuurnuuk* — a great spirit (Dawson, 1881: 101), while the Gundidjmara of Victoria saw a comet as an omen that lots of people will die (Howitt & Stahle, 1881). Aboriginal people in the Talbot District of Victoria likened comets (called *Koonk cutrine too*) to smoke, where *too* means “to smoke” (Smyth, 1878: 200). This is similar to a report from Cape York Peninsula,

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<sup>3</sup>It is unclear if this view was due to the coincidental arrival of a comet before or during a major drought. One candidate is the Great Comet of 1825 (C/1825 N1), which was visible from late August until the end of December 1825. From 1826–1829, a severe drought hit New South Wales, causing Lake George and the Darling River to completely dry up (Shaw, 1984). Another possible candidate (of many) was the Great Southern Comet of 1880 (C/1880 C1), visible in the evening skies in February (Kirkwood, 1880; Morris, 1880), which preceded a significant drought in New South Wales.

where an Aboriginal community saw a comet as the smoke of a campfire (Roth, 1984: 8). Similarly, the Aboriginal people of Bentinck Island in the Gulf of Carpentaria called a comet *burwaduwwuru*, which means “testicle with smoke” (Evans, 1992: 196).

A common view among Aboriginal communities of the Central Desert links comets to spears (e.g. Spencer, 1928: 409). A Pitjantjatjara man named Peter Kunari (Anon, 1986: 20) described comets as the manifestation of a being named *Wurluru* who lived in the sky and carried spears that he occasionally threw across the heavens (a possible reference to meteors?). A similar association is shared by the Kaitish, which is discussed further in Section 8.5.4. The Rainbow Serpent, a much feared evil spirit found in The Dreamings of many Aboriginal groups, was sometimes associated with comets (e.g. Healy, 1978: 194)<sup>4</sup>. Trezise (1993: 107) speculated that the origins of the Rainbow Serpent lay in transits of Halley’s Comet, which was seen every 75–76 years, reinforcing stories handed down by Kuku–Yalanji law-carriers and custodians of the Bloomfield River, Queensland.

Spencer & Gillen (1899: 550; 1904: 627–628; 1927: 415–417) describe a form of evil magic called *Arungquilta* (as mentioned in the previous chapter), which involved meteors and produced comets and was used to punish unfaithful wives in Arunta communities. If a woman ran away from her husband, he would summon men from his group and a medicine man to perform a ceremony intended to punish her. In the ceremony, a pictogram of the woman was drawn in the dirt in a secluded area while the men chanted a particular song. A piece of bark, representing the woman’s spirit, was impaled with a series of small spears endowed with *Arungquilta* and flung into the direction of where they believed the woman to be, which would appear in the sky as a comet (bundle of spears). The *Arungquilta* would find the woman and deprive her of her fat. After the emaciated woman died, her spirit appeared in the sky as a meteor. Strehlow (1907: 30) cites a nearly identical ceremony, which is discussed further in the next chapter. However, in Strehlow’s account, the man felt pity for his wife and decided

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<sup>4</sup>Additional information regarding the evil of comets can be found in Barker (n.d.) at the Australian Institute for Aboriginal and Torres Strait Islander Studies in Canberra. This item is under restricted access and cannot be copied or quoted (Fredrick, 2008: 105).

to revive her by rubbing fat into her body. As she healed, the comet faded from view. In some Arrernte and Luritja communities, comets are spears thrown by an ancestral hero to make his wife obedient to him (*ibid*: 30). To some Arrernte clans, a comet was also a sign that a person in a neighboring community had died, usually because of infidelity, and pointed to the direction of the deceased (Spencer & Gillen, 1899: 549). A similar description is given by Piddington (1932: 394) about the Karadjeri of coastal Western Australia, but is instead attributed to meteors. Given the two accounts by Spencer & Gillen of the same ceremony, it is possible they are confusing comets with meteors.



FIGURE 8.1: A rock painting at ‘Comet Rock’ near Kalumburu, Western Australia. Taken from Bryant (2001).

A direct association between comets and death is highlighted by a story from the Kimberleys of a great flood that was brought on by a “star with trails” called *Kallowa Anggnal Kude* (Mowaljarlai & Malnic, 1993: 194). Bryant (2001; see, also Bryant et al., 2007: 210–211) contends that this account is a description of a comet impact in the Indian Ocean off the northwest coast of Western Australia, which he speculates caused a massive tsunami that devastated the region. Bryant speculates that the “star with

trails“ is depicted in a rock painting (Figure 8.1) at a place called ‘Comet Rock’ near Kalumburu, Western Australia (home to Wunambal and Kwini speakers), which lies on a plain 5 km from the sea that is covered in a layer of beach sand (see Section 10.5.3).

## 8.5 Historic Visible Comets

Between 1800 and 2000, about forty naked-eye comets were visible (Table 8.2) from Australia, or on average one every five years. So one could say that naked eye comets are not particularly rare, and this is reflected in the fact that some of the literature and ethnographic accounts relating to Aboriginal astronomy do not simply describe perceptions of comets but refer to particular historic comets, including the Great (bright) Comets of 1843, 1861, 1901, 1910, 1927, and Comet Halley. In some cases, the comet is not identified by name, but is inferred from the description and date. Details of each comet observation or description are presented below.

### 8.5.1 C/1843 D1 (Great March Comet of 1843)

The Great Comet of 1843 (C/1843 D1) was a bright, sun-grazing comet visible in the Southern skies from late-February to mid-April. It was visible near the Sun (within  $1^\circ$ ) and became brightest on 7 March (see Kronk, 2003: 129; Sekanina & Chodas, 2008). The comet, so frightening in its brilliance (see Figure 8.2), prompted Aboriginal people near Port Lincoln (South Australia) to run and hide in caves (Schurmann, 1846: 242). The Ngarrindjeri of South Australia saw the comet as a harbinger of calamity, specifically to the white colonists. They believed the comet would destroy Adelaide then travel up the Murray causing havoc in its path, as described by Eyre (1845: 358–359)<sup>5</sup>:

*“In March 1843, I had a little boy living with me [in Moorunde, SA] by his father’s permission, whilst the old man went up the river with the other natives to hunt and fish. On the evening of the 2nd of March a large comet*

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<sup>5</sup>Johnson (1998: 49) mistakenly attributes this account to the Great Comet of 1811.

*was visible to the westward, and became brighter and more distinct every succeeding night. On the 5th I had a visit from the father of the little boy who was living with me, to demand his son; he had come down the river post haste for that purpose, as soon as he saw the comet, which he assured me was the harbinger of all kinds of calamities, and more especially to the white people. It was to overthrow Adelaide, destroy all Europeans and their houses, and then taking a course up the Murray, and past the Rufus [the site of an Aboriginal massacre], do irreparable damage to whatever or whoever came in its way. It was sent, he said, by the northern natives, who were powerful sorcerers, and to revenge the confinement of one of the principal men of their tribe, who was then in Adelaide gaol, charged with assaulting a shepherd; and he urged me by all means to hurry off to town as quickly as I could, to procure the man's release, so that if possible the evil might be averted. No explanation gave him the least satisfaction, he was in such a state of apprehension and excitement, and he finally marched off with the little boy, saying, that although by no means safe even with him, yet he would be in less danger than if left with me."*

Le Souef (in Smyth, 1878: 296) recounted events that took place when the Great Comet of 1843 was seen in Victoria (specific location not identified). When it was first seen, it caused "dreadful commotion and consternation" among the communities. "Spokesmen [presumably Elders or medicine men] gesticulated and speechified far into the night" in an attempt to rid the comet, but with no success. When their actions seemed in vain, they packed up camp in the middle of the night and moved to the other side of the river and remained huddled together until morning. They believed that the comet had been sent to them by the Aboriginal people near Ovens River in northern Victoria to cause harm. They left the area and did not return until the comet faded away. Aboriginal people near Kilmore (Victoria) told Curr (1886: 50) that the tail of this 'grand comet' consisted of spears thrown by Aboriginal people near Goulburn to

one another<sup>6</sup>.



FIGURE 8.2: The Great Comet of 1843 (C/1843 D1) as seen from Tasmania (Van Diemen's Land). Painting by Mary Morton Allport (1806–1895). Reproduced from Wikimedia Commons under Creative Commons License.

### 8.5.2 C/1844 Y2 (Great Comet of 1844)

There were no Aboriginal accounts of this comet in the reviewed literature. However, the explorer Ludwig Leichhardt saw a comet in the sky on 29 December 1844 while walking along the banks of a creek in central Queensland (Lang, 1847: 315), prompting him to name the site Comet Creek. The town of Comet in Queensland (originally Cometville) takes its name from this creek (now called Comet River). See Edwards (1994) for further details.

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<sup>6</sup>Curr stated that he recalled the event in 1842 although the only bright comet visible over the years prior to and following 1842 was in 1843.

### 8.5.3 C/1861 N1 (Comet Tebbutt)

After surviving the shipwreck of the *Peruvian* in the Great Barrier Reef in 1846, four members of the crew reached Cleveland Bay on the coast of Queensland near present-day Townsville. One of the survivors, James Morrill, lived among the local Aboriginal people for 17 years, publishing his journals in 1864 (Morrill, 1864). He notes how the Aboriginal people used the same word for comets and stars (*nilgoolerburda*) and explains that comets were believed to be the spirits of men killed far away returning home, making their way from the clouds to the horizon. He described seeing a comet during the previous dry season (June to November) and noted that the Aboriginal people thought it was “one of the tribe who had been killed in war” (*ibid*: 61). Morrill does not give a date for this sighting, but does go on to say that he witnessed a nearly total solar eclipse about six years earlier. From 1846 to 1864, only two “nearly total” solar eclipses (where the Moon covered  $> 80\%$  of the Sun) were visible from this region: on 5 April 1856 and 18 September 1857 (Figure 8.3). Both of these eclipses happened around the same time of day (after 5 pm). This gives a period of approximately five years between the eclipse and the comet sighting, revealing the best candidate is the Great Comet of 1861 (C/1861 J1 Tebbutt), which is depicted in Figure 8.4 as the Earth was about to pass through its tail.



FIGURE 8.3: Nearly total solar eclipses between 1846–1864 that were used to identify the comet described by Morrill (1864). **Left** – Eclipse on 05 April 1856. **Right** – Eclipse on 18 Sept 1857. Both eclipses are shown at the time of maximum coverage as seen from Cleveland Bay, Queensland, Australia using the Starry Night astronomy software package.

This comet was discovered by the Windsor-based Australian amateur astronomer,



John Tebbutt, and from Australia was visible as a conspicuous naked eye object from mid-May through to near the end of June, during the dry season (see Kronk, 2003: 293; Orchiston, 1998a; 1998b), which implies that Morrill's account was recorded in 1862. This comet had a distinctive tail that at its best extended  $42^\circ$ , and the comet appeared brightly in the northern sky throughout June as the Earth approached its tail (see Ellery, 1861; Raynard, 1872; Scott, 1861). The Aboriginal people told Morrill the comet was a spirit coming down from the clouds onto the horizon (Morrill, 1864: 61).

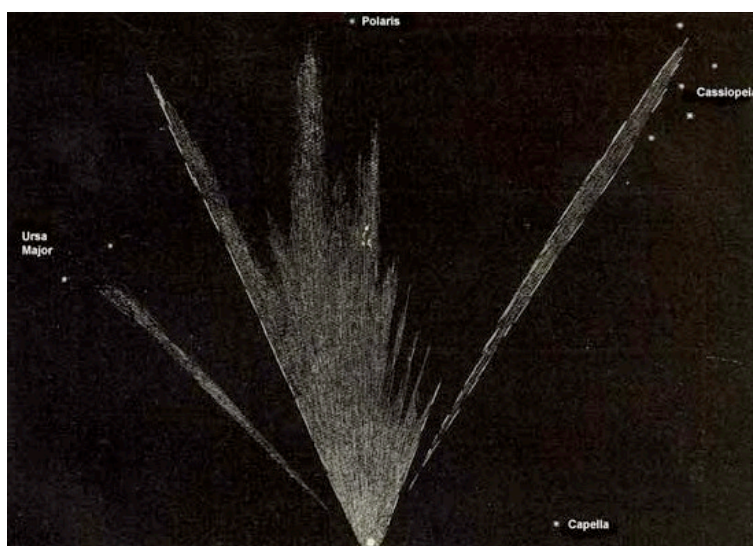


FIGURE 8.4: Williams' drawing of C/1861 (Tebbutt) made on 30 June 1861, just after the Earth passed through its tail. By this time it was a very conspicuous object but was only visible to Northern Hemisphere observers (after Chambers, 1889: 465).

#### 8.5.4 C/1901 G1 (Comet Viscara)

While engaging in ethnographic fieldwork in Queensland from 1901 to 1908, anthropologist and *Northern Protector of Aborigines*, Walter E. Roth (1984: 8), noted that the Tjungundji people near Mapoon (Marpuna) on the western coast of Cape York Peninsula saw a comet as a fire lit by two old women. This was probably a reference to the recent Great Comet of 1901, which was visible exclusively in the Southern skies from mid-April to late-May and displayed distinctive, bright twin tails (Gill,





FIGURE 8.5: The Great Comet of 1901 with bright twin tails, taken from the Royal Observatory, Cape of Good Hope. Image courtesy of the Royal Observatory, Cape of Good Hope, South Africa.

1901; Tebbutt, 1901; see Figure 8.5). In early May, when it reached peak brightness, the comet transversed the boundary between Taurus and Eridanus. The head of the comet, of magnitude 0 on 3 May and +2 on 6 May, would have appeared in the western evening skies near the horizon with the twin tails, comprising a  $30^\circ$  straight tail and a  $10^\circ$  curved tail, pointing upwards towards the star Sirius. By 12 May, the longer tail extended to the star  $\delta$  Leporis (Kronk 2007: 10–14)<sup>7</sup>. At this time, the comet would have looked very much like two smoke columns diverging from a single point on the horizon. The comet remained visible until 23 May with the tails increasing in length to  $45^\circ$  and  $15^\circ$ , respectively (Bortle, 1997).

The Kaitish of the Northern Territory believed a comet was a bundle of spears belonging to a star endowed with a very strong magic. The people feared these spears would be thrown to Earth, killing many. Spencer & Gillen (1904: 629; 1912: 327)

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<sup>7</sup>see also: The great comet of 1901 – *The Observatory*, Vol. 24, p. 297.

describe a bright comet visible during their stay in 1901, which is probably a reference to C/1901 G1. To avert the evil of the comet, a young, celebrated medicine man named Ilpailurkna was visiting the area from the neighboring Unmatjera clan. Each night he would project his magic stones towards the comet. As the comet faded away, its evil was overcome and the people were very grateful that Ilpailurkna had saved them<sup>8</sup>. In the eyes of the community, had Ilpailurkna not driven the comet away, it would have fallen to Earth as a bundle of spears and everyone would have been killed (*ibid*: 630).

### 8.5.5 C/1910 A1 (Great Daylight Comet of 1910)

In 1910, the world awaited the return of the famous Comet 1P/Halley in May. However, the unexpected arrival of a bright comet in mid-January created much fear and awe (e.g. Burnham, 2000: 184)<sup>9</sup>. Deemed the Great Daylight Comet of 1910 (see Figure 8.6), it was bright enough to be seen during the day and at its peak, was brighter than Venus. It began to fade away in early February, followed a few months later by the arrival of the fainter, but still significant, Comet Halley (Kronk, 2007: 170–179). When Comet Halley returned in 1986, many of the older people around the world who recalled seeing it in 1910 had clearly described the Great Daylight Comet of 1910 and not Halley (*ibid*)<sup>10</sup>.

In 1985 Jack Butler, a Jiwarli man from the Henry River in Western Australia, told of a “star with a tail in the east” he saw early in the year 1910 as a child (Butler & Austin, 1986: 85–88). The comet caused fear among the elder men who “questioned what it was”. When the comet faded away the men were confused and wondered

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<sup>8</sup>A similar description of medicine men throwing magical stones at a comet to drive it away is given by Hambly (1936: 23).

<sup>9</sup>*Not much is known of daylight comet; Greenwich Astronomer Thinks It Has Never Been Seen Before and May Never Be Again.* Special Cable to the New York Times, Sunday, 30 January 1910.

<sup>10</sup>There are no reported Aboriginal accounts of the 1986 return of Comet Halley found in the literature. However, the comet was adopted as the logo for the Arnhem Land Progress Aboriginal Corporation (FAQ webpage: “What is the ALPA logo?” [www.alpa.asn.au/pages/FAQ](http://www.alpa.asn.au/pages/FAQ)). Comet Halley’s return is also featured in Aboriginal artwork and literature, including Brogus Nelson Tjakamurra’s painting *Halley’s Comet* (1986) and Sam Watson’s novel *The Kadaitcha Sung* (1990).



FIGURE 8.6: The Great Daylight Comet of 1910 appeared just four months before Comet Halley but was brighter than Venus at its peak (image rotated clockwise by  $90^\circ$ ). Photograph from Lowell Observatory, reproduced from Wikimedia Commons under Creative Commons License.

where it had gone. According to Butler, the object he saw in 1910 was Comet Halley. However, the Great Daylight Comet of 1910 was prominent in the morning twilight, consistent with the “star with a tail in the east” visible early in the year. Therefore, it is probable that Butler was describing the Great Daylight Comet of 1910 rather than Comet Halley<sup>11</sup>.

### 8.5.6 C/1927 X1 (Comet Skjellerup–Maristany)

Paddy Roe, a Nyigina elder, told of the appearance of a comet in the early twentieth century by an Aboriginal community on the Roebuck Plains west of Broome, Western Australia (Duwell & Dixon, 1994: 80). The comet, which he described as “a star with a tail”, was seen as a bad omen. However, after nothing bad happened the community held a celebratory corroboree. Roe states that the comet was first seen during the “new

<sup>11</sup>During the joint University of California–Los Angeles/University of Adelaide Expedition to north-western Australia (1953–1955), Tindale (2005: 377) explained how researchers used Comet Halley as an indicator of age for more mature Aboriginal informants. While using either Comet Halley or the Great Comet of 1910 would have been sufficient for their study, it is probable that the informants’ descriptions were of the January comet.

moon when the moon was a crescent” (this refers to the time after a new Moon when the Moon appears as a thin crescent). These accounts date to the period “between the Wars”, presumably referring to World Wars I and II (between 1918 and 1939). The best candidate is the Great Comet of 1927 (see Figure 8.7), discovered on 4 December 1927 by the Australian amateur astronomer John Francis Skjellerup when it was a third magnitude object with a  $1^\circ$  tail (although others claimed to have discovered it on 28 November 1927; see Orchiston, 1999). The comet, first detected in the Southern Hemisphere, was visible primarily during the day and early evening. By the time it was visible at night, it faded rapidly. Since the comet was near the solar disc but could still be seen during the day, the sighting of Comet Skjellerup–Maristany is consistent with being seen at the time of a new Moon (the day it was claimed to have first been discovered, 28 November 1927, was just after new Moon, see Makemson, 1928; Seargent, 2009: 147–148), although this identification is uncertain.



FIGURE 8.7: Drawing of Comet Skjellerup-Maristany by R.A. McIntosh, 5 December 1927. Image reproduced courtesy of Wayne Orchiston.

## 8.6 Discussion & Conclusion

The relatively sudden and effectively unpredictable nature of comets (that is, unpredictable without making detailed observations over long periods of time) are the likely driving force behind their generally negative views not only among Aboriginal Australians, but among most cultures of the world (see Ridpath, 1985). Of the 25 accounts given in this paper, all but two were attributed to negative concepts, namely fear, bad omens, death, malevolent spirits or evil magic. This is consistent with global views of comets (e.g. Ridpath, 1985; Yeomans, 1991). The only non-negative views of comets likened them to smoke (Bobrowsky & Rickman, 2007; Evans, 1992: 196; Roth, 1984: 8; Smyth, 1878: 200), a view shared by some Maori tribes of New Zealand, who called some comets *Auahiroa* or *Auahi-turoa*, from the words *auahi*, meaning ‘smoke’, and *roa*, meaning ‘long’ (see Best, 1922; Orchiston, 2000) and by the Aztecs of Mesoamerica who called comets *citlalipopoca*, meaning ‘star that smokes’ (Aveni, 1980: 27).

It is unclear whether comets had always been viewed with fear or whether this fear was triggered by a coincidental catastrophic event. Clearly, some accounts establish a perceived link between the appearance of a comet and unrelated malign events, such as drought (e.g. Parker, 1905: 99), death or disease (e.g. Howitt & Stahle, 1881; Spencer & Gillen, 1899: 549; Tindale, n.d.), the presence of a hostile enemy (e.g. Morrill, 1864: 61), or a natural disaster (e.g. Mowaljarlai & Malnic, 1993: 194) — views shared by many cultures of the world (e.g. Andrews, 2004: 111–121; Köhler, 1989: 292)<sup>12</sup>. While scientists now know that comets are responsible for a percentage of destructive

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<sup>12</sup>Throughout history, people have tried to make a connection between passing comets and destructive events (e.g. Gadbury, 1665), including disease outbreaks (e.g. Bobrowsky & Rickman, 2007: their Chapter 5) and natural disasters (Bryant, 2001). Comet impacts may have caused environmental change in the past, creating poor environmental conditions where starvation and the spread of disease were more rampant. Others (e.g. Wickramasinghe et al., 2004) have speculated that cometary debris contains microbial bacteria, referred to as *Panspermia*, which seeded life on Earth and may be responsible for disease epidemics, such as SARS and the Bubonic Plague. This hypothesis has met substantial criticism (c.f. Vaidya, 2009) and is not generally accepted by the scientific community. Scientists, however, more generally accept the hypothesis that particular amino acids and water were brought to Earth via comets, and later evolved into life.

exploding meteors (see Napier & Asher, 2009)<sup>13</sup> and cosmic impacts (see Bobrowsky & Rickman, 2007), there is no evidence to link comets with disease outbreaks.

Most recorded views of comets indicate that the people who saw them were surprised. Although comets are not seen as frequently as other transient celestial phenomenon (such as meteors), they do make an appearance every few years. Total solar eclipses occur less frequently than comets, but appear as a reoccurring phenomenon in the oral traditions of many Aboriginal communities (e.g. Bates, 1944; Johnson, 1998; Norris & Hamacher, 2009; Warner, 1937). However, there are few accounts of comets in oral traditions (at least to the extent that they can be easily identified as such) and I am curious as to why this is the case. Additionally, the Morrill account reveals that people could notice partial eclipses, at least in cases where a majority of the sun was covered ( $> 80\%$ ).

Are there accounts of comets that we have failed to recognise? Some of these accounts may be found in the form of rock art, such as motifs found in rock engravings of the Sydney region, including the Bulgandry figure near Woy Woy, New South Wales (see Figure 8.8). If the objects held by Bulgandry represent the Sun and crescent Moon (e.g. Norris & Norris, 2008), then one may speculate that his ‘hair’ actually represents a comet. The hair or headdress of some culture heroes, such as Daramulan (McCarthy, 1989), has a similar appearance to comets and have been described by Elkin (1949: 131) as representing spears, suggesting a possible parallel with the communities from the Northern Territory that associate comets with spears. Numerous other examples of similar motifs are found in rock art of the Sydney region. Future work will involve looking into the possibility that these engravings represent comets, but any connection at present is speculation.

Although nearly all of the descriptions in this paper are second-hand Western accounts of Aboriginal perceptions of comets, these accounts provide an important

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<sup>13</sup>Although the composition of the 1908 Tunguska (Napier & Asher, 2009), 1930 Curuçá (Bailey et al., 1995), and 1935 Guyana (Steel, 1996) bolides has not been well established, they all occurred when the Earth passed through major meteoroid streams, which are produced by the dust tails of passing comets.

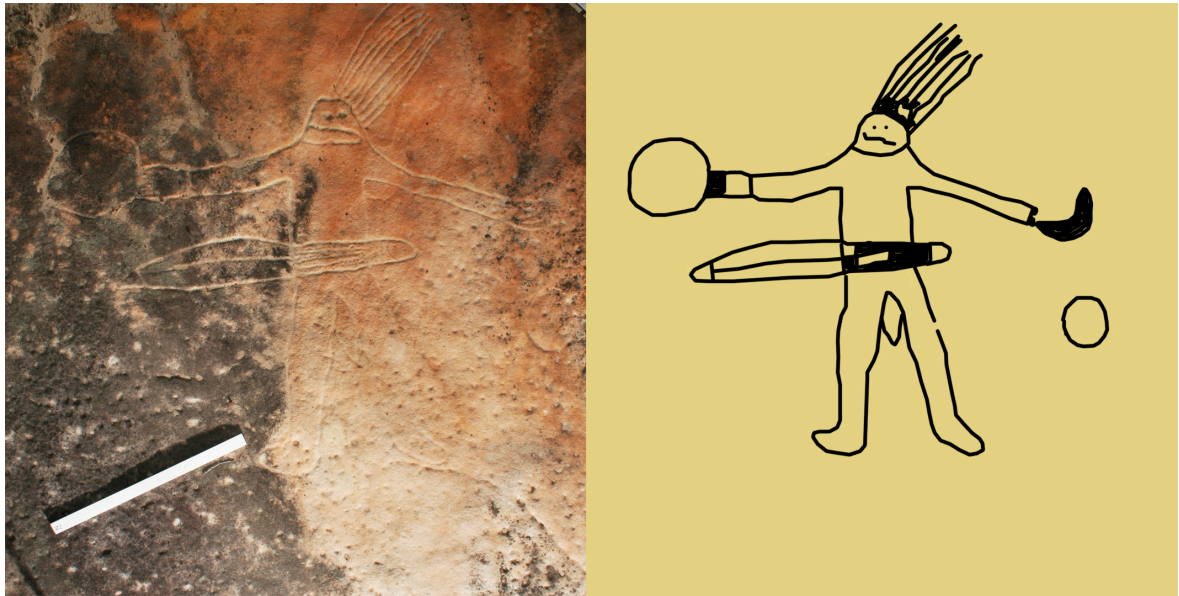


FIGURE 8.8: **Left** –The Bulgandry petroglyph near Woy-Woy, NSW (photo by Ray Norris). **Right** – Bulgandry drawing by W.D. Campbell in 1893.

historical record of Great Comets from an Aboriginal perspective. I conclude that comets are frequently associated with spears due to the comet's appearance resembling a bundle of spears, and that perceptions of comets amongst Aboriginal societies were usually associated with fear, death, omens, malevolent spirits, and evil magic, due to their awe-inspiring and relatively unexpected nature, consistent with many cultures around the world. I attribute their generally negative views to their unpredictable and significant appearance in an otherwise well-ordered cosmos. However, I remain puzzled by the fact that nearly all accounts are from colonial times, with few accounts in the recorded oral tradition and no apparent trace of comets in pre-colonial Aboriginal art.

TABLE 8.1: List of Aboriginal terms for Comets. Djadjawurung are from the Talbot District, Victoria (language group name not specified in text). Language group taken from the AIATSIS map of Aboriginal Languages. Kwini and Wunambal have the same word for a comet. The word Binnar is also used to denote a meteor.

Group	State	Term	Source
Bindal	QLD	Nilgoolerburda	Morrill (1864: 61,62)
Boiwoorarng	VIC	Jajowerong	Smyth (1878: 177)
Gumbaybggirr	NSW	Gumugan	Morelli (2008: 160)
Gunditjmarra	VIC	Puurt Kuurnuuk	Dawson (1881: 101)
Kayardild	QLD	Burwaduwuru	Evans (1992: 196)
Kwini	WA	Kallowa Anggnal Kude	Mowaljarlai & Malnic (1993: 194)
Ngiyampaa	NSW	Yangki (Halley)	Thieberger & McGregor (1983: 2.8)
Parnkalla	SA	Yandarri	Schurmann (1844: 79)
Pitjantjatjara	NT	Wuuluru	Goddard (1992: 202)
Djadjawurung	VIC	Koonk cutrine too	Smyth (1878: 200)
Wiradjuri	NSW	Muma	SALC <sup>a</sup>
Yarra Yarra	VIC	Bullarto tutbyrum	Smyth (1878: 136)
Yolngu	WA	Ngarrpiya	Lowe (2004: 116)
Unspecified	WA	Binnar	Moore (1842: 126)
Unspecified	VIC	Boiwoorarng	Smyth (1878: 162)

<sup>a</sup>Sydney Aboriginal Languages & Computing: [www.salc.org.au](http://www.salc.org.au)



TABLE 8.2: Naked Eye Comets that attained brightness greater than magnitude +2 recorded between 1800 and 2000, taken from Seargent (2009). Information regarding the Great Comet of 1844–1845 was taken from Bond (1850). When Comet Halley passed in 1986, it reached a maximum brightness of only +2.6 in early March. Therefore, the appearance of Comet Halley in 1986 is not included. <sup>a</sup>These comets possessed two or more distinctive tails visible to the naked eye.

Year	Common Name	Designation	Duration Visible
1807	Great Comet of 1807 <sup>a</sup>	C/1807 R1	Early Sep to Late Dec
1811	Great Comet of 1811	C/1811 F1	Late Mar to Jan
1819	Great Comet of 1819	C/1819 N1	Month of Jul
1825	Comet Pons	C/1825 N1	Late Aug to Late Dec
1830	Great Comet of 1830	C/1830 F1	Mid Mar to Mid May
1831	Great Comet of 1831	C/1831 A1	Month of Jan
1835	Comet Halley	1P/1835 P1	Late Sep to Mid Feb
1843	Great Comet of 1843	C/1843 D1	Early Feb to Mid Apr
1844	Comet Wilmot	C/1844 Y2	Mid Dec to Late Jan
1847	Comet Hind	C/1847 C1	Late Feb to Late Mar
1853	Comet Klinkerfues	C/1853 L1	Early Aug to Early Oct
1854	Great Comet of 1854	C/1854 F1	Late Mar to Mid Apr
1858	Comet Donati	C/1858 L1	Mid Aug to Late Nov
1860	Great Comet of 1860	C/1860 M1	Mid Jun to Late Jul
1861	Comet Tebbutt	C/1861 N1	Mid May to Mid Aug
1874	Comet Coggia	C/1874 H1	Early Jun to Late Aug
1880	Great Comet of 1880	C/1880 C1	Early to Mid Feb
1881	Great Comet of 1881	C/1881 K1	Late May to Late Jul
1882	Comet Wells	C/1882 F1	Late May to Early Jul
1882	Great Comet of 1882	C/1882 R1	Early Sep to Early Feb
1887	Great Comet of 1887	C/1887 B1	Mid to Late Jan

Year	Common Name	Designation	Duration Visible
1901	Comet Viscaraa	C/1901 G1	Mid Apr to Late May
1910	Great Comet of 1910	C/1910 A1	Mid Jan to Mid Feb
1910	Comet Halley	1P/1909 R1	Late Apr to Mid Jul
1911	Comet Belajawsky	C/1911 S3	Late Sep to Late Oct
1911	Comet Brooks	C/1911 O1	Late Aug to Late Nov
1927	Comet Skjellerup–Maristany	C/1927 X1	Late Nov to Early Jan
1941	Comet de Kock–Paraskevopoulos	C/1941 B2	Mid Jan to Late Feb
1947	Southern Comet of 1947	C/1947 X1	Early to Late Dec
1948	Eclipse Comet of 1948	C/1948 V1	Early Nov to Late Dec
1956	Comet Arend-Roland	C/1956 R1	Mid Mar to Mid May
1957	Comet Mrkos <sup>a</sup>	C/1957 P1	Late Jul to Late Sep
1961	Comet Wilson–Hubbard	C/1961 O1	Late Jul to Early Aug
1962	Comet Seki–Lines	C/1962 C1	Late Feb to Late Apr
1965	Comet Ikeya–Seki	C/1965 S1	Early Oct to Mid Nov
1969	Comet Bennett	C/1969 Y1	Mid Feb to Mid May
1970	Comet White–Ortiz–Bolelli	C/1970 K1	Mid May to Early Jun
1973	Comet Kohoutek	C/1973 E1	Late Nov to Late Jan
1976	Comet West	C/1975 V1	Late Feb to Mid Apr
1996	Comet Hyakutake	C/1996 B2	Early Mar to Early Jun
1997	Comet Hale–Bopp	C/1995 O1	Jul 1996 to Oct 1997

# 9

## Meteors

*“Going straight through the middle of Poojoorroona Gap, Tjidara is alight,  
flashing like a meteor”*

— Willy Cooper-Kalliguru

(Von Brandenstein & Thomas, 1974: 3)

In this chapter, I present a comprehensive analysis of Australian Aboriginal accounts of meteors. Accounts of meteors are to be expected, as they are a rather frequent phenomena. However, a proper analysis should reveal if a number of other characteristics were noted, including colour, sound, direction, brightness, and the re-occurrence of meteor showers. This analysis will also reveal how Aboriginal people perceived meteors and what role they played in the laws and traditions of Indigenous groups.

## 9.1 Introduction

The history of meteoritics as a scientific discipline has been studied extensively (e.g. McCall et al., 2006) and incorporates the observations and records of meteoritic phenomena by various cultures around the world (e.g. Burke, 1986; Zanda & Rotaru, 2001). The cultural impact of meteoritic phenomena has been studied more extensively recently as researchers gain a better understanding of the frequency and hazardous effects of cosmic impacts (Melosh, 1989; Cepplecha, 1992; Rabinowitz, 1992; Gehrels, 1994; Steel, 1995; Lewis, 1999). The discovery by Alvarez et al. (1980) that a cosmic impact may have been responsible for the demise of the dinosaurs highlighted the potential dangers of cosmic debris. When comet Shoemaker–Levy 9 fragmented and slammed into Jupiter in 1994 (Levy et al., 1995), researchers and the public were alerted to the destruction such an event could inflict on our planet, as well as on our species. Funding for surveys of Near Earth Objects, such as the Spaceguard Project in the 1990s (Steel, 1997), increased and the subject became more prominent in politics (see Remo, 1997, 1999). While this attention served to funnel more research into the scientific study of meteoritics, it focused little on the cultural and anthropological study of meteoritics.

I define Cultural Meteoritics as the study of the influence of meteoritic phenomena and material (including comets, meteors, meteorites, tektites, and cosmic impacts) on society, which itself is a branch of *Geomythology* (which will be discussed in the next chapter). Geomythology includes human interaction with meteoritic material and the role of meteoritic phenomena in art, religion, music, ritual, and mythology. While some researchers have addressed this topic (Brown, 1975; Bevan & Bindon, 1996; Olson & Pasachoff, 1999; Bobrowsky & Rickman, 2007), the *Meteor Beliefs Project*, sponsored by the International Meteor Organization, is the first large scale, peer-reviewed study of Cultural Meteoritics.

A majority of the Meteor Beliefs Project, to date, has focused on European views of meteors. In order to fill a gap in the literature, we present the first comprehensive

study of the perceptions and descriptions of meteors by Aboriginal Australians. Previously, Baker (1957) and Edwards (1966) focused extensively on the use of australites (Australian tektites) in Aboriginal cultures, while Bevan & Bindon (1996) were the first to address the Aboriginal use and transport of meteorites, but placed less focus on meteors.

## 9.2 Terminology

A chunk of natural debris floating in space, ranging in diameter from 100  $\mu\text{m}$  to 10 m, is called a meteoroid. Objects larger than 10 m diameter are considered asteroids. If the meteoroid enters the earth's atmosphere, it heats up, creating a visible streak called a meteor (from the Greek "*meteōros*", meaning "high in the air", sometimes called a "falling star" or "shooting star"). Meteors vary in brightness and visible duration, but are typically faint and are seen for less than a second. Using the International Meteor Organization definition, meteors brighter than or equal to  $-3$  at zenith are called fireballs. Although the term bolide is often synonymous with fireball, the International Astronomical Union has no official definition. Belton (2004: 156) defines a bolide (from the Greek "*bolis*", meaning "missile" or "flash") as a fireball with a brightness greater than  $-14$  at zenith. The U.S. Geological Survey defines a bolide as a generic crater-forming extraterrestrial body, while astronomers generally regard bolides as exceptionally bright fireballs or exploding meteors. In this paper, we define a bolide as an exploding or audible meteor. Because bolides generally explode in the upper atmosphere (mesosphere), the sound from a bolide is usually heard a few seconds after it is seen — something noted by several Aboriginal groups. Some non-exploding meteors can also make "hissing" or "crackling sounds (see Burdick, 2002)<sup>1</sup>, which is another characteristic noted by many Aboriginal groups. These sounds (as we discuss later) are often an important component of the story or account. Bolides are so significant that the Djaru even designate a special name for one: *gulungurru* (Goldsmith, 2000: 32).

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<sup>1</sup>C. Riley. Sound of shooting stars. *BBC News*, 21 April 1999.

If the meteor survives the trip to the ground, it is considered a meteorite. If the meteorite is of sufficient size (usually tens of meters or more), it will excavate an impact crater. For very large impacts, molten terrestrial material heated from the impact will be ejected into the atmosphere, cooling and falling to earth as black or dark green objects known as tektites (from the Greek “*tektos*”, meaning “molten”, see Faul, 1966). Meteor showers occur when multiple meteors appear to radiate from a single point in the sky. Although this is an optical illusion since the paths of the meteors are actually parallel, annual meteor showers are named after the constellation from which the meteors appear to radiate (e.g. *Leonids* from Leo, *Perseids* from Perseus, etc.). Meteor showers are the result of the earth passing through the dust tail of a passing comet. A comet (from the Latin “*cometes*”, originally from the Greek “*komē*”, meaning “hair of the head”) is a solar system object composed of ice and dust that is bigger than a meteoroid. Comets originate in the Kuiper Belt past Neptune as well as the Oort cloud, a shell of cometary debris that extends nearly a light year into space. As a comet nears the sun, solar radiation heats up the ice and dust, releasing gas and vapour into the surrounding space. This produces a coma with the gas and vapour trailing away from the sun, forming a tail.

I provide 63 Aboriginal words for meteors in Table 9.1, representing Aboriginal groups from all states of Australia (some groups have more than one word for meteors).

### 9.3 Methodology

I reviewed the available literature for any references to meteoritic phenomena (including “falling” or “shooting” stars) in Aboriginal culture. As noted in Chapter 2, these sources included ethnographic and historical data, Dreaming stories and songs, anecdotes, and archaeological data. Sources came in the form of books, magazine and journal articles, manuscripts, art forms, media sources, reputable web-sources, and postgraduate theses.

Statements such as “*The [Aboriginal group] see meteors as [...]*” are intended only to denote the Aboriginal group from which the story or account was taken and does not

necessarily represent the views of that entire group at all times in the past. In many cases, several different views or accounts of particular meteoritic phenomena may be found within a single Aboriginal community.

## 9.4 Results & Analysis

The search produced 229 original references, including  $\sim 150$  references to meteors. Of the data regarding only meteors,  $\sim 97$  Aboriginal groups were represented. The data revealed major themes in the perceptions of meteors, the most prominent being an association with death, spirits, or omens. Not all views are negative, as some groups see meteors as benevolent spirits or good omens. Here, they are broken down by theme.

### 9.4.1 Meteors as Benevolent Spirits

#### Spirits of the Deceased

The most common association between meteors and death is that they represent spirits, either good or evil. In many cases, meteors represent the benevolent spirits of important individuals, such as with the Worora, Ngarinyin and Wunambal peoples of the Kimberleys (Blundell & Woolagoodja, 2005: 41) and the Euahlayi of New South Wales (Parker, 1905: 91), while other times the sight of a meteor simply tells the people that “*an old blackfella has fallen down there*” (Smyth, 1878: 309), a reference to the deceased man’s spirit (star) falling from the sky. Meteors signifying someone had died was a view shared by the Aboriginal peoples of the Kimberleys (Kaberry, 1935/36: 38; Piddington, 1932: 394), Kuku–Yalanji of Queensland (Oates, 1993: 78–79), Dieri of South Australia (Elkin, 1937: 289), Kuninjkun of Arnhem Land (Taylor, 1996: 189–190), Kurnai of the Gippsland region of Victoria (Massola, 1968a: 163), Wardaman of the Northern Territory (Yidumduma Harney, 2009) and Wik–Munkan of Cape York Peninsula (McConnell, 1930/31: 183). If a meteor was seen, followed by a large crash, the Euahlayi and Narran of New South Wales believed a great medicine man had died (Parker, 1905: 91; Parker, 1978: 148). A meteor could signify the action of a spirit,

such as with the Aboriginal people near the Pennefather River, Queensland who saw a falling star as the spirit of a woman pouring water over yams to help them grow (Roth, 1984: 8). According to the Gunditjmarra near Port Fairy, Victoria, a haunted cave is believed to connect Julia Percy Island with the mainland. When a person dies, the body is wrapped in grass and buried. If grass is found at the mouth of the cave, it is proof that a benevolent spirit, called *Puit puit chepetch*, has removed the body through the cave to the island and has conveyed its spirit to the clouds. If a meteor is seen at the same time, it is believed to be fire taken up with the spirit (Dawson, 1881: 51–52). If a Yerrunthully person (central Queensland) dies, they climb to the sky on a rope. When they reach the top, they drop the rope, which is seen as a meteor. If the meteor makes a booming noise (explodes), it is the sound of the rope hitting the ground (Palmer, 1884: 292). A meteor can also signify that a person has been dropped as part of a game (Palmer, 1886: 174).

### Meteors as Flesh

Some groups believed that a deceased person's flesh could transform into a star or vice-versa, which sometimes relates to meteors. An Aboriginal group on the Lyne River in the Kimberleys believed that when a person died, their flesh became a star (Kaberry, 1935/36: 38–39), while Andedja and Yeidji peoples believed this only applied to a Barumannari (a medicine man or clever man). To the Yijji of the Lyne River, when a female Barumannari dies, she takes her child into the sky where their flesh becomes a star (*ibid*). Wotjobaluk of Victoria saw a meteor as the falling heart of a man that has been caught by a Bangal (medicine man) and deprived of his fat (Howitt, 1904: 368–369). The Yir–Yoront of Cape York Peninsula believe that when a man dies, his spirit becomes a star, with a transformation accompanied by a meteor (Sharp, 1934/35: 34). The Karadjeri describe the night sky as a dome composed of a hard substance, such as rock or shell, with the stars representing the spirits of the dead (Piddington, 1932: 394). One view is that stars are nautilus shells with living fish inside of them. A meteor is the dead fish dropping from its shell (*ibid*). Another view is that meteors represented chunks of flesh falling from a tree where the culture hero Marela was placed when he



died (*ibid*) . When a Wardaman person dies, their spirit goes up and passes through a hole in the sky, which we see as the star Garndarin (Spica). While in the sky, the spirit appears as a star and is looked after by the Rock–Cod star Munin (Arcturus). The spirit then falls back to Earth as a shooting star, falling into the streams where the Rock–Cod looks after it again. Eventually the spirit finds its mother-to-be, and enters her to be reincarnated as a baby (Yidumduma Harney<sup>2</sup>).

### Spirits Returning Home

To some Aboriginal groups, a meteor signified that the spirit of a person who died far from their home was returning to their home country, such as Yarralin (aka Walangeri) of the Northern Territory (Rose, 1992: 70), Nungubuyu of Arnhem Land (Harney, 1944: 74–75, 79, 163), Yintjingga of Cape York Peninsula (Montagu, 1974: 155), Arunta of central Australia, and Kukata and Narrinyerri of South Australia (Basedow, 1925: 296). This view was not confined only to the deceased. The Yolngu of Arnhem Land saw a meteor as a message that a living relative had arrived home safely (Wells, 1964: 42, 59).

#### 9.4.2 Meteors as Malevolent Spirits

Many Aboriginal groups associate meteors with evil spirits or magic, such as the Ngarindjeri of South Australia (Smith, 1970: 136). To several groups in the Northern Territory, meteors are the glowing eyes of evil spirit beings (typically serpents) that hunt for the souls of the sick and dying. These beings include the ghoulish Papinjuwari from the Tiwi of Bathurst and Melville Islands (Mountford, 1958: 144–146), the clawed Namorrorddo from the Kuninjku of Arnhem Land (Taylor, 1996: 189–190, see Figure 9.1), the one-eyed Indada from the Badaya and Gurudara peoples (Berndt & Berndt, 1989: 25–27), and the serpentine Thuwathu from the Lardil of the Wellesley Islands, who call meteors “*kuwa thungal*”, meaning “eye thing” (McNight, 2005:

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<sup>2</sup>*Message Stick — Before Galileo*. ABC Indigenous program, aired Sunday 1 November 2009 on ABC1. Ray Norris has a Wajuk account from Perth describing the relationship between meteors and children, but is currently unable to contact him to obtain permission to share this information.

209). Like Thuwathu, the Luritja and Arrernte of the Central Desert view meteors as the fiery eyes of celestial serpents that drop into deep waterholes (Strehlow, 1907: 30). Similarly, the Western and Eastern Aranda compare serpents' eyes to bright stars (Róheim, 1945: 183). According to the Tiwi, when time began, spirits of falling stars (probably the Papinjuwari) searched with blazing eyes for living things to devour. To hide and protect babies from the eyes of evil meteor spirits, an old Tiwi woman named *Mudungkala* placed the infants in a string bag tied around her neck (Allen, 1975: 89). David Blanasì elaborates on the evil of shooting star spirits<sup>3</sup>:



FIGURE 9.1: Namorrorddo is a malevolent spirit that manifests itself as a fiery meteor. The long claws are used to grab the souls of people and hearts of children, after which he speeds across the sky as a meteor. Bark painting “Figure with long fingers” (1960) by Arnhem Land artist Samuel Manggudja (1909–1983). Reproduced with permission, courtesy of Anthony Wallis © Aboriginal Artists Agency, 2009.

*“Namorrodor is a shooting star spirit. These spirits are evil. They are known to take babies from mothers. They go for the heart. This one is male. He carries with him a stone axe, for making lightning or cutting a tree in half, and a business bag with powerful magic in it. This is what he uses on his victims. The large object on the left-hand side is a large fighting stick (miyawul). The loincloth that he is wearing is the same as people used to wear — it covers the front part of the body. It is called djorrkkon and is made from possum fur and string from the budbud tree. The large fingers*

<sup>3</sup>See image at end of chapter: Namorrodor - shooting star spirit. Djilpin Arts Aboriginal Corporation: [www.djilpinarts.org.au](http://www.djilpinarts.org.au).

*of this spirit are for taking hearts out of the babies, and the long arms and legs allow him to move through the air faster. He also makes a sound like the thunder when flying through the air. This is a Yirritja painting,”*

The Boorong people of northwest Victoria saw a meteor as the evil being, *Porke-longtoute*, who would portend evil to men that have lost a front tooth (initiated men, Stanbridge, 1858: 140). This is in contrast to the Gunson (1974: 50) description from the Aboriginal people near Sugarloaf Mountain, outside Newcastle, NSW of an evil meteor-being named *Puttikan* that would kill and eat men that did not have a missing front tooth (non-initiated men). The Mara people tell of an unfriendly celestial father-son pair called *Minungara*. If a man is sick, the son will come to earth as a falling star to see how close the man is to death. If he is “close-up dead”, the father will come down and suck the blood of the dying man (Spencer & Gillen, 1927: 628). An unusual description of a malevolent meteor spirit is found among the Djirbalngan of Eastern Cape York Peninsula. The spirit, called *Jubena*, is associated with cooked eggs burnt on coals (which are seen as falling stars) and will hunt down people and tickle them to death (Dixon, 1964). If a meteor breaks apart in the atmosphere, an Aboriginal community in Cape York Peninsula calls it *titurie udzurra* — a spirit with lots of “young ones” that causes great fear among those who see it (Moore, 1979: 156).

Two nearly identical stories from opposite ends of the continent tell how meteors represent an evil being flying across the skies. These stories come from the Weilan people of northern New South Wales (June Barker in McKay et al., 2001: 112–114) and the Ooungyee people of the Kimberleys in Western Australia (Sawtell, 1955: 21–22). Both stories describe people disappearing from an Aboriginal camp near a waterhole. Upon noticing strange tracks, members of the community discovered that the missing people were victims of a shape-shifting monster who would lure people to the waterhole with sugarbag (honey) then drag them under the water to their deaths. In the NSW story, the monster was female, but in the WA story, it was male. In both stories, a clever man (*Wirrigan* in NSW and *Jubertum* in WA) made a strong cord using the hair of women in the community. Upon reaching the waterhole, the clever man was offered a leg of kangaroo by the monster. The man told the monster, who appeared in the

form of an Aboriginal man, that he wanted to take a nap first. The monster agreed and decided to nap as well. The clever man awoke, tied the cord to the sleeping monster, and jumped on its back. The monster woke and fought to remove the man from its back, diving into the water turning it into the “hot soda water it is today”. The man repeatedly stabbed the monster with a spear but it would not die. The monster flew into the sky with the man on his back, where they are seen today as meteors.

The only difference between the stories is the name of the clever man and the gender of the monster. Additionally, in the NSW story the clever man fell to the earth with a group of falling stars at Girilambone, NSW. The rest of the story is exactly the same, suggesting one story originated from the other. The account from the Kimberleys was recorded in the literature 46 years earlier than the NSW account, though it is unclear where the story was developed first. The Kimberleys story was published in a magazine “for the Aboriginal people of New South Wales”, suggesting the story may have been adopted by the Weilan in NSW. Given the nearly identical wording and theme of the text, these are not considered to be independent stories.

### 9.4.3 Meteors and Evil Magic

#### Mushrooms, Meteors and Magic

According to the Arunta of the Central Desert, falling stars contain an evil magic called Arungquila. Mushrooms and toadstools were believed to be fallen stars endowed with this magic. As such, they were considered taboo and their consumption was forbidden (Spencer & Gillen, 1899: 566, 1904: 627, 1927: 414–417). Although this taboo is not shared by other Aboriginal groups of the Central Desert (Kalotas, 1996: 1), it may stem from bad experiences resulting from the consumption of poisonous or hallucinogenic mushrooms common to the area, such as *Amanita phalloide*, *Paxillus involutus*, or *Psilocybe subaeruginosa*. The association of mushrooms with fallen stars is not unique to the Arunta, but is found across the globe (see Beech, 1986).

### Protection from Evil Magic

Aboriginal peoples employed various methods to protect themselves against the evil of meteors, including throwing firesticks in the direction of the meteors trajectory (Stanbridge, 1858: 140) or chanting and causing noise (Roth, 1984: 8). When a group of children from the Ooldea Region of western South Australia saw a meteor (which they called a devil–devil) they chanted “*Kandanga daruarungu manangga gilbanga*”, which roughly translates to “*star falling at night-time go back*” (Harney & Elkin, 1949: 130, Berndt & Berndt, 1943/44: 53). A spirit called Munpani lives in the bush and is constantly watching over the Mara people, protecting them from the evil Minungara (Spencer & Gillen, 1927: 628). To prevent Namorrorddo from stealing the hearts of babies, they sleep on their stomachs or sides when in the bush (Lewis, 2007: 2). If a Worora, Ngarinyin or Wunambal person saw a meteor while holding a baby, the person would kiss the baby on the forehead so the meteor–spirit would not see the infant as it flew overhead (Blundell & Woolagoodja, 2005: 41–42). Aboriginal peoples of the Western Desert believed an evil sky–being named *Wuuna* would throw spears, seen as meteors, through the sky as he wandered across the heavens (Tindale, 2005: 376–377). Because *Wuuna* hunted dingoes, epidemics spreading amongst the dogs were often blamed on the “evil of *Wuuna*”. The sight of a meteor would prompt the people to cover the animals in red ochre for protection (*ibid*). A special ceremony protected Tiwi initiates from the evil meteor spirit Mabinua (Spencer, 1928: 671), while only a medicine man could kill the Namorrorddo of Kuninjkun lore (Lewis, 2007: 3). Similarly, a ceremony involving birth and circumcision wounds is used to protect Wardaman people against various forms of evil. This ceremony is connected to the Southern Cross and *Wuja*, the Wardaman word for meteors (Cairns & Harney, 2003: 65).

#### 9.4.4 Meteors as Omens

##### Omens of Sickness and Death

The connection between meteors and evil spirits that hunt for the sick and the dead may account for the belief that meteors serve as omens of sickness or death, a belief

shared with the Tanganekald of South Australia (Tindale, n.d.), Aboriginal groups near the Bloomfield River, Queensland (Roth, 1984: 8), the Turrbal of Brisbane (Howitt, 1996: 429), Yir-Yoront (Sharp, 1934/35: 34), Lardil (Roughsey, 1972: 107), Kaurna of Adelaide (Schurmann, 1846: 242), and Kukatja of Western Australia (Poirier, 2005: 171). The Ngarrindjeri told of a being named Kulda who would manifest as a meteor emerging from the Southern Cross, warning the people of a disease epidemic. This led the people to shout *“peika baki”*, meaning *“death is coming”* (Tindale, 1934: 232; Tindale, 2005: 375; Parker et al., 2007: 400). Tindale (1937a: 111–112) records a “Fear Death” song associated with the appearance of Kulda and the smallpox epidemic that followed. The meteor, supposedly a fireball as it was very bright and “flashed” across the sky, came from the east and shot westwards towards Kangaroo Island, known by many Aboriginal people of the Coorong as the ‘home of the dead’ (*ibid*).

A colonist account<sup>4</sup> from Central Queensland noted a brilliant fireball in 1863:

*“I witnessed the reflection of an extraordinary phenomenon, described to me by those who saw its course as a brilliant meteor rising with a tail of fire like a Comet in the East, and burying itself in the West, over Mount Stewart. During its passage, balls of fire dropped like falling stars, and the blacks at Wilpend, who, with one exception, had never seen the like before, declared that it foreboded destruction to their countrymen.”*

## Positive Omens

Omens associated with meteors were not always negative. In one incident, an elderly Kukatja woman fell ill and was driven to a clinic. Along the way, a bright meteor flashed across the sky and the woman’s daughters-in-law saw it as a bad omen and feared the worst. However, when elderly woman began to recover, they instead viewed the meteor as a good omen (Poirier, 2005: 171). The Darkinung north of Sydney claimed meteors were a portent that something good was about to happen (Needham, 1981: 11). In Lardil culture, coloured meteors were identified with sickness, while white

<sup>4</sup>Peak Downs, *Rockhampton Bulletin & Central Queensland Advertiser*, 24 October 1863, p. 2e.

meteors were seen as a sign of good luck, such as the arrival of a baby or the finding of turtle eggs (McNight, 2005: 209).

### 9.4.5 Meteors and War

#### Portent of War

The association of meteors with omens of war is prevalent in various parts of eastern Australia, especially Queensland. In 1846, four survivors of a ship named *Peruvian* crashed into the Great Barrier Reef. The survivors escaped to the shore of Cleveland Bay, near Townsville, where they wandered for two weeks before being discovered and fed by a band of local Aboriginal people. The Aboriginal people said they had been led to the place by following the paths of falling stars night after night, which foretold of the presence of a hostile enemy (Morrill, 1864: 16; Robertson, 1928: 144). The morning following the sight of a fiery meteor, Aboriginal men of the Tully River, Queensland would walk in the direction of the meteor's path to search for tracks left by possible enemies (Roth, 1984: 8), while Aboriginal People of Proserpine, Queensland saw meteors as killed enemies (*ibid*). Ngarigo of southeast New South Wales believed that a bolide was a portent that the people where its path pointed were gathering for war (Howitt, 1996: 430; Pring, 2002: 27–28).

#### Implements of War

The link between meteors and war, including weapons of war, such as a spear or club, is found among several Aboriginal groups (e.g. Gibbs, 1996: 69). As noted before, Ngarigo believed a bolide warned of enemies gathering for war (Howitt, 1996: 430; Pring, 2002: 27–28). Wathi–Wathi of the Murray River saw a meteor as the celestial passage of a nulla–nulla (Figure 9.2), a short spear–like weapon used to hunt emu (Cameron, 1885: 365). Some Aboriginal groups in Queensland saw meteors as firesticks that were carried across the sky or thrown from the sky by their enemies (Roth, 1984: 8). Turrbal (aka Jagara) of the Brisbane region saw a meteor as a medicine man, called *Kundri*, dropping his firestick to kill (Howitt, 1996: 430), while Aboriginal people of

the Western Desert believed *Wuuna* would throw showers of spears (meteors) from the sky.



FIGURE 9.2: A nulla-nulla. Image from [www.carters.com.au](http://www.carters.com.au).

Images of the aforementioned Namorrorddo sometimes show him carrying a *mi-yarrul* (fighting club) used to stun his victims (e.g. Blanas, 1994, see Figure 9.3). The Yarrungkanyi and Warlpiri people of the Northern Territory tell how Dreaming men fell to the earth as shooting stars, bringing the Dreaming to the people. The men, armed with weapons, travelled through the sky as falling stars and landed at a place called Purrparlarla, southwest of Yuendumu, NT (Warlukurlangu Artists, 1987: 127).

#### 9.4.6 Meteors in Ritual & Ceremony

##### Causing Harm or Death

There exist a number of rituals in various Aboriginal cultures that serve to harm people, often involving pointing a bone or stick at a person or enemy while chanting or singing a particular song, which causes the victim to become sick and die (Hollenback, 1996: 208–210). Because meteors are frequently linked with sickness and death, they are often incorporated into these rituals. In Lardil culture, the bone-pointing ritual is called *puri-puri* (Roughsey, 1971: 75) and involves the spirit of a shooting star entering the victim, inciting a dream. In his dream, the victim sees the ceremony being performed and realizes it is directed at him. This causes the victim great worry and distress and his health deteriorates until he dies. During the ritual, people of the Star Totems (*Ngarridbelangee* and *Bungarinyee*) stayed awake at night chanting the name of the victim. If a meteor was seen, they knew the ritual was a success and the person had died. It was reported that the only cure for this act was to go to the man





FIGURE 9.3: Namorrodor with a fighting club, called a *miyarrul*, three bush potatoes, and two falling stars. Painting by David Blanasí © 2004.

the victim saw in his dream and ask him to perform a ceremony to remove the shooting star from his chest.

### Treating Sickness

Various rituals were utilised by the Lardil to treat an evil sickness called Malgri. One such ritual involved the treatment of a sick man by a group of medicine men. The medicine men made a long cord from human hair, tied it to the man's toe and trailed it out to sea. As the men chanted, a meteor shot across the sky. At that moment, the cord snapped and the man began to groan and roll about. This signified that the Malgri had left his body and returned to the sea (Roughsey, 1971: 80; Cawte, 1974: 110). If a meteor was seen from a Lardil camp where a person suffered from sickness,

the people in the camp gathered bushes of Wattle leaves. To banish the sickness, they repeatedly warmed the leaves over a fire then transferred the heat from the leaves to the sick person's abdomen whilst chanting a song. When another bright meteor of red or blue colour was seen, firesticks were thrown in the direction of the meteor. The Lardil believed the meteor was the evil of Thuwathu leaving the body and returning to the sea. If this did not happen, the sick person would probably die (Roughsey, 1972: 107).

### **Warning to Follow Laws & Traditions**

Other forms of ritual that included reference to meteors involved warnings to follow laws and traditions. Examples of this are found across central and northern Australia, from Alice Springs to Arnhem Land to the Gulf of Carpentaria. For example, if a Lardil man were to break traditional laws, Thuwathu would afflict him with Malgri (Roughsey, 1971: 80) while a Wardaman deity, Utdjungon, would manifest as a fiery falling star and destroy the earth (Harney & Elkin, 1949: 29–31). According to Wardaman tradition, only Aboriginal people could ward off the threat of Utdjungon (*ibid*). Harney & Elkin interpreted this to mean that if no Aboriginal people were present to ward off Utdjungon, the colonists would be destroyed by the falling star. Therefore, Wardaman felt it was in the best interest of the colonists not to force Aboriginal people from their lands or destroy their laws and traditions, as the consequences of their absence would be fatal.

In some cases, the casting of a star from the sky to punish lawbreakers was more literal. Harney (1969: 37) describes an incident where a married woman ran away with her lover. Enraged, her husband sang a sacred song inciting magic and slung a stone (which represented a sky stone) at her using his hair-belt. The stone flew over her head, frightening her. Sobbing, she ran back to her husband who gave her a second chance. This was a practical example of the Utdjungon story, showing the application of the warning. Harney cites a similar account from Arnhem Land, where a fireball was slung at unfaithful women by a spirit being who lurked in the Coal Sack (Coon, 1972: 294). Similarly, the western and southwestern Arunta of central Australia had rituals

involving meteors and sky-stones that were used to punish people for disobeying laws and traditions. A small spear-like device was used in a particular magic ceremony to punish a man for stealing another man's wife (Spencer & Gillen, 1899: 550, 1904: 627, 1927: 415–417). The spear, endowed with evil magic, was hurled in the direction of the man's home. The evil spirit within the spear would locate the law-breaker and kill him. The men conducting the ceremony would wait until a thunderous boom was heard, which signified that the spear had struck and killed the man (it is not clear whether this sound indicates a bolide). This form of Arungquilta is seen "streaking across the sky like a ball of fire" (*ibid*, 1927: 415–417).

Spencer & Gillen (1899: 550, 1904: 627–628, 1927: 415–417) describe another form of Arungquilta, which involved meteors and produced comets, that was used to punish unfaithful wives. A particular ceremony was performed to punish a woman who had run away from her husband. A pictogram was drawn in the dirt in a secluded area (Figure 9.4) while the men chanted a particular song. A piece of bark, representing the woman's spirit, was impaled with a series of small spears and flung into the direction where they believed the woman to be, which would appear in the sky as a comet. The Arungquilta would find the woman and deprive her of her fat. After a time, the emaciated woman died. Her spirit then appeared in the sky as a meteor.

The Kaitish believed that a falling star indicated the location of a man that had killed another by magical means using a pointing-stick or bone (Spencer & Gillen, 1904: 627–628). When such a death occurred, friends of the murdered man would watch for falling stars. When one was seen, they would "settle to their own satisfaction where it reached the earth" (*ibid*). Armed with a wailia-wailia (a device made from the hair of the dead man), the son-in-law of the murdered man organized an avenging party and travelled to that spot and killed the murderer by spearing him. They left the corpse for the women to bury at the spot where the star fell.

It is not clear if the women found the actual spot where the meteorite fell, or they simply guessed or collectively agreed as to the location of where they believed it fell. Spencer & Gillen stated that the women could easily locate the spot, as the ground was soft. This description is ambiguous, though the event is possible but rare (see the



FIGURE 9.4: The drawing represents a woman lying on her back, where (a) represents her head, (b) her eyes, (c) her arms, and (d) her legs. The asterisk indicates where the piece of bark is placed, representing the woman's spirit. From Spencer & Gillen (1927: 410, their Figure 126).

next chapter for further discussion).

### Initiation Rituals & Medicine Men

There is a close association between medicine men and meteors in many Aboriginal cultures. Amongst the Aboriginal people of Sugarloaf Mountain, NSW, the tooth-rapping ceremony (part of an initiation ceremony) was conducted by a medicine man who came to the earth from the Sky World as a fiery meteor and was considered a benevolent and good person (Gunson, 1974: 50). Among the Anula, medicine men are hereditary in the Yuntanara, or Falling Star Totem (Spencer & Gillen, 1904: 479, 488). Many rituals involving meteors centre on the disembowelment of the initiate and the replacement of his organs with those of a sky being, without harming him. Such rituals were found among several groups in Victoria, including Jupagalk (Elkin, 1977: 75–76), Mukjarawaint and Jajauring (*ibid*), Wotjobaluk (Smyth, 1878: 309; Massola, 1968a: 116; Howitt, 1996: 368–369), as well as Euahlayi of New South Wales (Parker, 1905: 54; Elkin, 1977: 89), Binbinga from the shores of the Gulf of Carpentaria (Howitt, 1996: 114–115), and Mara of Arnhem Land (Spencer & Gillen, 1904: 488; Elkin, 1977:

115).

Sometimes, the removed entrails were replaced with sacred stones that provided the initiate with the magic he would need as a medicine man. These stones were typically identified as quartz crystals or australites (Cowan, 2001: 21). Aboriginal peoples of the Bloomfield River in Queensland believed these quartz-like crystals to be fallen stars (Roth, 1984: 8). For Arunta, crystals were associated with divine properties and origins, believed to have fallen from earth as “solidified light” (Eliade, 1965: 25). In Wuradjeri lore, a spirit named Kurikuta came to the earth in a crystal body at night as a fiery meteor (Berndt, 1974: 28). Among Kokatha of South Australia, quartz crystals and australites, called *mabanba*, were used by medicine men to cure afflictions (Berndt & Berndt, 1943/44: 56–57). To the Ucumble (Jukambal) of NSW, a meteor signified that a medicine man threw a stone from one community to another<sup>5</sup>.

#### 9.4.7 Other Views of Meteors

Some perceptions of comets and meteors fall into none of the themes described above and have no apparent cultural counterpart elsewhere. In north-east Tasmania, the Plangermairrener tell of *Puggareetya*, a mischievous woman who fought a snake in its earthly home, driving the ground up to form the surrounding landscape (Noonuccal, 1990: 115–119). During the fight, the snake cast Puggareetya into the sky where she was held by the sky spirit *Mienteina*. Puggareetya continues to play her tricks on the sky deities who become annoyed and occasionally throw Puggareetya across the sky, seen as a meteor. The Mara tell about the supernatural conception of a child from a pair of spirit children that were beckoned by a meteor (Harney & Elkin, 1949: 35–36). In a similar vein, Narangga and Kaurna peoples in South Australia viewed meteors as orphans (Moorhouse, 1843; Black, 1920: 89; Parker et al., 2007: 400)<sup>6</sup>.

In New South Wales, Peck (1925: 160) tells how meteors were warnings that the red blooms of the Waratah flower (Figure 9.5) were being stolen, while a Queensland

<sup>5</sup>W.T. Wyndham. The food of the Aborigines. *The Queenslander*, 16 November 1895, pp. 938–939.

<sup>6</sup>Transactions of the Statistical Society (1842). *Report on the Aborigines of South Australia*. The Southern Australian, 1842 January 11.



FIGURE 9.5: A waratah, image from [www.ausemade.com.au](http://www.ausemade.com.au).

story tells of *Priepriggie*, a highly regarded figure in his community, who was able to make the falling stars dance to his songs (Reed, 1999: 88–89). To the Moporr (Dawson, 1881: 101) and Gundidjmara (Parker et al., 2007: 400) of Victoria, meteors represented deformity, which ties closely with sickness. Perhaps one of the strangest descriptions of a meteor comes from the Aboriginal people of the Loddon River in Victoria, who have a word for seeing a dog jump up and attempt to bite a falling star: *Burdi-durt* (Smyth, 1878: 205).

Some researchers describe woodcarvings of meteors, but references tend to be vague. Mathews (1896: 41) recounts an earlier description of an initiation site in NSW surrounded by tree carvings, including images of meteors. Brown (2000: 27) claims that in northwest and central Australia, marks and notches in wooden churungas depict astronomical objects such as the flights of meteors and comets, but gives no examples and cites no references.

#### 9.4.8 Meteor Showers

The idea of spirits acting as casual agents of natural events is found in Indigenous knowledge systems across the world (e.g. Horton, 1967). The similarities of perceptions of meteors among various Aboriginal groups may provide some insight into how

Aboriginal people organised their knowledge of meteoric phenomena. Some of the accounts cite a specific region of the sky where these spirits reside, or from which they fling the fiery stars. Do these and other accounts describe meteor showers?

Three accounts give a specific location in the sky for which a corresponding meteor shower could be identified: the Coalsack (Cairns & Harney, 2003: 65; Tindale, 1934: 232), Arcturus (Yidumduma Harney, *ibid*), and the Magellanic Clouds (Mountford, 1976: 457, described in the next chapter). There are no known meteoroid streams near the Magellanic Clouds, which is no surprise given their southerly galactic coordinates. There are meteoroid streams near the Coalsack and Arcturus. The Coalsack and Southern Cross are within a few degrees of the Alpha Centaurids meteor shower, which lasts from approximately 28 January to 21 February, peaking around 8 February. Alpha Centauri appears below the horizon from the latitude of Wardaman country until after 11:00 pm, when it rises in the southwest during the peak of the shower. The star Arcturus lies within a few degrees of the Kappa Serpentids meteor shower, which is short in duration (1–7 April, peaking on the 5th) and would have appeared in the northeastern skies of Wardaman country. It is currently unclear if these showers relate to the meteor traditions, but future work with the Wardaman and other communities may reveal more information.

Among the remaining Aboriginal accounts, there is no clear recognition of re-occurring meteor showers. I found only a single reference to an event that can be attributed to a particular meteor shower event, or more appropriately, a meteor storm. In 1939, an Amangu man from Mullewa, Western Australia told Tindale (2005: 376) that his paternal grandmother was a baby when “the stars fell”, alluding to a bright meteor shower in the early 19th century. Tindale speculates that this may have been the Great Leonid Meteor Shower of 1833 (see Figure 9.6), an event where thousands of bright meteors lit up the sky every minute. The shower peaked on 13 November 1833 (see Sawyer-Hogg, 1962).

The Boorong, near Lake Tyrrell, Victoria, saw a celestial Mallee fowl<sup>7</sup> as the manifestation of a creator-being named Neilloan in the Western constellation Lyra (Stanbridge, 1858: 138–139). Morieson (1996, 2002) speculates that the Boorong may have seen the annual Lyrid Meteor Showers as debris kicked up by the Mallee fowl, with the star Vega representing the kicking foot. However, there is no corroborating evidence from Boorong or Wergaia traditions to support this.



FIGURE 9.6: The day the sky fell – The Great Leonid Meteor Shower of 1833, seen worldwide. Image taken from Harvey (1889: 66), reproduced from Wikimedia Commons under Creative Commons License.

## 9.5 Discussion

While the views discussed generally focus on death, omens, war and the supernatural, not all views were negative. Here we tally all references to positive attributes, such as benevolent spirits and good omens, and negative attributes, such as malevolent spirits, bad omens, evil magic, weapons of war, or rituals causing harm. Some views are

<sup>7</sup>The mallee fowl was called a *Loan* in Stanbridge (1858). Also spelled *Lowan*.



neutral, showing neither positive nor negative attributes. When tallying the number of positive  $P$  and negative  $N$  views, we have attempted to include only the original reference. Of the 150 total accounts, 42% were negative, 25% were positive, and 33% were neutral.

The association between meteors and death or omens is prevalent among cultures around the world (e.g. Frazer, 1930: 60–69; Hughes, 1989; Littmann, 1999: 45; Cielo, 1996: 128–130). Why are these associations so commonplace? Why do various Aboriginal groups across Australia hold this belief, as well as by peoples around the globe, who had little or no contact with each other when the accounts were recorded (predominantly in the 19th and early 20th centuries)? In the rest of this section we consider three possible explanations.

### 9.5.1 Perceptions of Meteoritic Phenomena

The first explanation relates to the human perception of meteors. Hughes (1989) proposes that events in the sky, including the motions of the sun, moon, planets, and stars, had significance and meaning across the world. An unexpected event, such as an eclipse, the arrival of a comet, or a fireball flashing across the sky, must also have meaning. In researching meteor myths from South America, Masse & Masse (2007) claim that Indigenous South Americans viewed the world as regular and structured. Strange and unexpected events were integrated in their mythologies in order to categorise and explain them as well as to serve as lessons that were handed down to subsequent generations (*ibid*). Andrews (2000: 123; 2004: 131) argues that meteors were seen by various peoples as messages sent from someone in the heavens (e.g. spirits, deities, ancestors, etc.). Morrill (1864: 61) states that the Aboriginal people near Townsville believed they had control of heavenly bodies, and any unexpected celestial events were due to the actions of an Aboriginal person or spirit. Australian Aboriginal peoples viewed nature, including the sky, as an integral and central component of daily life (Elkin, 1938). Since meteors are bright, fleeting, and generally random in appearance, they were often met with fear and apprehension (e.g. Coon, 1972: 288), which may serve as the foundation for their generally negative views. However, a keen observer can count

several meteors per hour on a clear night. So while meteors (excluding annual meteor showers) are random, they are not rare events.

### 9.5.2 Witness of Cosmic Impacts

Even rarer than fireballs and bolides are meteorite falls and cosmic impacts, and it may be those that induce fear and apprehension. In these cases, a very real danger is present. Andrews (2000: 123) proposes that the significance of fire and its potentially destructive and deadly effects were the foundation of the association of meteors with evil. Perhaps a cosmic impact heavily influenced the oral traditions of a particular group of people, giving rise to the generally negative views of such phenomena. Such events have certainly occurred across the globe in the past and will certainly happen again in the future.

A modern event may highlight this argument: in September 2007 a bright, fiery meteor raced across the Peruvian sky, leaving behind a smoke trail. The object, dubbed the Carancas meteorite, crashed in the high plains of Peru, blasting debris up to 250 m away, some of which landed on a nearby house (see Kenkmann et al., 2009)<sup>8</sup>. The local residents were frightened by the blast and sickened by a noxious odour that came from the crater. The sudden blast and sickening smell caused many residents to fear for their lives. The sickness was caused by the release of noxious fumes into the air when the hot meteorite hit an underground water supply naturally tainted with arsenic. Although rare on short time scales, these types of impact events are inevitable on longer time scales. This event carried many traits found in the themes discussed in this paper: a bright, fleeting light, a loud noise, and a destructive impact that caused fear and sickness<sup>9</sup>. It can easily be understood how such an event would have a lasting

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<sup>8</sup>Orozco, J., Meteor Crash in Peru Caused Mysterious Illness. *National Geographic News (online)*, 21 September 2007.

<sup>9</sup>It may also be that the appearance of a bright meteor simply coincided with a disease pandemic. Tindale (2005: 374–375) recounts a Tanganekald story from South Australia, near the mouth of the Murray River: a being named *Kuldalai* “flashed a great light across the sky”, which caused a great pestilence called the “sickness of Kuldalai”. Tindale speculates that this sickness may have been recorded by Stirling (1911) who told of an old Aboriginal woman with a pockmarked face who

impression on the people whom it affected.

Many frightening meteoritic events have occurred in the last century, ranging from the larger bolide explosions of Tunguska, Siberia in 1908, Curuçá River, Brazil in 1930, Sikhote-Alin, Russia in 1947, Cando, Spain in 1994, and Vitim River, Siberia in 2002 to smaller events such as the meteorite showers that hit Murchison, Victoria in 1969, the Chicago suburb of Park Forest in 2003, Reisadalen, Norway in 2006, or Bunburra Rockhole in Western Australia in 2007. A small 4 m bolide exploded over Dubbo, NSW in April 1993 with an energy release equal to that of the Hiroshima bomb<sup>10</sup>. Similar examples abound, each with the potential to cause death or serious harm. Historical accounts from around the world tell of death or destruction caused by meteorite falls or bolide explosions (see Swindel & Jones, 1954; Halliday et al., 1984; Yau et al., 1994). It is plausible that disastrous or significant events have occurred in Australia over the last 40,000 years and had a significant influence on the people who witnessed them.

Continental Australia bears nearly thirty confirmed scars from cosmic impacts, with more being found annually. Accounts of blazing stars falling from the sky and striking the earth causing fire, death, and destruction are found across Australia. Chapter 10 gives a description of Aboriginal accounts of meteorite falls and cosmic impacts and Section 10.7 discusses the probability of such events occurring during human habitation of Australia.

### 9.5.3 Researcher & Discipline Bias

The final explanation is that the data is biased by the influence of Western researchers and their academic methods and philosophy. This chapter draws upon ethnographic work undertaken by (mostly Western) anthropologists and other researchers during the 19th and 20th centuries. Aboriginal stories and events were typically recorded, translated from that particular Aboriginal language to a European language (typically English, German or French), and interpreted and analysed by a non-Aboriginal researcher. Often, the stories or information presented to a researcher by an Aboriginal

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described a pandemic from her childhood years in early 19th century.

<sup>10</sup>Impact event: [www.absoluteastronomy.com/topics/Impact\\_event](http://www.absoluteastronomy.com/topics/Impact_event)

person in their language was only roughly translated, and in turn written in terms with which Western researchers would be familiar. The translated and analysed data were typically included in academic reports, books, and peer-reviewed journals to be read by Westerners. Besides the alteration or loss of data in translation, the context of the material might have been altered because the researchers and the informants have very different cultural backgrounds. Therefore, the work may not fully represent the meaning and context as intended by the Aboriginal informants. A good example of this effect is illustrated in a paper by Archer (2002), where female researchers of different ethnic backgrounds interviewed classes of Asian high school students in the UK and received differing and conflicting answers to the same sets of questions, apparently because of the students' views of the researchers based on their race and gender. Walter (2005) discusses claims that some Western researchers in the late 19th and early 20th centuries had a tendency to treat their research subjects as "*scientific specimens, stripping away their human dignity in the research process*", which led to much resentment and suspicion among Aboriginal people. This situation would have affected the information received by non-Aboriginal researchers.

In researching Mesoamerican views of comets and meteors, Köhler (1989) attempts to explain why more concrete descriptions of comets occurred after the Spanish conquest of Mesoamerica: during the conquest, which occurred during the Renaissance (14th through 17th centuries), celestial phenomena played an important role in European culture and thought. Considering these sources were written by Spaniards and Mesoamerican Indians influenced by European thought, Köhler suggests that this influence played a strong role. However, he noted that this did not fully explain why Indians had an interest in reporting comets, but suggested that the interest may have simply been fostered by European influence.

A similar situation could also be attributed to this paper, although quantifying the level of influence is difficult. Some sources from which this work draws are from Aboriginal authors, though it could be argued that they have been influenced by Western thought and written English. However, unless these accounts are completely fabricated, the influence of Western thought and the biases of the researchers cannot solely

account for the striking similarities in views among various Aboriginal groups.

## 9.6 Conclusion

I present a comprehensive analysis of Aboriginal Australian views of meteors representing  $\sim 97$  Aboriginal groups from all states of Australia. Many of these views fall into particular themes, most notably fear, death, omens, and war. Many descriptions of meteors are included in ritual and ceremony and focus on inciting harm to others or providing protection from harm. However, not all views of meteors are negative. Of the accounts that either describe positive or negative attributes, about a third describe positive attributes, such as benevolent spirits or good omens. About two-thirds of the accounts describe negative attributes, including evil spirits, evil magic, bad omens, weapons of war, deformity, or rituals causing harm. The remaining handful of stories describe neutral attributes, such as the role of meteors in initiation ceremonies, definitions of meteors, or views of meteors that are considered neither good nor bad.

Since many of these views are shared by Aboriginal groups across Australia, I have explored this by considering three explanations. Although researcher bias certainly plays a role in how accounts are recorded, there is little evidence to suggest that this explanation is the primary reason for these similarities. While circumstantial evidence exists to support the hypothesis that cosmic impacts caused the fear of meteors, no physical evidence to support this has been found to date, and such events are so rare that they are unlikely to have had any cultural effect. The most probable explanation is that unexpected and random celestial phenomena are fearful because they disrupt an apparently ordered and predictable cosmos.

TABLE 9.1: Aboriginal words for meteors, alphabetized by group name. Burarra is short for Burarra–Gun–Nartpa. Page numbers for each reference can be found in Hamacher & Norris (2010).

Group Name	State	Word	Reference
Arrernte	NT	ulthana	Spencer & Gillen (1927)
Awabakal	NSW	Puttikan	Gunson (1974)
Badaya	NT	Nyimibili	Berndt & Berndt (1989)
Bayungu	WA	gurilyanu	Burgman (2007)
Boorong	VIC	Porkelongtoute	Stanbridge (1858)
Bundjalung	NSW	yuaroam	Ryan (1963)
Burarra	NT	an-marlpa, nomarrarta	Glasgow (1994)
Danggali	NSW	purli ngaangkalitji	Jones (1989)
Dharawal	NSW	Duruga	Bursill et al. (2001)
Dieri	SA	Yaola	Elkin (1937)
Djaru	WA	gulungurru	Goldsmith (2000)
Djirbalngan	QLD	chiko-binna	Roth (1984)
Dharug	NSW	duruga	Thieberger & McGregor (1983)
Gamilaraay	NSW	mirii yanan	Ash et al. (2003)
Goulburn	NSW	Goorbenee turt	Smyth (1878)
Gunditjmarra	VIC	gnummae waar	Dawson (1881)
Gumbaynggirr	NSW	gumugan	Morelli (2008)
Gunwinggu	NT	jarijaning	Elkin et al. (1950/51)
Jajowerong	VIC	Yalleenillong	Smyth (1878)
Kayardild	QLD	burwaduwuru	Evans (1992)
Kamilaroi	NSW	mirriyannun, jirrawullung	Mathews (1903)
Kokatha	SA	Wonambi	Harney & Elkin (1949)
Kuku–Yalangi	QLD	Gi-we	Roth (1984)
	QLD	binyu	Oates (1993)
Kunwinjku	NT	Namorrorddo	Taylor (1996)

Group Name	State	Word	Reference
Lardil	QLD	Thuwathu	Roughsey (1971)
	QLD	kuwa thungal	McNight (2005)
Mara	NT	Tjan-wangu-wangu	Spencer & Gillen (1904)
Marduthunira	WA	Tjidara	von Brandenstein & Thomas (1974)
Martu/Wangka	WA	mayla	Burgman (2005)
Narrunga	SA	wajaga	Black (1920)
Ngalia	WA	Walanari	Mountford (1976)
Ngarrindjeri	SA	Kulda	Tindale (2005)
Plangermairreenner	TAS	Puggareetya	Noonuccal (1990)
Tanganekald	SA	Kuldalai/Kudai	Tindale (2005)
Tiwi	NT	Nimparipari	Berndt & Berndt (1974)
	NT	Papinjuwari	Mountford (1958)
Turrbal (Jagara)	QLD	Kundri	Howitt (1996)
Wardaman	NT	Utdjungon	Harney & Elkin (1949)
	NT	Wuja	Cairns & Harney (2003)
Wathi–Wathi	VIC	Tha-tha-puli	Cameron (1885)
Weilan	NSW	Gambil Gambil	McKay et al. (2001)
Wembawemba	VIC	payika-turt	Thieberger & McGregor (1983)
Wik–Mungkan	QLD	Pach-aw	Hercus et al. (2002)
	QLD	patja	McConnell (1930/31)
Worora	WA	mulalai	Blundell & Woolagoodja (2005)
Wotjobaluk	VIC	Yerigauil	Massola (1968a)
Wuradjuri	NSW	Kurikuta	Berndt (1974)
	NSW	kirela	Berndt (1947/48)
	NSW	girralang buundinya	Thieberger & McGregor (1983)
Yarra	VIC	Elalangi	Smyth (1878)
Yindjibarndi	WA	garuwarra	Thieberger & McGregor (1983)
Yolngu	NT	wulurrk	Lowe (2004)
	NT	maramara	Lowe (2004)
	NT	ngarrpiya	Lowe (2004)
Yupangathi	QLD	cho-i	Roth (1984)

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Group Name	State	Word	Reference
<hr/>			
Unspecified			
Western Desert	WA	Wuuna	Tindale (2005)
Central Australia	NT	Mama	Bates (1904-1912)
	NT	Burndila	Bates (1904-1912)
Not Specified	WA	binnar	Moore (1842)
Cape York	QLD	titurie udzurra	Moore (1979)
Southern Tasmania	TAS	Pachareah	Milligan (1866)

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# 10

## Meteorite Falls & Cosmic Impacts

*“A star bin fall down. It fell straight down and made that hole round, a very deep hole. The earth shook when that star fell down.”*

— Jack Jugari  
(Sanday, 2007: 26)

Descriptions of cosmic impacts and meteorite falls are found throughout Australian Aboriginal oral traditions. In some cases, these texts describe the impact event in detail, suggesting that the events were witnessed, sometimes citing the location. In this chapter, I explore whether cosmic impacts and meteorite falls may have been witnessed by Aboriginal Australians and incorporated into their oral traditions. This allows us to: (1) connect actual geological events to oral traditions, which can be used to better understand the event, date the story, and understand the significance and contribution

geological events have to oral tradition, (2) to determine if these accounts can be used to locate meteorites or impact sites that are currently unknown to Western science; and (3) to use these accounts to estimate the meteoroid influx rate and compare that to empirical estimates.

## 10.1 Introduction

Australian Aboriginal cultures possess strong oral traditions and complex social systems (e.g. Maddock, 1982; Ross, 1986: 232) that have been handed down over many generations (Ross, 1986). Threaded through these traditions are accounts of geological events such as volcanic eruptions, earthquakes, tsunamis, and descriptions regarding the origins of mountains and islands. In some cases, the description indicates that these events were witnessed first-hand, resulting in a significant impact on that community. The study of how geological events or geographical features and materials are incorporated into oral traditions is referred to as *Geomythology* (see Piccardi & Masse, 2007).

This chapter focuses on oral accounts relating to meteorite falls and cosmic impacts. Using the hypothesis that oral texts can serve as historical records of past geological events (Masse et al., 2007a), we examine these records for information that could be used to locate new meteoritic sites, model meteoritic events, or measure the antiquity of dreaming stories. Scientific data from these events, including the age, location, and impact effects, can assist in understanding the nature and evolution of oral traditions over time.

Given the substantial diversity of Aboriginal communities, customs, laws, and traditions may vary between Aboriginal communities, even those of the same language group. While some common themes exist across many Aboriginal communities, such as the concept of the Rainbow Serpent (Radcliffe-Brown, 1926), each group has a different variation of these themes. For this reason, each reference to a particular Aboriginal story, ethnography, or word in this chapter will include the name and location of that particular Aboriginal group.

## 10.2 Australian Impact Craters

Australia is home to 27 confirmed terrestrial impact structures and numerous suspected terrestrial and submarine structures (e.g. Gibbons, 1977; Becker et al., 2004; Abbott et al., 2005; Martos et al., 2006; Earth Impact Database<sup>1</sup>). These structures range in size from the 20 m Dalgara crater to the 90 km Acraman crater, and vary in age from billions of years to a few thousand years. Figure 10.1 (Top) shows the distribution of all 27 confirmed craters and (Bottom) shows the 9 unconfirmed craters. Details for each are given in Table 10.1. The vast majority (21) of confirmed impact structures are found in the Northern Territory and Western Australia. There are only two confirmed in Queensland, one suspected crater in Tasmania, and no confirmed craters in New South Wales or Victoria. The recent identification of a possible impact structure in northwest New South Wales may be that state's first known crater<sup>2</sup>.

Of the confirmed craters in Australia, the constrained dates of only two are known to have occurred within well-established human habitation of the continent ( $< 40,000$  years). These are the Henbury crater field in the Northern Territory and the Veevers crater in Western Australia. O'Connell (1965) mentions a handful of crater candidates in Australia that are not listed in Table 10.1, including a crater "seen on an Aboriginal reserve on Koolatong River near Blue Mud Bay" ( $13^{\circ} 10' \text{ S}$ ,  $135^{\circ} 40' \text{ E}$ , *ibid.*: 16), the Lake Hamilton craters on the west coast of Eyre Peninsula (South Australia,  $33^{\circ} 55' \text{ S}$ ,  $135^{\circ} 16' \text{ E}$ , *ibid.*: 70) and the Weepa Park Depressions 30 km east of Elliston, Eyre Peninsula, South Australia ( $33^{\circ} 26' \text{ S}$ ,  $134^{\circ} 16' \text{ E}$ , *ibid.*: 125) which are both estimated to be  $< 9,000$  years old and are probably solution-collapsed domes. O'Connell also includes the Mount Doreen crater, NT at the general coordinates of  $23^{\circ} \text{ S}$ ,  $133^{\circ} \text{ E}$ , but this site has been shown not to be of meteoritic origin<sup>3</sup>.

<sup>1</sup>University of New Brunswick, Canada: [www.unb.ca/fredericton/science/research/passc/](http://www.unb.ca/fredericton/science/research/passc/)

<sup>2</sup>Green, B. (2008). Shock discovery of huge meteorite crater. *Talking Headlines* (online), 13 November 2008.

<sup>3</sup>O'Connell (p. 88) estimated this crater candidate to have formed  $\sim 100$  years ago (see also Sangster, 1957). However, it was determined by Sangster (1959) that this was not a meteorite crater.

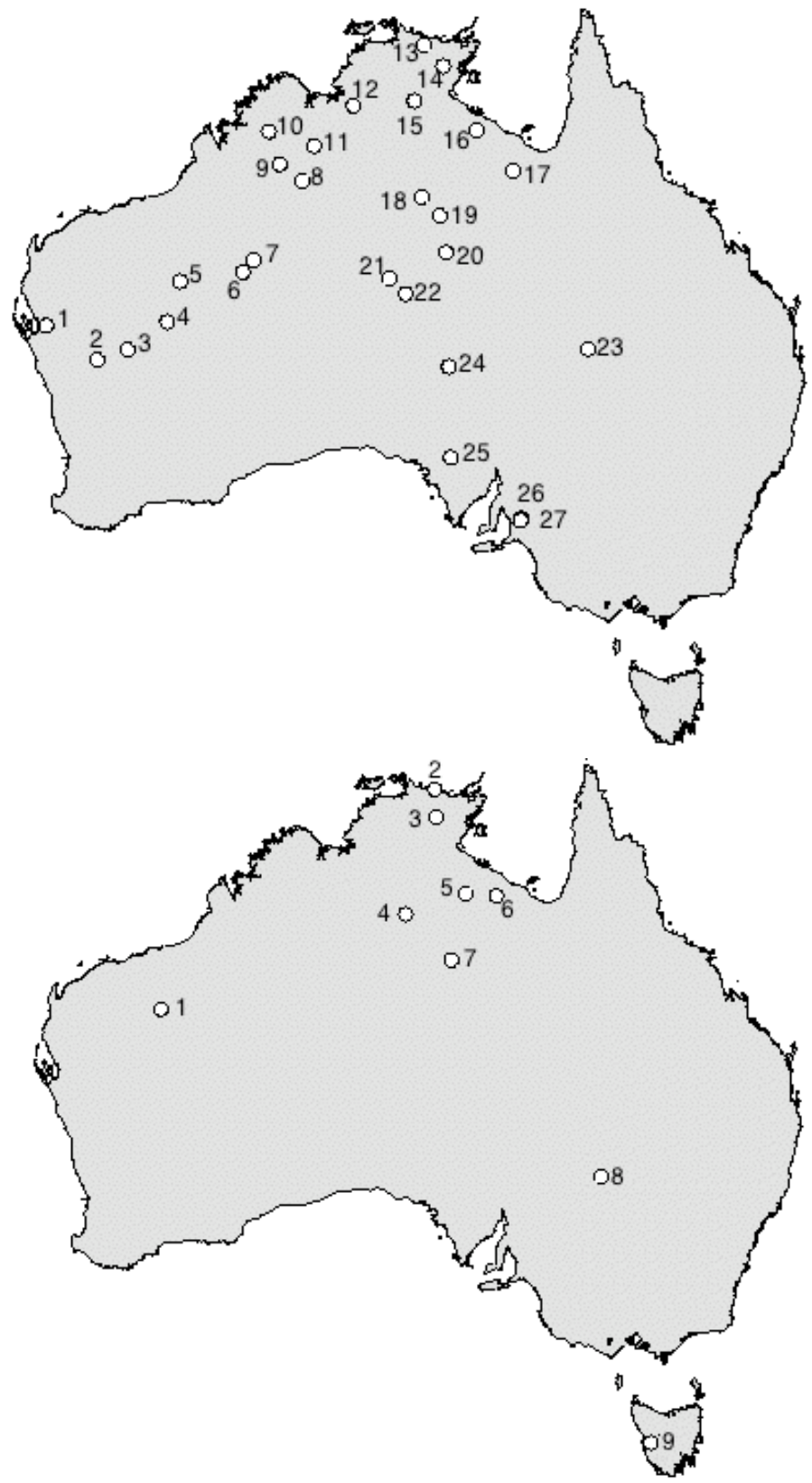


FIGURE 10.1: **Top** – 27 confirmed and **Bottom** – 9 unconfirmed but suspected terrestrial impact structures in Australia. Numbered in Table 10.1.

TABLE 10.1: 27 confirmed and 9 unconfirmed terrestrial impact craters in Australia, numbered as in Figure 10.1. Data from Matt Wilson crater taken from Kenkmann & Poelchau (2008).

N	Name	Latitude	Longitude	State	Age	D
1	Woodleigh	26° 03' S	114° 39' E	WA	364±8	40
2	Dalgaranga	27° 38' S	117° 17' E	WA	< 0.27	0.02
3	Yarrabubba	27° 10' S	118° 50' E	WA	~ 2000	30
4	Shoemaker	25° 52' S	120° 53' E	WA	1630±5	30
5	Glikson	23° 59' S	121° 34' E	WA	< 508	~19
6	Connolly Basin	23° 32' S	124° 45' E	WA	< 60	9
7	Veevers	22° 58' S	125° 22' E	WA	< 0.02	0.08
8	Wolfe Creek	19° 10' S	127° 48' E	WA	< 0.3	0.87
9	Goat Paddock	18° 20' S	126° 40' E	WA	< 50	5.1
10	Spider	16° 44' S	126° 05' E	WA	> 570	13
11	Piccaninny	17° 32' S	128° 25' E	WA	< 360	7
12	Matt Wilson	15° 27' S	130° 28' E	NT	Unknown	7.5
13	Liverpool	12° 24' S	134° 03' E	NT	150±70	1.6
14	Goyder	13° 28' S	135° 02' E	NT	< 1400	3
15	Strangeways	15° 12' S	133° 35' E	NT	646±42	25
16	Foelsche	16° 40' S	136° 47' E	NT	> 545	6
17	Lawn Hill	18° 40' S	138° 39' E	QLD	> 515	18
18	Kelly West	19° 56' S	133° 57' E	NT	> 550	10
19	Amelia Creek	20° 55' S	134° 50' E	NT	600–1640	90
20	Boxhole	22° 37' S	135° 12' E	NT	0.0540±0.0015	0.17
21	Gosses Bluff	23° 49' S	132° 19' E	NT	142.5±0.8	22
22	Henbury	24° 34' S	133° 08' E	NT	0.0042±0.0019	0.15
23	Tookoonooka	27° 07' S	142° 50' E	QLD	128±5	55
24	Mount Toondina	27° 57' S	135° 22' E	SA	< 110	4
25	Acraman	32° 01' S	135° 27' E	SA	~ 590	90
26	Flaxman	34° 37' S	139° 04' E	SA	> 35	10
27	Crawford	34° 43' S	139° 02' E	SA	> 35	8.5

N	Name	Latitude	Longitude	State	Reference
1	Hickman	23° 02' S	119° 40' E	WA	Glikson et al. (2008)
2	Maningrida	11° 53' S	134° 12' E	NT	Haines (2005)
3	Gulpuliyul	13° 19' S	134° 06' E	NT	Sweet et al. (1999)
4	Renehan	18° 18' S	132° 39' E	NT	Haines (2005)
5	Spear Creek	17° 16' S	135° 50' E	NT	Dunster (2009)
6	Calvert Hills	17° 22' S	137° 28' E	SA	Macdonald & Mitchell (2004)
7	Wessel	20° 36' S	135° 05' E	NT	Macdonald & Mitchell (2004)
8	White Cliffs	30° 47' S	143° 08' E	NSW	News Report <sup>a</sup>
9	Darwin	42° 18' S	145° 39' E	TAS	Howard & Haines (2007)

<sup>a</sup>R. Macey, Opal miner stumbles on mega meteorite crater. *The Age* (Fairfax Digital), 23 November 2008.

### 10.3 Geomythology

The study of geological phenomena (including astronomical events such as comets, eclipses and supernovae) inspiring aspects of oral traditions is referred to as Geomythology, a term coined in 1968 by Dorothy Vitaliano, a geologist at the University of Indiana (Vitaliano, 1968). The word “mythology” is derived from the Greek “*mythos*”, meaning “story” (or in some cases “word”) and “*logos*”, meaning “word” in the form of speech. Thus, mythology can be considered “spoken stories”. There is a long-standing debate regarding the nature and purpose of myth, and associated theories of myth vary significantly between academic disciplines. Here, we draw from Masse et al (2007a) that myths can serve as oral records of natural events and that these records can be elicited by modern science to understand or model historic natural events — in this case, cosmic impact events<sup>4</sup>. During the 20th century, the use of myth to explain geological events was viewed with scepticism by the scientific community, as there was little physical evidence to support the hypothesis. However, in the 21st century, physical evidence is helping geomythology gain new ground as a legitimate discipline. The

<sup>4</sup>For a similar study applied to South America, see Masse & Masse (2007).

first major peer-reviewed work on geomythology is “Myth and Geology” (Piccardi & Masse, 2007), which provides the theoretical foundation of the discipline and serves as the methodological basis of this work. Given the generally negative connotations of the word “mythology”, we use the more accurate term “oral tradition”.

While Piccardi & Masse (2007) provide a plethora of examples of geomythology from around the world, they represent only the tip of the iceberg. Many stories use natural events or landforms to illustrate a moral point, sometimes including warnings to future generations. On 26 December 2004, such an example was witnessed by the world as an earthquake off the western coast of Sumatra induced a tsunami that swept across the Indian Ocean, killing thousands. Some indigenous peoples of the Indian Ocean survived the tsunami because of information contained in their mythology (see Jankaew et al., 2008). These groups, including the Moken people of Thailand and Indigenous Andaman Islanders, possessed stories that told of great waves that would “eat men” and that this wave would come when the sea receded rapidly. Their stories told them that to survive they must immediately run to high ground. Their adherence to these stories saved their lives (Arunotai, 2006; Masse et al., 2007a: 18). This suggests that such events probably occurred in the past and were significant enough to be incorporated into story lines that lasted long periods of time, and these stories contained information and warnings about natural catastrophes that were crucial to the survival of the community.

One of the most well-documented examples of geomythology in Australia are the stories describing the volcanic eruptions that formed the Eacham, Barrine, and Euramoo crater lakes in Queensland, which formed over 10,000 years ago (Dixon, 1972: 28–29). The stories describe the region as covered in Eucalypt scrub as opposed to the current rainforest. This was later confirmed by the analysis of fossil pollen found in the silt of these craters, which showed the current rainforest to be 7,600 years old (Kershaw, 1970; Dixon & Koch, 1995; Rainforest Conservation Society of Queensland, 1986: 39). The Australian Heritage Commission includes these stories on the Register of the National Estate and within Australia’s World Heritage nomination of the wet

tropical forests as an “unparalleled human record of events dating back to the Pleistocene era” (Pannell, 2006: 11; Rainforest Conservation Society of Queensland, 1986: 41)<sup>5</sup>.

Similarly, Native American stories describe the eruption of Mount Mazama, which formed Crater Lake in Oregon. Sandals excavated under Mazama ash have been radio-carbon dated at 6,500 years old (Vitaliano, 2007), showing the area was inhabited and affected at the time of eruption. Stories from South America suggest indigenous cultures not only witnessed volcanic eruptions, but that the descriptions of these events remained in the oral tradition for hundreds, perhaps thousands, of years (Masse & Masse, 2007).

Another example of geomythology from Australia and New Zealand is given by Bryant (2001, et al., 2007), who suggests that the southeast coast of Australia was struck by a tsunami within the last 600 years. Bryant proposes that the tsunami was induced by a cosmic impact in the Tasman Sea and cites various Aboriginal and Maori stories describing tsunamis or cosmic impacts followed by a deluge to support his claim, including the Maori story about the “Fires of Tamatea”. This view was challenged by Goff et al. (2003), who argued that the Maori place names were mistranslated and that no ‘smoking gun’ (crater) existed. However, a submarine structure, named *Mahwika* after the Maori god of fire, was discovered in the Tasman Sea south of New Zealand by Abbott et al. (2003) who suggests it may be an impact crater  $20 \pm 2$  km in diameter with an estimated impact date of  $\sim 1443$  CE (Abbott et al., 2005), supporting Bryant’s hypothesis. However, the dating of this structure and its origins are still the topic of contentious debate.

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<sup>5</sup>Dixon & Koch (1995) cite other stories that describe events dating over 10,000 years ago, providing additional supporting evidence of geomythology in Australia.



## 10.4 Known Australian Impact Craters

### 10.4.1 Gosse's Bluff

Gosse's Bluff, approximately 200 km west of Alice Springs, is an eroded impact crater with a diameter of  $\sim 22$  km and a remnant circular uplift forming a mountain range  $\sim 5$  km in diameter and  $\sim 150$  m in height with an age of  $142.5 \pm 0.8$  Ma (Milton et al., 1996). Scientists first proposed impact origins of the structure in the 1960s based on the abundance of shatter cones (Dietz, 1967). To the Western Arrernte people, Gosse's Bluff is known as *Tnorala* and is considered a sacred place. An Arrernte story regarding its origins closely parallels the scientific explanation, as told by Ntaria Elder Mavis Malbunka (2009), wife of Herman Malbunka, the Traditional Owner of Tnorala.

In the Dreaming, a group of skywomen were dancing as stars in the Milky Way. One of the women grew tired and placed her baby in a wooden basket, called a *turna*. As the women continued dancing, the *turna* fell and plunged into the earth. The baby fell and was covered by the *turna*, which forced the rocks upward, forming the circular mountain range. The baby's mother, the evening star, and father, the morning star, continue to search for their baby to this day (Parks & Wildlife Commission of the Northern Territory, 1997: 1; Williams, 2004; Malbunka, 2009)<sup>6</sup>. She continues:

*"We tell the children don't look at the evening star or the morning star, they will make you sick because these two stars are still looking for their little baby that they lost during the dance up there in the sky, the way our women are still dancing. That coolamon, the one the baby fell out of, is still there. It shows up every winter."*

The *turna* can still be seen in the sky as the curve of stars in the constellation Corona Australia (Southern Crown)<sup>7</sup>, which is just south of the galactic bulge (Figure 10.2). This constellation is high in the sky during the early part of the night during

<sup>6</sup>Cauchi, S. (2003). Outer space meets outback and a bluff is born. *The Age*, 18 June 2003: [www.theage.com.au](http://www.theage.com.au).

<sup>7</sup>This was pointed out by a tour guide at Uluru. In a previous paper (Hamacher, 2011), I thought it was a reference to the galactic bulge, which was incorrect.

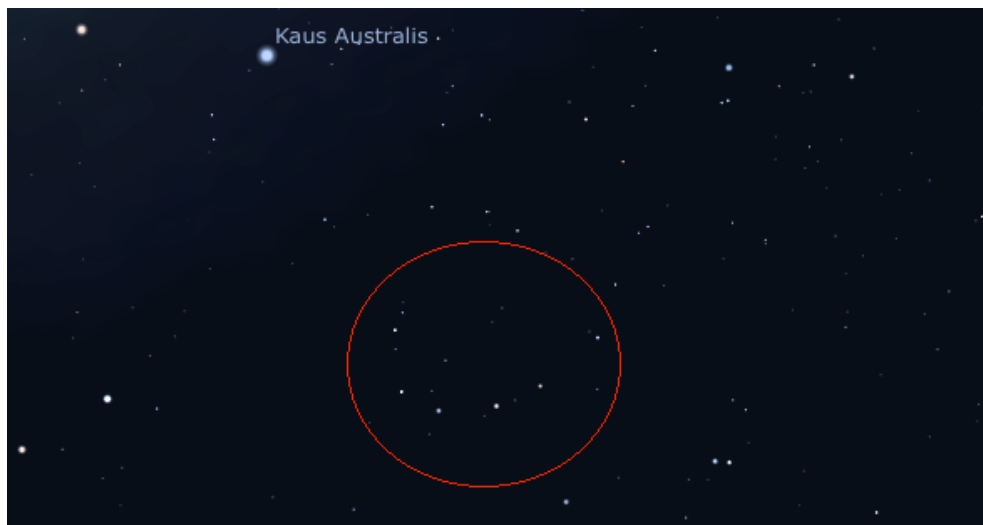


FIGURE 10.2: Corona Australis – the constellation that represents the celestial turna that fell from the Milky Way in the story of Tnorala, circled in red. Image taken from Stellarium.

the winter. The motif of the dancing stars (women) may be attributed to the Phi Sagittariids, a meteor shower that radiates from the centre of the galactic bulge between 1 June and 15 July, when the Milky Way is high in the winter night sky. However, the shower is rather faint and no current ethnographic evidence supports this idea.

#### 10.4.2 Wolfe Creek

Wolfe Creek crater, located in northeastern Western Australia, is 850×900 m in diameter with an estimated age of  $\sim 300,000$  years (Shoemaker et al., 1990). The area is home to the Djaru, who call the structure *Kandimalal* (Tindale, 2005: 376). According to Cassidy (1954), Kandimalal has “no particular meaning in their language, and no legend exists to hint of its origin”. However, the literature reveals multiple stories associated with the crater, some of which describe cosmic origins (see Sanday, 2007). One of the earliest Djaru accounts tells how a pair of subterranean Rainbow Serpents created the nearby Wolfe and Sturt creeks. One serpent emerged from the ground, creating the circular structure (Bevan & McNamara, 1993: 6; Goldsmith, 2000).

Another story tells how one night, the moon and the evening star passed very close to each other. The evening star became very hot and fell to the earth, causing a

brilliant, deafening explosion. This greatly frightened the Djaru and it was a long time before they ventured near the site, only to discover it was the spot where the evening star had fallen (Goldsmith, 2000). Goldsmith reports that the Aboriginal Elder told him this story came from his grandfather's grandfather, indicating it was handed down in its present form before the scientific discovery of the crater. A Djaru Elder named Jack Jugarie gave his account of the Wolfe Creek crater: "A star bin fall down. It was a small star, not so big. It fell straight down and hit the ground. It fell straight down and made that hole round, a very deep hole. The earth shook when that star fell down" (Sanday, 2007: 26). Speiler Sturt, a Djaru Elder from Billiluna, Western Australia, illustrates the cosmic origins of Wolfe Creek crater (*ibid*, see Figure 10.3):

*"That star is a Rainbow Serpent. This is the Aboriginal Way. We call that snake Warnayarra. That snake travels like stars travel in the sky. It came down at Kandimalal. I been there, I still look for that crater. I gottem Ngurriny – that one, Walmajarri/Djaru wild man."*



FIGURE 10.3: Wolfe Creek Crater and the Rainbow Serpent. Painting by Boxer Milner, a Djaru Elder from Billiluna, Western Australia © 2000. Image reproduced with permission, courtesy of Peggy Reeves Sanday ([www.sas.upenn.edu/~psanday/Aboriginal/](http://www.sas.upenn.edu/~psanday/Aboriginal/)).

### 10.4.3 Henbury

4200±1900 years BP, a fragmented nickel–iron meteoroid struck the Central Desert, creating thirteen craters covering an area of approximately one square km (Haines, 2005). Known as the Henbury crater field (Figure 10.4), this event was probably witnessed first-hand since Aboriginal people have inhabited the Central Desert for more than 20,000 years (see Smith, 1987; Smith et al., 2001). An addendum by L.J. Spencer in Alderman (1931: 31), however, suggests that Aboriginal people viewed the Henbury impacts with apprehension. A local prospector named J.M. Mitchell noted to Spencer that older Aboriginal people referred to them as “*chindu china waru chingi yabu*”, roughly translating to “*sun walk fire-devil rock*” (*ibid.*: 31). The crater-field, it appears, takes its name from the story surrounding its formation. In 1934, J.M. Mitchell<sup>8</sup> claimed that his Aboriginal guide would not go within half a mile of the craters or camp within two miles and warned him about going near them. He said people were not to drink the water that collected in the craters, as *china waru* (a fire-devil) would fill them with a piece of iron, a view shared by other clans in the area (which is from where the name above is derived). The guide said his paternal grandfather had seen the fire-devil and that he came from the sun.

However, there are conflicting accounts recorded in the literature. Brown (1975: 190–191) cites the Henbury craters as an important water source to the local people while Alderman (1931: 28) claims that Aboriginal people seemed to have “no interest” in the craters or any explanations regarding their origins. Although a story was recorded by Mountford (1976: 259–260) that describes an anthropomorphic figure throwing sand out of a hole, forming the rays of debris radiating from the crater. Because the story is considered “women’s business”, details of the story are not provided here.

These views and the name suggest recognition of the site as different from the surrounding landscape, highlighting the iron fragments that litter the area and the site’s

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<sup>8</sup>Meteorite Craters: old prospector’s experiences. *The Advertiser*, Adelaide, 11 January 1934, p. 12.



FIGURE 10.4: **Left** — A satellite image of the Henbury crater field, taken from Google Maps. **Right** — One of the larger Henbury craters. These craters retain water after rainfalls, creating small oases of trees and shrubs in the otherwise arid desert. The ground around these craters is still littered with iron fragments of the original impactor, although most large fragments have been removed (photo by D.W. Hamacher).

unusual nature. However, not all Aboriginal people of the area shared this apprehension. Brown (1975: 190–191) notes that the Henbury craters were an important water source to the local Aboriginal people, as the craters collected and retained rainwater for long periods of time. Although a story was recorded by Mountford (1976: 259–260) describing the crater’s origins, it did not attribute the structure’s formation to a cosmic impact. According to the Parks & Wildlife Commission of the Northern Territory (2002: 15), the Arrernte name for the crater field is *Tatyeye Kepmwere* (Tatjakapara) and state that “some of the mythologies for the area are known but will only be used for interpretation purposes after agreement by the Aboriginal custodians of the site”.

#### 10.4.4 Veevers

In the centre of Western Australia lies the small, 70 m wide Veevers crater, considered one of the best preserved small impact craters in the world and one of a minority that is associated with meteorite fragments (Shoemaker et al., 2005). Using cosmogenic nuclide exposure of the crater walls, the estimated age of Veevers crater is less than 20,000 years old. However, the well-preserved ejecta suggest it may be less than 4,000 years old (*ibid*). In either case, the Veevers impact may have been witnessed by humans, but no Aboriginal stories about it are recorded in the literature.

### 10.4.5 Boxhole

Boxhole crater is a 170 m wide impact structure located  $\sim 170$  km northeast of Alice Springs. The age of this structure is contentious, as Kohman & Goel (1963) report an age of  $5400 \pm 1500$  years using  $^{14}\text{C}$  exposure, while Shoemaker et al. (1990; 2005) report an age of  $\sim 30,000$  years using  $^{10}\text{Be}/^{26}\text{Al}$  exposure (see Haines, 2005: 484–485). In either case, the impact may have been witnessed, depending on the precise date of human arrival to the Boxhole region. Madigan (1937: 190) claimed that the local Aboriginal people seemed to have “no interest” in the crater and nothing else is reported in the literature.

### 10.4.6 Other Craters

A search for stories associated with other confirmed impact craters revealed a story about Liverpool crater in Arnhem Land (Haines, 2005), which is described as the nest of a giant catfish. This story is supported by pictographs of giant catfish on the walls of a rock shelter located within the crater (Shoemaker & MacDonald, 2005). The crater is  $\sim 1.6$  km wide and dates to  $\sim 150$  Ma. Except for Gosse’s Bluff, Wolfe Creek, Liverpool and Henbury, we were unable to locate associated stories relating to other confirmed impact craters.

### 10.4.7 Summary of the Evidence from Known Impact Craters

#### Why are there stories of Wolfe Creek and Gosse’s Bluff?

Two Australian impact craters, Gosse’s Bluff and Wolfe Creek, have associated stories that attribute extraterrestrial origins to the structures’ formation, even though the craters were formed long before human habitation of Australia. It is unclear if (a) the stories describing Gosse’s Bluff and Wolfe Creek as cosmic impacts incorporated the modern scientific explanation, (b) the Aboriginal people had deduced, without the influence of Western science, that these structures were formed by cosmic impacts, (c) parallels between scientific and Aboriginal views are simply coincidence, or d) the

information the Aboriginal elders provided to the researchers was misleading. Misleading information can be caused by a poorly worded question (e.g. Researcher: “*Do you have any stories about that meteorite crater we call [.....]?*”), in which case the Aboriginal informant may tell the researcher what they “want to hear” out of courtesy or respect (e.g. Clarkson, 1999). The first argument (a) could be falsified by showing, conclusively, that the cosmic impact stories predate the scientific discovery of the craters. Addressing (b), (c), and (d) requires a more detailed understanding of Aboriginal knowledge systems, Dreamings, and Aboriginal customs.

### **Why are there no stories of the known impact craters that occurred in human history?**

Three confirmed craters, Henbury, Boxhole and Veevers (and possibly Dalgara), were formed during human habitation of Australia and would undoubtedly have caused destruction in the region of the impact site. Although there are some stories related to the Henbury craters (some are not in the public domain) it is curious that no story exists regarding Veevers or Boxhole. Possible explanations are that (a) humans did not inhabit that area at that time, (b) that stories do exist, but are secret and thus not revealed to an uninitiated researcher, or (c) that stories did once exist, but have been lost in time, perhaps through cultural discontinuity. We do not currently have the information necessary to discriminate between these explanations.

## **10.5 Other Impact Sites**

A survey of the available literature revealed a plethora of stories and accounts that describe stars falling from the sky and crashing to the earth. These stories, which do not correspond to impact structures or meteorite finds known to Western science, could be used to model possible impact catastrophes (e.g. Masse & Masse, 2007) or assist in locating new impact sites. Some stories are somewhat vague and do not cite a specific location, such as that from the Wolmeri of the Kimberleys who tell how Venus came to earth and left a stone in one of the “horde countries” (Kaberry, 1939:

12), a Wawilak (Yolngu) place in Arnhem Land called *Katatanga*, meaning “the falling meteor place” (Warner, 1937: 251), or the Indjabinda story about Mangela, who came to the earth with a fleeting appearance at a place denoted by a sacred mound called *Kumana Kira* (Cowan, 1992: 28). Other stories, however, cite the specific location of the event. Here, we sort the stories by state, citing locations where available. The coordinates of all locations with a superscript *f* are given in Table 10.2 and shown in Figure 10.6. To facilitate later discussion, those events that may correspond to a historical event are assigned an “Event Number” (#).

### 10.5.1 New South Wales

Several oral traditions from NSW describe cosmic impacts, especially in the northwest region of the state. A story from the Muruwari of north-central NSW describes a catastrophic event that Mathews (1994: 60) interprets to be a meteorite impact, citing a large circular area near the town of Boneda<sup>f</sup>, where she believes the event took place (Event #1). The story, recorded between 1968 and 1972, involves fire falling from the sky to the earth, causing death and destruction. Gien, the man responsible for the catastrophe, fled to the sky and became the moon. Mathews recounts a nearly identical story from the nearby Ngemba peoples, who tell of a fireball that landed on the camp, killing everyone. A similar story from the nearby Kula peoples (recorded in 1804) describes a giant piece of burning wood that fell upon the camp, with the responsible party, Giwa, becoming the moon. The similar stories probably represent variations of a single account that has been incorporated into the storylines of adjacent Aboriginal communities, with each group reciting their own interpretation of the story. While Mathews suggests the event took place near Bodena, the Kula story cites the location as Multaguna Run near the Warrego River, approximately 90 km west of Bodena. It is uncertain where the story originated, but the earliest record in the literature is the Kula account. No geophysical survey of the site confirming or rejecting this hypothesis is reported in the available literature.

A Weilan story<sup>9</sup> (McKay et al., 2001: 112–114) tells of a female shape-shifter who

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<sup>9</sup>A nearly identical story from the Ooungyee people of the Kimberleys in Western Australia is



would lure men away from their camps and carry them away. A man cunningly led her to a water hole, where he tied a cord around her (made of human hair) while she slept. She awoke and fought to get him off her back, jumping into the water turning it a dull colour. He speared her in the back, but she would not die. She flew up to the sky with him still clinging on until they were in the path of falling stars. A falling star knocked the man off and he fell with some stars to the ground (Event #2) at a site known today as the town of Girilambone<sup>f</sup>. The Weilan also tell of a large star that fell to earth, lighting up all of the surrounding land – so bright, in fact, that several different Aboriginal groups saw it (e.g. Murrawarri, Barkinji, Weilan, Ngemba, Narran, Kamilaroi, and Wongaibon). There are no known impact craters in New South Wales, except for the newly discovered, albeit unconfirmed, structure near the town of White Cliffs, which is estimated to be more than two million years old<sup>10</sup>.

At a place called *Kurra Kurran*<sup>f</sup>, on Fennell Bay at the northwestern extremity of Lake Macquarie between Sydney and Newcastle, lies an area of petrified wood exposed at the surface. According to the local Awabakal people (Threlkeld, 1834: 51, recounted in Turbet, 1989: 126), the petrified wood represents remnants of a large rock that was cast from the sky by a giant goanna, killing many people (Event #3). Near the town of Wilcannia<sup>f</sup>, Jones (1989) recounts a story of a large fiery star that rumbled and smoked as it fell from the sky, crashing into the ground (Event #4). The impact was followed by a deluge, which Jones suggests is represented in rock paintings on Mount Grenfell, northwest of Cobar. The paintings show people climbing the mountain, supposedly to escape the rising water levels. Jones noted the presence of unusual black stones in the riverbed, indirectly suggesting they were meteorites. The story gives the impact location as the Darling riverbed northeast of Wilcannia at a place called *Purli*

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given in Sawtell (1955: 21–22). The Sawtell account was published 46 years prior to the NSW account, though the story's origins are unclear. The Weilan story was published in a magazine “for the Aboriginal people of New South Wales”, suggesting the story may have been adopted later by the Weilan. Given the nearly identical wording and theme of the text, we do not consider these to be independently contrived stories.

<sup>10</sup>R. Macey, Opal miner stumbles on mega meteorite crater. *The Age* (Fairfax Digital), 23 November 2008.

*Ngaangkalitji*. A survey of the area by astronomer Robert H. McNaught found no evidence of an impact crater or meteoritic material (Steel & Snow, 1992: 572). Bevan & Bindon (1996: 95) suggest that the story was recounted at this spot on the Darling River, but was not where the event actually took place. If the story describes a real event, the location of the original site is currently unknown to Westerners.

Stories from the Burraborang/Illawarra region to the west and south of Sydney describe an impacting meteor shower (Peck, 1933: 192–193; Event #5):

*“The sky moved, heaved and billowed. The stars tumbled and clattered and fell against one another. The Milky Way split and great star groups were scattered. Many stars fell to the earth, flashing in the sky. A large red glowing mass burst in the air, giving a deafening roar, as it scattered millions of molten pieces on the ground. This occurred all night. The ground was covered in burned holes and great mounds, formed from the falling pieces”.*

A similar story is recounted in Peck (1925: 79–86; 1933: 152–160): during a battle between two groups, a bright, burning blue light came hissing toward the earth from the sky. Surprised by this sight, the people thought it must have been an unknown great sorcerer. The earth trembled as the star crashed into the ground, sending rock and debris into the air. The noise of the explosion was deafening and reverberated around the surrounding hills. The men were filled with terror and they all fell flat to the ground (Event #6). Peck vaguely says this area is in “*the belt of basalt country where the waratah does not grow*” (*ibid*: 152).

On 8 June 1878, a bright fireball was seen streaking across the skies of southeast Australia<sup>11</sup>. The fireball appeared at 3:00 PM was seen over hundreds of kilometres. It was believed to have exploded between Cooma and Omeo, followed by a loud noise and a small earthquake from the shock. It was reported that meteorite fragments were collected in that district. This event contains remarkable similarities to the previous

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<sup>11</sup>The Recent Meteor. *The Argus*, Melbourne, 12 July 1878, p. 7.

stories recorded from the region south of Sydney and may in fact be the originator, although the connection is currently speculative.

### 10.5.2 Northern Territory

Two stories of falling stars in Arnhem Land describe fire resulting from the impact. A Gurudara story describes a bright star, named Nyimibili, falling from the sky onto the Marabibi<sup>f</sup> camp near the Wildman River, which burned all of the grass and trees, causing death and destruction (Berndt & Berndt, 1989: 25-27; Event #7)<sup>12</sup>. The Yolngu tell of Goorda, a fire-spirit from the Southern Cross, who came to the earth as a falling star to bring fire to people of the Gainmaui River, near Caledon Bay<sup>f</sup> (Event #8). Once he touched the ground, he set the grass ablaze. The fire spread, causing death and chaos (Allen, 1975: 109)<sup>13</sup>.

Many Aboriginal communities believe natural disasters are punishment for breaking laws and traditions. The Wardaman people warn of a fiery star named *Utdjungon* that will fall from the sky to destroy the earth if laws and traditions are not followed. The falling star will cause the earth to shudder, the hills and trees to topple and turn, and everything going black with night descending (Harney & Elkin, 1949: 29–31). A nearly identical story from the nearby Ngarinman tells of “a large black stone, thrown from the sky by Utdjungon – a killer who lives in the Milky Way and flings a fiery ball to slay” (*ibid*: 72–74; Event #9). No specific locations are cited in these stories, but presumably take place within Wardaman or Ngarinman country.

Some stories of falling stars have Western religious overtones. In the town of

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<sup>12</sup>The fiery star, Nyimibili, was described as having a large eye as bright as the moon, burning alight during the day and night. This description closely relates to other malevolent, one-eyed meteor beings found in the oral traditions of Aboriginal people of the upper Northern Territory, such as Namorrodor and Papinjuwari.

<sup>13</sup>There is some debate as to whether meteorite impacts can trigger fires (e.g. Jones & Lim, 2000; Durda & Kring, 2004). Masse & Masse (2007: 196) cite several examples from South America describing fires that were caused by fiery objects falling from the sky. Collins et al. (2005) cite the heat-energy levels required to ignite grass and trees, among other materials, based on nuclear tests by Glasstone & Dolan (1977).

Hermannsburg<sup>f</sup> (Ntaria), ~ 110 km west of Alice Springs, an Arrernte woman told of a star that fell to earth creating two holes on the site of the old Hermannsburg church prior to settlement of the area by Lutheran missionaries (Austin-Broos, 1994: 142; 2009: 39; Event #10). The story was heavily laced with Christian symbolism, resulting from the close association between the Aboriginal community and the missionaries. Austin-Broos (1994: 149; 2009: 37–38) believes this account may relate to the story of a star that fell to earth in a waterhole in nearby Palm Paddock. Róheim (1945: 183) provides an earlier record of this story, citing Western and Eastern Arrernte folklore about a star that fell into a waterhole where the serpent, *Kulaia*, lived, making a great noise like thunder. In the story, a thirsty boy who had only recently been circumcised (initiated) peered into the waterhole and saw the serpent, which rose and swallowed him whole. The boy's death caused much grief and mourning among his community, who promptly burnt the food they had collected for the his initiation and left the camp.

In some cases, the progenitors of knowledge of humankind were brought to earth via falling stars. The Western Arrernte say the first human couple originated from a pair of stones that were thrown from the sky by the spirit *Arbmaburinga* (Róheim, 1971: 370)<sup>14</sup>. A Luritja Dreaming by Trepina Sultan Thanguwa describes how life was brought to earth by a meteorite called *Kulu*:

*“All the animals had a big meeting. Who was going to carry the egg of life up to the universe? The Kulu was chosen. When you see where the egg of life was carried. Meteorite has landed and dropped, split three ways. This is our memory of the Kulu. And life began,”* (see Figure 10.5).

Yarrungkanyi and Warlpiri of the Northern Territory tell how celestial Dreaming men fell to the earth as falling stars, bringing the Dreaming to the people. The Dreaming men, armed with weapons, travelled through the sky and landed at a place called Purrparlarla (Warlukurlangu Artists, 1987: 127), southwest of Yuendumu<sup>f</sup> (aka Yurntumu, *ibid.*: 4). Another description of a “sky man” falling to the earth is from

<sup>14</sup>This story may relate to the two stones that fell in Hermannsburg at the site of the old church.



FIGURE 10.5: A painting describing the story of Kulu, the meteorite that brought life to earth in Luritja oral traditions. Painting © Trephina Sultan Thanguwa ([www.thanguwa.com](http://www.thanguwa.com)). Reproduced with permission.

Bickerton Island<sup>f</sup>, between Groote Eylandt and the mainland. Connie Bush (Pascoe, 1990: 31–32) recounts a story about a circular spot in the sand that was formed when a “terrific explosion in the sky” towards the west dropped a smoking white object to the earth early in the morning (Event #11). At the supposed impact site, two Aboriginal men saw a white man “standing in the sand up to his knees” about an hour after the impact. The man lived with the community for many years, marrying one of the women and having a child until he finally died. The story notes that the white man’s son died as a young man from a measles epidemic that spread to the island from Groote Eylandt before the arrival of missionaries in 1921. This may be related to a measles epidemic on Bathurst Island in 1913, but it is not clear. This implies that the event occurred during the end of the 19th century, ruling out a plane crash as the cause. According to Bush, the circle is still void of vegetation and shells are placed around the perimeter to remind people where the sky man fell. The discovery of the man and the bolide event may be purely coincidental, or perhaps the two separate events were incorporated into a single storyline.

### 10.5.3 Western & South Australia

In Western Australia, Wirrimanu artists tell a story of a star that fell from the sky to Lake Mackay<sup>f</sup>, explaining that the “Rainbow snake came to this place and ate up a lot of people” (Bevan & Bindon, 1996: 96). No meteorite finds or impact sites are currently known in or near Lake Mackay. Another Dreaming tells of a hunter named Mangowa and how his actions led to a group of stars falling to the earth, forming the circular lagoons that line the coast of the Nullarbor (e.g. Roberts & Mountford, 1965: 52; Smith, 1970: 24; Reed, 1993: 237–239). A Wirangu story describes a meteorite impact near the coastal town of Eucla<sup>f</sup>, close to the border of South and Western Australia (Education Department of South Australia, 1992: 32–33, retold by M. Miller and W. J. Miller):

*“A long, long time ago, a huge meteorite hurtled towards the earth from the northward sky, and smashed into the ground near Eucla. Because it was so*

*big, a dent appeared in the crust of the earth and the meteorite bounced high into the air and out into the Great Australian Bight where it landed with an enormous sizzling splash. It was hot from its trip through space so it gave off a great deal of steam and gas as it sank through the waves. But this was no ordinary meteorite. In fact, it was the spirit Tjugud. In the deep water near by, the spirit woman Tjuguda lay asleep. All the noise around her woke her up and she was very angry. She bellowed and the elements roared with her. The wind blew, the rain pelted from the sky and the dust swirled.”*

Because of the generous use of Western scientific terms in the story (“meteorite”, “crust of the earth”, etc), it is uncertain how close the story is to its original form, assuming it is pre-colonisation. There are no known impact craters on the Nullarbor, but Gibbons (1977: 265) and Bevan & Binns (1989) reveal numerous meteorites that have been found in area, including those found near the town of Forrest<sup>f</sup>, ~ 100 km northwest of Eucla.

A story associating a fiery catastrophe with a large circular depression on the McGrath Flat<sup>f</sup> (aka Magrath Flat) homestead in South Australia prompted Tindale (1938: 18) to conclude that the story described a meteorite impact (Event #15). To date, no meteoritic material has been found in or near the structure, but it is uncertain if the structure has been properly surveyed for evidence of an impact.

When Ngalia men shared sacred information about the *Walanari* (celestial deities who were seen as protectors of good men and punishers of bad men that lived in the Magellanic Clouds) with Mountford (1976: 457), the *Walanari* became very angry and threw glowing stones onto the Ngalia camp later that night. Ngalia informants claim that men have been killed by falling stars thrown by the *Walanari*. They said that when totemic ceremonies were being performed at Mount Doreen<sup>f</sup>, the *Walanari* would throw meteorites to the earth to express their pleasure (see *ibid*, Plate 584).

The Kimberley is rich in stories of objects falling from the sky, as well as floods that indicate tsunamis. Bryant (2001, et al., 2007) proposes a link between these stories, hypothesising that cosmic debris impacted the Indian Ocean creating tsunamis

that devastated the coastline. For example, Bryant (*ibid*) cites published evidence of mega-tsunami on the northwest coast of Western Australia, which he speculates was induced by a bolide impact. As evidence, he cites a rock painting on a rock, called *Comet Rock*, near Kalumburu, which depicts a comet-like motif and lies 5 km from the ocean on a plain covered in a layer of beach sand (as discussed in Section 8.4, see Figure 8.1). Aboriginal oral traditions provide descriptions of a deluge around Walcott Inlet<sup>f</sup> (e.g. Mowaljarlai & Malnic, 1993), covering mesas up to 500 m high (Bryant et al., 2007). One such account (Lucich, 1969: 52–57) describes a Jauidjabaija woman leaving Montgomery Island (Yawajaba Island) and canoeing to an island near the “fountain of the sea” (presumably near the mouth of Walcott Inlet, as it lies  $\sim 25$  km south of Yawajaba Island). The story recounts that the woman was on the coast of the island when the ocean rapidly receded, leaving many sea animals beached. A rushing noise followed some time later and the ocean tide came rushing back, covering the land, including mountains. The flood lasted a day before returning to the sea. Bryant argues that such mega-tsunamis are likely caused by a cosmic impact in the Indian Ocean. Tides in the Kimberleys can vary by as much as 10 m, but such a substantial flood, preceded by a rapid recession of the ocean, indicates a genuine tsunami and not merely a higher-than-normal tide.

An Aboriginal elder from the Kimberleys tells how when a man dies, his spirit is carried to Meteor Island<sup>f</sup> where he sits upon a long, chimney-like rock, regarded as a meteorite (Mowaljarlai & Malnic, 1993: 160). He turns away from his former life, placing his foot on the rock, causing it to overturn and crash into the sea shaking the earth, while his family chants “*Kaaaa-o*”. He then shoots like a rocket into the spirit world. Mowaljarlai and Malnic claim that Meteor Island and Entrance Island are so prone to meteorite falls, that one can simply go out and collect meteorites on the ground and in the sea with minimal effort. No coordinates were given for Meteor Island, but text states that it “lies near Augustus Island ( $\sim 90$  km northeast of Yawajaba Island) further out from Port George” (*ibid*).



A Dreaming story of the Karajaree in the Kimberleys tells how the culture hero Miriny, while wandering with his wives, Wade and Gololo, heard the noise of a bull-roarer (*bolewana*) in the sky and saw tjuringas (also known as *gaellgoro* – sacred stones) falling down from heaven (Worms, 1943/44: 297)<sup>15</sup>, which may describe a meteorite fall. The Worora, just north of Derby, have a children’s story about the moon falling to earth onto two children as punishment for staring at the moon (it was taboo for children to stare at the moon). At the site are two stone pillars representing the children (Lucich, 1969: 33–34).

#### 10.5.4 Tasmania

A story from Bruny Island in southeast Tasmania tells how two star-spirits fought each other and fell to earth in Louisa Bay<sup>f</sup>, where one turned into a large stone that can still be seen today (Coon, 1972: 288). A similar account from the nearby Needwonee is given in Haynes (2000: 57). A story from Oyster Bay<sup>f</sup> tells how fire was brought to the earth by two men who stood on a mountaintop and “threw fire, like a star” that “fell among the blackmen” (Robinson, 1966: 95). The two men live in the clouds and can be seen in the night sky as the stars Castor and Pollux (the Gemini twins). The concept of fire being brought to earth by sky spirits in the form of a falling star is also found among the Yolngu of Arnhem Land, as described previously. Although a direct comparison is made between fire and stars, the story states that fire was thrown *like* a star, not *as* a star.

#### 10.5.5 Queensland & Victoria

While Queensland and Victoria are both rich in stories and descriptions of comets and meteors there were no Aboriginal stories or descriptions of meteorite falls or cosmic impacts in the reviewed literature for Queensland and only one from Victoria. There were brief colonist accounts of meteorite falls or airbursts, such as the Tenham meteorite in Queensland and the Cranbourne meteorites in Victoria. To date, only two

<sup>15</sup>I was unable to obtain the original text from Worms (1940).

impact craters are known in Queensland and both are considerably large and old (see Table 10.1).

The only account found in Victoria is from Cave Hill in Lilydale, east of Melbourne. According to Smyth (1878: 456), the local Wurundjeri people called a deep cavern *Bukkertillibe*, which roughly translates to “bottomless pit”. It was formed when the sky-deity Pund-jel (Bunjil) became angry and caused a star to fall from the sky, striking the earth and creating the hole, killing many people. Bunjil was angry because the people did things that displeased him. This place is now in suburban Melbourne and has been destroyed by the David Mitchell Ltd. quarry. A sculpture commemorating this site is housed at the Lilydale campus of Swinburne University, which adjacent to the quarry<sup>16</sup>.

Victoria has no known impact craters, but several historic accounts of impact or bolide events are reported by newspapers. An historic account<sup>17</sup> from May 1880 near Bairnsdale, Victoria describes a daylight (11:00 AM) bolide that appeared to come from the sun, streak across the sky to the south, eventually exploding into a thousand fragments, illuminating the trees behind which they appeared to fall like a brilliant display of fireworks. Several Aboriginal people saw the event and were

*“exceedingly terrified at the sight, that, after giving vent to the cry, ‘See big one sun’, made direct for all the worldly goods and chattels they possessed, and commenced to make tracks for what they considered the shelter of the town.”*

An colonist account of a meteorite fall and near miss occurred in November 1882 within the Herbert River Valley between Cairns and Townsville in Queensland (Lumholtz, 1889: 175–176):

*“The last evening but one of this expedition a very curious event happened. While we were eating supper we suddenly heard a terrible cry from the*

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<sup>16</sup><http://www.lilydale.swinburne.edu.au/journal/sculpture.htm>

<sup>17</sup>Melbourne Chamber of Commerce Committee’s Annual Report, *Camperdown Chronicle*, 4 May 1880.

*women, who had a camp by themselves farther down the river. After a moment's reflection the men ran down and soon brought the women up to our camp. A stone had been thrown against a rock close by, nearly hitting one of them, and this made them afraid of camping down there alone. They assumed that the stone had been thrown by strange natives, and they requested me to 'shoot the land' to frighten them. When I had fired four or five times they thought they would be able to "sleep first-rate". The next morning I went down to the deserted camp, and they at once pointed out to me where the stone had hit the rock with great force. Close by we also found all the pieces, which together formed a heavy stone about the size of a potato, and was, no doubt, a meteorite."*

Accounts of near-misses by meteorites are not uncommon in Australia. A newspaper report from 11 July 1838 in Perth, Western Australia described a daylight meteorite that struck the Swan River, spraying water "to a height of nearly 20 feet", narrowly missing a boat-full of people<sup>18</sup>. On 29 April 1911, a bolide exploded over Beaufort, Victoria that killed an eagle<sup>19</sup>. Numerous other examples are found in newspaper articles across Australia.

A story from the Torres Strait Islands, which are administered by Queensland, describes a stone that fell from the heavens. The story tells of people camping on the tiny islet of Pulu<sup>20</sup> (near Mabuiag Island<sup>f</sup>). A "great stone" called *Menguzi kula* fell from the sky, crushing everyone except two lovers, who then became the progenitors of the current population (see Haddon, 1904: 22; Róheim, 1971: 370–371; McNiven et al., 2009: 311–313). Torres Strait Islanders are distinctly different from Aboriginal Australians, as they are of Melanesian extraction, having a close cultural and genetic link with Papuans.

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<sup>18</sup>Meteors. *The Colonist*, Sydney, 11 July 1838, p. 3.

<sup>19</sup>An Interesting Meteor. *Australian Monthly Weather Report and Meteorological Abstract*, Vol. 2(4), pp. 24826–B, April 1911.

<sup>20</sup>Pulu is a tiny islet, with an area of  $< 0.5 \text{ km}^2$  and is considered a sacred place (see McNiven, et al., 2009).

TABLE 10.2: Coordinates of the sites of cosmic impact stories or meteorite falls/finds described in this paper, listed alphabetically. <sup>a</sup>Coordinates are of the area between Entrance and Augustus Islands. Cranbourne and Bukkertillibe would appear superimposed on the map, as they are only 40 km from each other.

Name	Latitude	Longitude	State
Augustus Island	15° 20' S	124° 34' E	WA
Bickerton Island	13° 46' S	136° 12' E	NT
Bodena	29° 25' S	146° 40' E	NSW
Bukkertillibe	37° 46' S	145° 20' E	VIC
Caledon Bay	12° 46' S	136° 28' E	NT
Cranbourne	38° 06' S	145° 16' E	VIC
Entrance Island	15° 16' S	124° 37' E	WA
Eucla	31° 42' S	128° 50' E	WA
Forrest	30° 51' S	128° 06' E	WA
Girilambone	31° 14' S	146° 53' E	NSW
Hermannsburg	23° 56' S	132° 46' E	NT
Huckitta	22° 22' S	135° 46' E	NT
Jupiter Well	22° 52' S	126° 35' E	WA
Lake Labyrinth	30° 20' S	134° 45' E	SA
Lake Mackay	22° 35' S	128° 41' E	WA
Louisa Bay	43° 29' S	146° 14' E	TAS
Mabuiag Island	09° 56' S	142° 10' E	QLD
Marabibi	12° 37' S	131° 40' E	NT
McGrath Flat	35° 52' S	139° 24' E	SA
Meteor Island <sup>a</sup>	15° 19' S	124° 37' E	WA
Millbillillie	26° 27' S	120° 22' E	WA
Mount Doreen	22° 06' S	131° 26' E	NT
Oyster Bay	42° 09' S	148° 06' E	TAS
Port George	15° 22' S	124° 42' E	WA
Tenham	25° 44' S	142° 57' E	QLD
Wilcannia	31° 33' S	143° 30' E	NSW
Walcott Inlet	16° 25' S	124° 34' E	WA
Yurntumu	22° 15' S	131° 47' E	NT

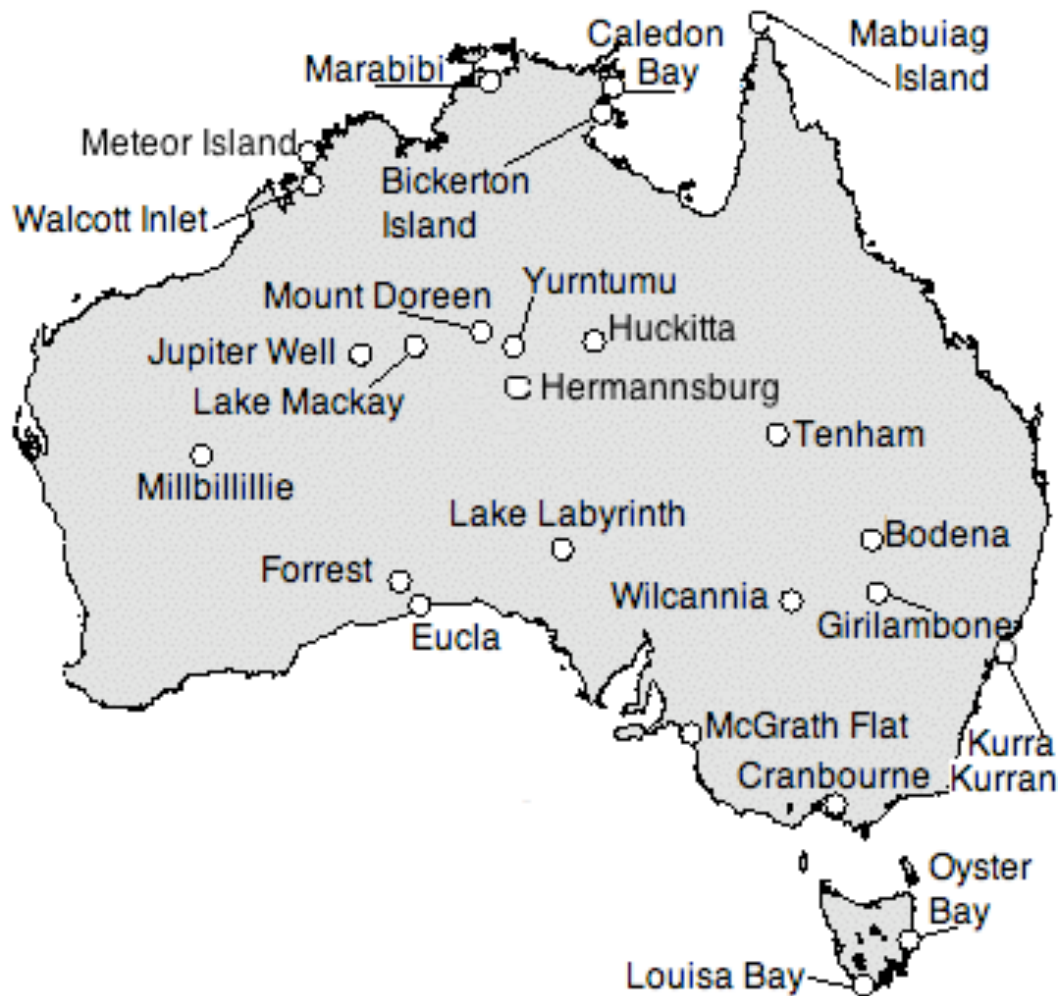


FIGURE 10.6: Sites of cosmic impact stories or meteorite falls/finds described in this chapter. The coordinates of these sites are given in Table 10.2.

## 10.6 Meteorites Falls & Finds

A meteorite fall may be a source of fear or fascination for the peoples who witness the event. Poirier (2005: 237–238) cites an example of a meteorite fall near Jupiter Well<sup>f</sup>, Western Australia that was incorporated into a new storyline, while Madigan & Alderman (1939: 355–356) tell how Aboriginal people would steer clear of the Huckitta meteorite<sup>21</sup> and suggested that they were in awe of the stone, perhaps considering it sacred. In 1879 a shower of meteorites fell near Tenham<sup>f</sup> station in South Gregory,

<sup>21</sup>The Huckitta meteorite was discovered by an Aboriginal worker named Mick Laughton.

western Queensland (Hellyer, 1971). It was reported<sup>22</sup> in 1900 that Aboriginal people were “deadly afraid” of the Warbreccan masses of the Tenham meteorite, suggesting that they had witnessed the fall:

*“They cover them in the bush with kangaroo grass, a twisted gidga bark and mud, and then by boughs over the top. Their idea is if the sun sees them, more stones will be shaken down to kill them”.*

According to Spencer (1937) the Warbreccan stones were taken by an opal dealer named T.C. Wollaston and sold to the British Museum, using an invented story to explain their origins and how he acquired them. The Aboriginal account is taken from files in the British Museum, so this account is considered dubious (although we do not know if the account is fictitious). However, a news article<sup>23</sup> describes an eyewitness account of the Tenham fall on Monday, 25 April 1880 that involved an Aboriginal policemen and their reaction to the event:

*“A few minutes after six o’clock [...] a very large and brilliant meteor shot from overhead and descended in a southerly direction. The meteor appeared to be the size of a six-quart billycan, and was one splendid ball of fire; it left no streak of light after it, and was the largest one I have ever seen. When the meteor had descended about three parts the distance from where I first saw it to the earth, I lost sight of it, as it was passing behind a large dark cloud. I stood looking in the direction the meteor was traveling, when a loud explosion took place in the same direction which slightly shook the ground for miles around; then a loud rushing noise could be heard as though a great blast of air was rushing through a large tube suspended in mid-air. This sound must have lasted for nearly two minutes when it died away. Next morning, when I rode up to Jundah, everyone there wanted to know what the explosion was, and the only conclusion we could arrive at was that when the meteor struck the ground it must have exploded, but we have not been*

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<sup>22</sup>British Museum of Natural History in the meteorite files under “Jhung” and “Tenham”.

<sup>23</sup>Tenham fall, *The Western Champion*, Blackall, Queensland, 19 May 1880, p. 3b.

*able to account for the rushing sound afterwards. Inspector Sharp of the black troopers [an Aboriginal police force] said that when the explosion took place, the house he was in shook very much, and that when he ran out to see what was taking place he saw all the troopers running into the barracks with fright depicted on each countenance. From what I could learn I was the only white man at Jundah who saw the transit of the meteor. It is my opinion that it struck the earth a few miles above Galway Downs, and close to the Barcoo River, or we could not have felt the earth shake when it exploded."*

There were conflicting accounts and dates of the fall recorded in the media (see Spencer, 1937). Although the account states that the Aboriginal policemen were struck with fright, this is an expected reaction for anyone who witnesses such an event.

The Yintjingga of Stewart River in the Kimberleys perceive a meteor as a spirit (*mipi*) and a portent that someone has died. Sometimes the *mipi* "brings his light" and crashes to the earth, creating noise. At the same moment, a "big devil" (*Wo'odi Mükkän*) that sits in a tree drops a "great stone" to the ground (Thompson, 1933: 499). This provides direct links between the meteor, the noise made upon impact, and the presence of a stone at that spot, presumably a meteorite. Thompson noted that the Aboriginal ideas of the stone being dropped from the sky "can be easily understood, for meteorites must at times have been seen actually to fall and bury themselves in the earth" (*ibid*). The Mycoolon of northwest Queensland believe that death resulting from a stone falling from the clouds is a penalty for children eating forbidden food (Palmer, 1884: 294).

However, not all meteorites were viewed negatively. The Mycoolon believe that falling stars strike and penetrate certain Acacia trees, transforming into gum (sap) that is a well-liked food source (*ibid*). Bevan & de Laeter (2002: 18) mention how a group of Aboriginal people would dance around a larger fragment of the Cranbourne<sup>f</sup> meteorite fall (southeast of Melbourne) while hitting it with stone axes, apparently "pleased by the metallic sound it made". The meteorite may have been part of a ritual or ceremony of some kind, which was either unknown or unacknowledged by the colonists. It may also be that the Aboriginal people interacting with the Cranbourne

meteorite did not see it fall and had no reason to fear it, as opposed to the Jupiter Well and Tenham meteorites. Meteorites have been found in deserted Aboriginal camps (e.g. Johnson & McColl, 1967; Alderman, 1936: 542), but there is little evidence for us to know whether the stones had any special significance or practical use.

### 10.6.1 Aboriginal Discovery of Meteorites & Impact Craters

Over the last century, Aboriginal people made significant contributions to the discovery of meteorites and impact craters in Australia. A lunar meteorite was found by an Aboriginal meteorite hunter in the Millbillillie<sup>f</sup> strewnfield in the Nullarbor near Calcalong Creek in Western Australia (Wlotzka, 1991; Hill et al., 1991). According to Hill et al. (1991), the creek derives its name from an Aboriginal word meaning “seven sisters (Pleiades) went up into the sky, chased by the Moon”, although this is not sufficient evidence that the meteorite has anything to do with the name of the creek. Dalgara Crater, located 75 km west of Mount Magnet in Western Australia, was discovered in 1921 by an Aboriginal stockman named Billy Seward (Bevan, 1996: 425) but was not identified as an impact crater until 1938 (Simpson, 1938). An Aboriginal man named Billy Austin witnessed a bright meteor around 5 February 1924 and a small crater was later discovered in the central South Australian desert near Lake Labyrinth<sup>f</sup> approximately 4 m in diameter, with the impacting meteorite 33 m to the west (Spencer, 1937: 353–354). Numerous additional meteorite discoveries have been made by Aboriginal people and are well recorded in the literature (see Hodge-Smith, 1939; Madigan & Alderman, 1939; Barker, 1964; McCall & de Laeter, 1965).

### 10.6.2 Aboriginal Use of Meteoritic Material

Bevan & Bindon (1996) published a comprehensive work on the Aboriginal use of meteoritic material, showing that there was no evidence that Aboriginal people worked meteoritic iron, despite some accounts of Aboriginal people using meteoritic iron for weapons (e.g. Peck, 1925: 152). There is evidence to support the transport of meteoritic material by Aboriginal peoples (*ibid*), but little physical evidence to explain the



use of meteorites or their significance to Aboriginal cultures.

However, the use and role of tektites (glass-like terrestrial rocks formed by meteor impacts) among Aboriginal peoples was studied extensively by Baker (1957) and Edwards (1966), who showed many Aboriginal groups had a number of uses for tektites, including surgical tools and implements used in ritual and ceremony. Some Aboriginal groups in Western Australia and the Nullarbor Plains believed tektites to be magic “sky stones” and associated them with meteors and cosmic impacts<sup>24</sup>.

Gibbons (1977) presents a comprehensive (albeit dated) list of meteorites, impact structures, and meteorite fall/find locations (as of the late 1970s) which can be used, in conjunction with current databases, to correlate associated Dreamings with known meteorite finds or cosmic impacts.

## 10.7 Statistics of Meteorite Falls & Impacts

We now attempt to quantify the meteorite influx rate in Australia, the probability of a person seeing a meteorite-producing meteor from any location in Australia, and the probability of a person being hit or killed by a meteorite or airburst (exploding meteor).

### 10.7.1 Meteoroid Influx Rate

It is difficult to quantify the rate of meteorite falls on earth’s surface given the number of variables and uncertain statistics. However, general estimates can be made using different techniques. One technique is to observe the number of bright meteors over a given area combined with the meteorite recovery rate (see Halliday et al., 1984). The technique used by Halliday et al. derives an annual fall rate, per million km<sup>2</sup>, of 39 for a minimum mass  $m > 0.1$  kg, 7.9 for  $m > 1$  kg, and 1.6 for  $m > 10$  kg. Another technique is to derive a fall rate based on recovered meteorites within a surveyed area (see Zolensky et al., 1990). Using a sample of recovered meteorites within an 11 km<sup>2</sup> area in New Mexico, Zolensky et al. provide a fall rate of  $\sim 940$  meteorites per million

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<sup>24</sup>Daisy Bates, Sky Stones. *Sydney Morning Herald*, 16 August 1924, p. 11d.

TABLE 10.3: The expected annual meteorite fall rate based on estimates given by Halliday et al. (1984) and Zolensky et al. (1990). Land areas are given in  $10^6$  km<sup>2</sup>, sorted by decreasing land area.  $N_{yr}(m)$  is the fall rate per year per minimum mass (in grams). Abbreviations are the same as in Table 10.1. Australia is abbreviated as AU. Values are rounded to the nearest whole number.

State	Area	$N_{yr}(m)$			
	$10^6(\text{km}^2)$	0.01	0.1	1.0	10.0
	1	940	39	7.9	1.6
AU	7.617	7144	296	60	12
WA	2.529	2378	99	20	4
QLD	1.730	1626	67	14	3
NT	1.349	1268	53	11	2
SA	0.983	921	38	8	2
NSW	0.800	752	31	6	1
VIC	0.227	213	9	2	0
TAS	0.068	64	3	1	0

km<sup>2</sup> per year with a mass exceeding 10 g. Table 10.3 lists the expected meteorite fall rates over Australia and each of its states and territories, given these estimates.

During known human habitation of Australia (using a lower limit of 40,000 years), an estimated 286 million meteorites with mass  $> 10$  g have fallen. During periods of lower sea levels, this number is higher because of the larger continent size. While Aboriginal language groups are not spread evenly in size and population density across the continent, a rough approximation of 300 major Aboriginal language groups (Walsh, 1991) of equal size gives a land area of  $\sim 25,300$  km<sup>2</sup> per group, showing that each group would expect approximately 23 meteorite falls per year within their land area, each assumed to be accompanied by a visible meteor<sup>25</sup>. Any attempt to quantify the

<sup>25</sup>However not all bright meteors (often dubbed “fireballs”) produce recoverable meteorites, as many burn up in the atmosphere.

probability of a person being struck by a meteorite or killed by an impact or airburst is difficult. We do not know exactly when humans first arrived to Australia, only a lower limit of 40,000 years. The land surface of Australia has changed as sea-levels rose and fell. We also do not know the population numbers, distribution, or density of people in Australia or the exact timescales for Tunguska-like airbursts. However, using reasonable estimates, we can derive general equations to give us a first-order approximation of the number of people struck and/or killed by meteoritic events, which is the focus of the next two subsections.

### 10.7.2 Probability of Being Struck by a Meteorite

Historic accounts of meteorites striking or killing people are recorded in the literature (e.g. Yau et al., 1994; Gritzner, et al., 1997; Lewis, 1999: 14–25). Accounts from Aboriginal sources include Mountford (1976: 457) who noted that men in Western Australia had been killed by fiery stones thrown to the earth by the Walanari. However, meteorite falls are a relatively rare occurrence at any given location, so what is the probability that a person was struck by a meteorite since humans first arrived in Australia?

Given the number of meteorites that fall per annum as described in the previous section over the land area of Australia ( $N_m = 7144$  for  $m > 10$  g, from Table 10.3) and assuming an evenly distributed constant population of 250,000 people ( $N_p$ ) over the course of human history in Australia ( $T_A = 40,000$  years), we estimate the number of people who have been struck by a meteorite in Australia ( $N_s$ ) as:

$$N_s = \left( \frac{A_H}{A_A} \right) \cdot N_m \cdot N_p \cdot T_A \quad (10.1)$$

Where  $A_H$  is the surface area of a person (from a “bird’s eye view”, estimated at  $0.3 \text{ m}^2$ ) and  $A_A$  is the area of Australia ( $7.6 \times 10^{12} \text{ m}^2$ ). For the values given, the number of human beings struck during the course of Australian human history is about three. Because this happens so infrequently, it is extremely unlikely that the literature would have records of such an event in Australian human history, yet there are

several Aboriginal accounts of people being struck or killed by meteorites. Of course, populations are not spread evenly across the continent and populations fluctuate in number, but the equation in this form will give approximately similar results if the population was confined to a couple of small areas, since meteorites are more likely to struck someone in densely populated areas.

### 10.7.3 Probability of Death or Injury from Cosmic Impacts

To estimate the probability of being within the destruction area of an airburst or impact in Australia, we first determine the area  $A_D$  (km<sup>2</sup>) of devastation caused by an impactor of energy, given in terms ‘of tons TNT’ equivalent (kilotons, kt; megatons: Mt), written as  $E$  (Mt) using the relationship given by Steel (1995):

$$A_D(E) \approx 400 E^{0.67} \quad (10.2)$$

Thus an impact energy equivalent to the Hiroshima bomb (13 kt) would destroy an area of  $\sim 22$  km<sup>2</sup>. Impactors with energies of 1 Mt will devastate an area of 400 km<sup>2</sup>, equivalent to the area of a large city. To estimate the frequency of impacts by impact energy, we estimate the time interval between impacts  $T_i$  (years) of a given impact energy  $E$  (Mt), using Collins et al. (2005: their Equation 3):

$$T_i(E) \approx 109 E^{0.78} \quad (10.3)$$

The 1908 Tunguska airburst in Siberia was estimated to have an energy of 10 Mt from a height of 8.5 km and destroyed  $\sim 2000$  km<sup>2</sup> of Siberian forest, in agreement with Equation 10.2 (Napier & Asher, 2009). Using Equation 10.3, Tunguska-like events are expected about every 650 years. However, other large meteor explosions have occurred within the last century, including the airburst over the Curuçá River, Brazil in 1930 (Bailey et al., 1995; Huyghe, 1996) with an estimated energy of 1 Mt (Chown, 1995) and a Tunguska-like blast over Guyana in 1935 (Steel, 1996). None of these airbursts left a known impact crater or meteorites, consistent with a cometary origin (since comets are composed of mainly low-density ice and dust). All three airbursts occurred when

the earth passed through major meteoroid streams (Napier & Asher, 2009), created by the dust tails of passing comets.

However, the atmospheric dynamics of meteors are still poorly understood and recent research indicates that the Tunguska blast had much lower impact energy than previously estimated (3-5 Mt, see Boslough & Crawford, 2008). Estimates of the time interval of Tunguska-like impacts ranges from once every 650 years (Equation 10.3) to once every 1000 years (Brown et al., 2002). Networks scanning the global atmosphere for explosions were not incorporated until the latter 20th century, so other airbursts could have occurred over the ocean unnoticed. Rocky meteoroids, corresponding to impact energies of up to 1 Mt, often explode high in the atmosphere, having little effect on the earth (Collins et al., 2005). Figure 10.7 shows the estimates of the impact frequency and impact energy of impactors based on several Near Earth Object (NEO) surveys. However, the assumptions and equations used in this paper provide a reasonable first-order approximation for estimating impact probabilities.

The time between impacts within Australia, using a modified version of Equation 10.3, is given as:

$$T_{i_A}(E) \approx 109 E^{0.78} \left( \frac{A_E}{A_A} \right) \quad (10.4)$$

Where  $A_E$  is the area of earth ( $5.1 \times 10^8 \text{ km}^2$ ) and  $A_A$  is the area of Australia ( $7.6 \times 10^6 \text{ km}^2$ ). Equation 10.4 tells us that a 1 Mt event occurs every  $\sim 7,300$  years. This means that  $\sim 5.5$  such events have occurred in Australia over the last 40,000 years. The total number of people we expect would be killed by any single 1 Mt event in Australia is:

$$N_{K_i} = \left( \frac{A_D(E)}{A_A} \right) N_P \quad (10.5)$$

Where  $A_D = 400 \text{ km}^2$  (from Equation 10.2),  $A_A$  is the area of Australia and  $N_P$  is the total estimated average population of Australia (250,000). Equation 10.5 shows that  $\sim 13$  people are killed by any single 1 Mt event. The total number of people killed by all combined impact events ( $N_K$ ) during Australian human history ( $T_A = 40,000$  years) is given by:

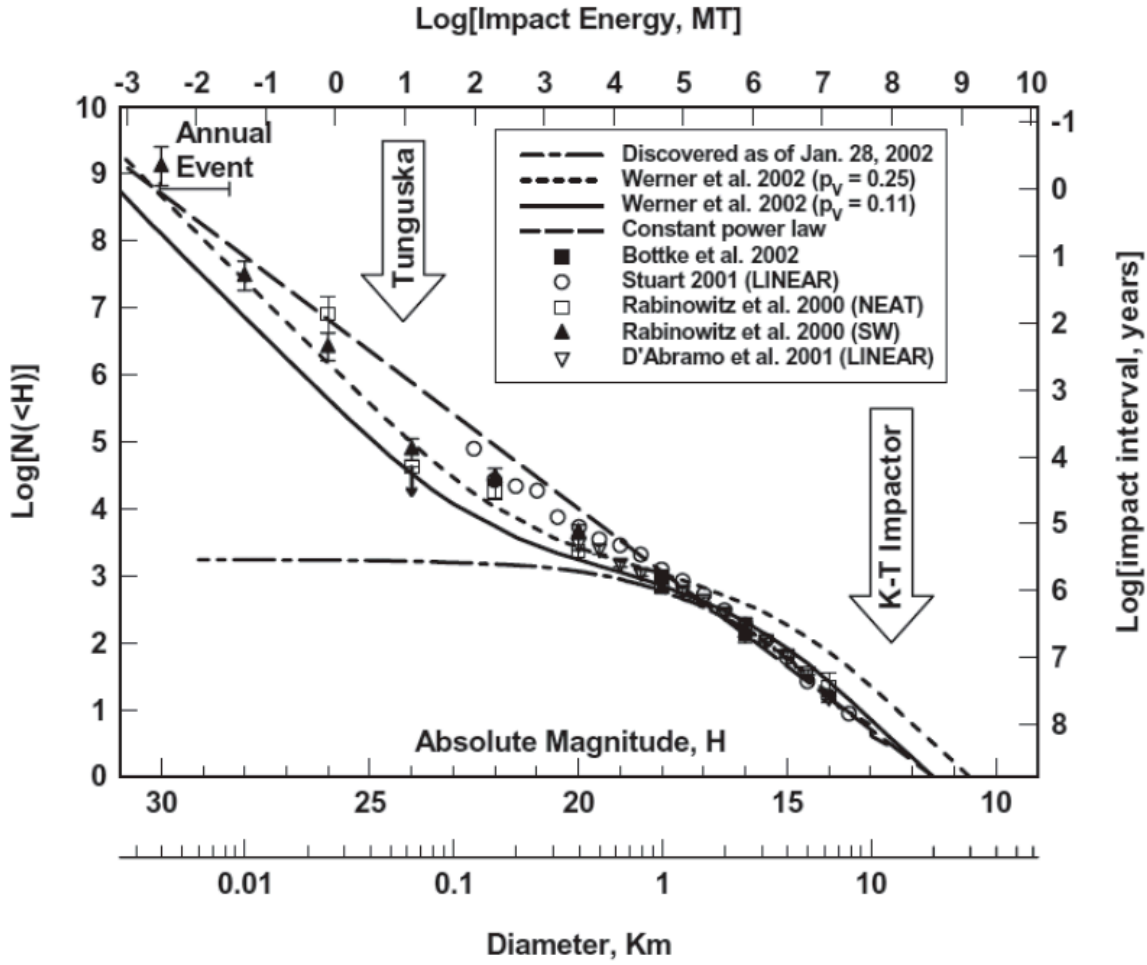


FIGURE 10.7: The impact frequency and energy of Near Earth Objects from several surveys (taken from Morrison et al. (2003), with corrected publication dates). The horizontal axis shows the impact energy and also the meteoroid diameter and absolute magnitude (luminosity) of the NEO. The vertical axis shows the time interval between such impacts and also the expected number of NEOs that are brighter than a given magnitude ( $H$ ). A review of this subject can be found in Ivanov (2008).

$$N_K = N_{K_i} \left( \frac{T_A}{t_{i_A}} \right) = \left( \frac{400 E^{0.67}}{109 E^{0.78}} \right) \cdot \left( \frac{N_P \cdot T_A}{A_E} \right) \quad (10.6)$$

For a 1 Mt event, Equation 10.6 shows that  $\sim 72$  people would have been killed over the course of human history in Australia. Of course, such events would have had an influence on the people in the region that witnessed the event but were not killed. For a 1 Mt event (Equation 10.2), the radius of destruction is  $\sim 11.3$  km from the impact. If we assume that people within a 25 km radius heard or saw the event, which

would have likely caused distress and surprise, then the “area of influence” would be  $\sim 2000 \text{ km}^2$ . This would mean 360 people were “influenced” by such an event during the course of human history in Australia, using Equation 10.6. However, this number should be taken as no more than a rough estimate, since it will depend on how the population is distributed.

Another approach to this problem is to simply estimate the number of language groups that would have witnessed an impact. If we assume 300 evenly spread language groups and estimate that six impact events (with  $E = 1 \text{ Mt}$ , using Equation 10.4) have occurred during the human history of Australia, then only about 1 in 60, or about 5, language groups would have witnessed an impact over the last 40,000 years. Over the last 10,000 years, that number drops to only one. If oral traditions can survive for 10,000 years, we would statistically expect to find only one story. And since many Aboriginal cultures, including their oral traditions, were damaged or lost because of colonisation, we should not be surprised if no groups have an oral tradition about a cosmic impact.

## 10.8 Discussion

I now compare the impact rates predicted by the meteor literature with those indicated by Australian Aboriginal traditions. The results are summarised in Table 10.4. I emphasise that extreme caution is needed when evaluating such subjective material quantitatively and that the following discussion should be treated as a guide to further research rather than as a definitive statement.

Table 10.4 shows that the number of events expected from meteoritic knowledge is comparable to that recorded in oral tradition, with the exception of witnessed destructive events, where the number of stories is about three times higher than that expected. However, the oral traditions sampled here are only a small fraction of those that have originated over the 40,000 years of Australian human history. While the longevity of oral traditions is not known (and remains the topic of debate), we have examples that suggest these records can last thousands of years, including those of the

erupting crater lakes in Queensland (Dixon, 1972: 29), the eruption of Mount Gambier in South Australia<sup>26</sup>, and the traditions associated with the Henbury impacts (Parks & Wildlife Commission of the Northern Territory, 2002: 15)<sup>27</sup>. If we liberally estimate that Dreaming stories have a typical longevity of 10,000 years and that perhaps a quarter of pre-contact Aboriginal cultures have had their oral traditions recorded and published (keeping in mind that some stories are considered sacred and secret and are not shared with outsiders), then the number of stories describing cosmic impacts exceeds the number expected by a factor of about 17, or, in the case of witnessed major impacts, by a factor of about 50. The explanation of this discrepancy may include a combination of the following factors:

1. These stories were not based on witnessed events.
2. These stories have been influenced by Western science.
3. A single story was shared with many other Aboriginal groups.
4. Impact events were more frequent than estimated.
5. Some unacknowledged factor plays a role.

The first possibility is considered if the accounts describing cosmic impacts had few similarities to actual events. In some cases, the description is vague (see Bevan & Bindon, 1996: 96; Lucich, 1969: 33–34), but in other cases, the description closely parallels the scientific explanation (see Peck, 1933: 192–193; Harney & Elkin, 1949: 29–31). The account of a cosmic impact near Wilcannia described by Jones (1989) in Section 10.5.1 is an example of a story that claims the event was witnessed but currently lacks physical evidence to support it (see Steel & Snow, 1992: 572). It is possible that the event occurred elsewhere in the past, at a location yet to be identified by Westerners (Bevan & Bindon, 1996: 95). While this explanation may be the case for some stories, other descriptions of impact events so closely parallel the scientific

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<sup>26</sup>An Aboriginal Legend, *The Sydney Morning Herald*, 8 August 1870, p. 4f.

<sup>27</sup>See Blong (1982) for examples from Papua New Guinea and Masse & Masse (2007) for examples from South America.



explanation that the story being purely fabricated seems unlikely. Prime examples are stories by Peck (1925, 1933). However, because Peck (a Westerner) recorded the stories, it is unknown how much his bias affected his writings.

It is also possible that the impact stories derived from logical deductive reasoning. For example, dropping a rock into the sand may have helped people recognise that larger falling rocks may have created larger craters that are of a similar shape. A smaller impact, such as the one witnessed at Lake Labyrinth, could have prompted elders to create a story about a similar event.

The second possibility is that these accounts were influenced by Western science, with Western information about cosmic impact events being incorporated into oral tradition. This is certainly possible in some cases. For example, the literature records no accounts of the Wolfe Creek crater having cosmic origins before it was known as an impact crater (see Sanday, 2007 versus Bevan & McNamara, 1993: 6). However, we are referring only to what has been recorded in writing. Many of the Aboriginal informants in Sanday (2007) and Goldsmith (2000) claim their stories describing the cosmic origins of Wolfe Creek (*Kandimalal*) were handed down over many generations, before Westerners knew of its cosmic origins, which could very well be the case. This is difficult to prove either way unless a written record exists of the story before the crater was identified by Westerners. Unfortunately, in the case of Gosse's Bluff and Wolfe Creek, no written records have been found describing these structures prior to their identification as impact craters by Western science.

There are existent examples of a story that was shared by several distinct groups, suggesting the third explanation as a possibility. Two of these were described in Section 10.5.1: the Mathews (1994) account and the McKay et al. (2001: 112–114) account. In this case, a single group witnessed an event and the story spread to other communities. However, this indicates that some group must have witnessed a real event, which I showed before is rather unlikely. The oldest recorded story may identify the particular community from which it came, but this evidence is circumstantial.

If the Aboriginal accounts described in this article are records of witnessed events, despite the statistics describing meteorite falls and cosmic impacts discussed above,

TABLE 10.4: Number of meteor events predicted by the meteor literature throughout human habitation of Australia (last 40,000 years) compared with those indicated by Australian Aboriginal oral traditions. For the first line, two other craters (Gosse's Bluff and Wolfe Creek) have impact stories but were formed before human habitation of Australia.

Phenomenon	Evidence	Oral Tradition	Event #
Known craters in Australia formed within span of human habitation.	Three craters known (Boxhole, Henbury, and Veevers).	No oral tradition of being caused by a cosmic impact, except perhaps Henbury, where the stories are secret.	
Meteorite strikes and kills a human.	About three fatalities expected.	One or two fatalities in oral tradition.	16?, 19
Meteorite impacts causing human fatality.	About five events expected.	Seven oral accounts of fatal events.	1, 3, 7, 8, 12, 16, 19
Meteorite impacts causing destruction or crater but not necessarily human fatality.	Expect about five language groups to have witnessed such an event.	17 events (including those involving fatalities) are recorded in the oral tradition.	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 19
Notable bright meteorite impacts but not causing destruction.	Many expected – difficult to quantify.		2, 14, 17, 18, 20

then the evidence suggests that we are underestimating the impact rate, supporting the fourth option. This could be because either the literature on impact rates systematically underestimates rates or impact events are more frequent than previously thought. The distribution of known impact structures is not uniform. For example, 25 craters are found in the Baltic countries and Scandinavia, while the rest of Western Europe contains only four. The remote, dry Australian continent contains 27 confirmed craters, while the much larger and wetter South American continent contains only eight. This indicates that many more impact craters remain to be discovered. In remote, moist areas such as the rain forests of the Amazon, Congo, and Southeast Asia, no confirmed craters have been found. On the ocean floor, which should account for  $\sim 70\%$  of impact craters, the search for these structures is difficult.

The hypothesis that impacts are more frequent than currently estimated was proposed by members of the Holocene Impact Working Group, which claims that some historic catastrophes were caused by impact events (see Baillie, 2007; Firestone et al., 2006; Masse et al., 2007b; Rappenglück et al., 2009)<sup>28</sup>. There are only 11 confirmed Holocene (i.e., within the last 12,000 years) impact sites out of 176 known craters to date (Earth Impact Database, 2009, see Table 10.5). Figure 10.7 shows the estimated impact intervals based on impact energy and impactor diameter. Using the scaling equations of Collins et al. (2005), we expect large impact events (impactors exceeding 1 km in diameter) to occur at intervals  $> 100,000$  years.

Proposed structures from the Australian–New Zealand region suggest that multiple large impacts have occurred over the last few thousand years. These include the Mahuika structure described above as well as two proposed submarine structures named Kanmare (Serpent) and Tabban (Rainbow) that are located on either side of Mornington Island in the southeast corner of the Gulf of Carpentaria (see Figure 10.8, Table 10.6, and Section 10.8.1). The latter two structures are estimated to be approximately 18 km and 12 km in diameter, respectively, based on satellite altimetry, and they have a measured date (first-order approximation) of  $572 \text{ CE} \pm 86 \text{ years}$  (Abbott

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<sup>28</sup>A full list of publications by the group can be found at [tsun.ssc.ru/hiwg/publ.htm](http://tsun.ssc.ru/hiwg/publ.htm).

TABLE 10.5: Confirmed Holocene impacts across the globe, including their names, locations, and ages, ranked according to age. Crater fields are noted, as well as any impact sites with related myths or records of the event. Basic information about the 2007 impact in Peru can be found here: [en.wikipedia.org/wiki/Carancas\\_impact\\_event](http://en.wikipedia.org/wiki/Carancas_impact_event)

Common Name	Country	Age (years)	Crater Field?	Associated Myths or Records
Carancas	Peru	4	No	Various Media
Sikhote Alin	Russia	63	No	Gallant (1996)
Wabar	Saudi Arabia	140	Yes	Bobrowsky & Rickman (2007: 30)
Haviland	United States	< 1000	No	—
Sobolev	Russia	< 1000	No	—
Whitecourt	Canada	< 1100	No	—
Camp de Cielo	Argentina	< 4000	Yes	Bobrowsky & Rickman (2007: 31)
Kaalijärv	Estonia	4000±1000	Yes	Bobrowsky & Rickman (2007: 29)
Henbury	Australia	4200±1900	Yes	Bobrowsky & Rickman (2007: 31)
Kamil	Egypt	< 5000	No	—
Boxhole	Australia	5400±1500	No	—
Ilumetsä	Estonia	< 6600	No	Bobrowsky & Rickman (2007: 29)
Macha	Russia	< 7000	Yes	—
Morasko	Poland	< 10000	Yes	—

TABLE 10.6: Proposed but unconfirmed submarine crater-like structures near Australia and New Zealand, shown in Figure 10.8 (excluding Burckle), including their proposed sizes and ages.

Name	Latitude	Longitude	D (km)	T (years)	Location
Kanmare	16° 34' S	139° 03' E	18	572 CE $\pm$ 86	Queensland
Tabban	17° 07' S	139° 51' E	12	572 CE $\pm$ 86	Queensland
Kangaroo	39° 02' S	141° 16' E	5	Unknown	Victoria
Joey	39° 09' S	141° 11' E	4	Unknown	Victoria
Mahuika	48° 18' S	166° 24' E	20	$\sim$ 1443 CE	New Zealand
Burckle	30° 51' S	61° 02' E	30	< 6000	Indian Ocean

et al., 2007)<sup>29</sup>. Numeric models of these impacts (using Collins et al., 2005) show that Mornington Island and the surrounding archipelago would have succumbed to devastating effects (including widespread fires, impact ejecta, tsunamis, and earthquakes), of which we should expect to find significant archaeological, geological, and environmental evidence. Another alleged submarine structure found in the southern Indian Ocean, Burckle, has a diameter of  $\sim$  30 km and a proposed age of < 6,000 years (Abbott et al., 2009).

In addition, there are several other large, alleged impact structures from the other regions of the world that have proposed dates within the last 6,000 years, for example, the Umm al Binni structure (see Master & Woldai, 2004) and the Chiemgau crater field (see Rappenglück et al., 2009)<sup>30</sup>. To account for this discrepancy, Baillie (2007)

<sup>29</sup>Tester & Abbott (2007) describe the craters as elliptical in shape, indicative of a low-angle impact (< 15°).

<sup>30</sup>Another close pair of submarine crater candidates consist of the 5 km-wide Kangaroo and 4 km-wide Joey structures (Abbott et al., 2006), located south of Portland, Victoria (see Figure 10.8, Table 10.6). Geophysical surveys of these structures are in progress (e.g., Abbott et al., 2006; Elkinton et al., 2006; Martos et al., 2006), although no age estimates have been published. A news account (An Aboriginal Legend. *The Sydney Morning Herald*, 8 August 1870, p. 4f.) of an Aboriginal story describing a massive tsunami that destroyed the region between Portland and Mount Eckersley, Victoria, suggests a potential link to the Kangaroo and Joey craters but includes references to volcanic activity on Mount Gambier, suggesting either a volcanic or landslide event or two separate events

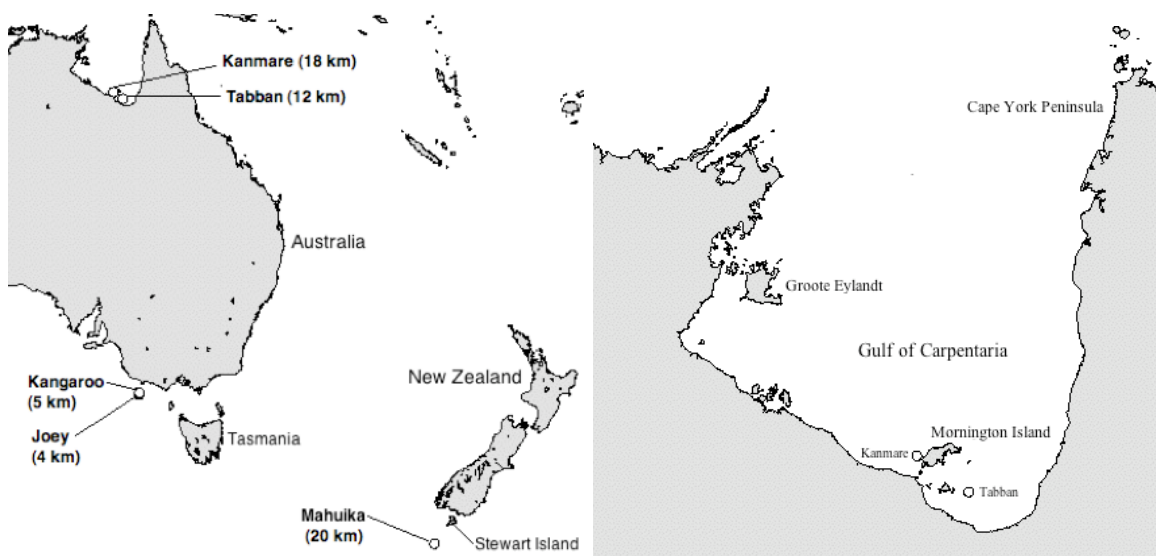


FIGURE 10.8: Proposed submarine impact structures near Australia and New Zealand (Left), which includes their estimated diameter in parantheses, with a zoomed image of the Gulf of Carpentaria (Right).

suggests that these impacts may have originated from fragmented comets or “dark” comets, which have a very low albedo and are difficult to detect (Napier et al., 2004), and that current impact estimates represent very conservative minima.

The main criticism of the hypothesis that several large (multi-km) impacts have occurred in the last few thousand years is that it stands in stark contrast to current estimates of the meteoroid influx rate. Impactors large enough to produce multi-km wide craters are expected to occur on the scale of millions of years, not hundreds or thousands. The hypotheses proposed by Holocene Impact Working Group have been met with criticism and controversy and continue to be heavily debated (e.g., Abbott et al., 2010; Baillie, 2007; Bourgeois & Weiss, 2009; Bunch et al., 2008; Firestone & West, 2008; Gusiakov et al., 2008; Pinter & Ishman, 2008; Rappenglück et al., 2009).

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incorporated into the same story. Any connection between the craters and the Aboriginal account is speculative.



FIGURE 10.9: Proposed chevron dunes on the coastal regions of the Gulf of Carpentaria, including the southeast coast of Groote Eylandt, the eastern coast of Arnhem Land, and Vanderlin Island, that may have been caused by an impact-induced tsunami. The chevrons radiate from the southeast, towards the Kanmare structure, though some researchers argue that chevrons are not caused by tsunamis.

### 10.8.1 A Tsunami in the Gulf of Carpentaria?

Proposed evidence that tsunamis struck the coastal regions of the Gulf of Carpentaria, including Groote Eylandt, Vanderlin Island, and parts of the eastern Northern Territory coast, has been proposed in the form of “chevron dunes”, which Abbott et al. (2007) and Tester & Abbott (2007) argue were formed when submarine sediment and coastal debris were washed inland by a tsunami. The chevrons all appear to strike (radiate) from the southeast, in the direction of Kanmare structure (see Figure 10.9), although this claim is contested (e.g. Bourgeois & Weiss, 2009).

## 10.9 Conclusion

Statistically, we do not expect to find the number of stories associated with cosmic impacts that we do if they are based on witnessed events. None of these descriptions correspond with currently known impact events that occurred during human history of Australia with the possible exception of Henbury. Although some impact/fall events occurred during Australian human history (e.g. Veevers, Henbury, Cranbourne), there is currently no physical evidence that Aboriginal people have been killed by airbursts or impact events (although most of these sites have not been surveyed for corresponding evidence). The statistics quoted in Section 10.7 serve only as a rough first-order approximation. Constrained estimates of the meteorite influx rate, populations of Near Earth Objects, atmospheric dynamics of bolides, and impact effects are required before a rigorous estimate can be made (see e.g. Steel, 1995). The uneven distribution of meteorite craters suggests that impact events have occurred that are not marked by currently known craters. New discoveries of impact craters and meteorite finds in Australia are expected, with two impact structures having been discovered recently using Google Maps.

Given my current statistical estimates, the evidence indicates that impact events were more common in the past than current estimates suggest. I recognise that this conclusion is controversial, but propose that oral traditions can be used to identify impact events/sites unknown to Western science and this hypothesis should be the

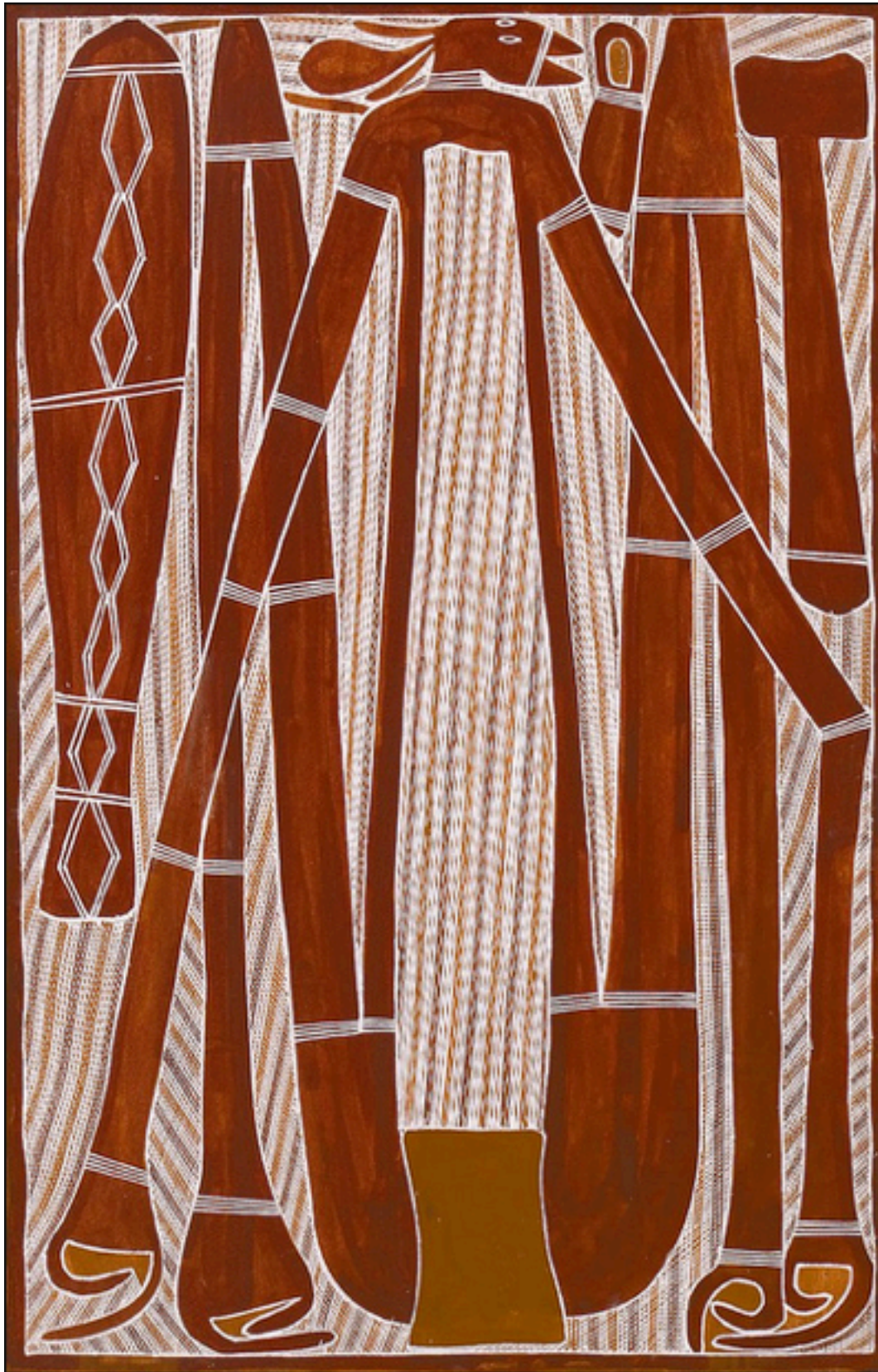


focus of future research.

I examine three possible explanations for why the stories may not be based on witnessed events:

1. The stories are post-colonisation and have incorporated information from Western science,
2. the Aboriginal people independently deduced that impact craters were formed from a cosmic impact, and
3. a single or small number of events were incorporated into oral traditions and spread to other communities across the continent. While we cite evidence supporting each explanation, we are unable to conclude with any certainty which explanation best explains the discrepancy.

I suggest that oral traditions may be used to identify potential impact structures and meteorite finds. Besides the plethora of useful scientific information that would benefit the fields of geophysics, mineralogy, meteoritics, astronomy, and Near Earth Object studies, the information gathered from an impact structure described in Aboriginal oral tradition, including its age, trajectory, and impact effects, could be used to help understand the formation and evolution of particular oral texts over long periods of time. Such information may also be of use in modeling proposed submarine Holocene impact events, such as Mahuika. For this reason, I encourage investigations of the sites mentioned in this chapter and surveys of the areas where cosmic impact stories were recorded, in close association with Traditional Owners and with appropriate permissions.



*Namorrodor — Shooting Star Spirit.* Painting by David Blanesi © 1997.

# 11

## Orientations of Linear Stone Arrangements

The final study of this thesis is to determine if Aboriginal people aligned linear stone arrangements to the cardinal points. The fieldwork component was done with the assistance of Robert Fuller and the Monte Carlo simulations were computed by Ray Norris. Therefore, I use the term “we” instead of “I” when discussing those topics.

### 11.1 Introduction

This chapter represents the first rigorous study of the orientations of stone arrangements in New South Wales (NSW), focusing on linear arrangements (‘stone rows’). Specifically, we test the hypothesis that linear stone arrangements have a preferred orientation to cardinal directions. We accessed site cards from the NSW Aboriginal Heritage Information Management System (AHIMS) database and filtered them

through a rigorous selection process to reject those with insufficient information from which to determine stone row orientations. We then measured the orientations of each stone row described in the site cards. To test the accuracy of information recorded on site cards, a subset of sites were also revisited and surveyed. Monte Carlo statistics were used to test whether or not any preferred orientation amongst linear stone arrangements is the result of chance. Finally, we discuss future work and explore the causes for any preferred orientations.

### 11.1.1 Cardinal Directions in Aboriginal Languages

The concept of cardinal directions is found among several of the hundreds of Aboriginal language groups in Australia (e.g. Breen, 1992, 1993; Edmonds-Wathen, 2011; Haviland, 1996; Kirton, 1987; Laughren, 1978, 1992; McGregor, 1990; Yallop, 1977). While many Aboriginal languages contain names or concepts for four cardinal directions, some languages contain as many as five or six (Laughren, 1978; Nash, 1980; Spencer & Gillen, 1899). Of particular interest with respect to Aboriginal astronomy is whether these directions are based on an abstract concept of relative space, or an absolute concept based on features of the landscape (e.g. Lewis 1976), wind directions, river flow directions or the rising/setting position of the sun.

Guugu Yimithirr speakers from Queensland describe the relative position of objects or places in terms of root words that represent the cardinal directions in four general quadrants (Haviland, 1979, 1993, 1996): north (*gungga*), east (*naga*), south (*jiba*) and west (*guwa*). In terms of gauging directions by solar positions, Kunwinjku speakers of the Northern Territory (NT) may refer to absolute directions in terms of sunrise and sunset, corresponding to *abalkbang manyij* (east) and *wurrying manyij* (west), respectively (Edmonds-Wathen 2011:222). Several language groups in Central Australia have particular words for the cardinal directions, most notable of which are the Warlpiri, who have an entire culture based on a system of cardinal directions (Laughren, 1978, 1992; Nash, 1980). Interestingly, Breen (1993) found that an Alyawarr community in the NT that had migrated to a different region altered the names of the cardinal points by 90°. The reason for this is currently unknown, but Breen noted that the

Wangkumara (QLD) terms for east and west are based on *mirla*, meaning sun. The linguistic relationship between east/west and the sun is also found in the Yirandhali and other Mari languages of QLD (Tindale, 1938/39). In the Yirandhali language, the term for east is *kunggari*, meaning literally *sun get up* (Breen, 1993; Tindale, 1938/39). An identical concept is found near Lake Boga, VIC, where east is *worwalling gnowie*, meaning *where the sun rises* and west is *purticalling gnowie*, meaning *where the sun sets* (Stone, 1911:451).

From this, it is clear that east and west are denoted by the rising and setting sun. However, it is not clear how exact these cardinal directions are to scientific definitions of cardinal directions based on the rotational axis of the earth. Breen (1993) tested the accuracy of various words representing cardinal directions in several different areas by asking Aboriginal people and found that the direction, as compared to a compass, ranged rather dramatically – up to 90dg in some cases, leading Breen to suggest that the names for cardinal directions represent a vague area rather than an exact direction, and it would be unreasonable to expect a person to even try to be exact (Breen, 1993: 28). Breen also concluded that, if people were placed in a new area with an unfamiliar topography, they would require the sun to determine direction by during the day, or the stars at night. If dropped in an unfamiliar area on a cloudy day, one would essentially be unable to determine the cardinal points (Breen, 1993: 27). In some regions, cardinal directions play a role in burial rituals. In NSW, for example, graves were found with the dead buried in a sitting position, facing east (Dunbar, 1943; Mathews, 1904: 274).

### 11.1.2 Stone Arrangements

Common to many Aboriginal cultures were stone arrangements of various designs and morphologies, including circles, lines, pathways, standing stones and cairns, with purposes that ranged from practical (e.g. fish traps, land boundaries) to mythological, and ceremonial/ritual (e.g. initiation or burial; Flood, 1999a).

Stone arrangements vary in size from a few meters to hundreds or even thousands of meters in length or diameter and are typically constructed from local rocks that are small and movable by one or two people, although occasionally they can weigh as much

as 500 kg (Lane & Fullagar, 1980; Long & Schell, 1999). The ages of stone arrangements are unknown, but smaller arrangements are likely on the order of hundreds of years old, as sedimentation and disruption by natural processes would likely have buried or destroyed older arrangements.

McCarthy (1940) suggested that stone arrangements used for ceremonial purposes incorporate the surrounding landscape, and may indicate the direction of a landmark or mimic a land feature. The results of the current study indicate that many of the stone arrangements examined were on a hill or a location of higher elevation that commanded a panoramic (full or partial) view of the surrounding landscape. Flood (1999b: 239–240) notes that in NSW, elevated sites were preferred for ceremonies, such as male initiation, or Bora, ceremonies. Bora sites were generally made of stone or raised earth in the form of two circles connected by a pathway (a project measuring the orientations of Bora sites in southeastern Australia is underway by Bob Fuller, Duane Hamacher, and Ray Norris).

Some researchers have noted that stone arrangements align to cardinal points in southeastern Australia and Tasmania. Examples include Black (1945: 212–213) and Flood (1999b: 208) who both describe linear stone arrangements oriented to a North/South direction and Bartholomai & Breeden (1961: 233) and Winterbotham (1957: 38) who describe ceremonial stone arrangements oriented to the East/West or North/South. Other examples include the Wurdi Youang and Carisbrook stone arrangements in Victoria, which are oriented to the cardinal points (Hamacher & Norris, 2011; Massola, 1963).

For a further treatise on stone arrangements, the interested reader is referred to Attenbrow (2002), Bannerman & Jones (1999), Black (1950), Campbell & Hossfield (1964), Dow (1939), Enright (1937), Frankel (1982), Kelly (1968), Lane (2009), Lane and Fullagar (1980), Long and Schell (1999), Love (1946), Massola (1968b), McCarthy (1940), Palmer (1977), Ross (2008), Ross & Ulm (2009), Rowlands & Rowlands (1970), Towle (1939a, 1993b), and Winterbotham (1949).

## 11.2 Methodology

### 11.2.1 Archaeological Site Cards

Aboriginal sites and artefacts in NSW are registered with AHIMS and administered by the NSW Office of Environment & Heritage. Information about each site is stored on archaeological site cards submitted by both professionals and amateurs: these can vary significantly in the quality and quantity of information provided. Therefore, the accuracy of the data collected is difficult to assess without physically resurveying each site. Not all existing stone arrangements are registered with AHIMS and some sites cards are restricted owing to their cultural sensitivity; no restricted sites were included in this study.

We examined 643 stone arrangement site cards from AHIMS (Figure 11.1), developing a rigorous selection process to cull sites that did not provide useful data. We rejected sites that did not meet all of the following five criteria:

- The arrangement must be clearly Aboriginal in origin<sup>1</sup>;
- The stones must form an unambiguous linear pattern;
- The arrangement must consist of at least five stones of comparable size;
- The linear pattern of stones must not clearly be a smaller component of a larger, non-linear structure, such as a circle, animal motif, or other pattern;
- A map or directions and a photo, diagram or a sufficient description of the site must be available.

Of the 643 AHIMS site cards examined, 618 were rejected as not meeting the criteria, leaving 24 sites consisting of 32 stone rows (Table 11.1); parallel rows (pathways)

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<sup>1</sup>Rows of stone were sometimes constructed as survey markers or borders by Europeans: these are generally called survey lockspits. These can mimic Aboriginal stone rows and some have been identified along the NSW/ACT border. All stone rows in our final dataset were cross-checked against the locations of known lockspits and rejected if they were discovered to be one.



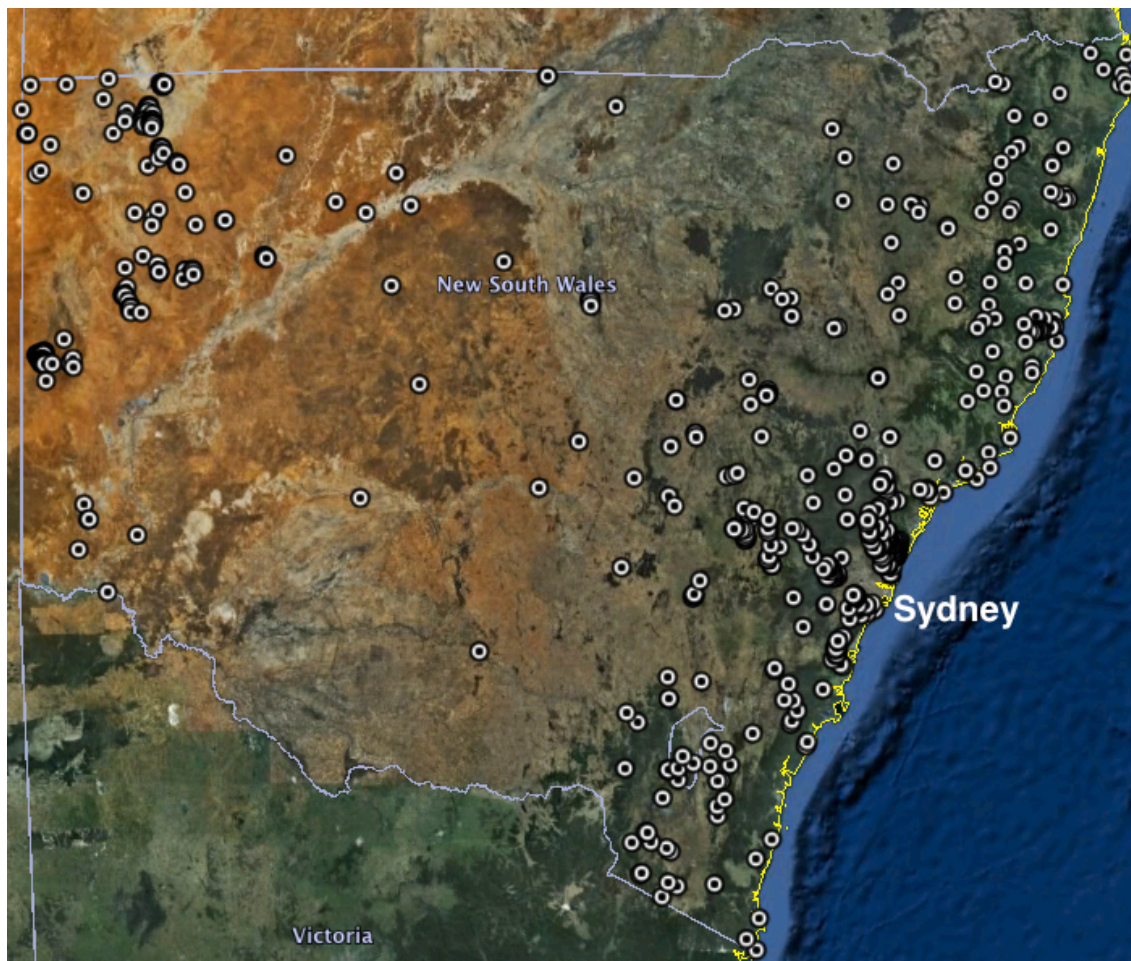


FIGURE 11.1: All sites identified in NSW as stone arrangements in the AHIMS database (includes the ACT). Image generated using Google Earth.

were categorised as a single row. Five of the sites contained multiple stone rows (12-2-0028, 12-5-0056, 28-2-0005, 44-6-0019, 45-4-0217). Although site card 44-6-0019 shows a stone circle, the three stone rows within the circle (two parallel rows to the north and one to the east) were included because they were distinct within the arrangement and not merely a straight component of the overall circle. Sketches of the stone rows, as shown in the site cards, are given in Figure 11.2. Some site cards provided orientations but not sketches.



TABLE 11.1: The general locations of the 24 sites in this study. Coordinates provided are for location within 10 km of the site so as to protect their specific location but give the reader an overall impression of their distribution. Data includes the site card number, Mercator projection zone, general coordinates, elevation, and the number of rows at the site ( $N$ ), totaling 32.

Site Card	Zone	Latitude ( $^{\circ}$ )	Longitude ( $^{\circ}$ )	Elevation (m)	N
03-5-0010	56	-28.8	152.1	960	1
12-2-0028	56	-29.1	152.3	980	2
12-5-0047	56	-29.6	152.2	880	1
12-5-0056	56	-29.8	152.1	1100	2
17-1-0006	55	-30.9	146.6	200	1
20-2-0005	56	-30.4	150.9	820	1
20-3-0015	56	-30.2	151.3	1000	1
20-3-0016	56	-30.2	151.3	1000	1
25-3-0057	55	-31.2	145.4	240	1
27-2-0004	55	-31.3	147.6	160	1
28-2-0005	55	-31.3	149.3	540	5
37-5-0206	56	-32.6	150.9	480	1
37-6-0471	56	-32.9	151.0	160	1
44-6-0019	55	-33.5	149.9	820	1
45-3-2147	56	-33.2	151.1	180	1
45-4-0217	56	-33.7	150.5	460	2
45-6-0224	56	-33.7	151.2	420	1
51-1-0053	55	-34.0	149.0	700	1
51-6-0250	55	-34.7	150.0	680	1
52-2-2245	56	-34.5	150.7	500	1
52-2-3253	56	-34.5	150.7	460	1
52-5-0343	56	-34.5	150.7	560	1
57-4-0209	55	-35.8	148.9	1660	1
62-4-0127	55	-36.7	148.5	300	1

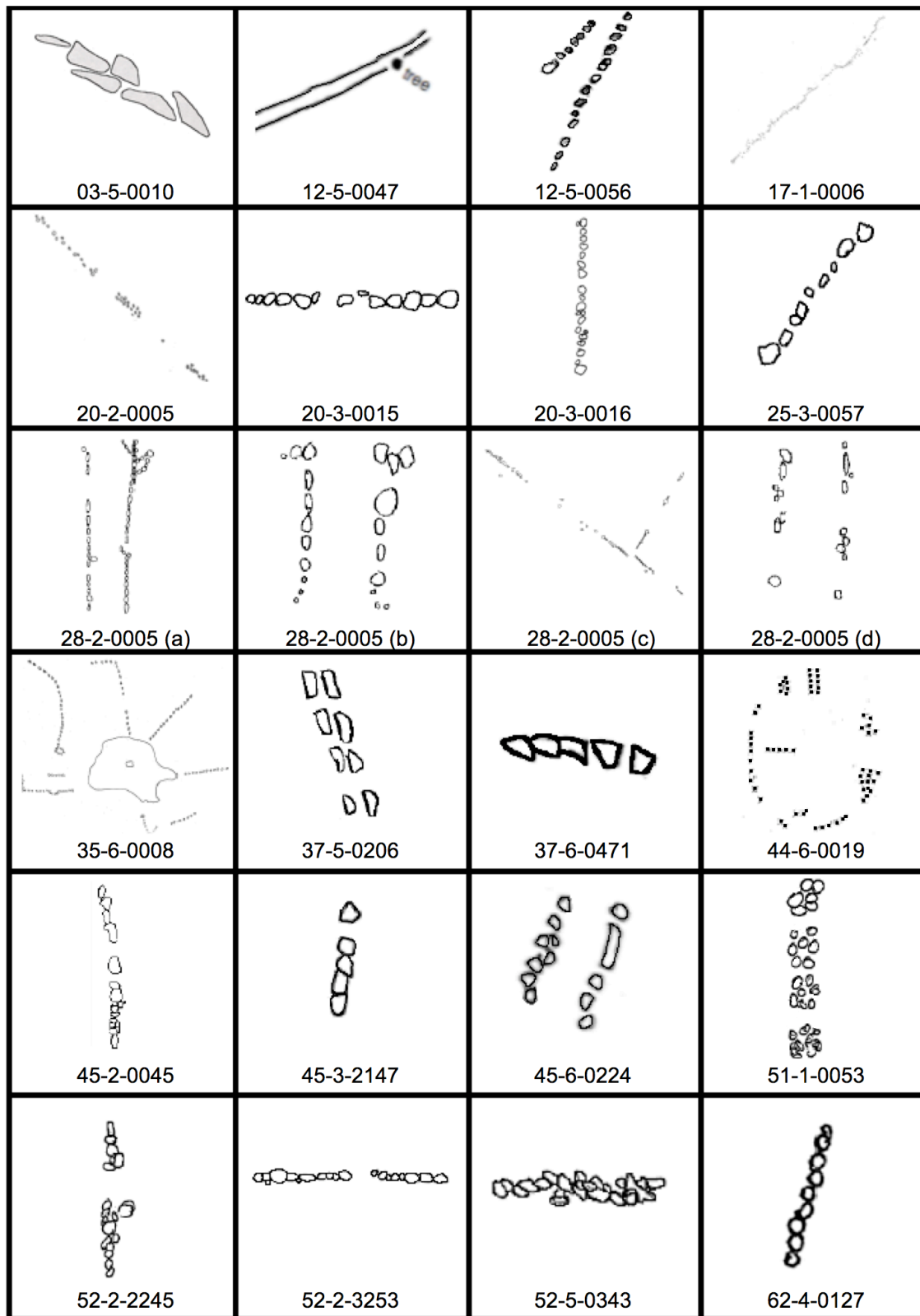


FIGURE 11.2: Stone arrangement sketches from the site cards. The stone rows have been cropped from the rest of the sketch in most cases (except 44-6-0019). Site 45-2-0045 was removed when it was revealed to be a survey lockspit and 35-6-0008 was rejected when I visited the site and found that the orientation was incorrect and the overgrowth concealed the arrangements. These arrangements were not used in this study. Sites that provided only a description or a photo are not included. North (as labeled in the site card) is to the top of the page. Images are not to scale with respect to each other.

### 11.2.2 Site Card Measurements

Using information provided on the site cards, we measured the azimuth of each stone arrangement (Table 11.2) using the compass azimuth if provided or by using a protractor and ruler on graph paper. Azimuths are given between  $0^\circ$  and  $179^\circ$ , with  $0^\circ/180^\circ$  representing north/south, and  $90^\circ$  representing east/west. Azimuths measured with a magnetic compass (i.e. that measures direction with respect to the magnetic north pole) in NSW are between  $9^\circ$  and  $13^\circ$  greater than their azimuth with respect to true (geographic) north. The difference between true and magnetic north is called *magnetic declination* ( $D_{\text{mag}}$ ). We used an online program provided by Geoscience Australia<sup>2</sup> to calculate  $D_{\text{mag}}$  using the geographic coordinates provided in the site cards, the elevation taken from Google terrain maps (with a relief of 20 m) and the date of the original site recording as noted on the site card.  $D_{\text{mag}}$  was calculated for every site and then added to the measured azimuth (Table 11.2); however, only five of the 24 site cards discriminate between true and magnetic north (the latter by indicating **MN**). The remaining site cards either labeled north as N or stated the orientation with no reference as to whether magnetic declination had been corrected for. For this reason, we only use the corrected azimuths (i.e. those determined by subtracting  $D_{\text{mag}}$  from the azimuth) for five sites in the analysis.

### 11.2.3 Field Survey Methods

To test whether the surveyors corrected for magnetic declination, we surveyed a subset of the 24 sites (Figure 11.2). Of these, we were unable to gain access to 17, either because of their remote location or our inability to contact or obtain permission from the traditional owners, the current landowners or NSW Parks & Wildlife. Sites 12-2-0028 and 45-6-0224 had been previously destroyed, Site 44-6-0019 was damaged, we were unable to physically relocate Site 45-4-0217 (which may have been destroyed since initial recording) and dense vegetation had grown over Site 35-6-0008 such that it was impossible to clearly identify the stones in any of the several arrangements noted on

<sup>2</sup><http://www.ga.gov.au/oracle/geomag/agrfform.jsp>

TABLE 11.2: Linear stone arrangements remaining after the application of selection criteria, giving the Site Card number, the azimuth measured from the site card ( $Az_{SC}$ ), the magnetic declination at each site ( $D_{mag}$ ), the azimuth corrected for  $D_{mag}$  ( $Az_C$ ). The five site cards with an asterix denoted north as magnetic.

Site Card	$Az_{SC}$	$D_{mag}$	$Az_C$	Date	Site Card	$Az_{SC}$	$D_{mag}$	$Az_C$	Date
	( $^{\circ}$ )	( $^{\circ}$ )	( $^{\circ}$ )			( $^{\circ}$ )	( $^{\circ}$ )	( $^{\circ}$ )	
03-5-0010*	120	11.112	131	Jun-77	51-1-0053	0	11.801	12	Dec-93
12-2-0028	0	11.277	11	Oct-97	51-6-0250	90	12.393	102	Jul-04
	90	11.277	101		52-2-2245	0	12.552	13	Jul-98
12-5-0047*	65	11.388	76	Nov-95	52-2-3253	90	12.552	103	Jul-98
12-5-0056	27	11.428	38	Sep-97	52-5-0343	90	12.552	103	Jul-98
	43	11.428	54		57-4-0209	0	12.415	12	May-06
17-1-0006	47	10.071	57	Jan-91	62-4-0127	15	12.616	28	Jul-81
20-2-0005	134	11.178	145	May-81					
20-3-0015*	178	11.301	189	Aug-79					
20-3-0016*	90	11.301	101	Aug-79					
25-3-0057	38	9.738	48	Jun-79					
27-2-0004*	90	10.496	100	Feb-91					
28-2-0005	1	11.005	12	Dec-79					
	3	11.005	14						
	0	11.005	11						
	32	11.005	43						
	125	11.005	136						
37-5-0206	157	11.958	169	Apr-94					
37-6-0471	101	12.101	113	Oct-90					
44-6-0019	0	11.970	12	Sep-78					
	90	11.970	102	Sep-78					
45-3-2147	2	12.242	14	Jun-93					
45-4-0217	0	12.238	12	Nov-92					
	90	12.238	102						
45-6-0224	16	12.467	28	Apr-92					

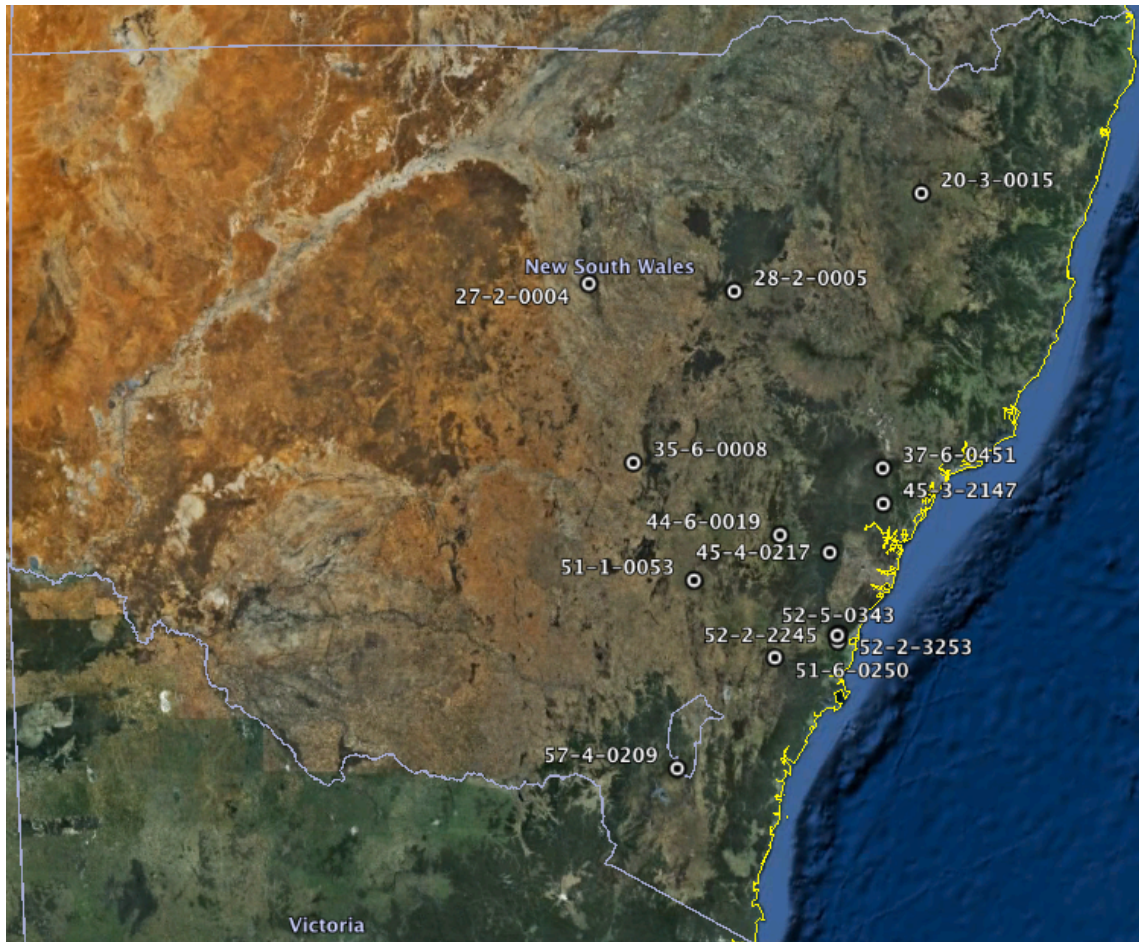


FIGURE 11.3: All sites that were selected to be surveyed for analysis. Images generated using Google Earth.

the site card (accordingly this site was also excluded from analysis). The sketch for Site 35-6-0008 did not indicate north, but it was assumed to be at the top of the page. However, upon visiting the site this assumption was proven incorrect based on the orientation of a large rock in the centre of the site. As such, Site 35-6-0008 was also excluded from analysis. Given time constraints, we were unable to survey three of the five rows at Site 28-2-0005 in detail. We surveyed five sites (Table 11.3) using a standard military lensatic compass, a Sokkisha C40 (D10355) automatic level (dumpy), stadia rod, tape measures and a hand-held GPS as follows:

1. The stones on each end of the linear arrangement were identified.

2. The leveled dumpy was placed 1 m from one end-stone along the axis of the end-stones, using a weighted string over the point on the ground to ensure accuracy.
3. The stadia rod was placed on the centre of the opposite end-stone.
4. Using the sight on the dumpy as an alidade, the magnetic azimuth of the stadia rod was measured by aligning the compass sight-wire along the dumpy sight to the edge of the staff.
5. Using the dumpy and stadia rod, the topographic relief was recorded along the stone row.
6. Each stone was numbered and its dimensions recorded.
7. The position of the centre of each stone was recorded relative to the line connecting the end-stones.
8. The site was photographed.
9. The presence of Aboriginal artefacts or art in the area was noted.

For the purposes of analysis the azimuths of parallel stone rows were averaged. This data is provided in Table 11.4, where all measured azimuths are rounded to the nearest degree (errors are discussed in the following section).

#### 11.2.4 Error Analysis

The two general errors that affect the measurements of stone rows are (1) site card errors and (2) our field survey errors. Site card errors include the accuracy of the original sketch, the accuracy of the survey methods and the skill of the surveyor. These errors are difficult to quantify without visiting the site. Some site card drawings are not to scale and represent only rough sketches. However, if the sketch of the site is taken to be accurate, the main source of error stems from physically measuring the azimuth given in the site card using a ruler and protractor. Both the site cards and our field surveys are subject to the same three general errors in measuring the azimuth, as described below.

TABLE 11.3: A list of the sites, showing whether or not the site was accessed, whether they had cardinal orientations, sites surveyed, the current condition of the site, and whether the site cards indicated magnetic north (MN). Sites that were surveyed are marked X, while sites that were visited but not surveyed are labeled V.

Site Card	Accessibility	Cardinal	Surveyed	Condition	MN
03-5-0010	None			Unknown	X
12-2-0028	None	X		Destroyed?	
12-5-0047	None			Unknown	X
12-5-0056	None			Unknown	
17-1-0006	None			Unknown	
20-2-0005	Granted		X	Good	
20-3-0015	None	X		Unknown	X
20-3-0016	None	X		Unknown	X
25-3-0057	None			Unknown	
27-2-0004	Granted	X	X	Good	X
28-2-0005	Granted	X	X	Good	
37-5-0206	None			Unknown	
37-6-0471	None			Unknown	
44-6-0019	Granted	X	X	Damaged	
45-3-2147	None	X		Unknown	
45-4-0217	Granted	X	V	Unidentified	
45-6-0224	Granted	X	V	Destroyed	
51-1-0053	Granted	X	X	Good	
51-6-0250	None	X		Unknown	
52-2-2245	None	X		Unknown	
52-2-3253	None	X		Unknown	
52-5-0343	None	X		Unknown	
57-4-0209	None	X		Unknown	
62-4-0127	None			Unknown	

### Errors in Measuring the Magnetic Azimuth

The azimuth of the stone row surveyed in the field was measured by taking several compass bearings and averaging them. The compass bearings varied by a maximum of  $\sim 2^\circ$ , which we consider to be the human error estimate.

### Errors in Magnetic Declination

The Earth's magnetic field varies over time, causing the  $D_{\text{mag}}$  to shift at any given location by  $\sim 0.3^\circ$  over a 25 year period. The azimuths recorded in the site cards were recorded as early as 1977 (33 years prior to our resurvey), thus giving an azimuthal error of  $0.3^\circ$ . If the location and elevation of the site and the date of the survey are known, the azimuthal error is reduced to only  $\sim 0.001^\circ$ . However, local magnetic anomalies can cause variations of up to  $4^\circ$  (Goulet 2001), such as the influence of iron-bearing stone.

The Great Dividing Range of eastern Australia, where many of the stone arrangements are found, is volcanic in origin. Volcanic (igneous) rocks, such as basalt, are typically iron-rich and in fact, many of the stones forming the arrangements are composed of basalt. Therefore, we use an upper error estimate of  $4^\circ$  to account for this effect.

### Errors in Measuring the Dimensions of Each Stone

The dimensions of each stone were recorded, including their maximum width, length and height (with respect to the ground surface). The width and length are relative to the  $x$  and  $y$  axes, as determined by the orientation of the two end-stones. The positions of each stone were recorded with respect to the midpoint of the width and length. Since measurements are taken from the centre of each stone with an accuracy of  $\pm 0.02$  m, the azimuthal error for an arrangement with an average length of 7.5 m is  $\sim 0.3^\circ$ .



### Final Error Estimates

The human error ( $2^\circ$ ), the error from local magnetic anomalies ( $4^\circ$ ), the error in magnetic declination ( $0.001^\circ$ ) and the error in measuring the dimensions of the stones ( $0.3^\circ$ ) are used to calculate an error of  $\sim 5^\circ$  ( $\pm 2.5^\circ$ ) for the surveyed azimuth ( $\sigma_{\text{mag}}$ ), given as:

$$\sigma_{\text{mag}} = \sqrt{(2)^2 + (4)^2 + (0.001)^2 + (0.3)^2} \approx 4.5^\circ \quad (11.1)$$

To account for this error in the analysis, azimuths are grouped into  $5^\circ$  bins. Because the value of  $\sigma_{\text{mag}}$  is dominated by magnetic anomalies and human error, we apply an error of  $5^\circ$  to orientations of stone arrangements in the site cards. However, we do not know how accurate the surveyors were in recording the azimuths, so this can only be considered an approximate estimate based on our quantified estimates.

## 11.3 Results & Statistical Analysis

### 11.3.1 Site Cards

The site card data consisted of 32 azimuths from 24 sites, mapped as a histogram shown divided into  $5^\circ$  bins centered at  $0^\circ$  (N/S) and  $90^\circ$  (E/W), as shown in Figure 11.4. As demonstrated, there is an unambiguous preference for cardinal orientations, with nine azimuths in the N/S bin and seven in the E/W bin. To test whether or not these peaks could occur by chance, we use Monte Carlo statistics. Monte Carlo statistics sample probability distributions to produce millions of possible outcomes, which is useful for determining the likelihood of something occurring by chance (Fishman 1995; Vose 2000).

A Monte Carlo simulation was performed in which 39 random angles were assigned to any one of the 36  $5^\circ$  bins from  $0^\circ$  to  $180^\circ$ . After running one billion ( $10^9$ ) simulations, in only  $\sim 6000$  of the simulations did any bin contain nine or more azimuths, showing that the probability of getting a peak of nine in any one bin is approximately  $6 \times 10^{-6}$ .

The site card azimuths did not attain a peak of nine in any random bin, but in the

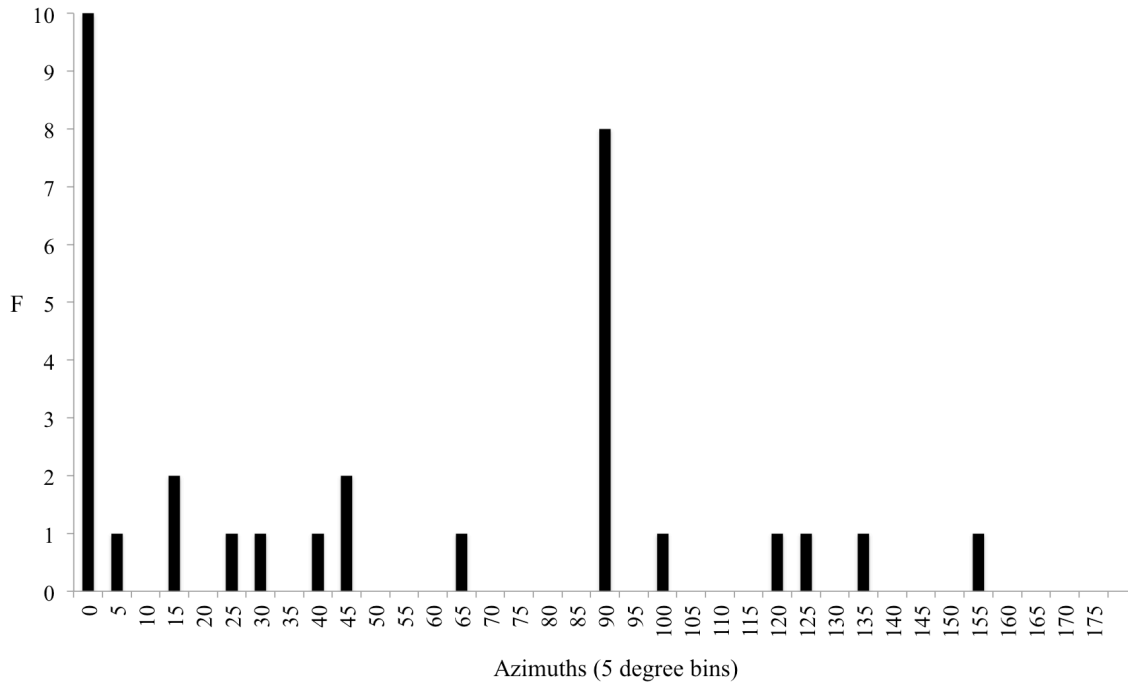


FIGURE 11.4: A histogram showing the azimuths of stone rows from the site cards. Measurements have an estimated error of  $5^\circ$ , which is why they are given in  $5^\circ$  bins.

bin centered at  $90^\circ$ . This occurred in only 1600 of the one billion simulations, implying that the probability of a peak centered at  $90^\circ$  occurring by chance is  $1.6 \times 10^{-6}$ . In none of the one billion simulations were peaks of nine or more obtained in both the  $0^\circ$  and  $90^\circ$  bins. We estimate the probability of obtaining two such peaks (at  $0^\circ$  and  $90^\circ$ ) to be approximately  $2 \times 10^{-12}$ . From this, we conclude that if the site cards are accurate, the preferred orientations of the stone rows are not the result of chance alignments.

### 11.3.2 Field Survey Measurements

To check the accuracy of information reported on the site cards, we surveyed a subset of six stone arrangements at five sites. Table 11.4 gives the azimuths for the six arrangements. To compare the accuracy of information on the site cards with the resurveyed data, we calculated the mean ( $\bar{\theta}$ ) and standard deviation ( $\sigma_{Az}$ ) of the difference between the surveyed azimuth and the site card azimuth ( $\Delta Az = Az_{SC} - Az_F$ ). Given six data points for  $\Delta Az$  from Table 11.4,  $\bar{\theta} = 11.7^\circ$  and  $\sigma_{Az} = 8.2^\circ$ .

The magnetic declination at the sites resurveyed ranged from  $10.5^\circ$ – $12.0^\circ$ , with a mean ( $\bar{D}_{\text{mag}}$ ) of  $11.3^\circ$  and a standard deviation ( $\sigma_{D_{\text{mag}}}$ ) of  $0.56^\circ$ . Because  $\bar{D}_{\text{mag}}$  is within  $1\text{-}\sigma$  of  $\bar{\theta}$ , it seems the site cards were probably not generally corrected for  $D_{\text{mag}}$  by the surveyors (i.e. most of the surveyors probably recorded the magnetic compass bearing rather than true North). The surveyed azimuths represent a small percentage of the site card azimuths ( $\sim 15\%$ ), so the remaining sites need to be surveyed to determine more accurately whether the arrangements are aligned to true or magnetic north.

TABLE 11.4: Data for all surveyed linear stone arrangements, including the site card number, the azimuth measured from the site card data ( $Az_{\text{SC}}$ ), the magnetic declination ( $D_{\text{mag}}$ ), and the azimuth calculated from a field survey ( $Az_{\text{S}}$ , which was corrected for  $D_{\text{mag}}$ ).  $m$  is the slope of the linear best fit,  $\chi^2$  is the chi-squared distribution,  $\theta_c$  is the correction angle, and  $Az_{\text{F}}$  is final calculated azimuth from the survey, measured with respect to true north.  $\Delta Az$  is the difference between  $Az_{\text{SC}}$  and  $Az_{\text{F}}$ . All azimuths are rounded to the nearest degree with an error of  $5^\circ$ . The northerly row at site 44-6-0019 had been destroyed by tree felling and bulldozing as noted in the site card.

Site Card	$Az_{\text{SC}}$	$D_{\text{mag}}$	$Az_{\text{S}}$	$m$	$\chi^2$	$\theta_c$	$Az_{\text{F}}$	$\Delta Az$
	( $^\circ$ )	( $^\circ$ )	( $^\circ$ )	( $^\circ$ )		( $^\circ$ )	( $^\circ$ )	( $^\circ$ )
20-2-0005	133	11.2	108	+0.0051	0.07	+0.3	119.5	14
27-2-0004	90	10.5	89	−0.0313	0.24	−1.8	97.7	8
28-2-0005	181	11.0	165	−0.0079	0.24	−0.5	175.5	6
	183	11.0	175	−0.0182	0.12	−1.0	185.0	2
44-6-0019	0	12.0						
	90	12.0	63	−0.0064	0.00	−0.4	74.6	15
51-1-0053	180	11.8	143	−0.0018	0.05	−0.1	154.7	25

We now determine whether or not the orientations of the entire dataset can be accounted for by chance. To account for the uncertainty in whether or not the azimuths were given with respect to true or magnetic north, we present the survey data with the site card data in  $10^\circ$  bins and smooth it using a 3-bin boxcar convolution (to account for uncertainty in whether or not  $D_{\text{mag}}$  was corrected), given as:

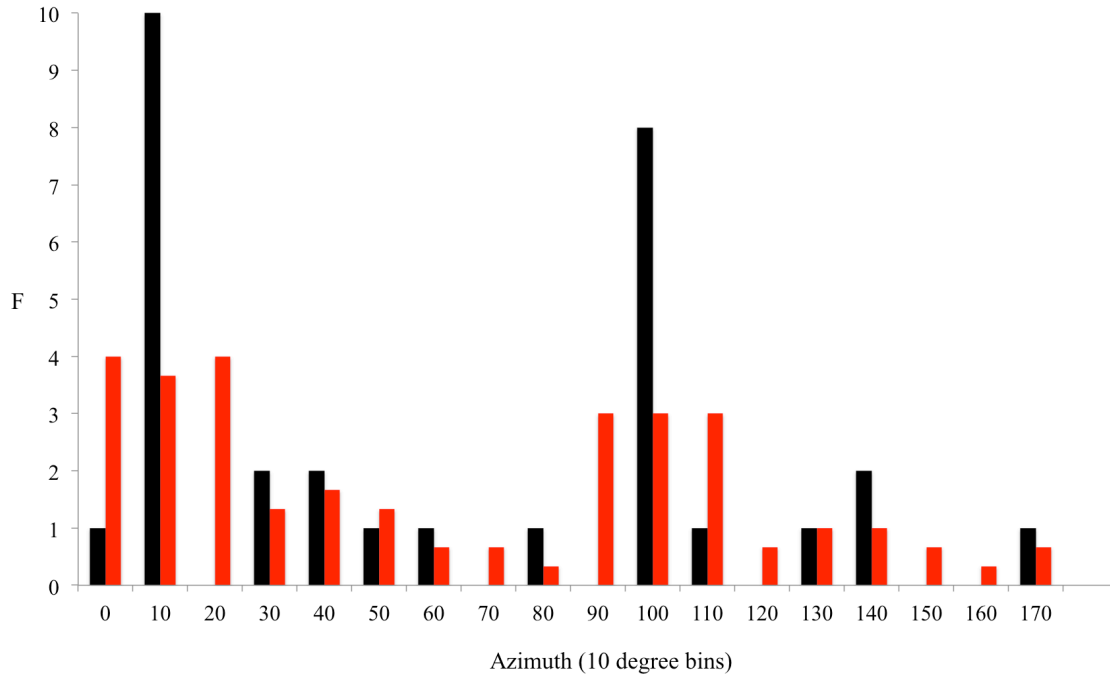


FIGURE 11.5: A histogram showing the azimuths (black) and the smoothed data (red) in  $10^\circ$  bins. This represents the entire data set corrected for  $D_{\text{mag}}$ , assuming all site cards gave magnetic north, as indicated by the analysis. The data is smoothed to account for uncertainty.

$$\text{bin } n = \left[ \frac{\text{bin } (n-1) + \text{bin } (n) + \text{bin } (n+1)}{3} \right] \quad (11.2)$$

Where  $n$  is each given bin in the histogram. The smoothed data is given in Figure 11.5. For the unsmoothed (original) data,  $10^5$  Monte Carlo simulations were performed, of which 650 attained a peak of 10 in the  $0^\circ$  or  $90^\circ$  bins. This gives a chance probability of 0.7%. For the smoothed data, the same number of simulations was performed, with a peak of 4.0 in the  $0^\circ$  bin occurring less than 0.5% of the time.

## 11.4 Discussion & Conclusion

From these results, it is apparent that there are two preferred orientations for linear stone arrangements: a lesser preference towards east/west and a greater preference towards north/south. To explain the preferred cardinal orientations, we consider three possibilities:

1. The stone rows were constructed by Europeans with a preferred orientation to cardinal points;
2. The stone rows were systematically drawn or described by the surveyors as having preferred cardinal orientations, despite the stone rows not actually having this preference; and,
3. The stone rows were constructed by Aboriginal people with a preferred orientation to cardinal points.

Possibility 1 depends on whether or not the stone arrangements are Aboriginal in origin. The first criterion in selecting stone rows for this study is that they were constructed by Aboriginal people. Some of the site cards identified arrangements that were European in origin (e.g. survey lockspits). These site cards were rejected during the selection process and all of the sites that passed this criterion are argued to be Aboriginal in origin based on their morphology, proximity to other Aboriginal artefacts (such as scarred trees and rock art), or their identification as such by members of the local Aboriginal community. Thus, we reject the position that these arrangements are European in origin.

Possibility 2 depends on the accuracy of information recorded on the site cards. The surveyors state in several of the site cards that their drawings are not to scale and were only rough sketches or descriptions. Since the mean Az for the surveyed sites ( $\bar{\theta}$ ) is  $11.7^\circ$ , it is within  $1\text{-}\sigma$  of Dmag at the sites surveyed ( $11.3^\circ$ ). This shows that the surveyors are reasonably accurate in recording their findings, except that they generally did not correct for magnetic declination.

Possibility 3 is that the arrangements are Aboriginal in origin and that Aboriginal people oriented stone rows to cardinal directions, both of which are supported by the site card information and the data analysis. However, we are puzzled as to why these arrangements seem to be oriented to magnetic north. There is currently no evidence that Aboriginal people used any form of magnetic compass. Since we have determined that the arrangements are not European in origin, it indicates that the bias may lie with the surveyors. It is probable that the surveyors used a compass and took a

general orientation, but did not place emphasis on high accuracy (which is why we say “reasonably accurate”). We do not know what percentage of the site cards gave magnetic or true north without revisiting each site. The smoothed data accounts for this uncertainty and shows us that preferred cardinal orientations are within the error limit.

This chapter is a preliminary test to see if linear stone arrangements have a preferred orientation to the cardinal points. Our analysis suggests that they do, but we were only able to survey a small subset of sites and are not certain of the reliability of the remaining site cards. Future work will involve locating and surveying as many arrangements as reasonably possible to better constrain our estimates. The geographical range of the sites surveyed in this paper is significant, ranging from the northern tablelands near Armidale to the southern slopes near Canberra and from the coast to central NSW. Most of the stone arrangements belong to different Aboriginal language groups. To overcome uncertainties, it would be ideal to survey a number of stone arrangements within a particular language group to see if these orientations remain statistically significant.

Future work should also focus on understanding how the orientations were estimated and what the purpose was in orienting stone arrangements to these points. We currently do not know the reason these arrangements were oriented to the cardinal points, but we can suggest ways these points were estimated. It may be that east/west orientations are related to the rising and setting position of the sun in the sky as noted by some Aboriginal cultures, such as the Wangkumara and Yirandhali. Other stone arrangements in Australia have been found with precise east/west orientations, such as Wurdi Youang (Hamacher & Norris, 2011). North and south are 90° to east and west, and the concept of right angle orientations is found in some Aboriginal cultures (e.g. the Warlpiri and Guugu Yimithirr). South can be roughly determined at night by locating the south celestial pole and looking in the direction of the horizon directly below this point. A number of techniques can be used to accomplish this, such as noting the midpoint of a circumpolar star. An Aboriginal man and educator from Port Lincoln, South Australia said that Venus was a good indicator of west, as it shone

brightly at dusk and is near the sun (Pring, 2002: 9). Another Aboriginal man from South Australia said he could tell direction at night based on the position of the Milky Way – it would stretch from east to west during the winter, and from north to south during the summer (*ibid*). These techniques are approximations of finding the cardinal directions; they are only accurate to within several degrees. For example, the position of the rising or setting sun on the horizon can vary by nearly  $35^\circ$  either side of due east or west. These extreme rising/setting positions occur at the summer and winter solstice. The only time the sun rises exactly at due east or sets due west is at the vernal or autumnal equinox.

We cannot currently say with any certainty why these structures were oriented to the cardinal directions or how those directions were determined, but examples across Australia give us clues. The concept of cardinal directions is found in the cultures of several Aboriginal groups and techniques for finding the cardinal points based on the positions of astronomical bodies are known, providing plausible explanations on which to base future work.





# 12

## Summary & Conclusion

*“The Aboriginal hunter was a keen observer of natural events. He followed the course of the sun in the heavens and the waxing and waning of the moon in the night skies. He identified the regular course of the constellations and watched as meteors flash across the sky.”*

— Louise A. Allen (1975: 95)

This thesis asks if Aboriginal Australians were astronomers in the scientific context, and if so, how scientific information was encoded into Aboriginal culture. Using definitions of science by Historians of Science, I explored several examples of how Aboriginal people understood and made use of celestial phenomena for practical, predictive, and cultural purposes. I showed that Aboriginal people were careful observers of the night sky, noting the changing brightness of particular stars, the complex motions of

the sun and moon, and the relationship between the positions of celestial objects and terrestrial events, such as changing seasons or the availability of new food sources. Aboriginal people also oriented stone arrangements to cardinal directions. From this, it is clear that scientific knowledge is found in Aboriginal culture and this knowledge was couched in the language of art and oral tradition. This shows that Aboriginal people practiced science, which Pingree (1992) defined as “*a systematic explanation of perceived or imaginary phenomena, or else is based on such an explanation*” and that “*mathematics finds a place in science only as one of the symbolic languages in which scientific explanations may be expressed*”. This scientific knowledge, expressed in the language of art and oral tradition, was incorporated in to Aboriginal culture over time.

As I discussed throughout the thesis, the astronomical knowledge presented in this research is not divided between pre- and post-contact. Some of the knowledge was post-contact, such as the Great Eruption of Eta Carinae, while other knowledge is very likely to be pre-contact. Aboriginal knowledge is dynamic and this research addresses Aboriginal astronomical knowledge collected since 1788. A summary of the results and conclusions from each chapter is given below.

### 12.0.1 Dating Techniques

In Chapter 5 I provided an age limit to oral traditions based on cosmic/terrestrial connections. The traditions are generally  $< 7,500\text{--}10,000$  years old. This suggests that astronomical traditions changed to incorporate new information as the positions of stars changed, which is driven by precession of the equinoxes. The technique of using stellar proper motion and radial velocity to estimate an age of a particular star pattern (asterism) shows that these patterns could be tens of thousands of years old (20,000 years for Crux representing an eagle’s footprint). The technique of using oral traditions that may describe celestial events or star positions in the distant past proves problematic, as the descriptions are usually ambiguous and are too open to interpretation to make a definitive identification.

### 12.0.2 Eta Carinae

In Chapter 6 we showed that the Boorong people observed the Great Eruption of  $\eta$  Carinae in the nineteenth century, which was identified using Stanbridge's description of its position, colour, brightness, designation, and the relationship between stellar brightness and positions of characters in Boorong oral traditions. This supports the argument that Aboriginal sky knowledge is dynamic and not static. The observations by the Boorong represent the first and only definitive indigenous record of the Great Eruption of  $\eta$  Carinae identified in the literature to date. This is clear evidence that Aboriginal people were careful observers of the night sky.

### 12.0.3 Eclipses

In Chapter 7 I explored the role of the sun and moon with a focus on eclipses. I showed that some Aboriginal groups acknowledged the relative motions of the Sun–Earth–Moon system and the relationship of lunar phases to events on the Earth. The Yolngu people of Arnhem Land provide the most complete evidence as they identified that the Sun and Moon move in an east to west motion across the sky, the Moon goes through repeated phases that affect the ocean tides, the Earth is finite in space, and the Moon covers the Sun during a solar eclipse. Particularly important are the accounts that Aboriginal people explained that lunar eclipses were associated with the Sun. Unexpected transient phenomena, such as eclipses, are relatively rare. This is probably the reason that eclipses are reported to be associated with fear and anxiety and why they are generally associated with negative attributes, such as death and disease.

### 12.0.4 Comets

In Chapter 8 I described the perceptions of comets in Aboriginal cultures and showed that they are typically associated with fear, death, omens, malevolent spirits, and evil magic, consistent with many cultures around the world. The relatively sudden and effectively unpredictable nature of comets are the likely driving force behind their

generally negative views. It is unclear whether comets had always been viewed with fear or whether this fear was triggered by a coincidental catastrophic event and the appearance of a comet. The origin and/or nature of comets was most commonly associated with smoke or human hair. It is curious why total solar eclipses are more common in Aboriginal oral traditions than comets, as the latter are a much more frequent phenomenon. This may come from difficulties in identifying comets when translating language or interpreting descriptions in oral tradition.

### **12.0.5 Meteors**

In Chapter 9 I presented a comprehensive analysis of Aboriginal Australian perceptions of meteors. It is no surprise that meteors are found rather extensively in Aboriginal traditions, as they are a fairly common occurrence. Like comets and eclipses, many of these perceptions are associated with fear, death, omens, and war. Descriptions of meteors are included in ritual and ceremony and focus on inciting harm to others or providing protection from harm. Some perceptions possessed positive attributes, such as benevolent spirits or good omens. The remaining stories describe neutral attributes, such as the role of meteors in initiation ceremonies, definitions of meteors, or views of meteors that are considered neither good nor bad. Although researcher bias certainly played a role in how accounts are recorded, there is little evidence to suggest that this explanation is the primary reason for these similarities. The most probable explanation, as with comets and eclipses, is that unexpected and random celestial phenomena are viewed with fear because they disrupt an apparently ordered and predictable cosmos.

### **12.0.6 Cosmic Impacts**

In Chapter 10 I explored whether Aboriginal people had witnessed impact events or deduced that meteors, meteorites, and impact craters are all directly related. Numerous oral traditions described impact events or attributed an impact origin to some craters. Statistically, we do not expect to find the high number of stories associated with cosmic impacts that we do if they are based on witnessed events. Although some impact/fall

events occurred during Australian human history (e.g. Veevers, Henbury, Cranbourne), there is currently no physical evidence that Aboriginal people have been killed by airbursts or impact events, although records of this happening are found in oral records. Based on the sheer number of reported impact events, I estimate that the meteoroid influx rate is significantly higher than expected, assuming these records are describing actual events. The uneven distribution of meteorite craters suggests that impact events have occurred that are not marked by currently known craters. I hypothesise that these oral records might be used to identify impact/fall sites that are currently unknown to Western science. I also propose that people could have been killed by airburst or impact events in the past. Oral records of particular events, such as Henbury, suggest that the memory of the event survived in oral traditions to modern times, supporting the hypothesis that oral traditions can survive for thousands of years.

### **12.0.7 Stone Arrangements**

Finally, in Chapter 11 I explored the hypothesis that stone arrangements have a preferred orientation to the cardinal points. A literature survey showed that many Aboriginal groups possessed the concept of cardinal directions, which played a major role in some groups. A preliminary analysis of archaeological data from reports and site cards showed that linear stone arrangements had a clear preference for cardinal orientations. Monte Carlo simulations of these orientations showed that they were not the result of chance. To test the accuracy of the site cards, a subset of the sites were surveyed. This showed that the site cards are reasonably accurate but that most surveyors probably did not correct for magnetic declination. An analysis of the data revealed a preference for N/S and E/W azimuth ranges.

Three reasons for preferred cardinal orientations were explored and it was concluded that Aboriginal people constructed these arrangements with a deliberate preference to cardinal orientations, although a preference for magnetic orientations is probably the result of surveyor bias. The exact reasons why Aboriginal people oriented stone rows to the cardinal points is uncertain, but may relate to the position of astronomical bodies such as the Sun, Venus, and the Milky Way as noted by Aboriginal people.

Understanding the reasons for cardinal orientations in stone arrangements is the focus of ongoing research.

## 12.1 Conclusion

In conclusion, I have shown that scientific knowledge is encoded in Aboriginal culture through the language of art and oral tradition. This knowledge was based on careful observations and measurements of the positions of celestial bodies and involved making predictions of future events, such as seasonal change, animal breeding patterns, food economics, and time keeping. This knowledge changed as the positions of celestial bodies gradually changed.

Not all of the studies in this thesis were conclusive. The Aboriginal explanation for the origins of some astronomical phenomena, namely comets, is still ambiguous, as most historical accounts refer to colonists noting the reactions of Aboriginal people to bright comets instead of an explanation regarding their origin or physical nature from Aboriginal people. It is also apparent that the people recording these stories did not have the appropriate background, as they confuse different astronomical objects and phenomena.

Many other astronomical phenomena and their perception and role in Aboriginal culture need to be better understood, such as aurorae, planets and their motions, navigation by stars (a topic I did not address in this work), and other variable stars. During the course of this work, my advisors and I have been contacted by several Aboriginal custodians who wish to share their knowledge, traditions, and material sites relating to the night sky. Many historical records exist that are full of astronomical information that still needs to be synthesised and analysed. A plethora of material sites, such as stone arrangements, rock art, and artefacts exists with potential connections to the sky. This is all the focus of future work.

This research has set the stage for future work including understanding the role of astronomy in culture and its use as a practical tool. This must be done in close collaboration with the proper Indigenous stakeholders, as it is their knowledge and

culture about which we are learning. The investigation, promotion, and dissemination of Indigenous culture and knowledge **must** be done on their terms and with a proper degree of acknowledgment and respect maintained at all times.

## 12.2 Communication & Education

It is essential for this work to be available to Indigenous communities, educators, researchers, and the general public. It is for this reason that I began the Aboriginal Astronomy Project blog in which I publish the latest research, events, educational materials about Aboriginal astronomy or biographical information about Aboriginal elders and custodians.

<http://aboriginalastronomy.blogspot.com>

The blog has been very successful, having achieved over 30,000 views between March and December 2011 alone. It is used as a source of information by several schools, museums, observatories, and planetariums. Future work in the subject needs to include a substantial educational component. Misunderstanding Indigenous culture is a detriment to understanding the role of science as well as public perception. An incident in 2010 illustrates this point. Professor Barry McGaw, chairman of the Australian Curriculum Assessment and Reporting Authority, stated on 4 March 2010 that references to the Aboriginal Dreamtime should not be incorporated into the curriculum for Year 4 school students:

*“One of the references in an elaboration and idea for teachers in the science curriculum was to introduce the Dreamtime as a description of the origin of things, and that is not a matter of science”<sup>1</sup>.*

In an era when pseudo-sciences, such as creationism and “intelligent design”, are constantly battling to establish a foothold in the education system, such a statement comes as no surprise. It is clear that the context of the Dreaming, and the scientific

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<sup>1</sup>*Dreamtime cut from curriculum*, ABC News, 4 March 2010.

knowledge contained within, is not well understood by the public, or even politicians and scientists in high ranking government positions. It is for this reason that this work be communicated to everyone, and astronomy is an effective way in which to garner public interest (see papers in Section IV of Ruggles, 2011a). I am currently involved in a number of projects involving education and outreach, such as continuing public talks, working with Indigenous elders and communities, working with schools, developing educational tools and packages, developing planetarium and observatory programs, promoting research findings, maintaining close ties with journalists and media outlets, and writing books and papers that are accessible to both academics and the general public.

It is my hope that this ongoing research will inspire students, both Indigenous and non-Indigenous, to turn their interests skyward and for non-Indigenous Australians to gain a better understanding of, and greater appreciation for, the oldest continuous cultures on Earth.



Giving a lecture on Aboriginal Astronomy to the Alexandria Park Community School in Redfern, Sydney.





# The Life & Legacy of William E. Stanbridge

The Hon William Edward Stanbridge (Esq, M.L.C., J.P.) was a prominent figure in colonial Victoria during the second half of the nineteenth century. After leaving England to pursue his fortune in Australia, he became a wealthy pastoralist and mining investor, a prominent politician, philanthropist, supporter of women's suffrage, and a writer of Aboriginal knowledge, yet little has been written about his life. His papers on Boorong society and astronomy are not only the only records of that culture in the literature, but continue to yield new discoveries 150 years later.

## A.1 Introduction

During the early days of colonial Australia, the Hon. William Edward Stanbridge (Esq, M.L.C., J.P.) left an indelible mark on education, philanthropy, womens suffrage, and

Aboriginal knowledge. Although little is written about him, his impact on Australian history has not gone unnoticed. In addition to his role as a wealthy pastoralist, philanthropist, politician, and supporter of womens rights, it is of his role as a promoter of Aboriginal knowledge that he is now arguably best known. His contribution to Aboriginal celestial knowledge was the first published on the subject and is still influential to this day.

## A.2 Personal Life

William Edward Stanbridge was born on 1 December 1816 in the village of Astley, near the city of Coventry, in Warwickshire, England to Edward and Anne (née Crofts) Stanbridge. His paternal grandparents were William and Edith Stanbridge, Esq. of Coventry (Burke, 1891; de Serville, 1991: 239), where William worked as a silkman and served as an alderman and later the mayor (1797–1798). W.E. Stanbridge had a brother, Oliver Thomas, and a sister, Edith (Burke, 1891: 299). Unfortunately, little is published about his childhood, education, or young adult life in England. At the age of 24 Stanbridge left England to seek his fortune in Australia.

In November 1841, Stanbridge arrived in Port Phillip, Victoria. Over the next few years, he partnered with Lauchlan McKinnon and moved around Victoria and South Australia to learn about managing sheep stations (Morieson, 1996), including Broken River, Victoria in 1842, Mount Gambier, South Australia in 1846, and Avoca, Victoria in 1847 where he managed the East Charlton run (a table of events is given in Table A.1). In September 1847, he was issued a pastoral license for Tyrrell Station, being the first non-Indigenous person to do so, on the east side of Lake Tyrrell in northwest Victoria (which he originally named Astley's after the village of his birth), which he maintained until January 1873 (Billis & Kenyon, 1932: 143). In 1848, Stanbridge was given a license for land near Wimmera<sup>1</sup> and in 1851, he purchased Holcombe Run and the 64,000 acre Wombat Run (Wombat Flat) in 1852<sup>2</sup> (Billis & Kenyon, 1932: 221).

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<sup>1</sup> *The Argus*, Melbourne, 10 November 1848, p. 4.

<sup>2</sup> *The Argus*, Melbourne, 12 December 1848, p. 1.

The rich mineral springs, including those of Spring Creek, and the discovery of alluvial gold on Wombat Flat brought Stanbridge substantial wealth. In 1854, Government Surveyor Fraser laid out a town site that became the township of Daylesford, as named by Governor Charles Hotham (MacDonald & Powell, 2008), of which Stanbridge is considered a prominent founder. Stanbridge Street in Daylesford is named in honour of his contribution as a founding father and mayor of the city. In addition to his land holdings in Victoria, Stanbridge held land in Clare, New South Wales, approximately 170 km northeast of Lake Tyrrell (Burke, 1891: 298).



FIGURE A.1: “North View from Daylesford” (1864) by Eugene von Guerard (1811–1901), whilst residing at Wombat Park, commissioned by Stanbridge. This painting depicts a working mine in the foreground, which is almost certainly the Garibaldi mine. The mountain due north in the middle distance is Mount Franklin, an extinct volcano and the centre of the Loddon Aboriginal Protectorate (1839–1949); slightly to the left of the mountain in the distance is Mount Tarrengower, present day Maldon. The track on the ridge at the left of the painting is the track between Daylesford and Hepburn. The gully in the left foreground is Kidd’s gully named after Alexander Kidd, a prominent early settler. To the right of the Garibaldi mine and just outside the painting was the Concordia tunnel, a rich alluvial mine and one which was successfully worked for the Stanbridge family, who received one-sixth of the gold as royalty for mining on their land. The Garibaldi mine was across the creek and to the left of Wombat Park. Countrytowns Productions © 2000 ([www.artistsfootsteps.com/html/vonGuerard\\_Daylesford.htm](http://www.artistsfootsteps.com/html/vonGuerard_Daylesford.htm)).

As a successful pastoralist and mining investor, Stanbridge’s income provided him a standard of living among the wealthy elite in Victoria. The extensive gardens on his Daylesford property were famous in his day and remain so today, now known as

Wombat Hill Botanic Gardens (Foster, 1989: 8, 79; Orr–Young, 1997; Figure A.1). On 21 August 1872, at the age of 56, he married Florence Colles, aged 21 (b. 1851), the youngest daughter of Richard Colles of Castlemaine, Victoria. They were wed at the Christ Church<sup>3</sup> in the Melbourne suburb of Hawthorn, Victoria by the Rev. William Wood<sup>4</sup>. On 1 August 1878, Florence gave birth to William’s only child, a daughter. Tragically, Florence died during childbirth at the age of 27. Stanbridge named his daughter Florence Colles Stanbridge after her mother<sup>5</sup>.

Stanbridge died a wealthy man in Daylesford on 5 April 1894 at the age of 77<sup>6</sup> and was laid to rest in a family vault at the Daylesford cemetery (Figure A.2). Upon his death, his estate was sworn at £54,045<sup>7</sup>, roughly equivalent to £5.2 million (AUD\$8.45 million) in today’s currency (at 4% inflation per annum). He was survived by his daughter and two grandchildren: Thomas Fredrick Doveton and Margaret Susan Tilley (*ibid*).

There is some ambiguity regarding his date of birth. The database of parliamentarians gives his date of birth as December 1816, but this may be a reference to a an earlier, still-born child. Other records state that he was “born at sea” in 1821. The *Daylesford Advocate*<sup>8</sup> cites his arrival date in Australia as 1841, but other sources say 1842.

### A.3 Academic Life

While nothing is currently published about Stanbridge’s education prior to his arrival to Australia, it is apparent that he was an educated man. During his tenure at Tyrrell Station, he worked closely with local Boorong people, a clan of the Wergaia language

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<sup>3</sup>In his will, Stanbridge left funds to erect an elevated chancel in red brick on Christ Church where he had been married, which was completed in 1896 (Lewis, 1991).

<sup>4</sup>*The Argus*, Melbourne, 22 August 1872, p. 4.

<sup>5</sup>*The Argus*, Melbourne, 3 August 1878, p. 1.

<sup>6</sup>Newspaper records claim he died at the age of 74. However, he was born in 1816, which would have made him 77.

<sup>7</sup>*The Argus*, Melbourne, 26 February 1895, p. 6.

<sup>8</sup>“Death of Mr. Stanbridge”, *Daylesford Advocate*, 7 April 1897.



FIGURE A.2: Stanbridge's final resting place, Daylesford cemetery. Photo (Paul Curnow pictured) courtesy of Gail Glasper © 2009.

group, learning their customs, language, culture, and oral traditions. During this time, he published material on Aboriginal culture and astronomy (Stanbridge, 1858, 1861) and donated Aboriginal artifacts to museums (e.g. Franks et al., 1877). On 8 July 1862, Stanbridge was appointed “honorary correspondent, for the Upper Loddon district, of the control board for watching over the interests of the Aborigines”<sup>9</sup>. During a time when colonists held indigenous people with little regard, considering them “of the lowest in the scale of mankind” (Stanbridge, 1861: 286), Stanbridge was a conscious supporter of Aboriginal knowledge and civil rights, and was active in academic societies.

Stanbridge was elected into the Philosophical Institute of Victoria in 1857<sup>10</sup>, the Royal Society of Victoria in 1860 (Royal Society of Victoria, 2010) and the Ethnological Society of London in 1861 (Front Matter, 1870: xxxiii). He was elected a Fellow of the Anthropological Institute, London (AIL) on 26 May 1863 (Nicholson, 1863: x), and as

<sup>9</sup> *The Argus*, Melbourne, 9 July 1862, p. 5.

<sup>10</sup> *The Argus*, Melbourne, 7 August 1857, p. 5.

the Local Secretary Abroad on 3 November 1863 (Blake, 1864: i). He was also a life member of the Acclimatisation Society of Victoria (1864: 18).

The work for which he is arguably now best known deals with Boorong astronomical knowledge. He presented a paper on Boorong astronomy to the Philosophical Institute of Victoria on 30 September 1857 (later contributed to the Royal Astronomical Society, 1862). In his seminal paper, he described the astronomy and mythology of the Boorong (Stanbridge, 1858), whose word for Tyrrell (*tyrille*) meant '[outer] space or 'sky' and prided themselves on knowing more astronomy than any other Aboriginal community (*ibid*: 137). He wrote:

*"I beg to lay before your honorable Institute the accompanying paper on the Astronomy and Mythology of the Aborigines, and in doing so I am sensitive of its imperfectness, but as it is now six years since I made any additions to it, and as my occupation does not lead me to that part of the country where I should be able to make further additions, I have presumed to present it to your society, hoping that it may be a means of assisting with others to gather further traces of the people that are so fast passing away.*

*This statement of the Astronomy and Mythology of the Aborigines is, as nearly as language will allow, word for word as they have repeatedly during some years stated it to me. It is in the language of, and has been gleaned from, the Booroung Tribe, who claim and inhabit the Mallee country in the neighbourhood of Lake Tyrill, and who pride themselves upon knowing more of Astronomy than any other tribe."*

The original copy of his 1858 paper was destroyed in a fire at the temporary offices of the Philosophical Institute (*ibid*: 304). In 1861, Stanbridge published an extended version of his 1858 paper that included cultural knowledge and customs of other Aboriginal groups in Victoria, including his observations of Aboriginal culture while living in Mount Gambier. He claimed to have gained his information on Boorong astronomy from two members of a Boorong family who had the reputation of having the best knowledge of astronomy. Describing his first experiences learning about learning

Boorong astronomy (*ibid.*: 303), he wrote:

*“In that result I shall have the fullest confidence if the facts in this paper produce in others the astonishment that I felt, as I sat by a little camp fire, with a few boughs for shelter, on a large plain, listening for the first time to two aboriginals, speaking of Yurree, Wanjel, Larnan-kurrk, Kulkun-bulla, as they pointed to those beautiful stars.”*

His work was later re-analysed by MacPherson (1881) and provided the foundation of the Master of Philosophy thesis of Morieson (1996). Since Stanbridge’s fieldwork in the mid-19th century, Boorong culture has dissipated and the clan no longer exists as an individual entity, although Boorong descendants still live in the region. Thus, his papers represent the only published knowledge of Boorong culture.

## A.4 Politics & Philanthropy

Stanbridge’s ambition combined with his wealth and position within the community led him into the world of politics and philanthropy. On 15 September 1862, he was appointed a magistrate for Daylesford<sup>11</sup>, a position he kept through the 1880s. He later held a seat in the Creswick Legislative Assembly and was elected Member First Council and First Chairman of Daylesford in 1868. He was Councilor of Daylesford from 1868–1874 and again from 1880–1892. From 1882 to 1883, he served as Mayor of Daylesford, was elected Member of the Local Council (MLC) of northwestern Victoria from December 1881 to November 1882, and MLC of north-central Victoria from November 1882 to August 1892 (Thomson & Serle, 1972). His unfailing support of education was reflected in his politics and philanthropy. In his 1881 fight for the seat of MLC in the north-western province, Sandhurst correspondent wrote<sup>12</sup>:

*“The contest for the vacancy in the North-western Province is being fought out entirely on the Education question. Mr. M’Kenna is a member of the*

<sup>11</sup> *The Argus*, Melbourne, 24 September 1862, p. 5.

<sup>12</sup> *The Argus*, Melbourne, 22 November 1881, p. 6.



*Kyneton Anti-Education League, whilst Mr. Stanbridge is a supporter of the act. In Sandhurst it is now apparent that, apart from all other considerations, Mr. Stanbridge will poll very heavily, and if he only has a reasonable share of support throughout the province generally he will win the election.”*

Stanbridge (Figure A.3) donated generous funds for scholarships and facilities at Trinity College, Melbourne<sup>13</sup> where he was member of the College Council (e.g. Maisondeau, 1912: 109; Smith, 1904: 17, 39). In 1878, Stanbridge provided £1,100 to found the women’s-only Florence Stanbridge Scholarship at Trinity College as a memorial to his late wife<sup>14</sup> and later donated £300 towards the construction of new buildings to house students. In his will, Stanbridge left £5,000 to found the Frances Colles Stanbridge Scholarship at Trinity College, named in honour of his mother-in-law, and a further £500 to Trinity to use as they saw fit, as well as £1,000 for the building of a (preferably) female ward at the Daylesford Hospital.

During his time in politics, Stanbridge was a supporter of women’s suffrage. On 19 December 1888, he proposed a clause be added to the Electoral Act 1865 Amendment Bill, stating that:

*“It shall be lawful for every female whose name appears on the rate-payer-roll of any municipality, and being rated for an amount sufficient to entitle any male person to vote in the election of members of both the Legislative Council and the Legislative Assembly, respectively. The town clerk of the city of Melbourne, of the town of Geelong, and of every borough and the secretary of the clerk of the council or board of every shire and district shall, if she have the necessary qualification insert the name of every female whose name appears in the rate-book of such city, borough, town, shire or district on the rolls of the rate-paying electors which such clerk or secretary*

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<sup>13</sup>Trinity College was founded by the first Anglican Bishop of Melbourne, the Rt. Rev. Charles Perry, after the model of Oxford and Cambridge Universities (Grant, 1972). In 1876, Trinity affiliated as a College within the University of Melbourne with Dr Alexander Leeper serving as the first Warden (Poynter, 1997).

<sup>14</sup>*The Argus*, Melbourne, 13 December 1881, p. 7.





FIGURE A.3: William Edward Stanbridge, courtesy of Keva Lloyd. Date probably ca. 1880s.

*is directed by the Electoral 1865 to make out for the Legislative Council and Legislative Assembly respectively, and the names of such females shall and may be objected to and dealt with in the same manner as provided for in the case of male persons.”*<sup>15</sup>

Stanbridge was a member of the Church of England Assembly and was a major benefactor to Christ Church (Figure A.4) and Church of England School at 54 Central Springs Road, Daylesford (built in 1857). Stanbridge donated funds to build a girls wing to the school in 1864. A plaque on the building reads “*This girls school room is a gift to education by W.E. Stanbridge out of gold obtained from the Concordia Tunnel and Defiance Paddock*” (Figure A.4). An elevated red brick chancel was erected at Christ Church in 1896 using funds left in Stanbridge’s will. Stanbridge is commemorated in a brass plaque set into the sanctuary floor (see Figure A.4).

## A.5 Legacy

Stanbridge’s philanthropy, support of women’s suffrage, and promotion of Aboriginal culture are still evident today. Considered by contemporary researchers as the father of the emerging discipline of Aboriginal astronomy, Stanbridge’s work on Boorong astronomy continues to be celebrated by both professional astronomers and the general public<sup>16</sup> as it is promoted in public star parties, planetariums, museums, and educational programs across Australia. His papers continue to yield new discoveries (e.g. Hamacher & Frew, 2010) and high citations in the literature.

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<sup>15</sup> *The Argus*, Melbourne, 19 December 1888, p. 6.

<sup>16</sup> e.g. Lake Tyrell Star Party 1–3 October 2010: [sealake.vic.au/starparty](http://sealake.vic.au/starparty)

TABLE A.1: A timeline of events in the life of William Edward Stanbridge.

Year	Event Description
1816	Born in Astley, Warwickshire, England
1841	Arrived in Port Philip, Victoria, Australia
1842	Resided in Broken River, Victoria
1846	Resided in Mt Gambier, South Australia
1847	Resided in Avoca, Victoria and issued a pastoral license for Tyrrell Station
1851	Moved to Daylesford, Victoria and purchased Holcombe Run
1852	Purchased Wombat Run, Victoria
1857	Elected member of the Philosophical Institute of Victoria Presented paper on Boorong astronomy to the Phil. Inst. of VIC
1860	Elected member of the Royal Society of Victoria
1861	Elected member of the Ethnological Society of London Published extended paper on Boorong Astronomy and Mythology
1862	Appointed Honorary Correspondent for the Upper Loddon District
1863	Elected Fellow and Local Secretary Abroad of the Anthro. Inst., London
1868	Held a seat in the Creswick Legislative Assembly Elected Member First Council and first chairman of Daylesford Elected Councilor of Daylesford
1872	Married Florence Colles in Hawthorn, Victoria
1878	Birth of his daughter and death of his wife during childbirth. Donated £1,100 for the Florence Stanbridge Scholarship at Trinity College
1880	Re-elected Councilor of Daylesford
1881	Elected MLC of north-western Victoria
1882	Elected MLC of north-central Victoria Elected Mayor of Daylesford
1888	Proposed women's suffrage clause to the Electoral Act 1865
1894	Died in Daylesford at the age of 77





FIGURE A.4: **Top Left:** Christ Church, Daylesford ca. 1890s, from Lewis (1991: 115). **Top Right:** the church ca. 2004, by Father Neal Salan ([www.anglicanchurchdaylesford.org.au](http://www.anglicanchurchdaylesford.org.au)). **Middle:** A brass plaque at the Christ Church, Daylesford, reading: “This girl’s school room is a gift to education by W.E. Stanbridge out of gold obtained from the Concordia Tunnel and Defiance Paddock, 1864.” Image taken from [www.onmydoorstep.com.au/heritage-listing/23245/christ-church-school-building](http://www.onmydoorstep.com.au/heritage-listing/23245/christ-church-school-building). **Bottom:** A brass plaque commemorating Stanbridge on the sanctuary floor, who left funds in his will for Christ Church. Plaque reads: “In memoriam, William Edward Stanbridge of Wombat Park, Member of the Legislative Council of Victoria [...] from 1881 to 1892”. Photos by J.R.M., 16 January 2008, [www.ohta.org.au/organs/organs/DaylesfordChristChurchAng.html](http://www.ohta.org.au/organs/organs/DaylesfordChristChurchAng.html).

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## About the Candidate

Duane was born and raised in mid-Missouri and attended school (K-12) in the small rural town of New Bloomfield. From 1996-1999, he attended Central Missouri State University and transferred to the University of Missouri (Mizzou) in 2000. He graduated with a Bachelor of Science in physics in 2004 (with an emphasis in astrophysics and minor emphasis in archaeology) and spent a semester abroad at Macquarie University in 2003.

Duane completed graduate coursework and research in astrophysics and archaeology at Mizzou before moving to Sydney in 2006. He enrolled in a research program in the Department of Astrophysics at the University of New South Wales. Using data he collected from the Automated Patrol Telescope and 40-inch Telescope at Siding Spring Observatory, he completed a Master of Science thesis entitled “*A Search for Transiting Extrasolar Planets from the Southern Hemisphere*” in 2008. He was then awarded a Research Excellence Scholarship to complete this thesis in the Department of Indigenous Studies at Macquarie University.

Duane works as an astronomy educator and consultant curator at Sydney Observatory and developed and managed the Association for Astronomy at Macquarie University.

After submitting this thesis, Duane took a position as a Research Fellow at the University of New South Wales to continue his research in Aboriginal astronomy. His wife, Tui Britton, is completing a PhD in radio astronomy at Macquarie University.



Duane Hamacher with senior Wardaman custodian Bill Yidimduma Harney at the AIATSIS Symposium on Indigenous Astronomy in Canberra, November 2009.

## About the Advisors

### Ray Norris

Professor Ray Norris is an astrophysicist at CSIRO Astronomy & Space Science in Sydney and an Adjunct Professor in the Department of Indigenous Studies (Warawara) at Macquarie University. He graduated from Cambridge University with an honours degree in theoretical physics and completed a PhD and postdoc in radio astronomy at the Jodrell Bank Radio Observatory, University of Manchester. During his summers as a student, he studied archaeoastronomy and surveyed stone circles across the UK with a group of students led by Clive Ruggles.

In 1983 he moved to Australia to take a position at the CSIRO, where he became Head of Astrophysics in 1994 and Deputy Director in 2000. He currently leads the EMU project, which aims to survey the entire Southern Sky in the deep radio continuum ( $\sim 10\mu\text{Jy rms}$ ) using the ASKAP radio interferometer in Western Australia.

He also studies Aboriginal astronomy and has enjoyed working with Indigenous groups such as the Yolngu and Wardaman communities of the Northern Territory. He has presented the results of this research to audiences across Australia and the world, including ABC Radio National and the Garma Indigenous Festival. In 2009, Ray and his wife, Cilla, published a book entitled “*Emu Dreaming: an Introduction to Australian Aboriginal Astronomy*”.

**Kristina Everett**

Dr. Kristina Everett is a social anthropologist and a Senior Lecturer in the Learning & Teaching Centre at the Australian Catholic University. She earned a Bachelor of Social Science (with Honours) in anthropology and sociology and a PhD in cultural anthropology from Macquarie University. She then took a lectureship in Warawara before moving to ACU. Her anthropological work engaged both theoretical and applied aspects relating to Aboriginal Australia and other Indigenous groups in the areas of cultural (re)emergence in urban contexts, Indigenous education, and Indigenous Studies.

Kristina is has been keenly involved in supporting and encouraging Indigenous and non-Indigenous teachers and students in generative interactions to develop and define the emerging field of scholarship called Indigenous Studies. She has published widely across disciplines, including history, cultural studies, post-colonial studies, Indigenous studies, sociology and anthropology. Her book *“Impossible realities: the (re)emergence of traditional Aboriginal culture in the city”* was published in 2011.

**John Clegg**

John Clegg is a retired Senior Lecturer in the Department of Archaeology at the University of Sydney. He earned an honours degree in archaeology and a Certificate in Education at Cambridge University and worked as a professional schoolteacher in the UK for four years before moving to Australia. He completed a Master of Arts (with Honours) in archaeology at the University of Sydney, where he spent the remainder of his academic career.

John has made substantial contributions to Aboriginal rock art research for over 35 years and has published numerous articles, book chapters, and books on archaeology and Aboriginal rock art, including the definitive work on Sydney rock art, entitled *“A Field Guide to Aboriginal Rock Engravings”* with Peter Stanbury in 1990.

## Michelle Trudgett

Dr. Michelle Trudgett is an Indigenous scholar from the Wiradjuri Nation in New South Wales and as of January 2013 is an Associate Professor and Head of Department in Warawara at Macquarie University. She earned a Bachelor of Arts, Master of Professional Studies, and a Doctor of Education, all from the University of New England in Armidale, NSW and came to Warawara as a Postdoctoral Fellow in 2008.

Michelle has developed an international reputation as a leading Indigenous Australian scholar whose research provides considerable insight into the area of Indigenous participation in higher education, with a specific focus on the postgraduate sector. She is passionate about developing strategies to ensure Indigenous higher education students receive culturally appropriate support throughout their academic journeys.

In 2011 Michelle developed a *Master of Indigenous Education* at Macquarie – the only such program in Australia. Her current ARC funded research seeks to create a model of best practice for the supervision of Indigenous doctoral students.



Ray Norris



Kristina Everett



John Clegg



Michelle Trudgett