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Notes

References in these notes are given only to the books listed under Further Reading. Where reference to other sources, typically scholarly articles, cannot be avoided, only their lead author, the year of publication and the journal name (in *italics*) are given.

Chapter 1: Recalling the Past

- 1 Hillman described his discovery in the *Portland Oregonian* newspaper on 3 June 1903. More details at www.craterlakeinstitute.com.
- 2 p. 36 in Deur (2002, *Oregon Historical Quarterly*).
- 3 Quoted on p. 39 of Deur (*op cit*).
- 4 You may wonder why the example of the tsunami of 27 March 1964 that impacted many parts of the Cascade coast is not used. It is because even though the earthquake that caused it occurred above a zone of plate convergence, it was generated off the south coast of Alaska, not locally.
- 5 A comprehensive account of the 1700 tsunami, nicknamed the ‘orphan tsunami’ because the earthquake that caused it has not been identified, is provided in the book by Brian Atwater and colleagues (2005), which painstakingly pieces together its effects along the continental margins of the North Pacific.
- 6 The parallels between this story and that of Persephone in Greek mythology are striking yet must be coincidental. Like Loha, the beautiful Persephone lived on the Earth’s surface but was abducted by Hades, the God of the Underworld, who was in love with her (and up against some stiff competition). Hades kept Persephone in his underworld kingdom until ordered by Zeus to return her to the above-ground world. But Hades had ensured that Persephone had tasted the food of the underworld (pomegranate seeds), something that compelled her to return there to his cold embrace for several months each year.

- 7 From pp. 53–55 of Clark (1953). The most convincing interpretation of this story is in the magnificent book *When They Severed Earth from Sky: How the Human Mind Shapes Myth* (Barber and Barber 2004).
- 8 The most convincing dates come from the tephra (ash deposits) blown out of Mt Mazama across a wide area during its terminal eruption. Radiocarbon dating of associated materials, such as wood fragments and rat faeces, within the tephra deposits shows that they were laid down between 7,682 and 7,584 calendar years BP (Before Present, where ‘present’ is AD 1950) (Egan, 2015, *The Holocene*).
- 9 This quote and the other below it come from the translation of the key oral history by Beaglehole and Beaglehole (1938: 386). Around 85km (53 miles) from the nearest inhabited land – the equally remote Nassau Island – Pukapuka is 175ha (432 acres) in area and rises mostly less than 2m (6½ft) above sea level. Some 600 people live there today.
- 10 The original text is on p. 116 in the book by Ricci (1969). The translation given here is on pp. 316–317 in the paper by Santilli and others (2003, *Antiquity*). Other quotes in this section come from the same source. Note that the calibrated radiocarbon age for the impact (AD 412) is unlikely to be its exact age.
- 11 It is possible that the Dionysian temple referred to was converted to the Church of Santa Maria della Consolazione at Secinaro.
- 12 The oldest known fossils of *Homo sapiens* are found in Ethiopia and are consistent with genetic evidence suggesting the emergence of our species about 200,000 years ago in the region (Gibbons, 2003, *Science*). See also Chapter 4.
- 13 Our hominid ancestor, *Homo erectus*, moved out of Africa, where it had evolved, to reach both China and Java more than 1,600,000 years ago. While *H. erectus* did not have the cognitive abilities of our species, its presence on Flores Island (Indonesia) at least 800,000 years ago shows that it was able to cross ocean distances of at least 19km (12 miles) (Morwood, 1998, *Nature*).

- 14 Of the clam species living today along the shores of the Red Sea, *Tridacna costata* comprises fewer than 1 per cent. Yet this species comprises about 80 per cent of the fossil shells found in the ancient shoreline of the region, demonstrating that it was once far more common. The association between these fossil shells of *T. costata* and human artefacts shows that its predation by people began at least 125,000 years ago.
- 15 Owing to the comparative abundance of food resources along the coasts of South Asia, it is generally thought that the dispersal of *Homo sapiens* east out of Africa followed a coastal route, most likely between about 70,000 and 130,000 years ago.
- 16 Perhaps they inferred that land existed because they saw smoke rising from distant wildfires. Perhaps they observed birds flying south and not returning, from which they deduced that a sizeable land mass with abundant resources existed in that direction.
- 17 Beyond the scope of this book is the question of what came before language. It was probably gestural communication – based on signs – that may have evolved into speech through echo phonology, ‘a repertoire of mouth actions which are characterized by “echoing” on the mouth certain of the articulatory actions of the hands’ (Woll, 2014, *Frontiers in Psychology*, p. 1).
- 18 Ever insightful, it was Jonathan Kingdon who suggested in his book *Self-made Man* (1996) that, once humans reached continental shores, they were no longer able to hunt and gather their food at the cooler (low sun) times of the day they preferred. Instead they became dependent on the tides, even sometimes having to walk out across reefs collecting shellfish at the hottest times of the day. Over time, people with darker skins became more successful at this, and less likely to suffer sunstroke or contract skin cancer, thereby resulting in a gradual darkening of human skin colour in parts of the world like coastal South-east Asia 70,000 years ago. Kingdon names the first people of this area with black (rather than brown) skins, the Banda, and speculates that their seafaring skills may have started with the building of rafts on which seafoods

could be piled, then progressed to platforms on which people could sit, and eventually to mobile watercraft.

- 19 The Wallace Line separates Bali from Lombok, Borneo from Sulawesi. On the Asian side (commonly called Sunda) are found land animals like orang-utans and rhinoceroses that are not found on the Australasian (commonly called Sahul) side, where an abundance of unique fauna (83 per cent of it endemic) – including kangaroos and koalas – exists.
- 20 The most efficient way that people could have crossed from the now-submerged extension of the Asian continental shelf to that of the Australian shelf would have been from south-east Borneo across Sulawesi Island to New Guinea, a route requiring eight ocean crossings, the largest being 70km (43 miles); from New Guinea at that time, it was a dry-foot walk to modern Australia. The earliest known date for a human presence in Australia and New Guinea comes from the Malakunanja rock shelter on the side of the valley of the East Alligator River in the Northern Territory. This rock shelter was occupied 52,000–61,000 years ago, but, being some 220km (137 miles) from the coast at this time, is likely to have been reached at least a millennium or two after the first human arrivals. More details in Chapter 2.
- 21 Many Aboriginal Australians reject ‘Western’ scientific ideas about their ancestors ‘coming’ to Australia from anywhere. Like many indigenous peoples, a belief that they have always ‘been here’ [where they are now] is commonplace. An insightful biographical extract, quoted by van den Berg (2002: 4), reports that:

As a child, around campfire talks with my parents ... I would ask, ‘Where did we come from?’

Their reply was, ‘We’ve always lived here.’ I accepted that explanation.

As I grew older and matured, I would ask the same question and get the same answer. ‘We’ve always lived here.’

Later in my learned wisdom of European ways, I would reply,

‘But white fellas say we come from overseas, from Asia.’

‘Well,’ they said, ‘Those *wujbullas* are talking out of their *nooroos* [their backsides]. They don’t know anything.

Our Dreamtime stories tell us our Rainbow Serpent made us and our land, our Mother. We belong here, to this country ... and don't you forget it.'

It is worth reflecting that there is no direct evidence that anyone 65,000 years or so ago crossed 70km (43 miles) of ocean between South-east Asia and Australasia – although the weight of inference suggests that they did.

- 22 I am aware this paints a fairly idealistic picture, fine for the purpose of generalisation but unrealistic when applied to the evolution of particular societies. When considering how societies diverged (and came to speak different languages) in the past, a process that can be tracked by genetics, it is often thought that language facilitated knowledge dissemination and that inequalities which appeared between different groups were a result of their respective histories. But it seems more likely that language was not used to freely communicate knowledge but rather to selectively *withhold it*, thereby creating a situation in which one group was better able to survive than another (Iain Davidson and Bill Noble, 1992, *Archaeology in Oceania*).
- 23 Urban centres are defined here as settlements large enough and complex enough to support people having roles other than those of primary food producers. Dates of around 7,000 years ago for the establishment of complex 'villages' in the Yangtze lowlands may qualify these as urban, although 1,000 years later in the same area, supported by rice agriculture, walled and moated cities were built.
- 24 Mesopotamian cities of note include Tell Brak (Syria), first established about 7,000 years or so ago. Recent research suggests that urbanisation in this so-called Fertile Crescent was a 'phased and pulsating phenomenon' rather than a continuous process (Lawrence, 2015, *Antiquity*). The agro-pastoral strategies were centred on the floodplain cultivation of wheat, barley and lentils, with olives and grapes in wetter areas complemented by domesticated food animals like pigs, then increasingly by sheep and goats as time went on. The latter also facilitated wool-based textile production in the region.

- 25 The evolution of imagination (and the associated vocabulary) is a subject of some debate. Humans may be the only extant species that uses imagination to help process things we perceive (Bronowski 1974). There is debate about whether the human imagination is innate (perhaps stimulated by dreams) and indeed defines us as a species, or whether it derives solely from the reception (typically through observation) and processing of external stimuli. At the moment, I favour the latter and draw an explicit link between our ancestors' observations of memorable natural phenomena (like volcanic eruptions, meteorite showers and giant waves) and mythmaking that underpins much of today's creative practice, including art and literature.
- 26 The subject of a notable compilation by Dorothy Vitaliano (1973).
- 27 My own research on the island of Kadavu (Fiji) highlights just such a situation (see also Chapter 6). At one time, the forest-cloaked volcanic mountain named Nabukelevu at the western extremity of Kadavu was assumed to be extinct, last erupting perhaps 50,000 years ago. But then there are myths from the nearby island of Ono that could be interpreted as observations of eruptions of Nabukelevu. Since people have been in Fiji for only about 3,000 years, these myths imply that the volcano is unlikely to be truly extinct. More recently a road cut along the base of Nabukelevu revealed pottery fragments covered by volcanic scoria – a sure sign that the most recent eruptions postdated human arrival in the area – and a validation of the myth.
- 28 These include the Big Island (Hawai'i) in the Hawaiian Islands, which is the highest single mountain on Earth, reaching more than 10km (6 miles) above the surrounding ocean floor. Through its Kilauea parasite, Hawai'i has been erupting continuously since 1983.
- 29 I analysed the Maui legends of the Pacific Ocean and explained how their foci appear to coincide with recent shallow-water volcanism (Nunn, 2003, *Annals of the Association of American Geographers*).

- 30 In his landmark 1982 book *Orality and Literacy*, Father Walter Ong wrote that 'oral cultures indeed produce powerful and beautiful verbal performances of high artistic and human worth, which are no longer even possible once writing has taken possession of the psyche. Nevertheless, without writing, human consciousness cannot achieve its fuller potentials, cannot produce other beautiful and powerful creations' (p. 14).
- 31 The argument is that at one time most human females died shortly after they reached childbearing age, but when an increasing number began to survive into older age and became grandmothers, they (and to a lesser their male counterparts) became key in imparting traditional knowledge to their grandchildren (Caspari, 2004, *Proceedings of the National Academy of Sciences of the United States of America*).
- 32 This is the mnemonic effect, elegantly described by Lynne Kelly (2016).
- 33 Traces of San ancestors – including spearheads, notched bones, warthog tusks and ostrich eggshell beads – have been found in Border Cave, South Africa, and dated unequivocally to somewhere between 45,000 and 60,000 years ago.
- 34 p. 243 in Guenther (2006, *Journal of Folklore Research*).
- 35 p. 113 in the chapter by Hough in a collection on *Myth and Geology* (Piccardi and Masse 2007).
- 36 p. S79 in Hunn and others (2003, *Current Anthropology*).
- 37 p. S87 in Hunn and others (*op cit*). The Tlingit had several other notable conservation practices designed to maintain supplies of particular food resources, including an avoidance of the use of paralytic fish poisons (used by many other cultural groups) that have unintended effects on many other nearshore marine food sources, particularly shellfish.
- 38 This is based on research at the Ozette archaeological site on the Washington coast, where it was found that fur-seal populations had not been discernibly affected by human predation in the period AD 1100–1800. It should be pointed out that not all such interactions between indigenous peoples and wild foods were so apparently sustainable. There are innumerable examples of instances where hunger evidently

took precedence over any sense of sustaining a future supply of a particular food resource.

- 39 In his poem 'The World-Soul', Emerson compared the present where 'the politics are base' and 'the letters do not cheer' with a place 'far in the depths of history' where we find that 'voice that speaketh clear'.
- 40 Two pairs of woollen trousers (long pants) made and worn about 15,000 years ago have been excavated from an archaeological site at the Turfan Oasis in western China (Beck, 2014, *Quaternary International*). It is likely that they were invented to allow horseback riders to remain comfortably for longer in the saddle, something that allowed more efficient and widespread communication at the time.

Chapter 2: Words that Matter in a Harsh Land

- 1 We do know that water availability was the single most important control on early (Aboriginal) exploration of Australia. Eighty-four per cent of archaeological sites more than 30,000 years old in Australia are within 20km (12 miles) of permanent water. And there were several adequately watered routes into the arid interior of the continent available to potential Aboriginal settlers (Bird, O'Grady and Ulm, 2016, *Proceedings of the National Academy of Sciences*).
- 2 The semi-arid lands in much of the Murray-Darling Basin contain huge quantities of salt that in places wash into the rivers and the groundwater. Not derived from bedrock (as you might expect), this salt is of largely aeolian origin, carried to the area by winds from the ocean and deposited in clay mantles across the ground surface. Today the extraction of salt from groundwater allows water better suited for agriculture to reach productive areas downstream, and also produces crystalline salt in commercial quantities.
- 3 The quote is from Sturt (1834: 108). I cannot resist adding Sturt's story of his encounter with kangaroo flies: 'We remained stationary the day after we left the range, with a view to enjoying a little rest; it would, however, have been infinitely better if we had moved forward. Our camp was infested by the kangaroo fly, which settled upon us in

thousands. They appeared to rise from the ground, and as fast as they were swept off were succeeded by fresh numbers. It was utterly impossible to avoid their persecution, penetrating as they did into the very tents. The men were obliged to put handkerchiefs over their faces, and stockings upon their hands; but they bit through every thing. It was to no purpose that I myself shifted from place to place; they still followed, or were equally numerous everywhere. To add to our discomfort, the [pack] animals were driven almost to madness, and galloped to and fro in so furious a manner that I was apprehensive some of them would have been lost. I never experienced such a day of torment; and only when the sun set, did these little creatures cease from their attacks' (p. 71).

- 4 Australia is currently moving north-north-east at a rate of 7cm (2¾in) each year, so fast (in geological terms) that the geocentric datum of Australia, defined by global latitude and longitude coordinates in 1994, was found in 2016 to be out by more than 1.5m (5ft) – see report accessed in September 2016 at www.abc.net.au/news/2016-07-28/aust-latitude-longitude-coordinates-out-by-1-5m-scientists/7666858.
- 5 A billion is 1,000,000,000. By measuring its U-Pb (uranium-lead) proportions, a zircon grain from the Jack Hills was dated to 4.4 Gyr (4,400,000,000 years) ago, 'shortly after formation of the Earth' (Valley, 2014, *Nature Geoscience*, p. 222).
- 6 It has been proposed that these ancient stromatolites developed in very similar conditions to those found on the surface of the planet Mars, and that they may in fact exist there.
- 7 Probably the last word on Australian geology for many decades to come is the beautifully illustrated and explained volume *Shaping a Nation: A Geology of Australia*, published in 2012 to coincide with the 34th International Geological Congress in Brisbane (Blewett 2012). It is the heaviest single book in my library.
- 8 Australia is currently home to more camels than any other country on Earth. Introduced in the 1800s to work in the

country's deserts, initially for their exploration and later for supply trains to aid infrastructure development, feral camel herds have grown vastly and are now subject to periodic culling.

- 9 In the words of one nineteenth-century traveller, the stony deserts of Australia's interior are 'so desolate that it is horrifying even to describe [them] ... truly the wanderer in its wilds may snatch a fearful joy at having once beheld the scenes, that human eyes ought never again to see' (from Book 5 of Giles 1889: 317–318).
- 10 Quotes from an unpublished letter by Charles Sturt.
- 11 Properly Malakunanja II Rockshelter, also called Madjedbebe.
- 12 These dates were obtained using optically stimulated luminescence (OSL), a measure of how long an artefact has been buried (and unaffected by ionising radiation), and are actually $53,400 \pm 5,400$ to $60,300 \pm 6,700$ years ago (Roberts, 1994, *Quaternary Science Reviews*).
- 13 The Malakunanja artefact ages are actually $45,000 \pm 9,000$ to $61,000 \pm 13,000$ years ago (Roberts, 1990, *Nature*). These ages were also obtained using OSL (see previous note), and any doubt that they might be too old, perhaps because the grains of material being analysed had received insufficient exposure to sunlight (and ionising radiation) before being buried, was dispelled by subsequent analysis.
- 14 There are numerous studies that trace the evolution of stone-tool manufacture in Australia through time (e.g. Mulvaney and Kamminga 1999).
- 15 The age quoted for the Layer 30 hearth at Devil's Lair was reported by Chris Turney and others (2001, *Quaternary Research*).
- 16 The mean age of this individual is $62,000 \pm 6,000$ years, so they could have been living as much as 68,000 years ago (Thorne, 1999, *Journal of Human Evolution*).
- 17 Research on the mitochondrial DNA (mtDNA) of ancient Australians – including Mungo Man – was once thought to indicate that there was a race of people in Australia before Aboriginal people arrived, a suggestion that more recent work

has conclusively dismissed (Heupink, 2016, *Proceedings of the National Academy of Sciences*).

- 18 Actually radiocarbon dates on charcoal can mislead in some instances. This may be because the particular tree that was burnt lived a long time – perhaps several hundred years – so that the age determined for it may be out by this much. And then it is always a possibility that the people who burnt wood, particularly for cooking fires or in ceramic kilns, used wood that was long dead – like driftwood on a beach – so that the calculated age might also be significantly different from the time of burning. These caveats apply most commonly to younger charcoals, where a few hundred years might make huge differences to the interpretation of human prehistory, but much less when we are dealing with older, less precise radiocarbon ages.
- 19 Such ‘fire stick farming’ was a hallmark of Australian Aboriginal subsistence strategies. Not only did it reduce the build-up of (vegetation) fuel loads and drive away venomous snakes, but it subsequently stimulated the growth of new plants, including edible bracken, which attracted animals like kangaroos that could then be more easily hunted.
- 20 The original interpretation of early human agency was based on analyses of charcoal and grass pollen in Ocean Drilling Project (ODP) core 820, but revised subsequently when it became clear that El Niño–Southern Oscillation (ENSO) effects could produce the same kinds of change.
- 21 The 120,000-year date comes from the original study by Gurdip Singh and others in a chapter in the collection by Gill and others (1981).
- 22 Re-dating of Zone F suggests that its correct age is about 60,000 years old, in line with the earliest dates for initial human occupation of other parts of Australia. Still, it is possible that Zone F was produced by natural processes, uninfluenced by human activity.
- 23 Waisted stone axes are considered to represent a huge technological jump in stone-tool design that opened up new possibilities, particularly for forest dwellers, as most people in Papua New Guinea were 40,000 years ago.

- 24 Many archaeologists and others would favour a younger age, pointing out that the 60,000-year ages from Malakunanja and Nauwalabila are at the upper ends of the OSL ages for these occupations, and that there is evidence – discussed in Chapter 6 – which implicates humans in an Australia-wide mass extinction of megafauna within a few millennia beginning some 45,000 years ago. The most recent research at Malakunanja appears to confirm an age for the site's occupation in excess of 60,000 years ago (Clarkson, 2017, *Nature*).
- 25 The key study is that by Heupink (*op cit*), who used improved DNA sequencing methods to re-evaluate the quite contrary yet influential conclusions of an earlier study. The latter analysed mitochondrial DNA (mtDNA) – that which is passed through the maternal line – from 10 skeletons found in western New South Wales that dated from well before the European arrival in Australia in 1770. By comparing the mtDNA sequences in these individuals to those from modern Aboriginal Australians, it was found that most had much in common but that – critically – two of the skeletons contained mtDNA that was *not* diagnostic of Aboriginal people. It was therefore concluded that there had not been just one period of human arrival into Australia before 1770, but multiple waves that explained the genetic diversity. The more recent study re-examined much of the original skeletal material as well as some new material. The conclusions were staggering. Some of the original bones analysed were found not to contain any verifiable human DNA, begging the question as to how this might have allegedly been sampled 15 years earlier. But more importantly, it was clear that the indiscriminate handling of the skeletal remains by (non-Aboriginal) scientists had introduced some of their mtDNA to the mix, resulting in the non-Aboriginal mtDNA identified in the earlier study. The presence of an authentic Australian Aboriginal haplotype in at least one of the skeletons analysed proved enough to confirm that Aboriginal Australians have been isolated for most of the time – perhaps 65,000 years – that they have occupied the continent.

- 26 The figure of 14,000 years ago for the sundering of the last land connection between mainland Australia and Tasmania comes from research by Lambeck and Chappell (2001, *Science*).
- 27 The research was based on mitochondrial DNA and suggests that dingoes were introduced to Australia from Indonesia (Oskarsson, 2012, *Proceedings of the Royal Society*).
- 28 A possible introduction from India to Australia during this event was the microlith, a small stone tool used in arrowheads and spear-tips. Until the genetic studies showing contact with people from India about 4,230 years ago, the abrupt development of microliths in Australian cultures around this time had puzzled archaeologists.
- 29 A study of the Macassan trepang-processing station at Malara, Anuru Bay, Arnhem Land (northern Australia) found numerous remains of earthenware pottery, introduced from about AD 1637, which all derived from the port of Makassar in southern Sulawesi. Macassans may also have introduced the tamarind tree to Australia. They certainly introduced numerous words that became part of Aboriginal languages along the continent's northern fringes, and are probably responsible for integrating aspects of Islam into Aboriginal spiritual beliefs and rituals in these parts of Australia.
- 30 One of the main purposes of Kerguelen's voyages in the Indian Ocean was to try and relocate 'Gonneville', a lush land apparently described from the region by Paulmier de Gonneville in 1504, but which subsequent research has determined to have been Brazil. Kerguelen's premature enthusiasm for Kerguelen Island may have arisen from his belief that it was actually Gonneville.
- 31 The rock art on sandstone cliffs in the Serra da Capivara National Park in Brazil has been dated to far earlier than the time at which it is generally assumed people first arrived in the Americas. Archaeological research suggests that people were in this area more than 20,000 years ago, which would mean that the orthodox view of the first Americans arriving from easternmost Asia across the Bering Strait to create the Clovis culture in the modern USA about 14,000 years ago, has to be wrong. This is not a popular view in some quarters, as you

- might imagine, and has led one group of non-partisan archaeologists to wonder whether ‘there is some sort of curse that affects the common sense both of archaeologists making the discoveries, and their colleagues, at the announcement of an age older than 14 000 cal BC’ (Boeda, 2014, *Antiquity*, p. 928).
- 32 These types of wasp construct mud nests that petrify after they are abandoned. The example referred to was built by wasps of the species *Sceliphron laetum* and came from a rock shelter near the King Edward River Crossing in the Kimberley.
- 33 *Tjukurrpa* is the word of the Pitjantjatjara people of central Australia for the Dreaming and is widely used as a standard translation. Other words for the Dreaming are *Ungud* (Ngarinyin people of the Kimberley), *Wongar* (Yolngu people of Arnhem Land), *Altjjerre* (Arrernte people of central Australia), *Bulurru* (Djabugay people of north-east Queensland) and *Kulhal* (Yaraldi people of South Australia).
- 34 From p. 357 of David Rose’s insightful 2013 article on the phylogenesis of the Dreamtime, published in *Linguistics and the Human Sciences*.
- 35 The range of books in the Dreaming Library were reported in much the same way in 1906 by the French ethnographer Arnold van Gennep, who found that they included ‘*des fragments d’un catéchisme, d’un manuel liturgique, d’un manuel d’histoire de la civilisation, d’un manuel de géographie, mais beaucoup moins d’un manuel de cosmographie*’ (1906: cxiv), translated as ‘fragments of a catechism, a liturgical manual, a history of civilisation, a geography textbook, and to a much lesser extent a manual of cosmography’.
- 36 ‘This kind of system, often labelled in Aboriginal English as the “owner-manager” relationship, requiring a story to be discussed explicitly across three generations of a patriline, constitutes a cross-generational mechanism which may be particularly successful at maximising precision in replication of a story across successive generations’ (Nunn and Reid, 2016, *Australian Geographer*, p. 40). If you are unclear still, then imagine three generations A, B and C. Grandfather A teaches stories to his son B, who teaches them to his son C. B’s sister gets her children Y (who learnt the stories from their paternal

grandfather X) to talk to A about B's and C's knowledge of the stories. Thus A, B and C all discuss the stories with Y, whose role is to 'manage' the stories within three generations of his mother's patriline. It works in the other direction as well. X, Y and Z all discuss their knowledge with B, who also has a role as a knowledge manager. Thus there is formalised cross-checking of stories across three generations of two patriline. When a grandfather (A or X) dies, the role of knowledge manager also passes on; in the case of patriline A-B-C, which is managed by Y, the death of A will mean that patriline B-C-D is now managed by Z (Y's child). At each generational stage, an 'owning' patriline has its stories checked by a 'managing' maternal relative – the 'owner-manager' relationship. I am grateful to Dr Nick Reid for this illustration of how cross-checking of Aboriginal knowledge transmission across generations worked.

- 37 Australian Aboriginal performances that combine song, dance and performance are known as *corroboree(s)*.
- 38 For Aboriginal stories, it is likely that 'song rhythms and tunes have a conventionalizing effect on the transmission of ideas in song form' (Berndt and Berndt 1996: 387), ensuring that detail is not changed or altered as stories are told anew to successive generations. Many of us today remember tunes we last heard a decade ago before we recall the associated lyrics.
- 39 The point is made neatly by Elizabeth Cameron, who wrote 'Australian Aboriginal symbols are visual forms of knowledge that express cultural intellect. Being classified by a Western interpretation of "art" devalues thousands of years of generational knowledge systems, where visual information has been respected, appreciated and valued' (2015, *Arts*, p. 68). She goes on to explain that 'Aboriginal creativity' was never considered by its creators to be primarily aesthetic, but rather in service to pragmatic ends.
- 40 The story of this map is told by anthropologist and linguist Donald Thomson and refers to a time when he was camped with the Pintupi at Labbi-Labbi on the edge of the Sandy Desert in 1957. 'And on the eve of our going, [Aboriginal informant] Tjappanongo produced spear-throwers, on the

backs of which were designs deeply incised, more or less geometric in form. Sometimes with a stick, or with a finger, he would point to each well or rock hole in turn and recite its name, waiting for me to repeat it after him. Each time, the group of old men listened intently and grunted with approval – “Eh!” – or repeated the name again and listened [to me] once more. This process continued with the name of each water hole until they were satisfied with my pronunciation, when they would pass on to the next. I realized that here was the most important discovery of the expedition – that what Tjappanongo and the old men had shown me was really a map, highly conventionalized ... of the waters of the vast terrain over which the Bindibu [Pintupi] hunted’ (p. 62 in Thomson, *Geographical Journal*).

- 41 Many European Australians in the nineteenth century found it difficult ‘to appreciate that Aboriginal hunter-gatherers, whose material culture seemed to them so primitive, had a sophisticated artistic life, not to speak of one of the most complex systems of social organization in the world, and a religious life to which the older and more privileged members of society devoted a great deal of their time’ (Ross, 1986, *Oral Tradition*, p. 232).
- 42 There was ‘a comforting colonial conceit that the Aborigines made no use of their land’ (Henry Reynolds in Foreword to Gammage 2011: xxiii).
- 43 The quote is from p. 81 of Tim Flannery’s influential (1994) book *The Future Eaters*, and was the first popular expression of this fact – and of the decades of its increasingly obvious nature being ignored by settlers. Flannery also makes the observation that the nomadism practised by Aboriginal Australians was ‘an adaptation to tracking the erratic availability of resources as they are dictated by ENSO’ (p. 283), something manifested in the characterisations of Australia as a land of ‘droughts and flooding rains’, a place where long-term averages are consequently better represented by medians rather than by means (see colour plate section).

- 44 A good account of the two responses to drought stress by the Ngaatjatjarra (Ngatatjara) Aboriginal people of the Western Desert was given by Gould (1991, *Oceania*). 'Drought escape' involved the temporary abandonment of the worst drought-stricken areas and resettlement in distant ones where more water was available, often areas where kinfolk lived. 'Drought evasion' was often employed when the likely duration of a particular dry spell was considered shorter rather than longer; it involved the relocation of groups within their home area, usually congregating in places where there was a relatively dependable water supply. Gould argues that such drought-response strategies may elsewhere have been key to stimulating the domestication of plants.
- 45 See Cook (1893: 244).
- 46 Observation made by Sydney Parkinson (1773: 124) on 27 April 1770.
- 47 This account is from pp. 136–137 of Haygarth's (1861) *Recollections of Bush Life in Australia*.
- 48 From pp. 412–413 of Thomas Mitchell's (1848) *Journal of an Expedition into the Interior of Tropical Australia*.
- 49 The assumption that Australia was in fact *Terra Nullius* in 1770 when James Cook first saw it was overturned in 1992 by the High Court of Australia that ruled – by a six-to-one majority – that the Meriam people, who had brought the case, were 'entitled as against the whole world to possession, occupation, use and enjoyment of (most of) the lands of the Murray Islands'. This ruling opened the way for the introduction of native title into Australian law and has led to numerous instances of title being restored to groups of Aboriginal landowners.
- 50 Quote from Flannery (1994: 282). While nomadism was characteristic of most Aboriginal groups until post-colonisation, there is clear evidence that some groups that found themselves stranded by postglacial sea-level rise on offshore islands responded by both increasing their consumption of coastal-ocean foods and becoming more sedentary. This transition is demonstrated by the discovery of 'stone houses' on islands in the Dampier Archipelago

(*Murujuga*), which date from more than 8,000 years ago, and by changes in the subjects of its rock art.

- 51 Among the worst bush fires in recent Australian history were those on 7 February 2009 (Black Saturday) in Victoria, in which 173 people died and nearly 3,000 houses were destroyed. In south-east Australia, bush-fire incidence is projected to increase strongly by 2100, with longer fire seasons as a result of higher temperatures. Besides posing direct risks to livelihoods and property from burning, bush fires in Australia are also implicated in increased exposure of urban dwellers to atmospheric pollutants.
- 52 This and the previous quote come from Carnegie (1898: 17).
- 53 Much of this information comes from the excellent review of desert Aboriginal water management by Bayly (1999, *Journal of the Royal Society of Western Australia*). He includes a more graphic account of frog-water-drinking from the 1930s: 'My amazement reached a climax when he [an Aboriginal escort] seized the frog, placed the head-end in his mouth and squeezed its body. And while he squeezed he drank! It was not a mere sip, either; I should say the fluid he swallowed would have been sufficient to fill a teacup. As he drank, the old fellow looked at me out of the sides of his eyes in a very quizzical way; and when he had drained this most remarkable goblet to its last drop he smacked his lips afresh and exclaimed "Bullya Marra" ["Good! Good!"]' (p. 23). When the frog's water was all drunk, the rest of the frog was duly eaten.
- 54 Referring to the Aboriginal people of the Western Desert, Scott Cane found that 'almost every Aboriginal person I have spoken to can recall times when they were close to death – or members of their immediate family had died in attempts to find water' (p. 157 in Meeham and White 1990).
- 55 And most Aboriginal communities did live well for most of the time before 1788 in Australia. I note the comment of anthropologist Donald Thomson about the Pintupi (Bindibu) people of the central desert of Australia, apparently one of the harshest environments the country has to offer, that they 'have adapted themselves to that bitter environment so that

they laugh deeply and grow the fattest babies in the world' (Thomson 1975: 4).

- 56 In February 2016, Severe Tropical Cyclone Winston – the strongest hurricane ever recorded in the southern hemisphere – tore a track through the islands of Fiji and Tonga, leaving massive destruction in its wake. A friend told me what happened in one of the affected villages in Fiji. The people were gathered around a radio listening to official warnings about the cyclone's path, on the basis of which they decided *not* to evacuate the community to the caves inland. At the time, meteorologists thought the cyclone was moving away from the area where the village is located. But the older people in the village thought otherwise because the birds were flying unusually close to the ground, a traditional precursor of an approaching hurricane. Science was favoured by the village decision-makers and, when the cyclone was found to have changed course, razing the village, it had a human impact that might have been avoided had tradition been favoured over science. I am grateful to Dr Lavinia Tiko for this story.
- 57 Modelling suggests that the ice-age population of Australia may have fallen overall because of aridity (Williams, 2015, *Quaternary Science Reviews*). It is certainly clear that people at this time (14,000–28,000 years ago) abandoned vast tracts of land where they had formerly lived because of the lack of water, shifting to better watered refugia like the Murray-Darling River Basin and south-west Tasmania. Over several millennia (5,000–11,000 years ago) after the end of the last ice age, Australian Aboriginal populations grew in every part of the continent as both temperatures and rainfall increased.
- 58 An intriguing question is whether the Aboriginal groups that reoccupied formerly abandoned areas of Australia knew that their ancestors had lived there – and had kept that knowledge alive during the millennia they spent in refugia – or whether they merely saw the formerly unoccupied environments becoming habitable and moved there. The most parsimonious explanation – the type science invariably favours – is the latter, but in the light of the likelihood that Aboriginal stories can survive for 7,000 years or more (see Chapters 3 and 4), we should perhaps not be too quick in dismissing the former.

Chapter 3: Australian Aboriginal Memories of Coastal Drowning

- 1 Australia's snake species are many and disproportionately venomous. There are about 140 species of land snake and many are deadly, even though they account for a mere 4–6 deaths each year. An *Australian Geographic* article on the topic can be found at <http://tinyurl.com/o6v45aa>.
- 2 This argument hinges on the plausible idea that the Rainbow Serpent represents an amalgam of observations of 'snakes slithering away from drowning landscapes, rainbows overhead and strange "new" creatures such as pipefish washed ashore' (Tacon, 1996, *Archaeology in Oceania*, p. 117), a metaphor that helped people make sense of the rapid changes to the landscape they were witnessing.
- 3 At Delphi, the priestesses of the Oracle sat above cracks in the ground from which these gases (rich in CO₂-H₂S or ethylene or CH₄) rose, going into trances and purporting to predict future events. Geologists who examined the site found that no gases are escaping today, but that its structure shows that they once did, earthquakes periodically altering the circulation and storage (in shallow chambers) of gases produced from movements of hydrothermal fluids deeper within the Earth's crust. It is probable that the Delphic Oracle remained in place for the few hundred years that it took for a particular 'gas-exhaling chasm' to empty itself. This study was carried out by Luigi Piccardi who, together with Bruce Masse, deserves credit for helping make the topic of geomythology respectable among scientists, through a dedicated session (standing-room only!) at the 2004 International Geological Congress and publication of a derivative volume (Piccardi and Masse 2007).
- 4 This is the main focus of my 2009 book, *Vanished Islands and Hidden Continents of the Pacific*, which reviews stories about 'vanished islands' from many Pacific Island cultures, concluding that many represent memories of actual events. Some of the most plausible are the disappearances of the islands of Teonimenu and Vanua Mamata in the Solomon Islands and Vanuatu (South-west Pacific) respectively (Nunn 2009).

- 5 Loch Ness lies directly above the most seismically active part of the Great Glen Fault, one of the most active in Scotland. When there are earthquakes in the area, the surface of Loch Ness is often agitated, waves being created that may have been mistaken for the thrashing of a sea monster. This explanation is strengthened by noting that the earliest Latin descriptions of the appearance of the ‘dragon’ in the lake noted that it was accompanied ‘with strong shaking’ (*cum ingenti fremitu*) and disappeared ‘shaking herself’ (*tremefacta*).
- 6 See Ross (1986, *Oral Tradition*).
- 7 From p. iii of Dawson (1881).
- 8 All quotes in this paragraph are from Volume 1 of Matthew Flinders’s journal, *A Voyage to Terra Australis* (Flinders 1814). He first entered Spencer Gulf on 9 March 1802 and left it 11 days later. The night before, there was an eclipse of the moon and one wonders whether the Narungga associated this with the arrival of the *Investigator*, an event that would come to profoundly challenge their view of the world and their situation within it.
- 9 This story was sung in 1928 by a Wirangu woman named Susie from Denial Bay (Eyre Peninsula), and is recorded on p. 16 of Cooper (1955).
- 10 This account is from pp. 168–169 of Smith’s 1930 book. There is reason in this instance to suspect that Smith plagiarised the work of David Unaipon, a tireless promulgator of Aboriginal culture (Krichauff 2011).
- 11 One detailed account was collected by anthropologist Charles Percy Mountford from the Adnyamathanha (Aboriginal) people living at the Nepabunna Mission in the Flinders Ranges (South Australia) in 1937. It states that Spencer Gulf ‘was once a valley filled with a line of fresh-water lagoons, stretching northwards for a hundred miles or more. Each lagoon was the exclusive territory of a species of water bird. One lagoon belonged to the swans and the ducks, another to the grebes and the cormorants, still another to the water-hens, coots and reed-warblers. The trees belonged to the eagles, crows and parrots, while in the open country

between the lagoons lived emus, curlews and mallee fowls. Further out were the animals, the dingoes and many kangaroo-like creatures, and in the thick grass by the waters were the snakes, goannas and lizards' (Roberts and Mountford 1989: 18).

- 12 All quotes in this paragraph are from p. 18 of Roberts and Mountford (1989).
- 13 Native to Australia, willie wagtails (*Rhipidura leucophrys*) are birds that often appear in Aboriginal stories of different kinds, perhaps because they always seem so busy and sing so uniquely.
- 14 The quote in this paragraph comes from p. 172 of Smith (1930), while the idea that flooding of Spencer Gulf restored harmony between the competing groups of animals comes from Roberts and Mountford (1989), who probably derived their version of this Narungga story from a different source to that of Smith.
- 15 This and the previous quote are both from Volume 1 of Flinders (1814). 'Naive' fauna such as Flinders found on Kangaroo Island do indeed indicate a lengthy period of evolution without predators, as he surmised. Initial discovery by humans of many isolated oceanic islands also met with similar creatures, whose inability to recognise and avoid human predators invariably led to their extirpation or even extinction.
- 16 When Ronald Lampert started his PhD on the archaeology of Kangaroo Island in the 1970s, 'the problem had all the characteristics of a classic mystery story: a large offshore island without people, separated from the mainland nearly 10,000 years ago, yet with abundant evidence for a prehistoric population' (Lampert 1981: 1).
- 17 There are at least two extant accounts, collected independently, written down in the nineteenth century (Meyer 1846, Taplin 1873), and several more recent in date. The most comprehensive is that of Berndt (1940, *Oceania*), which was collected in the 1930s from the Jaralde people living in the lowermost part of the Murray River. The text in Chapter 3 includes elements from several versions of the Ngurunduri story.

- 18 The only direct indigenous version of this story to be written down, by David Unaipon in the 1920s, paints a different picture, in which Ngurunduri is portrayed as a good man whose affections were captured by two devious maidens he rescued from their imprisonment in a grass tree near Lake Albert. While Ngurunduri was temporarily absent, they caught and ate forbidden fish, for which he decided they should be punished. So they ran away from him (Unaipon 2001).
- 19 If this seems implausible, consider that Aboriginal women of that time had a different way of bathing from men (Berndt, 1940, *op cit*, footnote 36). Women often played 'water games' that involved hitting the water with the flats of their hands; 'she then very quickly uses her index finger, poking it in and out of the water she has divided, the result being a popping sound' (p. 179) that can sometimes be heard far away.
- 20 Quote from p. 181 of Berndt (1940, *op cit*). Other expressions of this key fact state that these events happened 'when the island was connected with the mainland [via] a strip of land' (Unaipon 2001: 131), or that 'Kangaroo Island ... was separated from the mainland only by a line of partly submerged boulders' (Roberts and Mountford 1989: 24), or that there was a shallow channel between the two, an isthmus in some accounts, across which a person could wade (Reed 1993, Parker 1959).
- 21 These words are from the Jaralde account given in the 1930s (Berndt 1940, *op cit*, p. 181). A story collected in the 1920s states that Ngurunduri began singing the Wind Song when his wives were halfway across. '*Pinkell lowar mia yound, Tee wee warr, La rund, Tolkamia a tren who cun, Tinkalla!* (Fall down from above, oh thou mighty Wind; swiftly run and display thy fleetness! Come thou down from the Northern sky, oh water of the deep! Come up in a mighty swell!)' (Unaipon 2001: 132).
- 22 From p. 57 of Taplin (1873).
- 23 From p. 181 of Berndt (1940, *op cit*).
- 24 From p. 182 of Berndt (1940, *op cit*).
- 25 This and all other quotes about MacDonnell Bay come from pp. 22–23 of the book by Smith (1880).

- 26 In addition to being used the seeds and roots of wattles (acacias) as food, the gum that many exude was used as a traditional medicine by Aboriginal Australians and was also a sweet treat for children.
- 27 The most comprehensive account of the geological history of Port Phillip Bay is that by Holdgate and others (2001, *Australian Journal of Earth Sciences*), while the issue of whether it dried up several millennia after the sea level had reached its present level is addressed by a similar group (2011, *Australian Journal of Earth Sciences*).
- 28 The quote is from p. 193 of Georgiana McCrae's biography (Niall 1994). It is likely that her main informant was Benbenjie, the 'premier huntsman and fisherman' of the Bunurong, who became her 'particular friend' and helped her compile a dictionary of the Bunurong language.
- 29 From p. 176 of McCrae (1934).
- 30 Both quotes from p. 12 of Hull (1859, *Report of the Select Committee of the Legislative Council on the Aborigines, 1858–9* (Victoria)).
- 31 Quote from p. 49 of Rogers (1957).
- 32 This may be a memory of a river flood ('rolling down') that drowned Port Phillip Bay, rather than inundation by the ocean or, more likely, a fusion of memories about change and causes that renders the extant story slightly ambiguous. This quote is from pp. 47–48 of Massola (1968).
- 33 Aboriginal Tasmanians were among the worst treated in the early decades of colonial Australia and were once thought to have died out with the death of Truganini in 1876, although this view was clearly wrong (Ryan 2012). In 1831 it was reported that Aboriginal people from Tasmania's east coast stated that 'this Island was settled by emigrants from a far country, that they came here on land, that the sea was subsequently formed' (Robinson 2008: 514, ML.A7085.2).
- 34 The quote is from pp. 267–268 of Fison and Howitt (1880). The finest *turnدون* or bullroarers were made from cherry-tree wood and were used in men's initiation ceremonies in Aboriginal Australia, to which women and uninitiated children were not privy.

- 35 From p. 101 of Tench's (1793) *A Complete Account of the Settlement at Port Jackson*. In a footnote Tench stressed his point. 'The words which are quoted may be found in Mr Cook's first voyage, and form part of his description of Botany Bay. It has often fallen to my lot to traverse these fabled Plains; and many a bitter execration have I heard poured on those travellers, who could so faithlessly relate what they saw.'
- 36 The two quotes in this paragraph come from pp. 11 and 14 of the story of the Gynea Lily in the chapter by Bodkin and Andrews in the collection by Kuhn and Freeman (2012). This crimson-flowered plant, *Doryanthes excelsa*, is endemic to coastal areas around Sydney.
- 37 This story is part of an account by Bruce Howell in the 2016 volume of the *Sutherland Shire Historical Society Bulletin* entitled 'The Man They Called Mister (An Aboriginal Man living on Gunnamatta Bay in the 1920s)', which is based on conversations with James Cutbush in December 2015 that in turn recalled stories told him by his father Bill Cutbush, who spent his childhood in the area in the 1920s, befriending the man they called Mister.
- 38 Bailer shells (*Melo* sp.) are marine molluscs, often beautifully decorated, that can reach more than 40cm (16in) in length and have been commonly used in Australia and elsewhere for bailing water from canoes.
- 39 Quote from pp. 17–18 of Noonuccal (1990).
- 40 Bopple bopple trees are likely to have been either *Hicksbeachia pinnatifolia* or *Macadamia integrifolia*, both of which bear edible fruits/nuts, making them of particular interest to children.
- 41 The details in this paragraph are paraphrased from the account of Thomas Welsby (1967: vol. 2, 34), who probably collected this story himself.
- 42 This possibility is raised by O'Keeffe (1975, *Proceedings of the Royal Society of Queensland*), who also concedes that Cook's apparent observation of a single island 'may have been an illusion caused by the angle from which he viewed the place' (p. 85).

- 43 At the time of Cook's observations of Moreton and North Stradbroke Islands in 1770, the world was still in the grip of the Little Ice Age – most studies consider that it spanned about AD 1400–1800. During the Little Ice Age the sea level in this part of the world was lower than it is today during the Little Ice Age (Nunn 2007), so it is possible that the two islands were joined at this time.
- 44 This story is recounted by Dixon (1972: 29).
- 45 See Dixon (1980: 46).
- 46 Details from Gribble (1932), the quote from p. 57. Another version of this story (McConnel, 1935, *Art in Australia*), collected independently from the same area in the 1930s, notes that Goonyah (Ngúnya) had been using fish poison, probably from the leaves of *Derris trifoliata*, to catch fish: a practice often frowned upon in subsistence societies because it kills fish indiscriminately and can pass on the toxins they absorb to people who consume them.
- 47 For example, Dixon's Yidinjdji informant Dick Moses explained that Goonyah (Gunya) placed a sacred *woomera* (spear-thrower) in the prow of his boat to attempt to 'calm the waves', but to no avail. '*Bamaay ginuuy daguulji/banaang miwalnyunda gadangalnyuun/*; [The sea was coming in bringing with it] the three people and the canoe. The water was lifting up and bringing in [the canoe with the people in it] ... *Balur ganaanggarr jarraal/banaagu wanggungalna/budiilna bana/*; [They] stood the curved *woomera* up in the prow [of the boat], to calm the water, to make it lie flat' (Dixon 1991: 92). In this story, we find echoes of the attempt by the English king Canute to command the waves to stop rising and, more pragmatically, an early account of people's increasing efforts to halt the encroachment of the sea onto the land.
- 48 From pp. 348–349 of McConnel (1930, *Oceania*). A related story comes from the Dingaal Aboriginal people, who occupy the Cape Flattery area about 200km (125 miles) north of Cairns, and have traditional title claim to Lizard Island (Dikaru), a high granite island just over 30km (19 miles) north-east of Cape Flattery and sheltered by the Great Barrier Reef to the east. Gordon Charlie, a Dingaal spokesman, 'says

- that his direct ancestors once walked to the island from Cape Flattery. When the sea levels rose and the Aboriginal people could no longer walk there, they paddled their canoes from island to island to reach it' (Falkiner and Oldfield 2000: 9).
- 49 Details in this section come from pp. 14–15 of Dixon (1977); note that I have anglicised Yidin words for ease of reading.
- 50 During the last ice age, much of Australia was drier than it is today, yet in contrast to other lake basins on the continent, Lake Carpentaria is never known to have dried up completely within the period 12,200–35,000 years ago. It was a large lake, covering an average area of some 35,000km² (13,500mi²), and containing 48km³ (12mi³) of water for most of the time it existed. The beginning of its end came about 12,200 years ago when rising sea level overtopped the Arafura Sill and seawater spilled into the lake. Its conversion to full marine conditions was completed by about 10,500 years ago. There is a sole Aboriginal story about the formation of the Gulf of Carpentaria, but its resemblance to that of the kangaroo with the giant digging bone retold for Spencer Gulf, to which it seems uniquely suited, suggests that it may not be an authentic tradition for the Gulf of Carpentaria (details in Reed 1965: 189–192).
- 51 You might think that given the comparative plethora of drowning stories from elsewhere along the Australian coast, there would be some among the peoples of the Torres Straits Islands. Yet despite considerable anthropological and linguistic research in these islands, no stories have been formally reported, although Dixon alludes to a 1988 conference presentation in which Ephraim Bani, a Torres Strait islander, spoke of 'ancient legends' that tell of people 'who actually walked as if on dry land, from the Australian mainland to the Papuan coast' (Dixon, 1996, *Oceania*, p. 129).
- 52 The story tells that 'the two Djanggau Sisters, Daughters of the Sun, came in their bark canoe with their Brother from the mythical land of the dead, Bralgu, somewhere in the Gulf of Carpentaria' (Berndt and Berndt 1994: 16). Another Yolngu tradition about Bralgu [Island] is its link with the planet Venus, known as Barnumbir and associated with

- death. Two old women on Bralgu hold Venus on a long string to ensure that it cannot escape (Bhathal, 2009, *Journal and Proceedings of the Royal Society of New South Wales*).
- 53 This and the quote in the following sentence both come from p. 20 of Dick Roughsey's autobiography, *Moon and Rainbow* (1971).
- 54 The channel-cutting stories were collected by Paul Memmott and analysed as part of his 1979 PhD. Ages of 5,000–5,500 years ago were assigned to them after consideration of the history of postglacial sea-level changes in the Gulf of Carpentaria. These ages are superseded by those presented at the end of Chapter 4 in the present book.
- 55 It may seem self-evident to us that people would not deliberately strand themselves on islands becoming cut off from the mainland. Yet we should be wary of superimposing our own views – what we would do in a particular situation – on people with quite different worldviews confronted by the same situation in the past. A good analogue that I have been researching for some time is the issue of how Pacific Island coastal communities should respond to the sea-level rise they have been experiencing for some decades, and which appears to be accelerating. The 'Western' approach is to understand the context of the problem, evaluate scenarios for future sea-level rise, and explain to coastal dwellers that they should move. But that ignores the ways in which island people have long coped with environmental adversity; it ignores their spiritual beliefs and, for as long as they are given messages in foreign languages (like English) that privilege foreign thinking, it seems likely that they will continue to resist such exhortations. See also my 17 May 2017 article in *The Conversation* at <https://tinyurl.com/khzm6nl>.
- 56 From p. 194 of Josephine Flood's (2006) *The Original Australians*.
- 57 Quote from p. 108 of Isaacs (1980).
- 58 I am struck by the similarity between the 'sandbars' of the Yolngu Ancestresses and the sarns of Celtic cultures. Sarns – literally highways – are linear sedimentary features that

- extend from the land out across the sea floor, probably ancient moraines or levees bulldozed into place by growing glaciers, whose form and composition have been modified by the sea following their submergence after the last ice age.
- 59 This story is recounted on p. 40 of Berndt and Berndt's (1994) magisterial *The Speaking Land*.
- 60 This story was told originally by Peter Namiyadjad in the Maung language (Berndt and Berndt 1994: 40). A more recent version, in which the main actors are anthropomorphised, was collected by Siri Veland (2013, *Global Environmental Change*).
- 61 Quote from p. 25 of Corn (2005, *Journal of Australian Studies*).
- 62 Story told by Mangurug of the (northern) Gunwinggu people, reported on p. 88 of Berndt and Berndt (1994).
- 63 In my book *Vanished Islands and Hidden Continents of the Pacific* (Nunn 2009), I quote the examples of Teonimenu in the Solomon Islands and Malveveng and Tolamp in Vanuatu as places where the (abrupt) sinking of an island was accompanied by giant waves that observers believed to be the cause (rather than a consequence) of earthquake-induced island submergence.
- 64 From pp. 88–89 in Berndt and Berndt (1994).
- 65 This is the assumption, made for the sake of analytical completeness, by myself and Nick Reid in Table 1 of our 2016 paper in the *Australian Geographer*, freely available online at <http://tinyurl.com/hl8bdgt>.
- 66 This quote is from p. 14 of Morris (2001). Details of the Tiwi stories are from this source as well as from the account of Sims's chapter in the (1978) collection by Hiatt.
- 67 From p. 165 of Sims (*op cit*).
- 68 Quotes from p. 10 in Morris (2001).
- 69 The language of the Tiwi islanders and the ways in which their society is organised make them distinct from mainland Aboriginal groups, differences that are attributable to the isolation that began when the Tiwi Islands became separated from the mainland by the rising sea level.
- 70 A parallel record of the isolation of the Tiwi Islands by postglacial sea-level rise may be the 'extraordinary' level of

endemism shown by its rainforest ant fauna. Of the 34 species of ant found there, only nine are found anywhere else; the other 25 have been found only on these islands and perhaps evolved only after all land connections with the mainland became severed (Andersen, 2012, *Insectes Sociaux*).

- 71 Recollections of the effects of postglacial sea-level rise along other Tiwi coasts may include Myth 1 in the collection by Osborne (1974), which tells of a man stamping his foot repeatedly, causing the sea to rise over the land.
- 72 A readily accessible summary was published in *The Conversation* (online) on 6 April 2015.
- 73 This research was presented by Jo McDonald (2015, *Quaternary International*) and depended on the temporal sequencing of rock art in Murujuga. McDonald's continuing research in these islands uncovered evidence that their former Aboriginal inhabitants had built huts on stone platforms, something that many had previously thought Aboriginal Australians had never done.
- 74 None of these stories has been published. Most details here were supplied by Dr Katie Glaskin (University of Western Australia), who collected the majority of them as part of her 2002 PhD thesis; others come from testimony given by various Bardi and Jawi informants (Jimmy Ejai, Khaki Stumpagee and Aubrey Tigan) to a federal court case (*Sampi vs State of Western Australia*, 2005, FCA 777).
- 75 From p. 8 of the *Dictionary* (Moore 1884).
- 76 Much of the oldest evidence for human occupation of Rottnest is found within ancient soils (palaeosols) that have been buried by younger lithified sand dunes. These dunes contain the remains of land snails whose shells were able to be dated using aspartic acid racemisation assays. Dates on these shells of more than 50,000 years suggested to Patrick Hesp and others (1999, *Australian Archaeology*) that this was a minimum age for the human artefacts, although more recent work using optically stimulated luminescence dating suggests that the artefact-bearing layer is 10,000–17,000 years old (Ward, 2016, *Journal of the Royal Society of Western Australia*).

- 77 This account is from p. 341 of Mathews (1909, *Folklore*), and is part of a number of Aboriginal stories from the area that were collected by one Thomas Muir.
- 78 The story is found in Collet Barker's journals (Mulvaney and Green 1992: 361).
- 79 Quote from p. 157 of Maio and others (2014, *Palaeogeography Palaeoclimatology Palaeoecology*).
- 80 All the quotes in this section come from pp. 142–146 of Ethel Hassell's (1935, *Folklore*) collection of folktales from the Wheelman (Wiilman) tribe made before 1930.
- 81 Annual rainfall in the Nullarbor averages 150–250mm, but potential evaporation is closer to 2,000–3,000mm – unarguably a desert.
- 82 This is not strictly accurate. Between three and six million years ago, enough rain was falling on the Nullarbor for water to percolate into the subsurface limestone caves and form speleothems (stalactites and stalagmites). Pollen recovered from these suggests that gum trees (*Eucalyptus* sp.) and banksias (*Banksia* sp.) dominated a mesic forest that grew across the Nullarbor – at that time – in stark contrast to its present-day situation.
- 83 The Roe Plain(s) is part of the formerly more extensive coastal plain that existed during the lower sea level of the last ice age, but which is visible today only because it was uplifted shortly after it formed during Pliocene times, between 2.5 and 5.5 million years ago. It comprises a veneer of calcarenites – sediments laid down in shallow ocean water – covering an erosional platform in the bedrock limestone that formed when the Pliocene cliffs of the Nullarbor were receding at an astonishingly rapid rate: perhaps 85km (53 miles) in three million years.
- 84 Mallee eucalypt is the name given to at least three species. They have adapted to semi-arid conditions in Australia by developing long roots that extend laterally outwards, sometimes tens of metres, in search of water in every direction from the base of the tree. They also have roots that can penetrate downwards almost 30m (98ft). In 1928, in the desert north of the Nullarbor, one Archer Russell was being

guided by an Aboriginal man named Tuck who spotted 'a clump of big scrub-mallee'. Russell tells the story of what happened next. 'The trees I now noticed, had roots with sections growing alternately above and below the ground, and all the roots were long and twining. With Tuck wielding the shovel a root was soon exposed and torn from the ground. It was thirty feet (nine metres) long and no thicker than a man's wrist ... it is in reality an underground stem or rhizome. In each rhizome, which often contains a length of fifty feet (15 metres) or more, is enough water to sustain a man for a day' (Russell 1934: 100–102).

- 85 Quotes in this section are from pp. 89 and 91 of Scott Cane's (2002) comprehensive account of the Pila Nguru or Spinifex people who live in the Nullarbor.
- 86 Quote from p. 15 of Wright (1971).
- 87 Quotes from pp. 104–105 of Flinders (1814, vol. 1).
- 88 Quote from p. 401 of Berndt and Berndt (1996). Another version of this story – told by Mushabin (Bidjandjara), Harry Niyen (Antingari) and Marabidi (Ngalia-Andingari) – states that the brothers camped at Won-genya near Fowler's Bay and that, after the skin was pierced, 'all the water spread across the countryside and flowed down to the coast to become the Southern Ocean' (p. 44). Still another version – told by Sugar Billy Rindjana, Jimmy Moore and Win-gari (Andingari) and by Tommy Nedabi (Wiranggu-Kokatato) to Ronald Berndt in 1941 – adds the detail that the sea flood was prevented from spreading over the whole country by the 'action of various Bird Women' who gathered the roots of the *ngalda kurrajong* tree (probably *Brachychiton gregorii*), placed them along the coast to make a barrier and so 'restrained the oncoming waters', a response similar to that of the Wati Nyiinyii at the foot of the Nullarbor cliffs.
- 89 Assuming that, on average, a person acquired knowledge of these stories at the age of 15 and passed them on at the age of 35, this means that we count 'generations' for this purpose as lasting 20 years. Thus for a story to be passed on for 7,000 years (a minimum for these stories), it must be passed down through 350 generations.

Chapter 4: The Changing Ocean Surface

- 1 The earliest known remains of modern humans (*Homo sapiens*) are found within the Kibish Formation in the valley of the Omo River in southern Ethiopia. They date from about 195,000 ($\pm 5,000$) years ago (McDougall and others, 2005, *Nature*). There is evidence for *Homo sapiens* living at Asfet on the Red Sea coast of Eritrea as early as 150,000 years ago, although the main period of occupation would probably have been during the subsequent interglacial, when this coastal region became better watered and altogether more attractive to these of our ancestors.
- 2 The Quaternary Period began 2.6 million years ago and is characterised by regular climate (glacial-interglacial) oscillations divided on the basis of oxygen-isotope values for ocean-floor sediments of various ages. There are 104 Marine Isotope Stages (MIS) within the Quaternary; each even-numbered stage marks a cool (glacial) period or ice age, and each odd-numbered stage marks a warm (interglacial) period. The Last Interglacial shown in Figure 4.1 is thus MIS 5, while the coldest part of the Last Glacial (the last ice age) is MIS 2.
- 3 An argument along these lines was laid out to explain the start of cross-ocean discovery and occupation of oceanic islands in the Western Pacific Ocean in my book *Environmental Change in the Pacific Basin* (1999).
- 4 Information comes from the study by Scott and others (2014, *Antiquity*), who argue that the bone accumulations at La Cotte represent the final resting places of the megafauna that were extirpated here because they were unable to withstand the onset of cold conditions within the Last Glacial. There is a range of ages for the human and faunal presence at La Cotte, from 40,000 to 238,000 years ago, but another study quotes the more recent terminal age of $25,700 \pm 3,000$ years ago that is noted in the text (Bates, 2013, *Journal of Quaternary Science*).
- 5 The most comprehensive study of Doggerland is the book by Gaffney and others (2009).
- 6 Such remains began to be recovered in earnest after a Dutch fishing innovation called beam trawling, which involved dragging weighted nets along the ocean floor, was developed;

- ‘sometimes an enormous tusk would spill out and clatter onto the deck, or the remains of an aurochs, woolly rhino, or other extinct beast. The fishermen were disturbed by these hints that things were not always as they are. What they could not explain, they threw back into the sea’ (Laura Spinney, *National Geographic Magazine*, December 2012).
- 7 The sabre-toothed cat (*Homotherium latidens*) lived in Europe, Asia and North America. In size and musculature, it more closely resembled modern lions than modern tigers. Most of the details in this section come from the book by Mol and others (2008).
 - 8 In short, the wetter times of the last ice age appear to coincide with periods of expansion of areas occupied by modern humans (*Homo sapiens*), the proposed connection being that more rain would have made drier places more attractive to our ancestors because of the increased livelihood possibilities associated with the establishment of vegetation diversity. Using analyses of speleothems (dripstone deposits like stalagmites and stalactites), one research project reconstructed rainfall in North Africa during the last ice age and found just this for human expansion within and beyond this region. With remarkable precision, it proved possible to link a wet phase (50,500–52,500 years ago) to the movement of modern humans out of North Africa into the Middle East, where they first encountered – and interbred with – Neanderthal humans (Hoffmann, 2016, *Scientific Reports*).
 - 9 Megafauna in most parts of the world became extinct approximately simultaneously in the latest Pleistocene, typically by 10,000–13,000 years ago. In some places, the weight of evidence for megafaunal extinction favours predation by increasing numbers of increasingly well-armed and cooperating humans, while elsewhere deglacial climate changes are implicated. Explanations involving both rapid climate changes and human predation have also been mooted for some places. See also Chapter 6.
 - 10 One of the pioneers in the use of ‘island dipsticks’ for measuring postglacial sea-level change was one of my heroes,

the late Art Bloom of Cornell University, in many of whose footsteps around the Pacific Islands I have followed.

- 11 It is unclear whether most of the meltwater from the collapse of this ice saddle entered the Pacific or Atlantic Oceans. The former perhaps received the larger part because the thermohaline circulation, which is most vulnerable to freshwater inputs in the North Atlantic, did not shut down during MWP-1A.
- 12 The argument is neatly articulated in Barber and others (1999, *Nature*).
- 13 An earlier study suggested that the instantaneous rise of the sea level in the Mississippi Delta may have been as much as 1.2m (nearly 4ft), although this probably includes a background sea-level rise component as well as the effects of the outburst flood.
- 14 There have been serious suggestions from sensible scientists that future sea-level rise might cause the West Antarctic ice sheet to collapse catastrophically, raising sea levels an average of 3.3m (11ft) along the world's coasts, albeit with significant regional variations (Bamber, 2009, *Science*). Similar suggestions have been made for the Greenland ice sheet (Shannon, 2013, *Proceedings of the National Academy of Sciences of the United States of America*).
- 15 The origin of rice agriculture, if indeed there was a single place of origin, is disputed and may be becoming an issue of national pride rather than detached empiricism. That said, most evidence points to the Yangtze as an important place of early rice domestication, although there is increasing evidence that it may not have been the sole place of origin.
- 16 The comparatively 'late' development of agriculture in the Vistula Delta has long puzzled archaeologists. In addition to the effects of an oscillating sea level, which may have frustrated attempts to establish enduring crop production and animal husbandry here, it may simply be that the collection and processing of amber proved more profitable for many of the Roman-era Pomeranians living here. In addition to bedrock deposits of amber suited to mining, the shores of the Gulf of Gdańsk are as famed today for the deposition of

- wave-borne amber (often in nuggets) as they were in Roman times. From here, the amber was exported along an 'amber road' to Mediterranean markets, where it was in great demand for jewellery and for medicinal purposes.
- 17 The model for the Pacific Islands that links climate change and sea-level fall to an enduring food crisis about AD 1300, and a subsequent abandonment of coastal settlement in favour of hillforts, is described in considerable detail in my book *Climate, Environment and Society in the Pacific Islands during the Last Millennium* (Nunn 2007).
 - 18 My most recent research into Fiji's hillforts, conducted in collaboration with the Fiji Museum, has been in the Bua area of Vanua Levu Island. A popular account of this project was published online in SAPIENS on 15 June 2016 and is downloadable from <http://tinyurl.com/z9st6eb>.
 - 19 Quotation comes from p. 55 of Henry Britton's *Fiji in 1870*, a collection of articles he wrote for the *Argus* newspaper in Melbourne (1870).
 - 20 The most comprehensive and accurate assessment of current and recent rates of sea-level change is found in the 5th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). The science was assessed by Working Group 1. The Summary for Policymakers is an accessible summary for non-specialists – see ipcc.ch.
 - 21 Closure of the 'sea-level budget' for 1993–2010 was a major achievement of the 'Sea Level Change' chapter in the 5th assessment report of the IPCC. Until this point, there was uncertainty about exactly which cause/s of sea-level rise were most important. Settling the issue has implications not only for the understanding of past sea-level changes and the modelling of future ones, but also for strategies to mitigate the effects of future climate change.
 - 22 The original area of the contiguous land mass of Sahul (comprising modern Australia, Papua New Guinea and Irian Jaya, or Indonesian Papua) during the Last Glacial Maximum about 20,000 years ago (when the sea level was about 120m/400ft lower than it is today) was 11,021,024km² (4,255,241mi²). The modern land area totals 8,473,836km² (3,271,766mi²), so

- 2,547,188km² (983,475mi²), or 23 per cent, was inundated when the sea level rose after the end of the last ice age.
- 23 This authoritative compilation of past sea level around Australia was developed by Stephen Lewis and others and published in 2012 in the journal *Quaternary Science Reviews*.
 - 24 Delicate bivalves (like *Donax* and *Paphies* spp.) have been used in Australian sediment cores to identify former shorelines. Where these shells are found unbroken rather than pulverised, this indicates that they had hardly been moved from the coast they formed.
 - 25 Six sediment cores collected from the sea floor between the Arafura Sea and Gulf of Carpentaria show that the sill separating the two was covered by seawater most recently about 9,700 years ago (Chivas, 2001, *Quaternary International*).
 - 26 David Hopley's pace-setting 1982 book on the *Geomorphology of the Great Barrier Reef* made the case for coral-reef coring as a precise way of reconstructing past sea levels with an almost unmatched degree of precision. This book has more recently appeared in an updated version (Hopley, Smithers and Parnell 2007).
 - 27 See Dixon (1980: 46).

Chapter 5: Other Oral Archives of Ancient Coastal Drowning

- 1 I am grateful to Marjorie Le Berre for information in these two paragraphs, which is based on conversations we had in Nantes in November 2016 and is used with her permission.
- 2 The city of Ys is sometimes placed not in the Baie de Douarnenez, but in the Baie des Trépassés, or in the Baie d'Audierné (Guyot 1979), all along the west-facing coast of Brittany.
- 3 English translation on p. xiii of the book by Guyot (1979), from Bertrand d'Argentre's (1588) *L'Histoire de Bretagne* (The History of Brittany).
- 4 '*La ville d'Ys fut submergé et presque tous ses habitants périrent*': French text from p. 22 of Sébillot (1899).
- 5 '*Les pêcheurs de Cancale dissent que quand la mer est belle et claire, on voit entre le Mont Saint-Michel et les îles Chausey de debris de*

- murailles. Ce sont les restes d'une ville disparue*: French text from p. 23 of Sébillot (1899).
- 6 Quotes from p. 336 of Peacock (1865, *Proceedings of the Royal Geographical Society of London*), who also concluded that the monastery at Menden is now under 8m (26ft) of ocean, that at Mandan (west of St Pair) now under 10m (33ft), that named after St Moack now under 13–14m (43–46ft), and Taurac (or Caurac) now submerged to a depth of 16m (52ft).
 - 7 St Guénolé (or Guignolé) is often remembered in English-language texts as St Winwaloe; details of his life were summarised by Doble (1962).
 - 8 Nowhere is this perhaps more obvious than on the delta of the Brahmaputra–Ganges–Meghna river, occupied mostly by several tens of millions of Bangladeshis, which has over recent decades experienced storm surges that have reached progressively further inland as a result of these being imposed on sea-level rise. As the sea level rises in the next few decades, so storm surges will reach even further inland.
 - 9 *'Au temps jadis la Manche n'était pas si grande que maintenant; l'on pouvait aller à Jersey sans rencontrer d'autre obstacle qu'un ruisseau qui n'était pas très large'* (Sébillot 1899: 23). In addition, a contemporary story about 'the conjunction of Jersey to Normandy' was alluded to by Poingdestre (1889: 75).
 - 10 From *Gazette de l'Île de Jersey*, 28 April 1787, quoted by Peacock (*op cit*, p. 329), who identifies numerous other instances of submerged forests in the Channel Islands.
 - 11 Reading Alan Seeger's eponymous 1916 poem, written at a time when the ancient tradition was probably better known than it is today, Lyonesse sounds as though it might have been Ys – as indeed it may:

*In Lyonesse was beauty enough, men say:
 Long Summer loaded the orchards to excess,
 And fertile lowlands lengthening far away,
 In Lyonesse.*

*Came a term to that land's old favouredness:
 Past the sea-walls, crumbled in thundering spray,
 Rolled the green waves, ravening, merciless.*

*Through bearded boughs immobile in cool decay,
Where sea-bloom covers corroding palaces,
The mermaid glides with a curious glance to-day,
In Lyonesse.*

- 12 From an 1854 translation of *The Chronicle of Florence of Worcester*, quoted in Hunt (*op cit*) at www.sacred-texts.com/neu/eng/prwe/prwe085.htm, accessed in April 2009.
- 13 Quoted by Hunt (*op cit*). Other authoritative sources that name Lyonesse and place it off the coast of Land's End include *Britannia* (Camden 1590) and the 1602 *Survey of Cornwall* (Carew 1723). Camden was an antiquarian who collected folk tales. He concluded that Lyonesse (the City of Lions) was located off Land's End where the Seven Stones reef now lies. Camden also reported that sailors could hear the bells of Lyonesse ringing when they crossed the area during heavy seas.
- 14 There are examples from the South-west Pacific island groups of the Solomon Islands and Vanuatu in which islands have reportedly vanished as a result of large-wave impact but which must also have been affected, either during the earthquake that produced these (tsunami) waves or a short time after it, by rapid subsidence. It was the latter that caused the islands to disappear. Examples include Teonimanu and the Pororourouhu group in the Solomon Islands, and islands like Malveveng and Tolamp in Vanuatu. These and other examples are in my book *Vanished Islands and Hidden Continents of the Pacific* (Nunn 2009), available as an audio book at <https://tinyurl.com/lbrrgfa>.
- 15 A contemporary account notes that to the astonishment of onlookers on the south coast of Cornwall, 'the Sea rose near six feet [1.8m], coming in from the South-East extremely rapid; then it ebbed away with the same rapidity to the Westward for about ten minutes; till it was near six feet lower than before; it then returned again, and fell again ... the first and second fluxes and refluxes were not so violent as the third and fourth, at which time the Sea was as rapid as that of a mill-stream descending to an under-shot wheel, and the rebounds of the Sea continued in their full fury for fully two

hours' (Borlase 1758: 53–54). This happened at a distance of around 1,500km (932 miles) from the epicentre. The Reverend Borlase described a more locally centred earthquake on 15 July 1757, during which 'on the island of St. Mary, Scilly, the shock was violent'.

- 16 The Roman count is found in Strabo's *Geography* (AD 17?), at a time when the Scilly Isles were called the Cassiterides.
- 17 Causeways and house foundations have also been found underwater within the Scilly archipelago (Ashbee 1974).
- 18 The story is immortalised in the Welsh-language poem *Clychau Cantre'r Gwaelod* (The Bells of Cantre'r Gwaelod) by J. J. Williams. The extract quoted here was translated by Dyfed Lloyd Evans and accessed at www.celt.net.org.uk in October 2007.

*O dan y môr a'i donnau
Mae llawer dinas dlos
Fu'n gwranddo ar y clychau
Yn canu gyda'r mos.
Trwy ofer esgeulustod
Y gwiliwr ar y tŵr
Aeth clychau Cantre'r Gwaelod
O'r golwg dan y dŵr.*

Beneath the wave-swept ocean
Are many pretty towns
That hearkened to the bell-rings
Set pealing through the night
Through negligent abandon
By a watcher on the wall
The bells of Cantre'r Gwaelod
Submerged beneath the waves.

- 19 A much larger area of more than 6,200km² (2,400mi²) is envisaged in the analysis of Flemming (1972), who was consequently sceptical that such a land ever existed. The name Cantre'r Gwaelod means 'the bottom cantref', a *cantref* being an area of perhaps 466km² (about 180mi² – Flemming 1972).
- 20 All quotes paraphrased from accounts quoted by Doan (1981, *Folklore*).

- 21 The quotes in this sentence and the next come from p. 81 of Doan (*op cit*), who also quotes authoritative sources for the age determination.
- 22 'It is to representatives drawn from among the famous legendary heroes of the sixth century, the period assigned to the beginning of their national traditions, that medieval *cyfarwyddiaid* [storytellers] attached the legends of the great inundations' (from p. 241 in the chapter by Rachel Bromwich in the collection by Fox and Dickens (1950)).
- 23 Quoted by Bromwich (*op cit*, p. 229) from a 1917 account by Richard Fenton.
- 24 This information is found on p. 334 of Wilson's (1870) *The Imperial Gazetteer of England and Wales*. The idea that human-made structures are visible at Caer Arianrhod was roundly criticised by North (1957) and others, yet they do not address the more subtle point about whether or not the memory of such a place may be authentic ... even if its currently favoured physical manifestation may not.
- 25 A submerged forest in the Dovey Estuary was dated to 4,700–6,000 years ago when the sea level here may have been 2–4m (6½–13ft) lower.
- 26 Another estimate by Kurt Lambeck suggests that there was a wide land bridge between Ireland and Wales from 13,000 to 20,000 years ago, but it is not explained when it may have become impassable. Yet it is noted that about 14,000 years ago, because of the huge volumes of meltwater pouring into the Irish Sea, the shrinking land bridge would have been 'a swampy and inhospitable region at best' (1995, *Journal of the Geological Society of London*, p. 443).
- 27 The quotes come from p. 30 of a recent translation of the *Mabinogion* (Jones and Jones 2001). Renowned Anglo-Saxon scholar Rachel Bromwich commented that 'this passage may represent the eleventh-century tradition about the submerged lands' between Wales and Ireland and is a story that appears 'quite independent' of that about Cantre'r Gwaelod (*op cit*, p. 228).
- 28 As an aside, it is fascinating to consider the possibility that an oral tradition like that of Brân walking from Wales to Ireland

may have seen him posthumously changed to a giant, for how else might anyone be persuaded to believe he had crossed an ocean on foot? It may be that an implausible tradition, preserved for millennia, led to the belief that giants once existed. And of course, once that particular fantastic door had been opened, any number of similar traditions became game for the involvement of giants.

- 29 These calculations are based on modelling of postglacial sea-level change by Lambeck (*op cit*). Cornwall is currently sinking at an estimated 0.6mm each year; assuming this rate applied to the last 10,000 years or so (which it probably did not), then we can ascribe some 6m (20ft) of submergence to it, which still requires the sea level to have been 60–70m (200–230ft) lower for these Lyonesse stories to be based on observation of a land bridge between the Scilly Isles and Cornwall.
- 30 In AD 1250, Dunwich housed more than 5,000 people living in at least 800 taxable dwellings, spread out over some 330ha (815 acres) (Sear, 2011, *International Journal of Nautical Archaeology*).
- 31 This effect can be explained by Global Isostatic Adjustment (GIA), which pictures the Earth's crust as continuing to respond to the removal of terrestrial ice loads during the last ice age. Areas that were thickly ice covered are rising because of the 'flow' of crustal (lithospheric) material towards them from areas that were not ice covered, or at least not so thickly. The zone of maximum subsidence in north-west Europe crosses the southern North Sea and can be considered a significant contributor to land sinking along the East Anglian coast.
- 32 Not to be confused with the Herakleion on the Mediterranean island of Crete.
- 33 These figures are those proposed by Stanley (2007). Founded in the sixth century BC, Herakleion thrived for some 600 years; Eastern Canopus was probably established a little later and remained visible until the mid-eighth century AD.
- 34 The most complete account of the Canopic distributary and the rediscovery of its Greek port cities is by Stanley (2007).

A comparable explanation refers to the ‘disappearance’ of the city of Vineta in the Oder River Delta on the Baltic coast of modern Poland or Germany.

- 35 A contemporary account of the disaster by Pausanias described how ‘the sea flooded a great part of the land and encircled the whole of Helike. Moreover, the flood from the sea so covered the sacred grove of Poseidon that only the tops of the trees remained visible’ (quoted in English in the chapter by Soter, p. 41 in the book by Iain Stewart and Claudio Vita-Finzi, 1998).
- 36 This remarkable piece of geological sleuthing was carried out by Soter and Katsonopoulou (2011, *Geoarchaeology*).
- 37 Movements of extremely hot water and steam within the Phlegrean Fields caldera, where these ports were located, account for the sometimes frenetic movements of the Earth’s surface here. Hot water or gas, superheated by its proximity to liquid rock below, forces its way upwards through the Earth’s crust, often pushing into chambers just below the surface and causing them to expand, sometimes only temporarily, and the ground surface to rise. Once these chambers empty, the surface can fall. Alternate rise and fall of the ground surface makes the geography of the Phlegrean Fields region one of the most changeable in the world. In 1982–1984, an increase in such ‘bradyseismic’ effects rendered the city centre unsafe and raised the adjacent sea floor by some 2m (6½ft). Somewhat ominously, the dominant cause of ground-surface changes in the region changed in about 2012 from hydrothermal to magmatic, that is from the subterranean movement of hot liquids to the emplacement of a lava reservoir, as shallow as 3,000m (9,850ft), below the streets half a kilometre (½ of a mile) from the seafront in Pozzuoli.
- 38 Most of the information about the seismotectonic history of the Rann of Kachchh comes from the work of Bilham (in a chapter in the book by Stewart and Vita-Finzi, cited above), who painstakingly analysed all the qualitative accounts to produce a plausible quantitative scenario that can be used to inform future earthquake planning in this region. Reduced crustal stress in the Kachchh area probably means that

another big earthquake here is unlikely in the foreseeable future, although accumulated stress may have been transferred along regional fractures towards Karachi, Pakistan.

- 39 Cited in Bilham (*op cit*, p. 5).
- 40 Quotes in this paragraph come from the Griffith translation of Hymn 87 (LXXXVII) accessed online in February 2017 at www.sanskritweb.net/rigveda/griffith.pdf.
- 41 The most comprehensive account of Dwaraka is the book by Rao (1999).
- 42 This information is found in the *Harivamsa*, an appendix to the *Mahabharata*. A *yojana* is considered to have been a measure of distance, perhaps 12–15km (7–9 miles), not area, so it is not straightforward to estimate how much land was reclaimed at Dwaraka. If we assume the extent of coastal protection structures (bunds and sea walls) to be 12km, then the area reclaimed may have been 5–6km² (about 2mi²).
- 43 Never underestimate people's attachment to place, especially when this is imbued with considerable investment of money and effort. After the devastating impact of Hurricane Katrina on New Orleans, USA, in 2005, there were calls for the most vulnerable parts of this iconic city – those as much as 2m (6½ft) below sea level – to be abandoned and their occupants to be compensated and relocated elsewhere. It did not happen.
- 44 From the *Mausala Parva* (Book of Clubs), the sixteenth book of the *Mahabharata*.
- 45 The key details in stories transmitted orally often become compressed, an effect dubbed 'memory crunch' (Barber and Barber 2004).
- 46 Thermoluminescence (TL) dates were reported by Vora and colleagues (2002, *Current Science*). When applied to ceramics, the TL technique can measure the time elapsed since firing, a process that resets the TL clock to zero. By heating crystalline samples (as in bits of pottery), light is produced – the thermoluminescence – and the amount of this light is proportional to the radiation dose that has accumulated over time, something that can be converted to age.

- 47 Based on the work of R. N. Iyengar (2005, *Journal of the Geological Society of India*).
- 48 The Harappan cultural tradition appeared about 5,200 years ago (3250 BC) along the Indus River Valley, and spread, based on a system of complex urban centres sustained by agricultural production. The Sausashtra Peninsula, where Dwaraka was located, was on the margins of Harappan culture. It is possible that the Rann of Kachchh, today one of the least hospitable parts of India, was awash and navigable during Harappan times, something that would have transformed the productive and exchange potential of this area.
- 49 The story is told in Book Six (*Yuddha Khanda*) of the *Ramayana*. In the prose rendering of Sarga (Chapter) 22, Rama spoke harshly to the ocean – ‘O, ocean! I will make you dry up now along with your nethermost subterranean region. A vast stretch of sand will appear, when your water gets consumed by my arrows; when you get dried up and the creatures inhabiting you get destroyed by me. By a gush of arrows released by my bow, our monkeys can proceed to the other shore even by foot. O Sea, the abode of demons! You are not able to recognize my valour or prowess through your intelligence. You will indeed get repentance at my hands’ (from www.valmikiramayana.net/yuddha/sarga22/yuddha_22_prose.htm, accessed in February 2017).
- 50 These dates are reviewed in Krishnaswamy and Nandan (2005, *Journal of the Geological Society of India*), who reconciled geological evidence for a period of unusually cold winters in India with the description of these in the *Ramayana*.
- 51 The story of the failed bridge is found in the seventh-century poem *Setubandha*.
- 52 We cannot discount the possibility that tectonics – land movements – also had a role in the disappearances (and appearances) of Ramasetu. Uplifted coral reefs, some 4,000 years old, are found on the Indian side of Ramasetu.
- 53 A likely chronology for the Pallava Era is from about AD 300, when Sivaskandavarman ascended the throne, until AD 869, when Nandivarman III died.

- 54 This information comes from Sundaresh and others (2004, *Current Science*), who also quote an eighth-century Tamil text describing Mahabalipuram as a place ‘where the ships rode at anchor bent to the point of breaking, laden as they were with wealth, big-trunked elephants and gems of nine varieties in heaps’ (p. 1231).
- 55 From an 1869 account quoted by Sundaresh and others (*op cit*, p. 1232).
- 56 Research reported by Rajani and Kasturirangan in the 2013 issue of the *Journal of the Indian Society of Remote Sensing*.
- 57 The Bay of Bengal, which is bordered by the east coast of India (where Mahabalipuram is located), is a structural feature that is experiencing subsidence of as much as 3mm per year resulting from regional tectonic movements in addition to the effects of both sediment loading of the ocean floor and sea-level rise. The Bay also experiences instances of rapid subsidence associated with earthquakes that have contributed to the progressive submergence of the Mahabalipuram area over the past few millennia.
- 58 To the south of Mahabalipuram on India’s east coast, there are also stories about submerged places at Poompuhar and Tranquebar. Older perhaps are stories about a submerged continent, Kumari Kandam, off the southern coast of India, which may have influenced European stories about a supposed ‘lost continent’ named Lemuria in the Indian Ocean (Ramaswamy 2004).

Chapter 6: What Else Might We Not Realise We Remember?

- 1 The greenhorn was the author, who published a detailed analysis of the Kadavu volcano myths (1999, *Domodomo* [Fiji Museum]). Years later, the cutting of a new road around the base of Nabukelevu revealed volcanic scoria lying above soils in which potsherds were found, unequivocal evidence for eruptive activity here since the human settlement of Kadavu Island. Kadavu is part of a volcanic island arc, similar to many in the Western Pacific,

formed by volcanic activity linked to the underthrusting of one crustal plate beneath an adjoining one. The lower plate is forced into the Earth's interior where it melts, the liquid rock finding its way to the surface above – in places like Kadavu.

- 2 An absorbing study of the 'times of darkness' in highland New Guinea is by Russell Blong (1982), who employed mineralogical analyses of ash to determine which eruptions from which volcanoes had affected particular places – and might therefore do so in the future.
- 3 The quote comes from William Dampier's (1729) *A Continuation of a Voyage to New Holland*, accessed online through Project Gutenberg in February 2017; the original spellings are quoted on p. 1 of *Fire Mountains of the Islands* (Johnson 2013).
- 4 Lines of intraplate (not plate-boundary) islands in the world's ocean basins are explained as a result of an oceanic plate (piece of Earth's crust) moving over a fixed mantle plume, known as a hotspot. As long as the plume keeps leaking liquid rock, a succession of volcanoes will form, the only active one(s) being that closest to the hotspot (Nunn 1994). The best-studied example is the Hawaii-Emperor island-seamount chain that extends nearly 6,000km (3,750 miles) across the North Pacific and has been active for at least 80 million years. The youngest above-sea volcano in this chain is the Big Island (Hawai'i), which is nearing the end of its active life. Yet lurking 1.2km (¾ mile) beneath the ocean surface, 35km (22 miles) to its south-east, lies the active and growing volcano of Lo'ihi, destined one day to spectacularly break the ocean surface and grow into a massive structure like the Big Island is today.
- 5 There has been a lot of research on this topic. What has recently emerged as a more compelling explanation of NVP volcanism, supported by teleseismic tomography of the solid earth beneath the area, is edge-driven convection (EDC). This requires abrupt changes in crustal (lithospheric) thickness, expressed along its lower boundary by steps within each of which liquid rock is circulated by convection. Below

- the NVP there is a step within which liquid rock is circulating, an anomaly in an Australian context, but likely to be responsible for NVP volcanism within the last five million years.
- 6 Many evangelical Christian groups interpret the time periods specified in the Bible literally, believing that the Earth since its divine creation is only a few millennia old. To justify this interpretation, it is then deemed necessary to discredit radiometric dating, something that a few authors have gone to tortuous lengths to attempt. A fine review of creationism and its historical antecedents is the book by Arthur McCalla (2013).
 - 7 A billion here means 1,000,000,000. For some of the oldest rocks on Earth, other techniques involving even slower rates of isotope decay are used, including the awesome rubidium-strontium method in which ^{87}Rb decays to ^{87}Sr with a half-life of 50 billion years.
 - 8 Tennateona was so cruel and savage that some people, to save themselves from him, 'laid themselves on ant heaps and let the ants cover their bodies as if dead' (Smith 1880: 24).
 - 9 The earliest written version of this story (much was misquoted subsequently) is found on pp. 14–15 of the book by Christina Smith, a missionary who lived in the Mt Gambier area from 1854 until her death in 1893. She learnt to speak the local Bungandidj language and recorded numerous stories of the Buandig (Booandik) people (Smith 1880).
 - 10 Dating of materials below (and therefore predating) the youngest lava flows at Mt Gambier show a maximum age for these of perhaps 4,300 years ago. A similar date of 4,930 years ago was obtained from Mt Schank.
 - 11 The quotation is from p. 102 of Dawson (1881); other stories are reported herein and another about the eruption of Mt Buninyong by Howitt (1904).
 - 12 A good example of the arbitrariness of history is that Mt Eccles was originally Mt Eeles, named for a prominent war veteran, but a draughting error in the 1850s rendered it 'Eccles', which name has been used since!

- 13 Depth-age calculation from Figure 4.3 in Chapter 4 shows that the sea level around Australia was 33m (108ft) below its present level between 10,150 and 10,750 years ago. A likely age for the Tyrendarra flow is around 36,000 years ago.
- 14 The name Gerinyelam, rendered more recently as Derrinallum, for Mt Elephant is recorded on p. 179 of Smyth (1878). The dates for the most recent eruptions of Mt Elephant are reported in an anonymous article but appear to be estimates.
- 15 Information from www.kanawinkageopark.org.au, accessed in March 2017.
- 16 For example, a 2017 study by Ben Cohen and others stated that 'the cause of the young lava field volcanoes in Queensland is not well known ... no single model satisfies all observations' (*Quaternary Geochronology*, p. 80).
- 17 Quote from p. 90 in Cohen's work (see previous note).
- 18 This date is actually a range from 5,000 to 9,000 years ago; the median age is 7,000 years ago. The unusually large error ($\pm 2,000$ years) is because a comparatively new dating technique ($^{40}\text{Ar}/^{39}\text{Ar}$) was employed; future refinements are likely to see error margins reduced.
- 19 I am not sure what to make of the Aboriginal story, recorded about 1917 'halfway up the Tully River', 100km (60 miles) north-east of Kinrara, which 'related how long ago ... fire and flames had erupted suddenly from the rocks and a rain of stones had fallen in the surroundings' (Mjöberg 1918: 141). The explanation given was that this had been the work of an evil spirit seeking revenge; it was noted that at that time, local people 'avoided getting too close to the place of the eruption'. The problem is that there is no known youthful volcano in this area, so it is possible this story came here from somewhere else.
- 20 This Mamu/Ngajan version of the story was told by George Watson in the Mamu dialect of Dyirbal. It is summarised on pp. 153–154 of linguist Robert Dixon's entertaining memoir (1984). An alternative version, told by Dick Moses in the coastal dialect of Yidiny, is written in both the original and translation in another of Dixon's books (Text 3 in Dixon 1991).

- 21 The Fujisan legend quoted comes from the landmark compilation by Dorothy Vitaliano (1973), which also contains examples from other parts of the world.
- 22 For a popular yet scientifically rigorous account of Krakatau, I recommend the book by Simon Winchester (2003). Indonesia was also the site of the even larger Toba supereruption about 75,000 years ago (on Sumatra Island), which produced some 2,800km³ (670mi³) of material; in 1883 Krakatau produced about 12. By pouring so much airborne material into the Earth's atmosphere, the Toba event may have caused a 'volcanic winter' that blotted out the sun, causing plant growth to diminish to a point where humanity became imperilled; people everywhere starved to death. The Toba supereruption was once believed to have been responsible for a bottleneck in modern human evolution, although subsequent research suggests that this view might be overstated; people in India appear to have coped, and those in East Africa were apparently unaffected.
- 23 The date of 16,000 years ago for the draining of Lake Bandung near Tangkuban Perahu comes from research by Dam and colleagues (1996, *Journal of Southeast Asian Earth Sciences*). I have woven together several versions of the story of Sangkuriang and Dayang Sumbi, the principal published version being that in Vitaliano (1973).
- 24 This story is found in the memoir by Charachidzé (1986).
- 25 Using the potassium-argon (K-Ar) technique, lavas from Kazbek and Elbrus and numerous other Caucasian volcanoes have been dated (Lebedev, 2014, *Journal of Volcanology and Seismology*). In about AD 320, an eruption of Elbrus caused avalanches that buried ancient soils (palaeosols), which have been dated using radiocarbon to determine the age of the eruption (1,780 ± 70 years ago). The first indication that ice-capped Elbrus might be about to spring back to life was when scientists noted moss growing above cracks in the ice surface, suggesting that heat from beneath the ice was escaping to the surface along these cracks. Subsequent investigations confirm that the mountain's top is hotter than would be expected – it sits more than 5,600m (18,370ft)

- above sea level – perhaps because of the filling of a shallow subterranean magma chamber (see <https://sputniknews.com/voiceofrussia/2010/08/02/14236033.html>, accessed in February 2017).
- 26 Bacteria do not have brains because they are unicellular, but it could be argued that bacteria have ‘minds’ since the receptors on the outside of their cells are designed to identify ‘good’ and ‘bad’ foods that determine in which direction they travel.
- 27 The clathrate-gun hypothesis is the subject of a book by Kennett and others (2002). In fairness, it should be pointed out that there are other explanations for the collapse of methane-hydrate-filled sediment piles along continental margins, including one involving changes in water temperature (associated with glacial-interglacial cycles) that simply causes the ice casings of the methane to melt, releasing the gas in large quantities almost simultaneously and leading to collapse. Scientists have worked backwards from discoveries like that of finding that collapsed material at the edge of the underwater Amazon Delta contained some 10 per cent methane hydrates, a strong indication that the dissociation of these caused the associated collapse.
- 28 This event is the Storegga Slide, the main part dated to $8,100 \pm 250$ years ago. Wave heights associated with the Storegga Slide were calculated by Stein Bondevik and colleagues (2005, *Marine and Petroleum Geology*); the scattering of stone tools consistent with tsunami impact was deduced for a site in Inverness by Alastair Dawson and colleagues (1990, *Journal of Archaeological Science*).
- 29 The destruction of worlds by fire, flood and earthquake is a persistent theme in Norse mythology (Gaiman 2017), perhaps most famously in anticipatory descriptions of Ragnarok, the future world-ending battle, the equivalent of Armageddon in Greco-Roman cultures.
- 30 How and why islands can disappear is explained in my 2009 book, *Vanished Islands and Hidden Continents of the Pacific* (Nunn 2009), now available to listen to – see <https://tinyurl.com/lbrrgfa>.

- 31 More details about the original Teonimenu story (and stories of other vanished islands in the vicinity) are found, together with a cogent geological explanation, in the work by myself and others (2006, *South Pacific Studies*). The transcription of an original story about Teonimenu by Zacchariah Haununumaesihaa'a, collected from Ulawa Island by Tony Heorake, is found in Appendix 1 of my 2009 book (Nunn 2009).
- 32 This remarkable story was told by Wolfe and colleagues in the 1994 *Journal of Geophysical Research*.
- 33 This extraordinary piece of cartographic detective work was reported by Filmer and others in the 1994 issue of *Marine Geophysical Researches* and is supported by indigenous stories recalling a 'large disaster' in the area around the year 1800.
- 34 Quote from p. 463 in the book on *Yurok Myths* by Kroeber (1976).
- 35 Coastal settlements throughout the Cascadia region (north-west USA and south-west Canada) have been affected by abrupt, earthquake-induced subsidence; a wealth of oral stories about these events is reported in the 1996 volume of *American Antiquity*.
- 36 Earthquakes are estimated to occur only every 2,000 years along the Sparta Fault. That is why the timing of the destructive 464 BC event may be so significant for an understanding of Plato's thinking about the role of catastrophic events in societal collapse.
- 37 Chapter XI of Book III of Thucydides (431 BC).
Geoscientists remember Thucydides as the first person to correctly infer a connection between earthquakes and tsunamis. The following is a continuation of the quote used in the text. 'The cause, in my opinion, of this phenomenon must be sought in the earthquake. At the point where its shock has been the most violent, the sea is driven back and, suddenly recoiling with redoubled force, causes the inundation. Without an earthquake I do not see how such an accident could happen.'
- 38 Plato is generally considered the originator of the 'Socratic dialogue', a literary device based on oral debates. The details of the Atlantis story appear in two of his dialogues, *Critias*

and *Timaeus*. Plato's most prominent disciple, Aristotle, probably reflected his master's teachings when he pondered the modes of persuasion furnished by the spoken word in his *Rhetoric* (350 BC); he identified three modes, the third of which explained that persuasion is achieved through the speech itself when a truth (or an apparent truth) is proven by means of the persuasive arguments suited to the case in question. Indeed.

- 39 In the immediate aftermath of the explosion, one eyewitness stated that 'we saw around us a miracle, a terrible miracle. The forest was not our forest. I have never seen such a forest in my life. It was so unfamiliar. We had here a dense forest, a dark forest, an old forest. And now there was in many places no forest at all. On the mountains all the trees were lying down and it was light; one could see far away. And it was impossible to go under the mountains, through the bogs: some trees were standing there, others were down, still others were bent, and some trees had fallen one upon another. Many trees were burnt, dry trunks and moss were still burning and smoking' (part of Akulina's story, quoted in the paper by Suslov in the 2006 issue of the *Russian Institute on Anomalous Phenomena (RIAP) Bulletin*).
- 40 This is the English translation in the 1996 issue of *Meteoritics & Planetary Science* of part of the original account by Antenor Álvarez (1926).
- 41 Australian microtektites – tektites small enough to circulate some distance in the atmosphere – have been found in Chinese loess and in accumulations of eroded material around the Transantarctic Mountains.
- 42 During a visit to the Henbury meteorite crater field in June 1931 by a group from the Kyancutta Museum (South Australia), a journey of more than 4,800km (3,000 miles) by 'motor truck', contact was made with 'a local prospector' who supplied the Aboriginal name for this site. A neat summary of traditions by Duane Hamacher about the Henbury craters was published online in *The Conversation* on 4 March 2016 (<http://theconversation.com/finding-meteorite-impacts-in-aboriginal-oral-tradition-38052>).

- 43 One example is of Wolfe Creek crater (Western Australia), which formed from bolide impact about 300,000 years ago. Long before Western-trained scientists had worked out its origin, local Djaru people had stories consistent with this, even though its formation must have gone unwitnessed by people. One account by Djaru man Jack Jugarie states that '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' (quoted in Sanday 2007: 26).
- 44 From pp. 32–33 of *The Adnyamathanha People*, produced by the Education Department of South Australia.
- 45 This story was collected from Aboriginal informants in the Shoalhaven region by Ellen Anderson, between perhaps 1870 and 1920, and comes from pp. 192–193 of *Australian Legends* by Charles W. Peck (1933).
- 46 Flood myths feature in almost every long-established culture (Dundes 1988), and in most cases probably represent stories of successive flood events.
- 47 A trailblazing survey of preservice (trainee) teachers in the United States found that 'sizeable minorities ... awaited more evidence' as to whether fantastic beasts (like Bigfoot and the Loch Ness Monster) were real (see Susan Losh, 2011, *Journal of Science and Education*, p. 473). The study concluded that 'more training is needed for preservice educators in the critical evaluation of material evidence'. I agree.
- 48 Less charitably referred to as hobbits (which are imaginary creatures), the details of this extraordinary discovery – extraordinary because it had long been regarded as an orthodoxy that our species was the only one of *Homo* to have been around in the last 100,000 years or so – were first announced in the journal *Nature* on 28 October 2004 in three short pieces and an article.
- 49 See the 2016 paper in *Nature* by Sutikna and others.
- 50 Details are in Forth's *Beneath the Volcano* (1998).
- 51 See the most recent book by Forth (2008).

- 52 If stories of small people coexisting with larger ones (like us) intrigue you, I recommend the riveting and scientifically rigorous book *Pygmonia* (McAllister 2010).
- 53 This quote comes from an unpublished 1845 manuscript without page numbers entitled *An account of some fossil bones found in Darling Downs* by F. N. Isaac.
- 54 Quotes from Barrett (1946: 29–30).
- 55 The first quote in this sentence is from Opit (2001: 45), whose account includes many other accounts of possible or claimed *bunyip* sightings. The second quote, together with that in the following sentence, comes from the description of *Palorchestes azael* in the superbly illustrated book by Archer and others (1991: 115). Several scientists have suggested that Aboriginal stories about *bunyip* and similar creatures might be based on observations thousands of years ago of diprotodontoids like *P. azael*.
- 56 I am troubled by the oft-used argument that because *Palorchestes azael* became extinct some 40,000 years ago (which it perhaps did not – see the next note) it could not possibly be represented in rock art, especially given the compelling arguments to the contrary (see, for example, the paper by Murray in the 1984 issue of *Archaeology in Oceania*).
- 57 The Riversleigh terrace date of 23,900 (+ 4,100 or – 2,700) years ago was reported in the 1997 *Memoirs of the Queensland Museum* by Davis and Archer. The Spring Creek date of 19,800 $\pm$ 390 years ago is from cave deposits containing megafaunal remains including those of *Palorchestes azael* (see Tim Flannery's paper in the 1984 issue of *The Australian Zoologist*). Popular accounts of this creature often claim that it survived until 11,000 years ago in Australia, but I have been unable to find a reliable source for this claim.
- 58 It is easy to forget that because Australia is so vast and most of it is so sparsely populated there is a greater potential here, compared to most other places, for animals regarded as extinct (at least recently) to be discovered alive. For example, science regards the Tasmanian Tiger (*Thylacinus cynocephalus*), an endemic thylacine, to have become extinct in the 1930s, yet in March 2017, in response to increasing numbers of

plausible sightings in far north Queensland, scientists began to look for it there (www.jcu.edu.au/news/releases/2017/march/fnq-search-for-the-tasmanian-tiger, accessed in March 2017). Naturally, they are keeping coy about precisely where they lay their camera traps.

- 59 Just to note that the American cheetah was probably slower than its modern counterpart, better at climbing trees than running. And that the camels, notwithstanding genomic evidence showing their links to African and Asian camels, appear to have been more akin in appearance and habit to modern llamas than modern camels. And that the American horse, once almost ubiquitous in ice-free North America, became extinct about 11,000 years ago – modern horses (including those in North America) are all descended from those that have existed for millions of years in Africa and Eurasia. Why one group became extinct while the other did not remains a puzzle.
- 60 The Antarctic Cold Reversal occurred between 12,700 and 14,400 thousand years ago (overlapping the Younger Dryas in the northern hemisphere) and was a significant departure from the long-term postglacial warming trend in which it is embedded. Patagonian megafaunal extinction took a surprisingly short time – no more than 300 years around 12,280 years ago.
- 61 The palaeontologist was Richard Owen, and it was in 1859 that he named Australia's marsupial lion *Thylacoleo carnifex*. Since this lion was manifestly a marsupial mammal, scientific prejudices about all such diprotodonts being herbivores led to considerable argument about whether Owen's characterisation of this beast as a carnivore was correct. Later research proved him right.
- 62 This study was reported by Trueman and colleagues in the 2005 issue of the *Proceedings of the National Academy of Sciences of the United States of America*.
- 63 Utilising amino acid racemization (AAR) and electron spin resonance (ESR) dating techniques, the revision of the Tasmanian megafaunal extinction ages suggests that humans were in fact the main cause of this (see work by Chris Turney

and others in the 2008 issue of the *Proceedings of the National Academy of Sciences of the United States of America*). Another intriguing study, covering all of Australia, reached the same conclusion. At several places around Australia, these researchers analysed sediments from both the ocean floor and onshore cave fills to determine the amount of the dung fungus, *Sporormiella*, in layers of different ages. *Sporormiella* is a proxy for herbivore biomass – the more there is, the more large-bodied herbivores (including megafauna) were living in a particular place at a particular time. It was found that *Sporormiella* levels were high between 45,000 and 150,000 years ago, but that a ‘marked decline’ (p. 1) occurred between 43,100 and 45,000 years ago, which is interpreted as bracketing in time the main period of megafaunal extinction (see van der Kaars, 2017, *Nature Communications*).

- 64 The quotes in this paragraph are from the account of how *mihirung paringmal* (thunder birds) were once hunted; it comes from pp. 92–93 of the book by Dawson (1881), who gives the phonetic names for these birds as *meecheeruung parrinmall*. I have paraphrased Dawson’s account, which also dates this tradition to the time ‘long ago when the volcanic hills were in a state of eruption’ (p. 92), something that dates this account of the *mihirung* to perhaps 5,000–10,000 years ago.
- 65 The identification of *Genyornis* bones by Aboriginal people as *mihirung* was reported from excavations at Lancefield Swamp, New South Wales (Murray and Vickers-Rich 2004). The painting of a megafaunal bird, possibly *Genyornis newtoni*, at the Nawarla Gabarnmang site in northern Australia was reported and discussed by Ben Gunn and others (2011, *Australian Archaeology*) and is shown in the colour plate section.
- 66 The view that *Genyornis newtoni* became extinct around 47,000 years ago contrasts with the view that it may have co-existed with humans in Australia until much more recent times (Gerritsen 2011). The latter study quotes from an 1845 report by George Adney in western Victoria about the time he unearthed some giant bones near Lake Colongulac that the local (Aboriginal) Tjakut speakers stated were the remains of ‘a fearful monster ... on two legs with a neck and head like

- a large emeu [emu] and a breast covered with shaggy hair and killing men by hugging them with his large flappers' (p. 64), plausibly an account of the *mihirung* or *Genyornis newtoni*.
- 67 Quote from p. 147 of the paper by Grellet-Tinner and others in the 2016 issue of *Quaternary Science Reviews*.
- 68 A good article on the subject of this case of mistaken identity was published online in *The Conversation* on 14 January 2016 (<http://theconversation.com/a-case-of-mistaken-identity-for-australias-extinct-big-bird-52856>).

Chapter 7: Have We Underestimated Ourselves?

- 1 Research in Kerala showed that the local fishing community trusted its traditional knowledge of coastal risk, especially storm surges and tsunamis, more than the understanding implicit in the strategies imposed by central government (Santha, 2014, *Natural Resources Forum*). The framing of tsunami precursors in myths and other types of traditional oral knowledge saved numerous lives during tsunami events in Simeulue during the great Indian Ocean Tsunami of 2004 and in southern Pentecost during a 1999 event (McAdoo, 2006, *Earthquake Spectra*).
- 2 Motifs are 'the smallest element in a tale having the power to persist in tradition' (Thompson 1977: 415). Motifs define 'tale types', over 2,000 of which have been codified in the Aarne-Thompson-Uther (ATU) Index.
- 3 The research on the *Little Red Riding Hood* tale types was reported by Jamie Tehrani (2013, *PLOS One*).
- 4 Many thinkers have argued along such lines before now. To René Girard, most myths had an empirical basis, distorted representations of real events that non-literate people encoded and passed on for posterity (Golsan 2002). To Walter Ong, the replacement of vibrant spontaneous orality with colourless literacy was to be lamented; he cautioned that the world of oral knowledge was in danger of being consigned to the rubbish bin of history (Ong 1982).
- 5 In his magisterial *Eden in the East* (1998), Stephen Oppenheimer proposed that memories of the drowning of the Sunda Shelf (where island South-east Asia lies today), perhaps soon after the end of the Last Glacial Maximum

about 18,000 years ago, may be preserved in stories of lands being 'pulled up' that are found in cultures all around it.

- 6 The earliest written accounts of Australian Aboriginal watercraft described them as 'rafts and canoes made of logs or sewn bark, bark or reed bundles ... the uses of these watercraft were restricted historically to be used close to shore or to have been restricted to visiting islands only as far as 25 km and mostly less than 10 km offshore' (Jane Balme, 2013, *Quaternary International*, p. 71).