

THE MOUNT TARAWERA VOLCANIC ERUPTION IN NEW ZEALAND AND MĀORI COMETARY ASTRONOMY

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Abstract: In *The Astronomical Knowledge of the Maori*, which was first published in 1922, the Dominion Ethnologist Elsdon Best mentions that the name *Tiramaroa* was applied to comets, and that *Tiramaroa* was seen about the time of the Tarawera eruption (which occurred on 10 June 1886), and also during the siege of Te Tapiri in 1865. In this paper we identify naked eye comets that were visible from New Zealand in 1865 and 1886, and examine other comets seen during the half-century from 1850 that also were associated with disasters of some kind. We also list other Māori names that were used for comets.

Keywords: Aotearoa/New Zealand, Māoris, Elsdon Best, comets, *Tiramaroa*, Mount Tarawera eruption, Te Tapiri Pa, disasters, Māori fatalities

1 INTRODUCTION

The Māori were the initial human settlers of Aotearoa/New Zealand, and during the thirteenth century CE they brought with them a well-established astronomical system from their ancestral homeland in the Cook Island–Society Island area of the Pacific. Part of their knowledge base focused on cultivation of their traditional dietary staples, the taro and yam, but the cold climate of Aotearoa/New Zealand made their cultivation marginal at best, and it took considerable experimentation before the *kumara* (*Ipomoea batatas*; also known as the ‘sweet potato’) was established as the new dietary staple (Furey, 2006; Yen, 1961)—at least as far south as Banks Peninsula in the South Island (Bassett et al., 2004). For New Zealand localities mentioned in this paper see Figure 1. As in other indigenous cultures, there was an intimate connection between human ecology and astronomy, and the prominent place of *kumara* in Māori ecology, along with the existence of a whole new suite of edible flora and fauna, called for a major reorientation of the original ancestral astronomical knowledge system (Orchiston and Orchiston, 2017).

During the ensuing centuries Māori astronomy continued to evolve, and by 1769, when the British and French explorers James Cook (1728–1779; Beaglehole, 1968) and Jean-François-Marie de Surville (1717–1770; Dunmore, 1981) reached the coast of Aotearoa/New Zealand, astronomy was an integral part of everyday Māori life. Thus,

... the Maori had names for the Sun, the Moon, all of the naked eye planets, some of

the brighter stars, the Milky Way, the coal Sack, both Magellanic Clouds, and even the Zodiacal Light. There also were names for comets and meteors. (Orchiston, 2016: 33).

European settlement of New Zealand during the first half of the nineteenth century saw the wholesale destruction of traditional Māori society and culture (King, 2003), and because of its perceived association with ritual and religion European missionaries were instrumental in assisting in the rapid loss of Māori astronomical knowledge. Consequently, by the end of the nineteenth century it was only possible to obtain information about traditional Māori astronomy from a relatively small number of aging experts living mainly in the northern part of Northland, in Taranaki, up the Wanganui River, in the Ureweras, in the Lake Taupō–Rotorua–Bay of Plenty area and in the Wairarapa (in the North Island), and in a few isolated South Island locations, including Temuka.

Maori astronomy always was the preserve of a privileged few, who spent years learning the fundamentals, which were passed on by word of mouth, from generation to generation, often through myths chants and sayings. Prior to European settlement, the Māori had no written language. Nor did they have any telescopes or astronomical instruments, and all observations were made with the naked eye.

The first detailed study of Māori astronomy was carried out by the amateur ethnologist, Elsdon Best (1856–1931; Figure 2; Craig, 1964; the late Elsdon Best, 1932), who later was appointed Ethnologist at the Dominion Museum in the nation’s capital, Wellington.



Figure 1: New Zealand localities mentioned in the text (map: Wayne Orchiston).

During the last decade of the nineteenth century and first decade of the twentieth, he carried out fieldwork, particularly in the Ureweras in the East Coast region of the North Island ... [He] subsequently published a suc-

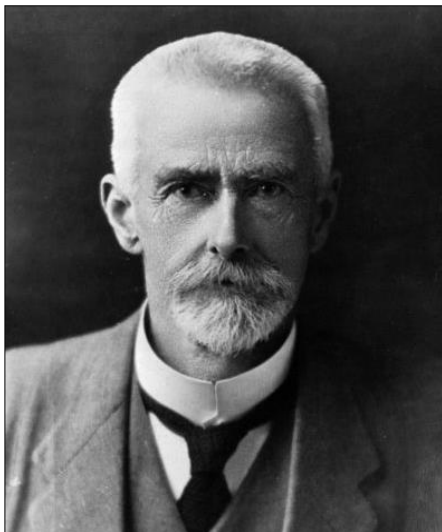


Figure 2: A photograph of Elsdon Best by Stanley Polkinghorne Andrew (courtesy: Alexander Turnbull Library, Ref. 1/1-018778-F).

cession of Monographs and Bulletins of the Dominion Museum (as it was then known) on aspects of Maori culture. (Orchiston, 2016: 34).

In 1922, Dominion Museum Monograph No. 3, *The Astronomical Knowledge of the Maori*, was published. This 80-page soft-cover book (Figure 3),

... contained a synthesis of information drawn from his own fieldwork and that culled from earlier published accounts. Subsequently, Best included astronomical material in two other Monographs, *The Maori Division of Time* (No. 4) and *Polynesian Voyagers. The Maori as a Deep-sea Navigator, Explorer, & Coloniser* (No. 5). To this day, these remain the only substantive works written on the 'traditional' astronomical systems of the Maori, and they have been through numerous reprintings ... (Orchiston, 2016: 34–35).

However, Best's studies of Māori astronomy have severe limitations in that they were carried out more than one hundred years after the first Māori–European contacts, by which time extensive changes had taken place in Māori culture,

and many elements had been lost entirely. Furthermore, Best's account of Māori astronomy largely was based on data derived from the central and southern regions of the North Island and especially from just one localized area—the inland, mountainous, heavily forested, inhospitable, geographically-isolated Ureweras—and therefore did not allow adequately for the regional variations that occurred in Māori culture, as documented by Archey (1967), Golson (1959), Green (1975), Harlow (1979), Hjarno (1967), Mead (1969), Orchiston (1972; 1974), Skinner (1921; 1974), and others. Thus, Best's account of Māori astronomy is at best no more than a general indication of the overall trends that occurred in specific parts of the North Island of New Zealand at around the end of the nineteenth century.

Having said that, there was general Māori knowledge of comets. For centuries, comets had been viewed as harbingers of doom in Western culture, and similar sentiments held sway in Māori society. Best (1955: 69) reports:

Early writers tell us of native speculations anent [concerning] the comet of 1843, and a Wellington newspaper stated that "... the Maoris hailed it as an evil omen, and commenced howling very pathetically." Lieutenant Meade tells us of a comet seen during the native disturbance of the "sixties", the portent being interpreted in totally different ways by the two parties of natives, friendly and hostile.

Seen in a totally unequivocal light was the comet said to be visible in southern skies prior to the disastrous eruption of Mount Tarawera near Rotorua in 1886, and another comet reportedly associated with the siege of Te Tapiri Pa in 1865. This paper attempts to identify the comets associated with these two events, and determine whether there were other comets visible during 1850–1900 that also were associated with notable loss of Māori life.

2 IN SEARCH OF THE 'TARAWERA COMET'

2.1 The Eruption of Mount Tarawera

Scott (1992) describes how

Early morning on 10 June 1886 residents of Rotorua and surrounding districts were awakened by earthquakes which increased in frequency and intensity until shortly after 2am when the volcanic eruption commenced at Ruawahia Dome on Mt Tarawera. The eruption extended both NE and SW as the fissures opened. By 3.30am the eruption extended 17 km SW through the lake basins of Rotomakariri and Rotomahana to the region now known as Waimangu ...

The eruptions had ended by 6am.

Figure 4 is based on a painting by the British-born landscape painter Charles Blomfield

(1848–1926) drawn from eyewitness accounts. The view is looking across Lake Tarawera towards the volcano, which is in full eruption. Apparently, Mount Tarawera's three peaks erupted one after the other, and by 3.30am the mountain had been split apart, creating the aforementioned 17-km long rift. Figure 4 shows all three peaks in full eruption.

As a result of the eruption, millions of tonnes of volcanic ash, mud and debris were deposited across the surrounding landscape, destroying all vegetation and burying everything to an average depth of 20 m. Villages surrounding Lake Tarawera were destroyed, and about 120 people lost their lives. Most of them were local Māoris.

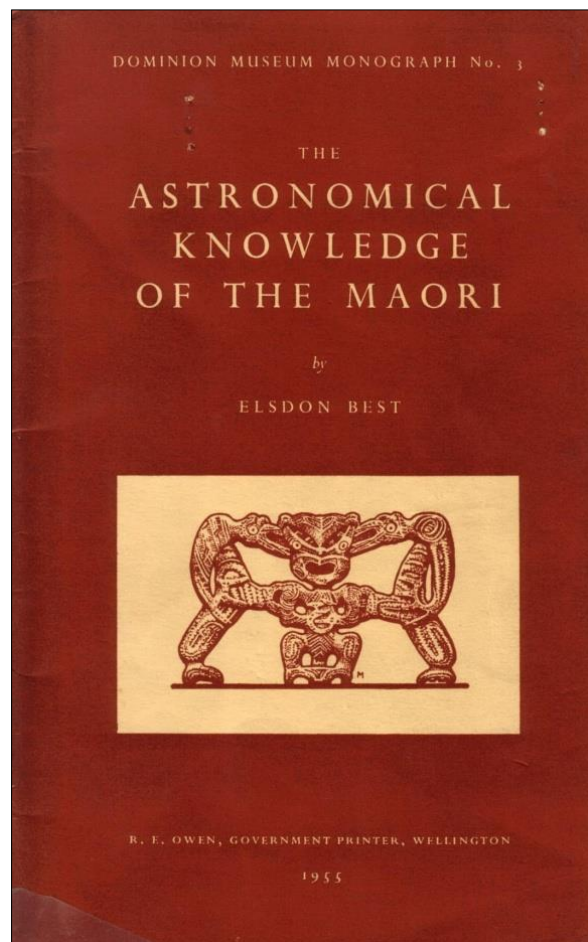


Figure 3: The 1955 reprint of Best's *The Astronomical Knowledge of the Maori* (Orchiston Collection).

This was by far the most violent and devastating volcanic eruption witnessed since the European settlement of New Zealand (Cole, 1970), and apart from the substantial loss of Māori life in the villages of Kokotaia, Moura, Otupane, Piripai, Pukekiore, Te Koutu, Te Tapahoro, Te Wairoa, Totariki and Waingongoro, the justly famous Pink and White Terraces—widely regarded as the 'Eighth Natural Wonder of the World'—were destroyed.

Subsequently, hydrothermal activity associated with Mount Tarawera began to occur in



Figure 4: A chromolithograph made by A.D. Willis from a painting by Charles Blomfield of the eruption of 1111-m high Mount Tarawera, based on eyewitness accounts (courtesy: Alexander Turnbull Library).

1900, and has continued, intermittently, through to the present day. A large eruption on 1 April 1917 destroyed a nearby accommodation house and two people died.¹

2.2 Mount Tarawera and the Comet

The association of a comet with the 1886 eruption of Tarawera is mentioned in a research paper about Māori mythology written by Elsdon Best (1899: 108):

A star known as Whetu Puhuhi derives its name from the fact of it having a tail of auahi (?light). This star has not been seen since the year of the Tarawera eruption. It is probably Tiramaroa.

By the time *The Astronomical Knowledge of the Maori* was published, in 1922, Best had refined this account to read (*inter alia*):

It is quite likely that the name of Tiramaroa is also applied to a comet. This Tiramaroa was described by a native as having long *puhihi* (rays), which are sometimes directed upwards and sometimes downwards. This looks somewhat like the tail of a comet. It is said to have been seen during the siege of Te Tapiri, in 1865, and again about the time of the Tarawera eruption (1886). (Best, 1955: 65).

As Best suggests, *Tiramaroa* looks suspiciously like the name for a comet, with a long tail. If this is so, we would expect a conspicuous naked

eye comet with a long or impressive tail to have been visible shortly before the Tarawera eruption on 10 June 1886. What is the evidence for this?

Marsden and Williams (1999) list six different comets that were observed from somewhere on the Earth during the first six months of 1886, but Vsekhsyatski (1964) reveals that only two of these were of naked eye magnitude and visible from New Zealand.

The first of these was Comet C/1885 X1, which was discovered by the Parisian astronomer Louis Fabry (1862–1939; Fayet, 1939) on 1 December 1885, and was observed through to 20 July 1886. Initially a far northern object, by the end of April 1886 it was readily visible from New Zealand as a naked-eye object, with a magnitude of about 0. According to Vsekhsyatski (1964: 278–279), on

1 May, Eddie (Cape) [= Royal Observatory, Cape of Good Hope] saw the comet first as a conspicuous object with a 15' head and a tail up to 9° long and 1½° wide. Straw-coloured comet; straight, sharply outlined tail ... 4 May, slightly curving 6° tail appeared ... 5 May, tail 5° long, very faint ... 7 May, a 2° tail visible in hazy atmosphere. 11 May, still visible to the naked eye in bright moonlight ... 12 May, appeared to the naked eye as a dull spot; 14 May, invisible to the naked eye in bright moonlight (5 to 6^m).

The other candidate is Comet C/1885 X2, which was discovered by Barnard of Nashville, U.S.A., on 3 December 1885. This comet was observed through to 26 July 1886, and like C/1885 X1 (Fabry) was also a naked eye southern object in May 1886, one month before the Tarawera eruption:

22 April, Engelhardt described a short fan-shaped tail. 30 April, Barnard saw the comet with the naked eye, tail exceptionally narrow and straight ... 3 May, comet brighter, tail wider and longer ... 7 May, visible to the naked eye as a nebulous spot; tail at least 3° long ... 12 May, dull, hardly visible to the naked eye. (Vsekhsvyatski, 1964: 281).

Of these two comets, *Tiramaroa* is more likely to have been used in reference to C/1885 X1 (Fabry). This comet was the more conspicuous of the two and featured a more prominent tail, yet neither comet could be classed as a 'Great Comet' that would have attracted widespread Māori attention.

3 TIRAMAROA AND THE SIEGE OF TE TAPIRI PA

Best mentions that the term *Tiramaroa* also was applied to a comet seen in 1865 during the siege of Te Tapiri.

Te Tapiri was a small redoubt or 'gunfighter pa' constructed by Ngati Manawa Māori in May 1865 to prevent the Hauhau chief Kereopa and his followers from leaving the Ureweras, crossing Ngati Manawa land and going to the Waikato to recruit supporters and converts to their new religious movement. It was located at an altitude of more than 600 m on the northern flanks of the Ureweras, near the Rangitaiki River and overlooking the plains to the north (see Figure 1). It was a small pa measuring approximately 64 × 15 m, and featured two flat platforms for *whares* (houses) and other structures surrounded by a palisaded ditch-and-bank containing a number of gun-recesses (see Figure 5). It was constructed by Ngati Manawa Māori, but when Ngati Rangitihui reinforcements arrived they could not all be accommodated within the confines of Te Tapiri so another redoubt, Okupu, was constructed nearby, on the other side of the track that led from the Ureweras to the Kaingaroa Plains and on to the Waikato. The two small parties based in these *pa* were armed mainly with shotguns and muskets, and over several consecutive weeks in May–June 1865 they fought Kereopa's party, with loss of life on both sides (see Cowan, 1956: 84–94).²

Elsdon Best claims that a comet was visible in the sky during these hostilities, but this does not tally with the astronomical evidence. The Great Southern Comet of 1865, which now has the designation Comet C/1865 B1, was the *only* major naked-eye comet visible from New Zea-

land during 1865. It was first reported by the Australian astronomer Francis Abbott from Hobart (Orchiston, 1992), although he generally is not credited with its discovery (Orchiston, 1997). In his 'discovery report' Abbott (1865a) states:

A remarkably fine Comet suddenly appeared at Hobart Town on the 17th of January. At 8h 20m it was a distinct object low down in the south-west horizon, alternately disappearing and reappearing amongst dark cumuli clouds. It has a fine bright nucleus, with a straight tail 10 or 12 degrees long.

Subsequently, Abbott submitted a longer report, with positions listed for 17 evenings between 10 January and 14 February (inclusive). Although the tail reached a maximum length of more than 25° on 20 January (Vsekhsvyatskii, 1964), Abbott only provided his first description of it more than a week later:

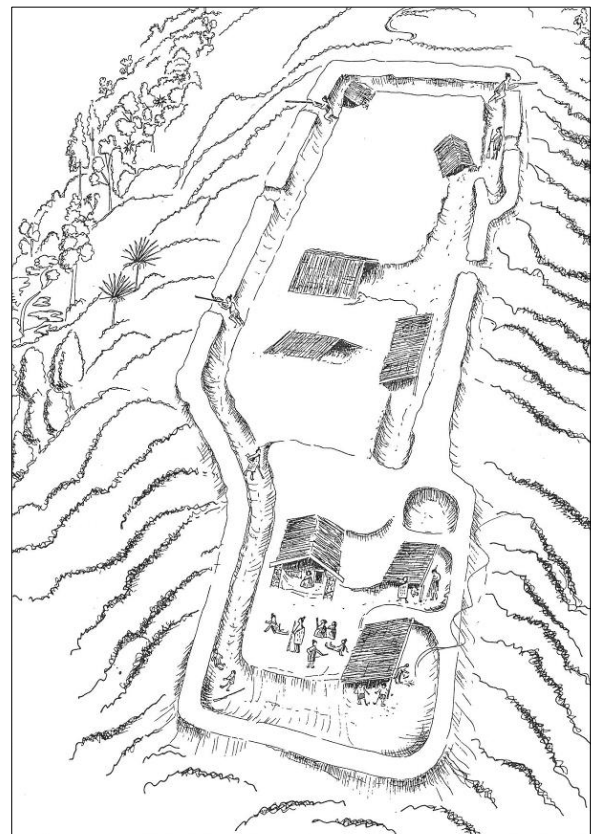


Figure 5: An artist's sketch showing what Te Tapiri may have looked like in 1865, when viewed from the north (after Jones, 1989: frontispiece).

The low position of the Comet, together with the unusual cloudiness of the evenings, have rendered it difficult to get good stars to observe with the Comet ... The night of the 28th of January was the most favourable, the sky was clear and brilliant with stars ... the Comet ... had a fine planetary nucleus with a bushy tail, very little curved and about 14° in length. From this date it diminished in appearance ... and on the 4th of February was much fainter, with a tail only 4° in length ... [By the] 14th ... the Comet had decreased much in size, the nucleus

Table 1: Major naked-eye comets visible from New Zealand, 1850–1899, and their association with disasters.

Year	Name	$m_{v(max)}$	Max. Tail (°)	When Visible	Disaster?
1853	C/1853 G1 (Schweizer)	1–2	10	30 April–6 May	No
1858–1859	C/1858 L1 (Donati)	0	41	10 October–11 November 1858	No
1860	C/1860 M1 (Great Comet)	2	15	5–20 (?) July	Yes
1861	C/1861 J1 (Tebbutt = Great Comet)	0	42	27 May–28 June	[Yes]
1862	109P/Swift-Tuttle	2	7	1–21 September	[Yes]
1864	C/1864 N1 (Tempel)	3	Very short	10 August–2 September	Yes
1865	C/1865 B1 (Great Southern Comet)	1	>25	17 January–22 February	Yes
1874	C/1874 H1 (Coggia)	1	?	27 July–mid-August	[Yes]
1880	C1880 C1 (Great Southern Comet)	?	75	1–12 February	[Yes]
1881	C/1881 K1 Tebbutt = Great Comet)	2	20	22 May–7 June	[Yes]
1882	C/1882 F1 (Wells)	1–2	45?	11 June–1 July	[Yes]
1882–1883	C1882 R1 (Great Southern Comet)	–5	25	1 September 1882–7 Feb 1883	[Yes]
1886	C/1885 X1 (Fabry)	0?	9	1–7 May	Yes
1887	C/1887 B1 (Great Southern Comet)	1–2	41	18–30 January	[Yes]

had lost its planetary appearance, and the tail was not more than 1° in length. (Abbott 1865b: 198).

As we have noted, Best (1955: 65) claimed that this comet was seen “... *during* the siege of Te Tapiri, in 1865 ...” (our italics), but the timing is wrong. Comet C/1865 B1 had faded below naked eye visibility by the end of February 1865, whereas hostilities at Te Tapiri took place three months later. But although the comet was long gone, perhaps memories of it from late January still lingered in the minds of both the Ngati Manawa and the Urewera Māoris, thus inviting the view that its earlier appearance portended the fatalities that would occur.

4 DISCUSSION

4.1 Were There Other Major Comets Visible from New Zealand and Associated with Disasters and Loss of Māori Life?

It is interesting that Best only relates the term *Tiramaroa* to two specific comets and to the siege of a *pa* and a major volcanic eruption. Both of these events occurred in contiguous regions of the central North Island, and within a 20-year period. Moreover, both were significant events in Māori history, and in the case of the Tarawera eruption was associated with considerable loss of life—both Māori and Pakeha (see *The Great Volcanic Outbreak ...*, 1886). Comet C/1865 B1 was a ‘Great Comet’ with a long tail that was visible from New Zealand more than four months before the hostilities at Te Tapiri Pa, while C/1885 X1 (Fabry) was an equally bright comet, but with a much shorter tail, and was most conspicuous about one month before the 10 June 1886 eruption of Mount Tarawera.

During the half-century from 1850 to 1899, when Best’s informants would have noticed any bright comets with conspicuous tails, there was an amazing over-abundance of conspicuous naked-eye comets visible from New Zealand. Consequently, this was a period that was unique in Māori astronomy, as none other since the original Polynesian settlement of Aotearoa/ New Zealand in the thirteenth century (Anderson,

2017; Wilmshurst et al., 2011) had offered astronomers such cometary opulence. Comets with maximum visual magnitudes ($m_{v(max)}$) of ≥ 2 are listed in Table 1. The names in the second column are as listed in Kronk (2014); the $m_{v(max)}$ and Maximum Tail listings (columns 3 and 4) are after Kronk (2014) and Vsekhsvyatskii (1964), except for those of Great Comets of 1861 and 1881 which are after Orchiston (2017: Chapters 6 and 9 respectively). The fifth column lists the period when each comet was visible from New Zealand, with information drawn from Kronk (2014), Orchiston (2017) and Vsekhsvyatskii (1964).

A notable feature of Table 1 is that most of the comets listed were far more visually stunning than the two *Tiramaroa* comets referred to by Best. This raises the question: were any of these other comets also associated with significant events in Māori history that resulted in major fatalities? Possible ‘significant events’ considered were:

- (1) major earthquakes;
- (2) major floods and cyclones;
- (3) landslides;
- (4) eruptions of other New Zealand volcanoes;
- (5) boating tragedies; and
- (6) major conflicts during the New Zealand Wars

It was easy to eliminate major earthquakes because GNS Science in Wellington has a map on their web site that includes all major New Zealand earthquakes experienced during our target date-range of 1850–1899 (Anonymous, 2016). These occurred in 1855, 1863, 1888 and 1893, all years devoid of major naked eye comets.³

Similarly, there were no conspicuous comets visible at or immediately preceding the dates of the nation’s most serious floods (some of which were caused by cyclones), as listed in the Government’s web site about New Zealand Disasters (<https://nzhistory.govt.nz/culture/new-zealand-disasters/timeline>).

A review of disastrous New Zealand landslides produced only one instance that resulted

in multiple Māori fatalities. This occurred just outside of our designated time-period, on 7 May 1846, when a landslide obliterated the village of Te Rapa on the south-western shore of Lake Taupō, killing about 60 people, including the paramount chief Mananui Te Heuheu Tūkino II (Devastating landslide ..., 2018). But note that no major naked eye comet was visible from New Zealand during 1846.

Apart from Mount Tarawera, there are three other active volcanoes in the Taupō Volcanic Zone that were active during the period from 1850 to 1899. From north to south (see Figure 1) they are: Mount Tongariro, Mount Ngāuruhoe and Mount Ruapeha (Gregg, 1960; Williams, 2001). Major eruptions of Mount Tongariro and Mount Ngāuruhoe occurred in 1868, 1896–1897, and in 1867 and 1870, respectively, but no naked-eye comets were visible from New Zealand before or during these events. The same applies to the eruptions of Mount Ruapehu in 1889 and 1895, and even to the major eruption that took place in January 1861, four months before the spectacular appearance of Comet C/1861 J1 (Tebbutt) in May. However, a Mr Henry Sergeant describes the lahar associated with this eruption:

In the mid-summer of 1860-61 ... I was standing on the bank (of the Whangaehu River) ... when I suddenly saw coming around a corner in the distance a huge wave of water and tumbling logs. They filled the whole trough of the stream ... As it passed us it appeared to be covered with what we first thought to be pumice but the intense cold which soon made us shiver and turn blue caused us to discover that ... [this] was no less than frozen snow. Mixed with this was a mass of logs and debris. Very soon a bridge passed us stuck in the roots of a giant tree and a few minutes later about a dozen canoes came down. (Cited in Neall et al., 1999).

Whether the canoes seen had been moored on the river bank prior to the arrival of the lahar, or were occupied at the time and there were Māori fatalities, is not stated.⁴ If this unfortunately was the case, the Great Comet of 1860 appeared too early to portend this particular disaster.

While there were eight ship-wrecks along the New Zealand coast between 1850 and 1899 the only tragedy that was an all-Māori affair occurred at the very end of our time-frame. On 5 August 1900, sixteen school children and two adults perished when trying to cross the Motu River by canoe near the village of Maraenui in the eastern Bay of Plenty (see van der Wouden, 1991). Unfortunately, there was no comet to forewarn anyone of this impending tragedy..

We now need only determine whether the so-called 'New Zealand Wars' of the 1860s and

early 1870s plus an 'outlier event' in 1881 had any cometary associations. Archaeologist Nigel Prickett reminds us that

The New Zealand Wars of the 1840s and 1860s-70s were part of Maori-Pakeha conflict over land (whenua) and sovereignty (rangatiratanga) which began earlier and has continued to the present day. The wars were central to this country changing from the Maori land it was for hundreds of years, to one dominated by Europeans.

Historian James Belich (1996: 249) refers to 'swamping', in which Maori were simply outnumbered by the newcomers. In 1858, two years before the major conflict began, Maori and Pakeha each numbered about 60,000; at the end of the 1860s Maori were one in five of 300,000 New Zealanders; by the end of the century Maori made up only one in twenty of the country's population. War led directly to the confiscation of large tracts of North Island Maori land and indirectly to the further dispossession of weakened and divided tribes at the hands of the Maori Land Court.

To understand the present we must know the past. War was at the heart of a process of expansion and dispossession that has defined our country for 150 years.

To review the progress of the New Zealand Wars we consulted the Government's Te Ara and Disasters web sites, James Cowan's *The New Zealand Wars: A History of the Maori Campaigns and the Pioneering Period. Volume II: The Hauhau Wars, (1864–72)*, reprinted in 1956, and Prickett and McGovern Wilson's (2009) monograph *Planning a Future for New Zealand War Sites and Landscapes*. This last-mentioned volume lists eight different 'events' that occurred during the New Zealand Wars of 1860–1872, plus one event in 1881. These are listed in Table 2, and summarized on the basis of the aforementioned sources (and others). From our perspective, critical vis-à-vis any possible cometary association are (a) the date of each campaign, and (b) whether or not there were Māori casualties. Meanwhile, in order to claim an association, the comet in question must have been visible either during the campaign itself, and/or within a 2-month period immediately preceding the campaign.

The results of our analysis of the New Zealand Wars are shown in Table 1, column 6, and reveal that there were two comets, other than C/1865 B1 (Great Southern Comet) and C/1885 X1 (Fabry), that were associated with specific campaigns during these Wars where there was notable loss of Māori lives. These comets were C/1860 M1 (Great Comet) and C/1864 N1 (Tempele). Each of these is described below.

Comet C/1860 M1, also known as the Great Comet of 1860, was discovered in Italy as a naked-

Table 2: The New Zealand Wars, 1860–1881.

Year(s)	Event/Region	Brief Description
1860–1861	First Taranaki War	<p>The First Taranaki War arose over the illegal sale of land at Waitara, near New Plymouth, for a township and farms. On 20 February 1860, Māoris with the authority to reject the sale prevented the surveying of the land, and this led to armed confrontation in early March 1860, but initially with few casualties. Further fighting occurred in March with 14 Europeans killed and about 50 Māoris. After a further battle near Waitara near the end of June with heavy European losses, Martial Law was declared at the fortified European settlement of New Plymouth, and most of the women and children were evacuated.</p> <p>It was at this time that Comet C/1860 M1 first became visible in the southern sky, and during August 1860 there were scattered attacks in the countryside surrounding New Plymouth, with fatalities on both sides. Meanwhile, the Māoris systematically burnt down deserted European buildings in farms and settlements but they "... invariably respected the churches in the abandoned settlements, and those at Henui, Bell Block, and Omata were found untouched at the end of the war." (Cowan, 1956: 190). Throughout September the Europeans retaliated, destroying a number of <i>pa</i> (fortified Māori settlements) and Māori villages, and although there were fatalities on both sides they were relatively minimal.</p> <p>A major battle with substantial loss of life occurred on 6 November when a large contingent of European soldiers attacked a much smaller fighting force of Waikato Māori (there to aid their Taranaki cousins) at Mahoetahi, near Waitara. Cowan (1956: 198) reports that "... the total loss of the Maoris was estimated at about fifty and as many more wounded, out of not more than a hundred and fifty engaged ... Besides Wetini, a number of chiefs of importance fell at Mahoetahi." By contrast, British casualties were very light. Another major battle occurred on 23 January 1861 at Huirangi near Waitara when about 50 Taranaki and Waikato Māoris perished. Further skirmishes occurred until March 1861, but with few casualties on either side, and then a truce was brokered. Thus ended the First Taranaki War, and the involvement of Comet C/1860 M1. Just two months later C/1861 J1 (Tebbutt = Great Comet) made its spectacular appearance in Taranaki skies.</p>
1863–1864	Waikato War	<p>For Māori, the Waikato War was one of the most disastrous episodes in nineteenth century New Zealand history, as hundreds of Māori lives were lost in a series of engagements with Government troops that were determined to break the Māori King movement and its quest to prevent further loss of Māori lands (e.g. see Cowan, 1956; O'Malley, 2016). However, from our viewpoint the Waikato War was too early: it commenced on 12 July 1863 and ended on 2 April 1864, more than four months <i>before</i> Comet C/1864 N1 (Tempel) appeared in Waikato skies.</p>
1863–1865	Second Taranaki War	<p>The Second Taranaki War, also known as the 'Hauhau campaign', is regarded by some scholars as a mere extension of the First Taranaki War. Fighting re-erupted because of earlier and more recent illegal confiscations of Māori land, which "... was inevitably a source of bitter and undying hatred." (Cowan, 1956: 2). This time, leaders of the emerging Hauhau movement, described as a radical component of the charismatic Māori Pai Mārire religion, played a key role in the War.</p> <p>The first skirmishes began on 4 May 1863 with the ambush deaths of 9 Government soldiers, thus launching the Second Taranaki War. Exactly one month later a battle left about 24 Māori and 3 Government soldiers dead. Further deaths on both sides occurred on 2 October in a battle at Omata near New Plymouth. Between 20 and 25 January 1864 Government forces successfully attacked Māori fortifications at Oakura near New Plymouth and also destroyed gardens with maize, potatoes, tobacco and other crops. However, on 6 April a further attack in the same area backfired when a contingent of Government troops was ambushed and 7 were slaughtered. When found, the bodies were naked and had been decapitated—this was the first known case of Hauhau mutilations. Hauhau warriors had a passionate hatred of Europeans and in future campaigns, apart from beheading victims, would sometimes remove their hearts, and even indulge in cannibalism. Hauhau warriors then attacked the Government redoubt at Sentry Hill near New Plymouth on 30 April 1864, but 34 of the fighting force of 200 died (despite their incantations, which they believed would shield them from bullets). Only 1 Government soldier died.</p> <p>All of the aforementioned episodes occurred <i>prior</i> to the appearance of Comet C/1864 N1 (Tempel) in Taranaki skies from 10 August through 2 September, but did its presence coincide with or foreshadow further major altercations? In fact, no battles occurred during its presence, but six days after it disappeared Government forces attacked and occupied a Hauhau <i>pa</i> near New Plymouth. But they were too late as the Hauhau had already abandoned the site, and three days later Government troops and 'friendly' Māoris occupied another nearby Hauhau settlement that also had just been abandoned. So no loss of life was connected with either of these campaigns or with the rather inconspicuous Comet C/1864 N1 (Tempel).</p> <p>But did the Great Southern Comet of 1865 (C/1865 B1)—which was a spectacular-looking object—have a different story to tell? It was visible from 17 January to 22 February 1865, and during this period Government forces were in the</p>

		<p>process of confiscating further Māori land in Taranaki, in response to legislation passed by Parliament in December 1863. By September 1865 nearly half a million hectares of additional Māori land in Taranaki were confiscated—with little regard for whether the land was owned by ‘rebels’ or by Māori groups that supported the Government. Not unexpectedly, this led to isolated skirmishes and to further battles, in June and July 1865, when there were further Māori casualties. But by then the comet was long gone. Meanwhile, the July battle brought the Second Taranaki War to a close. For further details of this War see Cowan (1956).</p>
1864	Tauranga Campaign	<p>The relatively short-lived Tauranga Campaign occurred in 1864 when Government troops tried to stop Tauranga Māoris was joining the Waikato War or sending supplies to their Waikato colleagues. On 29 April 1864 Government forces tried to dislodge Māoris at Gate Pa, near Tauranga, with the loss of 20 Māoris and 31 Government soldiers. Nearly two months later Government forces made a surprise attack on the still-unfinished <i>pa</i> at Te Ranga, near Tauranga, leaving 120 Māoris and 13 Government troops dead. The Tauranga Māoris then agreed to withdraw their support for the Waikato War and the Tauranga Campaign was over, one month before the appearance of Comet C/1864 N1 (Tempel) in Tauranga skies.</p>
1864–1866	Wanganui–South Taranaki War	<p>The Wanganui–South Taranaki War was a geographical and chronological extension of part of the Second Taranaki War. Even before the appearance of Comet C/1864 N1 (Tempel) some Hauhau transferred their focus to the Wanganui region, and on 14 May 1864 a group of ‘friendly’ Wanganui Māoris attacked a party of Hauhau warriors, killing 5 of them, with 15 losses among the local Māoris. Then in July, not long before the comet’s arrival, Government forces and friendly local Māoris defeated a Hauhau contingent up the Wanganui River, killing 13–20 of them, and suffering only 4 wounded themselves.</p> <p>No further battles took place during or soon after the 1864 comet’s appearance, but its successor, the Great Comet of 1865 was a different story. The Government was keen to secure access to land it had bought between Wanganui and Hawera, but some blocks were occupied by Hauhau, who also maintained <i>pa</i> in the disputed area. On 24 January 1865, with the Great Comet conspicuous on the sky, Government troops began their march from Wanganui, and on the first two days were attacked by Hauhau, losing 50 men, with 23 Hauhau dead. The size of the Government force was then increased, and the troops proceeded up the coast. On 15 March (after having farewelled the Great Comet) the Government forces were ambushed by 200 Hauhau near Hawera. In the battle the Hauhau lost 80 warriors, while there was only 1 Government death. Given the statistics, we could be excused for assuming that on this occasion the comet gave forewarning of the Hauhau casualties.</p> <p>With the Great Comet long gone, there were further Hauhau fatalities during skirmishes in October and November 1865. On 30 December a large Government force supported by local ‘friendly’ Māoris mounted a major campaign against Hauhau warriors entrenched in forest <i>pa</i> and villages to the north-west of Wanganui. Over the next five weeks the Government party destroyed seven <i>pa</i>, twenty-one villages and numerous cultivations, and caused more than 50 Hauhau casualties. As retaliation, Hauhau warriors attacked a number of small European parties and convoys in June 1866, resulting in a Government attack on their <i>pa</i> near Hawera on 1 August when 3 Māoris were killed. In September and October Government forces attacked further Hauhau <i>pa</i> and villages, inflicting heavy casualties. Houses and crops were destroyed and people were burnt alive, and there was public outrage over the brutality of the attacks. Surviving Hauhau were weakened and intimidated, and the War finally came to an end in November 1866. For further details of the Wanganui–South Taranaki War see Cowan (1956).</p>
1865–1866	East Coast War	<p>The spectacular appearance of the Great Southern Comet C/1865 B1 from 17 January to 22 February 1865 also heralded the onset of the East Coast War, which was primarily about the illegal confiscation of Māori land by the Government and was fanned by the fiercely anti-European attitude of local Hauhau warriors who had recently converted to the Pai Mārire religion. The Comet’s appearance foreshadowed a succession of incidents from Opotiki in the eastern Bay of Plenty and along the length of the East Coast–Hawkes Bay region that led to Government responses, sometimes with the support of friendly local Māoris.</p> <p>Sparking the start of the East Coast War was the hanging and beheading of the Ootiki-based German missionary Carl Volkner on 2 March 1865, with their leader, the Pai Mārire prophet Kereopa Te Rau scooping out his eyes and swallowing them during a ritual. From 5 July 1865 until 11 October 1866 Government troops and friendly local Māoris attacked a succession of Hauhau <i>pa</i> and settlements, near Opotiki, at Hicks Bay, along the East Coast north of Gisborne, at several locations near Gisborne, at a number of locations near Lake Waikaremoana in the Ureweras, and near Napier, killing or capturing a large number of Hauhau, including some (but not all) of those responsible for Volkner’s murder. Meanwhile, Government and friendly Maori casualties were relatively light. Many of the prisoners were jailed, thus bringing to an end the Hauhau-inspired East Coast War (see Cowan, 1956).</p>

1868–1869	Titokowaru's War (South Taranaki and Wanganui)	No bright comets
1868–1872	Te Kooti's War (Poverty Bay, Hawkes Bay, Ureweras, Whakatane)	No bright comets
1881	The Parihaka Campaign (Taranaki)	<p>Comet C/1881 K1 (Tebbutt) was an impressive-looking comet with a long tail that was visible from New Zealand for a 2-week period in May-June 1881 (Orchiston, 2017: 256–265), five months <i>before</i> the totally unwarranted invasion of the west Taranaki Māori settlement of Parihaka.</p> <p>Led by the chiefs Te Whiti o Rongomai and Tohu Kākahi, the occupants of Parihaka aimed to live in harmony with the Europeans, despite the fact that the Government had reneged on its promise to establish Māori reserves. This all changed in late 1878 when European settlers wanted farms and the Government began surveying land near Parihaka that had been illegally confiscated in the 1860s. Te Whiti and Tohu and other Parihaka Māori began a campaign of peaceful resistance by ploughing the intended fields of the European farmers, and the armed constabulary began arresting the 'trespassers'. The first 40 ploughmen were charged and subsequently jailed in the South Island, but the Government decided not to lay charges against the remaining 180 Māori ploughmen from Parihaka who had been arrested. These first arrests occurred one year <i>before</i> the Great Comet of 1881 was visible in Taranaki skies. Then, as further arrests of the unarmed ploughmen and fence-builders occurred, there was bloodshed, and it subsequently was reported that many of the hundreds of arrested Māoris died in South Island jails.</p> <p>By mid-1881, as the arrests mounted, the Government feared there would be an armed uprising and so they decided to close down Parihaka, which at the time was reputed to be the largest Māori settlement in New Zealand, with a population of more than 2,000. Thus, on 5 November a contingent of 1,600 Government troops invaded Parihaka at dawn, but instead of resistance they were greeted by hundreds of skipping and singing children who offered them food. Nor was there any resistance or bloodshed when Te Whiti and Tohu were arrested (and subsequently imprisoned), or when 1,600 residents were driven out of Parihaka and had to find food and shelter elsewhere. Most of the buildings in the village were looted and destroyed by the troops, and the remaining 600 residents were given passes that controlled their movements. Although the earlier presence of the comet forewarned of a major disaster, at least in this instance there was little bloodshed.</p> <p>The whole Parihaka Campaign was later judged to be one of the most disgraceful episodes in the history of New Zealand, and since 2006 the annual Parihaka International Peace Festival has been held in Parihaka. For further details of the Parihaka Campaign see Riseborough (1989) and Scott (1975).</p>

eye comet on 18 June 1860. During June and early July it was a northern object. It was first observed from the Southern Hemisphere on 5 July, when it was at its brightest (magnitude 1) and with a conspicuous 15° tail. William Scott, the founding Director of Sydney Observatory (Orchiston, 1998) reported that "... a large comet ..." was seen from different parts of Australia soon



Figure 6: Wilhelm Tempel (commons. Wikimedia.org).

after sunset on 6 July. Melbourne Observatory Director, Robert Ellery (see Gascoigne, 1992) "... described the comet as very bright, with a ... tail over 4° long." (Kronk, 2014: 286). By 12 July it had faded markedly, and the tail was down to just half a degree (ibid.). Thus, Comet C/1860 M1 was an impressive naked eye object from New Zealand for only one week, in early July.

Comet C/1864 N1 (Tempel) was discovered by the German astronomer, Ernst Wilhelm Leberecht Tempel (1821–1889; Figure 6; Bianchi et al., 2010) on 4 July 1864, while living in Marseilles, France. Prior to 11 August it remained a bright naked eye object in the northern sky, but only developed a short tail in early August. On 11 August it was

... discovered independently in the southern sky by Moesta (Santiago) with the naked eye, as bright as a 2^m star; no sharp boundary to the nucleus; nebula up to 1° in diameter; tail invisible to the naked eye ... (Vsekhsyatskii, 1964: 209).

When viewed in a telescope it revealed a short tail, but during its New Zealand apparition was

devoid of any naked-eye tail. Thus, although it was indeed an object visible to the naked eye, it was hardly an impressive comet with a conspicuous tail—that was bound to attract the attention of Māori astronomers.

These two comets are further examples of comets that preceded Māori disasters with loss of life, yet they were not referred to as *Tiramaroa* by Best. In the case of Comet C/1864 N1 (Tempel) the lack of a tail is a likely explanation, but further criteria must have applied in the naming of Comet C/1860 M1, which mimicked C/1865 B1 (Great Southern Comet) and C/1885 X1 (Fabry) in basic appearance. The fact that neither new comet was associated with battles in the Urewera–Taupo–Rotorua region, suggests that *Tiramaroa* was a geographically-specific term reserved for bright naked-eye comets with conspicuous (but not necessarily very long) tails seen by Māori from the central region of the North Island. Following Harlow's (1979) linguistic lead, this may be yet another indication of the existence of geographically-defined culture areas in nineteenth-century New Zealand, and on the basis of other evidence, Orchiston (2016: 33–88) and Orchiston and Orchiston (2017) have already suggested that this concept applied to Māori astronomical terminology.

Inspired by the Te Tapiri and Mount Tatawera episodes referred to by Elsdon Best, our quest thus far has been to identify other major naked-eye comets seen between 1850 and 1899 that heralded Māori loss of life. But perhaps we have been too restrictive in our definition of what constituted a 'disaster' as viewed from a Māori perspective at this time. Surely the New Zealand Wars of the 1860s and the early 1870s and the very nature of Māori–Pakeha interactions during the remaining decades of the century constituted a formidable on-going 'disaster' for almost all Māori. Apart from lives, they lost their lands, their culture, their language, their identity and, above all, their *mana* (see Belich, 1996; King, 2003). This is why we have placed 'Yes' in brackets in the right-hand column of Table 1 for *all* those comets that may not have been directly connected with loss of life in battle. We contend that collectively all of these comets heralded a disaster for Māori.

4.2 Other Māori Names for Comets

Tiramaroa was by no means the only term—or the most commonly-employed term—used by Māori astronomers for a comet. These celestial visitors were more generally known as *Auahi-roa* or *Auahi-turoa*, but other names given by Best (1955) are *Auroa*, *Manu-i-te-ra*, *Meto*, *Puaroa*, *Puihihi-rere*, *Purereahu*, *Taketake-hikuoā*, *Tunui-a-te-ika*, *Upoko-roa*, *Wahieroa*, *Whetu* and *Whetu-kaupo*. Some of these, like *Tiramaroa*,

may have been generic names of regional rather than national significance. Others were descriptive, for particular kinds of comets (e.g. those with prominent tails), while others again may have referred to individual comets. Apart from *Tiramaroa*, terms listed above that relate specifically to the nature of a comet's tail are *Meto*, *Puaroa* and *Tunui-a-te-ika*.

4.3 Comet C/1885 X1 (Fabry) and John Grigg

It should be mentioned that apart from its association with the term *Tiramaroa*, Comet C/1885 X1 (Fabry) has another claim to fame within the context of New Zealand astronomy—and specifically cometary astronomy. This was the comet that triggered the amazing amateur astronomical career of John Grigg (1838–1920; Figure 7), who went on to discover four different comets (three of which now bear his name). Grigg also pione-

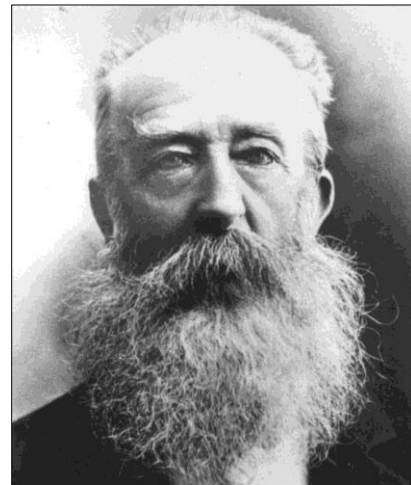


Figure 7: John Grigg, New Zealand's foremost astronomer in the early twentieth century (Orchiston Collection).

ered the early development of astrophotography in New Zealand, and he was passionate about popularising astronomy, and operated his modest Thames Observatory as a *de facto* city observatory. By the first decade of the twentieth century, he was arguably New Zealand's foremost astronomer. For further details of Grigg's remarkable achievements see Orchiston (2016: 271–291; 481–508; 597–625).

5 CONCLUDING REMARKS

In his *Astronomical Knowledge of the Maori* Elsdon Best relates the term *Tiromaroa* to two comets seen in 1865 and 1886, and he associates them respectively with the siege of Te Tapiri and the eruption of Mount Tarawera. By analysing naked-eye comets visible from New Zealand during these years, we have been able to identify C/1865 B1 (the Great Southern Comet) and C/1885 X1 (Fabry), as the comets that Best's informants were most likely referring to, but there is a problem with the timing of the 1865

comet which was only conspicuous many months before hostilities commenced at Te Tapiri.

We also noted that two other naked-eye comets, C/1860 M1 (Great Comet) and C/1864 N1 (Tempel) were visible in New Zealand skies during specific episodes in the New Zealand Wars that involved Māori fatalities. Since neither of these comets was referred to by Best as *Tirohanga*, we suggest that *Tirohanga* was a term used only by Māori from the centre of the North Island. We present this as yet another example of the regional variations in astronomical terminology that occurred in New Zealand during the second half of the nineteenth century.

By adopting a looser definition of what constitutes a 'disaster', we also suggest that *all* conspicuous naked eye comets visible in New Zealand skies between 1860 and 1899 could be viewed as portends of disaster, given the horrific changes that occurred in Māoridom during this period.

Returning for a moment to a specific event, the Mount Tarawera eruption of 1886, we should note that the appearance of Comet C/1885 X1 (Fabry) was not the only portend of a disaster: "Before the eruption, people reported seeing a phantom Maori war canoe on the lake below the volcano." (McSaveney, et al., 2006). This was thought to be a spirit canoe, which forewarned of a major catastrophe.

Finally, we are heartened by the current resurgence of interest in Māori astronomy (e.g. see Harris, et al., 2013) and hope that this will lead to the recovery of further information about comets and their long-term residue, meteors and bolides.

6 NOTES

1. Prior to the 1886 eruption, Mount Tarawera was not known to be an active volcano. However, subsequent research has shown that it was in fact the site of a major eruption in about CE 1305 (Nairn et al., 2001), which led to the unusual overall shape of the mountain and to the formation of the three different peaks that were active in 1886. This prehistoric eruption, which certainly would have been witnessed by local Māori, was on a much grander scale than the disastrous 1886 event, ejected an estimated 5 km³ of magma compared to the comparatively modest out-pouring of just 1 km³ in 1886 (Nairn, 1993: Table 1).
2. Prickett and McGovern (2009: 23) only mention "... a 3 or 4 day battle." In April 1988 the *pa* was damaged when parts of it were bull-dozed during a forest fire. Jones (1989) describes attempts made by the Department of Conservation to reconstruct the site.

3. New Zealand is precariously positioned on the 'Ring of Fire' and is therefore witness to frequent seismic activity. All current New Zealand residents live with the knowledge that a major earthquake could occur anywhere, at any time, and change their lives completely (or even end them). Major earthquakes also were a feature of pre-European Māori society, and are discussed by Goff and McFadgen (2001). As with volcanic activity, it has yet to be determined whether any of these prehistoric events correlated with the appearance of a notable comet. The principal challenge in this case is to accurately date these prehistoric earthquakes.
4. For those now living in or near the Taupō Volcanic Zone (which extends from Mount Ruapehu in the centre of the North Island to White Island in the Bay of Plenty), devastating and life-threatening volcanic eruptions are always a possibility at any time. This was also the case in prehistoric times, and Lowe et al. (2002) discuss the role that volcanic activity played in early Māori society. It has yet to be determined whether any of these prehistoric eruptions led to major loss of life and was preceded by the appearance of a notable comet.

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Finally, we pay our respects to all those who died as a result of the events mentioned in this paper, and we dedicate this paper to their memory. *Haere ra ...*

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history of meteoritics; and the history of radio astronomy.

Wayne's recent books include *Eclipses, Transits, and Comets of the Nineteenth Century: How America's Perception of the Skies Changed* (2015, Springer, co-authored by Stella Cottam); *New Insights from Recent Studies in Historical Astronomy: Following in the Footsteps of F. Richard Stephenson. A Meeting to Honor F. Richard Stephenson on His 70th Birthday* (2015, Springer, co-edited by David A. Green and Richard Strom); *Exploring the History of New Zealand Astronomy: Trials, Tribulations, Telescopes and Transits* (2016, Springer); *John Tebbutt: Rebuilding and Strengthening the Foundations of Australian Astronomy* (2017, Springer), *The Emergence of Astrophysics in Asia: Opening a New Window on the Universe* (2017, Springer, co-edited by Tsuko Nakamura); *The History of World Calendars and Calendar-making. Proceedings of the International Conference in Commemoration of the 600th Anniversary of the Birth of Kim Dam* (2017, Yonsei University Press, co-edited by Nha Il-Seong and Richard Stephenson); and *The Growth and Development of Astronomy and Astrophysics in India and the Asia-Pacific Region ...* (2019, Hindustan Book Agency and Springer, co-edited by Aniket Sule and Mayank Vahia). Three further books (on the 1868 Total Solar Eclipse, Southeast Asian Astronomical History and Early Australian Radio Astronomy) will be published by Springer in 2020).

While working at the National Astronomical Research Institute of Thailand Wayne's research interests have focused mainly on Asia, and especially Indian, Indonesian, Japanese, Philippines and Thai astronomy, and astronomical links between SE Asia and India and SE Asia and Australia. Wayne has been a member of the IAU since 1985, and has been very active in commissions dealing with history of astronomy, radio astronomy, and education and development. Currently he is the President of Commission C3 (History of Astronomy). In 1998 he co-founded the *Journal of Astronomical History and Heritage*, and is the current Editor. He also co-edits Springer's Series on Historical and Cultural Astronomy. He is the co-recipient of the American Astronomical Society's 2019 Donald Osterbrock Book Prize, and minor planet '48471 Orchiston' is named after him.



John Drummond became fixated with astronomy at the age of ten when his mother pointed out the Pot in Orion to him. From that moment on he was hooked on the Universe. Joining the Junior Section of the local Gisborne Astronomical Society not long after, John would regularly do

group meteor watches, telescope viewing and listen to astronomy talks. He also developed an interest in photography, and it was not long before he combined these two interests and began astrophotography. John's photographs have been used in many overseas books and magazines—and were used on two New Zealand stamps. He was the Director of the Royal Astronomical Society of New Zealand's Astrophotography Section for thirteen years until 2018. He

is currently the Director of the Society's Comet and Meteor Section.

John lives about 10km west of Gisborne, on the east coast of the North Island of New Zealand, and has a range of telescopes up to 0.5 metres in diameter. He regularly images with these telescopes and CCDs, and also carries out astrometry of comets, asteroids and NEOs, and sends his observations to the IAU Minor Planet Center. In 2018 John made 466 observations (the second-highest number of observations taken in New Zealand, the University of Canterbury's Mount John Observatory supplying the most). John has also confirmed several comets. His Possum Observatory has the IAU code E94. John has also co-discovered about 20 exoplanets in collaboration with the Ohio State University—including the unusual 2-Earth-mass planet orbiting a binary star, which forced astronomers to rethink planetary formation models. John is a co-author of more than 60 research papers, and he is also a contributing editor for the *Australian Sky and Telescope* maga-

zine. He enjoys giving talks around New Zealand on historically-famous astronomers.

John was the President of the Royal Astronomical Society of New Zealand from 2016 to 2018 and is currently the Society's Executive Secretary; in 2019 he was made a Fellow of the Royal Astronomical Society of New Zealand. In 2016 John was awarded an MSc (Astronomy) by Swinburne University in Melbourne (Australia), and he has just begun a part-time off-campus internet-based PhD through the Centre for Astrophysics at the University of Southern Queensland (Australia), supervised by Dr Carolyn Brown and the first author of this paper. John's thesis research will examine the history of cometary astronomy in New Zealand (including traditional Māori knowledge relating to comets).

When not doing astronomy, John is a secondary school science teacher. He also enjoys surfing the great waves of Gisborne and pottering around on his small farm tending to his sheep.