OBSERVATIONS OF THE GREAT SEPTEMBER COMET OF 1882 (C/1882 R1) FROM NEW ZEALAND

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Abstract: In this companion paper to Kapoor’s (2020) study of Indian observations made of the Great Southern Comet of 1882 (C/1882 R1), we examine observations of this comet made from another British colony, New Zealand. We review New Zealand newspaper accounts of this impressive comet, and we critically examine the popular claim that someone from Auckland, New Zealand, was one of the first in the world to see and report the comet. We conclude by reviewing the concept of nuclear splitting and the Kreutz family of sungrazers.

Keywords: Great Comet, Comet C/1882 R1, New Zealand, J.T. Stevenson, nuclear splitting, Kreutz sungrazers

1 INTRODUCTION

With the publication of Kapoor’s (2020) “Comet tales from India: the Great September Comet of 1882 (C/1882 R1)” in a recent issue of JAHH, we decided to prepare a companion paper about observations of the same comet made from New Zealand (Figure 1). Sources used in this study include the books by Kronk (2003) and Vsekhsvyatskii (1964), research papers published in scientific journals, and articles and reports that appeared in New Zealand newspapers. Kronk (2003: 503) describes Comet C/1882 R1 (originally known as Comet 1882 II or Comet 1882b) as “… one of the most spectacular comets of the 19th century.” Stoyan (2015: 136) agrees: “C/1882 R1 was, with its estimated magnitude of −17, the brightest comet of modern times.” It must be noted however that some nineteenth century observers judged that the Great March Comet of 1843 (C/1843 D1) was even more spectacular (e.g., see Seargent, 2009: 208).

Comet C/1882 R1 was at its brightest during September 1882 and gradually faded over the ensuing six months, but remained visible to the naked eye until the beginning of March 1883 (Vsekhsvyatskii, 1964: 265). Grego (2014: 119) points out that it was visible for 135 days without optical aid. During this time, it lay just south of the celestial equator, and at southern declinations, which particularly suited New Zealand’s Southern Hemisphere location (latitude ~35° to ~47° South). The comet displayed a long tail and was an easy naked eye object for the public. Reports also reveal that for several days Comet C/1882 R1 was visible in broad...
daylight, and was observed by numerous New Zealanders. Stoyan (2015: 138) wrote that when close to the Sun, it could be seen through a solar filter, and he suggested that at this time its apparent visual magnitude was between −15 and −17.

In this paper we investigate the path of Comet C/1882 R1 in New Zealand skies, and its accessibility to astronomers and the public. Observations of the comet from New Zealand will then be presented, as will photographs of the comet purportedly taken from New Zealand. Public interest in this comet also will be gauged on the basis of articles and reports in New Zealand newspapers. We will conclude by reviewing the concept of nuclear splitting and the Kreutz family of sungrazers, studies of both being inspired by this comet.

2 THE DISCOVERY AND INTERNATIONAL VISIBILITY OF COMET C/1882 R1

The Great September Comet of 1882 was, as the name suggests, a major spectacle in September 1882. Reports of a naked-eye comet visible in the pre-dawn morning sky began to appear in Southern Hemisphere newspapers in early September 1882. According to Vsekhsyatskii (1964) and Kronk (2003), the earliest observations were not first-hand accounts, but rather, observations reported to astronomers from the public and then published in the astronomical literature. Kronk (2003: 503) notes that the German astronomer, Johann Gottfried Galle (1812–1910), Director of the Breslau Observatory, wrote that the comet was first seen from the Gulf of Guinea and the Cape of Good Hope in Africa on 1.2 September (UT). Vsekhsyatskii (1964: 265) states that the first observation of the comet from the southern hemisphere was "... by sailors on board (an) Italian ship." [which was in the Gulf of Guinea]. Kronk (2003: 503) says it was then seen from Auckland, New Zealand, on 2.7 September according to the British astronomer W.T. Lynn (1903), while the Director of the Argentine National Observatory, Benjamin Athorp Gould (1824–1896), was informed that several railway workers also saw it around this time (Lynn, 1903: 326). Although of interest to us, the 'discovery-history' of this comet lies beyond the scope of our paper, and it is investigated in detail by the third author of this paper (GK) in a forthcoming book (see Kronk, n.d.).

After discovery, Comet C/1882 R1 progressively increased in brightness until it reached perihelion and naked eye daytime visibility on 17 September. After that, it slowly faded over the following months, and was last observed telescopically on 1.97 June 1883 by Gould's Assistant Astronomer at the Argentine National Observatory, fellow-American John M. Thome (1843–1908). At the time, Thome said it was "... an excessively faint whiteness." (cited in Kronk, 2003: 513).

Table 1 lists the constellations that the comet travelled through between September 1882 and June 1883, according to Gray's Project Pluto GUIDE 9 planetarium software.

From 1 September 1882 until 30 June 1883 the comet's declination ranged from −01° to −31°. As will be discussed later, Comet C/1882 R1's magnitude possibly spiked at about −16. See Figure 2 for its approximate change in magnitude over time. As of July 2020, Comet C/1882 R1 was in Canis Major and estimated to be about magnitude 28 (based on GUIDE 9).

3 THE VISIBILITY OF COMET C/1882 R1 FROM NEW ZEALAND

Considering that September 1882 was the best time to view Comet C/1882 R1, we decided to use GUIDE 9 planetarium software to determine the pre-discovery path and approximate magnitude of this Great Comet. This Section discusses the potential visibility and brightness of the comet, which would determine whether

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<td>Leo Major</td>
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<td>Virgo</td>
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<td>Leo Major</td>
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<td>Sextans</td>
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local astronomers and members of the public could see it from New Zealand.

The comet spent the entire month of July 1882 in Monoceros. During this period, it was tracking just south of the celestial equator never venturing more than two degrees into southern declinations. It was probably about apparent visual magnitude 9 at the start of July and magnitude 8 by month’s end. In mid-July, it was rising about 40 minutes before astronomical twilight began across New Zealand.

During August 1882 the comet kept traversing Monoceros until near the end of the month when it moved into Hydra. During the entire month it remained close to the celestial equator. From the start of August it brightened rapidly, and by the end of the month would just have been visible to the naked eye. On 1 August it rose at about 4:30 am local time, and by 31 August was rising at approximately 4:00 am. Note that during this southern winter month, astronomical twilight in New Zealand started at about 5:30 am local time.

During September, the month the comet was named after, it was a fairly easy naked-eye object. At the start of the month it was rising at about 4:00 am, but as it headed towards its perihelion encounter with the Sun on 18 September (NZST) it was rising later in the morning and progressing into the realm of the Sun’s influence in the twilight sky.

By this stage, observations of the new comet began to circulate, and many sightings were reported by members of the public.

After its ‘glory month’ of September 1882, Comet C/1882 R1 began to gradually fade. Each day it moved slowly into greater southern declinations. On 1 October it was in Sextans and rising at about 3:50 am, and by 31 October it had crossed the border into Hydra and was rising just after midnight. At that stage, it was at a declination of –20°.

4 OBSERVATIONS OF COMET C/1882 R1 FROM NEW ZEALAND

4.1 September 1882

In addition to the international observations of Comet C/1882 R1 as recorded by Kronk (2003) and Vsekhsvyatskii (1964), numerous casual observations of the comets were conducted from New Zealand.

As noted previously, the first known visual observation of The Great September Comet from New Zealand was reputedly made from Auckland on 2.7 September 1882. However, this is based solely on a report published by Lynn (1903), more than twenty years later. One of the authors of this paper (GK) has critically evaluated this claim and others made by Lynn and finds that he is not always reliable. On the basis of newspaper reports, we doubt that anyone in Auckland (or elsewhere in New Zealand) observed the comet on 2.7 September.

As the following review will show, the earliest reliable newspaper report of an independent observation of the comet from New Zealand dates to 9 September (the same date that it was reported in the Sydney newspapers). The New Zealand report was made by a night watchman in Wellington. The following day, the comet was reported from Auckland, Tīmaru, Wanganui and by crew members of two ships, one in the Bay of Plenty and the other near Wanganui. Next day, 11 September, it was seen throughout New Zealand.

As Comet C/1882 R1 approached perihelion, its brightness increased and it became a conspicuous object in the predawn skies of New Zealand, and was widely observed.

Let us now conduct a thorough chronological examination of the reports published in the various New Zealand newspapers.

The first such account was published in Wellington’s Evening Post on 9 September:

Mr. James Brown, nightwatchman on the Queen’s Wharf, writes to us as follows:—

“This morning, about 4 15, I observed a very large and brilliant comet, between northeast and east, between Somes Island [in Wellington Harbour] and the point. I got the glasses to see it … It has a very large
head, pointing towards the earth ... As I am the first to notice it I think I am entitled to have it named after me." (The New Comet, 1882a).

But as the newspaper pointed out, the comet had already been seen earlier in Australia, so Mr Brown

... will have to seek another opportunity of distinguishing himself before his desire to be enrolled among the band of famous astronomical observers can be gratified. (The New Comet, 1882a).

Inspired no doubt by this account, on 13 September the Evening Post published the following poem:

James Brown would give his own name to the comet;
But found, instead, he’s got another from it.
The stranger’s still unnamed; throughout the town
The honest watchman’s known as “Comet Brown.” (The Watchman and the Comet, 1882).

Meanwhile, the Daily Telegraph newspaper (1882) confirmed Mr Brown’s account, that a “... large and brilliant comet ... [with] a large head pointed towards the earth ...” was first observed from Wellington on the morning of Saturday 9 September. At this time it was described in more detail in the New Zealand Times (1882):

The new comet ... was seen here to great advantage on Saturday morning [9 September]. The nucleus was unusually bright, and may be compared to a star of the second magnitude, being, of course, less sharply defined. It is of a pale yellow colour. The tail appears to be somewhat longer than was mentioned in the [Sydney] telegram.

A report from Timaru dated 10 September described the comet as “… a very brilliant object in the north-eastern sky early this morning.” (The New Comet, 1882b).

On 11 September there was an account from the coastal collier, S.S. Oreti (Figure 3), that the comet also was seen on 10 September when the ship was crossing the Bay of Plenty (The New Comet, 1882c). The second engineer, Mr Duthie, said it was due east and close to the Moon. He described it as “… having a tail of considerable dimensions.” (The New Comet, 1882b). The article notes that it is undoubtedly the comet referred to in the Sydney cablegram, which stated:

A new comet with a well defined nucleus, equal in brilliancy to a star of the second magnitude, is now visible in the eastern sky, the tail extending over an area of three degrees ...

The article mentioned that the newspaper had received other telegrams about the comet. For example, on 11 September an observer from Wellington described the comet as

A large and brilliant comet, between north-east and east, was visible here at 4:15 this morning. The comet has a large beak, point-
ed towards the Earth, and is lost sight of about 5 o’clock. (The New Comet, 1882a).

Note that according to GUIDE 9 the comet at that time was in Sextans (RA 10h 00m, Dec – 01° 22’); nautical twilight started at 5:15 am NZST.

A report in the Wanganui Chronicle (1882) dated 11 September indicates that the comet also was seen near Wanganui the previous day:

Shortly before 5 o’clock yesterday morning the comet was observed by Captain Whitwell, of the Charles Edward, before reaching this port.

The 141-ton Charles Edward was built in Dumbarton (Scotland) in 1864, owned by the Anchor Shipping Company of Nelson, and was used to carry passengers and cargo between New Zealand ports. This paddle-steamer is shown in Figure 4. Captain T.W. Whitwell (ca. 1830–1904), who reported sighting the comet on 10 September,

... was a man who commanded most of the Anchor ships of his day but whose name will always be associated with the Charles Edward. (Kirk, 1967: 18).

On 11 September the Wanganui Herald (1882) advised local residents that the comet was visible in the eastern sky before sunrise (weather permitting).

The comet also was visible from Nelson on 11 September, and was reported by someone (identified only as “M”) with an obvious interest in astronomy and knowledge of comets:

I saw it well this morning at a little past five o’clock ... It is about the same apparent size, I should judge, as Wells’ comet when first seen here, but the nucleus, I think, is larger and brighter than, and the tail at least as bright as that of the other comet. I may add, by way of record, that I saw the latter on the 8th, and for the last time, on the 9th of August. (M, 1882).

The first New Zealand report of observations of the comet from Auckland appeared in an all-too-brief statement of Auckland news in the 11 September issue of the Thames Star (1882a) newspaper: “A large comet was observed at 4 o’clock yesterday morning.” The same day an article by Auckland’s Professor S.J. Lambert FRAS (1882a) titled ‘The New Comet’, appeared in the Auckland Star (1882), where he wondered whether this was the eclipse comet of May 1882. It was not. On the 13th, a report from Auckland mentioned that “The nucleus and a small tail were well defined.” (Thames Star, 1882b).

The comet also was visible from Gisborne on 11 September, although the Moon was interfering with the observations:

The comet ... may be seen in Gisborne by anyone willing to rise at five. It has a brilliant nucleus almost equal to a star of the first magnitude but its present position
is unfavourable for observing the tail, the light of which pales before that of the moon; but this will only be for about one more day, as the moon is on the wane. (*Poverty Bay Herald*, 1882).

The same day in Blenheim “The Comet was clearly visible here this morning between four and five o’clock.” (*The Marlborough Express*, 1882).

The comet also was visible further south, in Timaru, on 11 September (*Timaru Herald*, 1882a), and:

...in several parts of the Colony [of Otago]. It is between N.E. and E., has a large head pointing towards the south, and is lost sight of at about five o’clock in the morning. (*The Evening Star*, 1882).

On 11 September residents in the coastal town of Oamaru also were forewarned that the comet was visible: “Early risers will, on a careful scrutiny of the heavens observe a large comet.” (*North Otago Times*, 1882). It also was described as “… very brilliant …” when viewed from Tuapeka in South Otago (*Tuapeka Times*, 1882), on 11 September.

A correspondent also advised the *Otago Daily Times* (1882) on 11 September that the comet was easily visible from Dunedin as a conspicuous object in the eastern sky before sunrise, and

The nucleus was large, abot [sic] the size of a star of the second magnitude, and the tail was well defined for a distance of for [sic] degrees.

On 12 September, “... the comet was seen to great advantage [in Wellington] ... The tail is by no means imposing, but the comet has a very brilliant nucleus.” (*Evening Post*, 1882).

By 13 September the citizens of Timaru were treated to a good view of the comet:

The comet which suddenly appeared in the eastern sky a few days ago appears to be approaching the sun very rapidly ... It’s brightness and apparent size are increas-ing, which indicates that the stranger is al-so moving towards the earth at the present time. (*Timaru Herald*, 1882b; our italics).

Meanwhile, on 13 September the citizens of Christchurch were advised that

The comet can be seen here ... It is low down in a north-eastern horizon, and the tail is very faint. The nucleus, however, is particularly brilliant. (*The Star*, 1882).

On 13 September the comet was visible from the nearby port of Lyttelton: “… the tail was very faint. The nucleus, however, is partic-

icularly brilliant.” (*Lyttelton Times*, 1882).

It was only on 12 September that we find the first appearance of the comet used for advertising purposes in a New Zealand newspaper. The article in Gisborne’s *Poverty Bay Herald* (1882) starts innocently enough:

Have you seen the comet? This celestial stranger is engrossing all the attention. It is presumed that every one jumped out of bed this morning to have a peep at it, with its brilliant nucleus and its long sweep of tail. If so, what have you seen? Nothing certainly that can have done you any good … Perhaps it has frightened you ...

Then comes the ‘punch-line’:

We can all do without a comet, but boots we must have, and this being so when you look at the comet let your minds be directed to GARRETT BROS, shop where you can obtain quality, neatness, and cheapness in every description of boots and shoes.

Residents of Westport on the West Coast of the South Island were warned on 15 September that the comet was visible in the eastern sky, just before dawn (*Westport Times*, 1882).

By 19 September 1882, there were numerous reports that the comet was visible to the naked eye in broad daylight! The *Auckland Star* simply stated:

The comet is distinctly visible here this afternoon, close to the sun. Crowds in the street are witnessing it. (*The Comet Visible in Daylight*, 1882).

Using GUIDE 9 software we calculated that Comet C/1882 R1 reached perihelion on 18 September 1882 at about 7:00 am NZST (17.7 September 1882 UT). At that stage it was travelling at 12’/hour with a PA of 255° (approximately WNW). At that time of year, a few days before the Southern Hemisphere spring solstice, the Sun and comet were rising due east and setting on the celestial equator.

*The New Zealand Herald* stated that the comet was visible at 2 pm on 20 September, and all a Wellingtonian (or any New Zealander) had to do was block the Sun out and the comet would be easy to see (*The Comet Visible During the Day*, 1882).

Dr (later Sir) James Hector (1834–1907; Figure 5), the Director of the Colonial Observatory in Wellington’s Botanic Garden (Figure 6; see Orchiston, 2017a), stated that it was 5° from the Sun and rapidly approaching it. He described the tail as short and fan-like (*The Comet Visible During the Day*, 1882).

Similarly, Dunedin amateur astronomer Arthur Beverly (1822–1907; Figure 7) said that on
on 19 September the comet was “... plainly visible in the afternoon ...”, even though it had reached perihelion the previous night, and it
... approached its perihelion on the remote side of the sun, and is receding from it on the near side, hence it is much nearer the earth than before.

He summarised that at the sunrise after perihelion, Comet C/1882 R1 was 4° west of the Sun, and a few hours later, at 10am, it was 4.5° west of the Sun. He predicted that it would probably be visible to the naked eye during the daytime for a few more days (ibid.).

Regarding the maximum magnitude, Australian academic and comet expert Dr David Seargent, believes that it reached magnitude −10 (pers. comm., 13 June 2020). Others suggest that it could even have reached −15 to −17 (see Stoyan, 2015: 138).

Let us now insert a few key international observations of Comet C/1882 R1 at around perihelion in order to provide a context for the New Zealand reports.

Vsekhsvyatskii (1964: 265) states that Australia’s leading nineteenth century astronomer and comet expert John Tebbutt (1834–1916; Figure 8; Orchiston, 2017b) saw the comet with the naked eye during the daytime on 16 September. Based on observations made by W.H. Finlay and William Elkin at the ‘Cape Observatory’, its magnitude at this time was around −16, making this the brightest comet recorded in recent history (Stoyan, 2015: 138). On 17 September Finlay noted that “The silvery light of the comet formed an impressive contrast with the reddish-yellow light from the Sun.” (quoted in Stoyan, 2015: 138). Kronk (2003: 505–506) agrees that the comet was “… easily visible in broad daylight for more than two days …”, with a date-range of naked eye observations between 16.98 September and 19.26 September UT. Stoyan
(2015: 138) extends this range to 20 September. During this period the comet’s tail was about 1° in length (Kronk, 2003: 505). David Gill, Director of the Cape Observatory, described the comet on 17 September:

It was only necessary to shade the eye from direct sunlight with the hand at arm’s-length to see the comet with its brilliant white nucleus, and dense white, sharply-bordered tail of quite ½° in length. (quoted in Ashbrook, 1961: 331–332).

Ashbrook (1961) described how at perihelion the comet passed within 305,000 miles (491,000 km) of the solar surface,transiting the solar disk (which was not seen from Earth because of the Sun’s intense glare and the comet’s small nucleus). The comet then reached greatest eastern elongation, traveling westwards behind the Sun and heading approximately to the west from then on. Based on these observations, it seems that the comet was visible to the naked eye during the daytime on four days: 17–20 September included.

Back to New Zealand Professor Lambert (1882b) supported these observations in an article published in the Auckland Star, where he stated that on 20 September he saw the comet with the naked eye at 9:30 am when it was 7° from the Sun. He stressed that the number of reliable observations were too few for him to compute the orbital elements, or the period, but he stated that it was highly probable that this was the same comet that Pons had discovered in 1812, with a period determined by Professor Encke, of ~70 years. Further observations and computations, proved this statement to be wrong—a situation that Lambert forewarned might happen.

Lambert (1882b) and other observers stated that the head of Comet C/1882 R1 resembled that of C/1858 L1 (Donati). Lambert (ibid.) also speculated in the Auckland Star that the current comet was possibly Comet ‘Tewfik’ that was seen very near the Sun during the total solar eclipse of 17 May 1882. During the intervening months observers in both hemispheres had searched in vain for the ‘eclipse comet’. Lambert would later retract his statement. In 1967, Marsden (1967: 1182) pointed out that four different sun-grazing comets were detected during 65 different solar eclipses that occurred in the previous 100 years.

After perihelion, Comet C/1882 R1 began moving from a westerly to a south-westerly direction and heading deeper into the Southern sky. And after its close encounter with the Sun, its magnitude began to slowly fade.

A brief article in the Auckland Star on 12 September 1882 (The Comet, 1882a) stated that the comet was then as bright as Jupiter (i.e. magnitude $m_V \approx -2$). One week later, on 19 September, the New Zealand Herald declared that C/1882 R1 was possibly “… the largest since Donati’s comet, in 1858, and if anything, brighter.” (Australian News, 1882). Note that this was based on reports from Melbourne, Australia.

Near the end of September S.J. Lambert (1882b) wrote that the comet “… has developed into a most beautiful object …” and could be well seen by 4 am. He stated that it was moving in a south-westerly direction. It had a tail of about 7° that was curved towards the north, and “… as it moves further from the sun its tail grows both longer and wider.” By this stage, the head was still comparable in brightness to Jupiter (magnitude –2) (The Comet, 1882b). The following day, the 30 September issue of the Auckland Star reported that the comet was directly east at 4:40am, at an alti-
tude of about 25° (The Comet 1882b). It was at this time that an observer in India likened the tail to “… the tusk of an elephant …”, and that it took nearly an hour for the tail to rise out of the sea—indicating a length of 10–15° (Ashbrook, 1961: 332). For other Indian observations see Kapoor’s (2020) paper in the August 2020 issue of JAHH.

4.2 October 1882

In October, Comet C/1882 R1 continued to move further into Southern skies. By this stage enough observations (between 8 and 17 September) had been made to determine an approximate orbit and perihelion passage.

Sydney amateur astronomer and populariser George Butterfield,6 commented on its brilliance and size and that many members of the public had seen it. He wrote that it had a close perihelion passage of just ~13,000 miles (21,000 km) from the Sun, values that we now know to be totally incorrect. Butterfield stated that the comet approached the Sun from the south at an angle of 38° relative to the plane of the Earth’s orbit, reached perihelion on 17 September, and then headed away from the Sun “… on the south side of the plane of our orbit.” (The Comet, 1882d). Sadly, for Northern Hemisphere observers, Comet C/1882 R1 was predominantly a Southern Hemisphere object.7 Butterfield predicted that it would remain a bright object for many weeks, rising a little earlier each morning until it became circumpolar. He added that it should be visible to the naked eye until the end of the year.

It should be noted that the interest of the public in comets was growing thanks to Comet C/1882 R1. The Auckland Star recorded that the Reverend Dr Thomas Roseby (1844–1918; Figure 9)8 from Dunedin gave a lecture on comets (including C/1882 R1) in Timaru. He suggested—incorrectly as it later turned out—that Comet C/1882 R1 may be the same as the major comet of 1864 (i.e. C/1864 N1 Tempel) or another with the same orbital parameters (Scintillations, 1882).

On 31 October S.J. Lambert reported that “The brilliancy of our visitor is growing dim.” (The Comet, 1882f). He also noted that the tail was slowly fading.

4.3 November 1882

About two months after its discovery, members of the public were even writing poems about Comet C/1882 R1, such as this one (only the first two lines are quoted below) by the Reverend Edward Best of Christchurch9 who addressed the comet while shivering in his night-shirt10 and observing it from his bedroom window:

Hail, glorious stranger! Amid the stillness of this early morn,
While millions sleep, I stand and gaze on thee. ("Besting" the Comet, 1882).

Reverend Best then proceeded to ask the comet

… questions out of the Church Catechism,
and deliver him an evangelical "address."
What pleases the general reader of this Address is the fact that it is as much about Mr Best as about the comet. (ibid.).

Around this time, Christmas Cards of New Zealand Views, were starting to be sold for the approaching Christmas, one of which (there were ten) featured the Great Comet of 1882. It was stated in advertisements that

These very choice Christmas cards will give friends in England and elsewhere a good idea of the beauties and wonders of the ‘Britain of the South’.

They sold for one shilling each. Possibly the southern view of the comet would have been of interest to those in the Northern Hemisphere who could not see it (Advertisements, 1882. Advertisements, 1883)! We wonder if the photograph of Comet C/1882 R1 over Mount Taranaki (see Sub-Section 5.1.2 below) was possibly the photograph used in this Christmas card.

In mid-November 1882 Hugh Garden Seth-Smith (1848–1935; Figure 10), astronomy enthusiast and District Judge and Resident Magistrate in Auckland, gave a lecture on comets at Saint James’s Hall, Auckland (Comets – Lecture by Mr. Seth Smith, 1882).11 He discussed the orbits, composition and tails of comets, and the fact that they introduce “…

Figure 9: The Reverend Dr Thomas Roseby (courtesy: Mitchell Library, Sydney).
discord into the harmony of the spheres ..." was also spoken about. Smith acknowledged
the age-old public reservation and even fear regarding comets that was then still evident
in contemporary society. He stated that the tail of Comet C/1882 R1, near perihelion, was ~12
million miles long, or ~19 million kilometres (The Comet, 1882g).

An interesting side-note, brought to the notice of newspaper readers in November 1882,
was the claim—initiated by some comments by the famous British astronomy populariser
Richard A. Proctor (1837–1888)—that if Comet C/1882 R1 had fallen into the Sun (or would do
so in 1883), then the increase in mass would cause the Sun to become hotter, to the detri-
ment of the Earth and other inner planets of the Solar System. In an attempt to counter this
scare-mongering, Arthur Stock (1823–1901; Figure 11), 12 the ‘Astronomical Observer’ at the
Government’s Colonial Observatory in Wellington, wrote in the 20 November issue of the
New Zealand Herald that this hypothesis had no merit at all as the Sun’s immense mass
would remain unaffected by something as small and insignificant as a comet (Stock, 1882).
As might be imagined, this attracted several ‘Letters to the Editor’ over the following days.

Alongside the inevitable end-of-the-world prophesies, there was discussion among re-
search astronomers about the similarities between the Great March Comet of 1843 (C/1843
D1), the Great Southern Comet of 1880 (1880 C1) and C/1882 R1 (see The Evening Star,
1882). All three exhibited retrograde motion, had similar orbital inclinations, and had very
small perihelion distances (i.e. they were ‘sun-grazers’). We will return to this interesting
topic later, in Section 5.3.

4.4 December 1882

By December 1882, the number of New Zea-
land observations of Comet C/1882 R1 report-
ed in newspapers had dwindled.

One of the last was a side-comment in connection with the other astronomical spec-
tacle that was attracting public interest in late 1882, the 7 December transit of Venus. Fol-
lowing the highly-publicised 1874 transit Venus (see Orchiston, 2016: 371–387; 410–443),
New Zealand was far from ideally placed for the 1882 transit since ingress began at about
2:00 am local time when the Sun was ~22° below the south-eastern horizon. By sunrise,
at about 4:37 am, Venus was nearly halfway across the Sun’s disk, and the transit ended at
about 8:15 am when the Sun was ~40° in altitude. Nonetheless, the transit attracted atten-
tion from astronomers and the public alike

(Orchiston, 2016: 387–419), and as they prepared to make their observations “Our old friend
the comet watched us pleasantly.” (Transit of Venus, 1882).

One can imagine that as the astronomers
set up their equipment in anticipation of sun-
rise they casually observed the comet which
was located ~80° above the northern horizon
in Pyxis. Although no magnitude estimate was
published, there is a good description of the
tail: it was broader than in earlier months, and
there were two of them (presumably, a dust tail
and an ion tail). The writer states:

The under side of the tail is far wider than
the other, and this broad tail is evidently
the secondary tail, which, when first notic-
ed, was also wider on one side than the...
other, never having had the same axis as that of the main tail. (Transit of Venus, 1882).

It should be noted that observations by international observers placed the magnitude of Comet C/1882 R1 at about 4 in early December (Vsekhsvyat斯基, 1964). However, Kronk (2003: 511–512) mentions that the only magnitude estimate made in December was on the 1st, when Mardwick compared it to a 5th magnitude star, but Kronk also states that the comet remained a naked eye object throughout January 1883. Vsekhsvyat斯基 (1964: 266) states that Gould observed the comet in mid-January and estimated it to be magnitude 3–4. Determining cometary magnitudes is always a challenge, even for experienced visual observers, so we can only wonder how reliable these magnitude estimates are.

4.5 1883

There appear to be no more New Zealand newspaper articles containing observations of Comet C/1882 R1 in the months that it was still visible, namely January (when it was still a naked eye object), February (Tebbutt’s last successful naked eye observation was on the 12th) and March (by now it was a telescopic object). The final recorded observation was by Thome (at Cordoba) on 1 June 1883 (Kronk 2003: 513; Vsekhsvyat斯基, 1964: 267).

This ends our review of New Zealand observations of Comet C/1882 R1 reported in local newspapers. It was a naked eye object for 5–6 months, and was an impressive daytime object around 16–19 September 1882.


Although New Zealand’s professional astronomers and amateurs provided the public with various accounts of the Great Comet, the only one to publish a research paper in an international journal was Auckland amateur astronomer John Torrens Stevenson (1854–1914; Figure 12). However, his 1-page paper (Stevenson, 1882) that appeared in the December 1882 issue of Monthly Notices of the Royal Astronomical Society, was extracted from a letter that Stevenson sent to the leading British amateur astronomer, Reverend T.W. Webb (1807–1885), and was not submitted directly by Stevenson to MNRAS. Nonetheless, this provides a valuable overview of the observations of the comet that he made between 19 September and 12 October 1882 using a 6.5-inch reflecting telescope manufactured by the celebrated British craftsman, George Calver (Dall, 1975).

Stevenson (1882: 54; his italics) begins his short account with a description of the post-perihelion appearance of the head:

… when viewed in the telescope the head appears just like a double star, when the power is not sufficient to separate the disks; of course I do not mean that the head is double, but it is elongated in an east and west direction, which is at present the direction of the comet’s motion. On the 5th instant and once before I saw a minute point in the nucleus which glowed brightly.

Meanwhile, the tail

… is grand in the extreme; I have never seen anything equal to it. At the extremity it is at least several times broader than the Moon’s apparent diameter. I can see the faintest stars visible through even the thickest portion of it. With a small glass I can trace plainly the dark space running up through it from the head and here I notice another peculiarity—namely, that this space is not central in the tail, but divides it into two unequal portions, the northern of which is much broader than the other. (Ibid).

Stevenson (1882: 54–55) also noted the emergence of dust and ion tails, and even the eventual appearance of an anti-tail:

Up to October 6, on the occasions on which I observed, there was also seen a
fainter tail extending from the north part of the head and reaching as far as the brighter one; with the naked eye the northern part of the tail was seen to be darker than the other parts, and it is this part which I consider the second tail. I was particular in trying to trace it right down to the head, as I had a suspicion that it had a square-shouldered aspect (I might call it) where it joined the nucleus; but of this I was not sure.

Yesterday morning, however (Oct. 6), on looking at the comet, which was then very low, I was surprised to find that the fainter portion of the tail had extended itself on both sides of the head and appeared as a second tail pointing towards the Sun. I traced it fully two degrees beyond the nucleus—that is, in a direction contrary to the brighter tail. (Stevenson, 1882: 55–56; his italics).

On 10 October, just before the mail closed for England, Stevenson succeeded in gaining one final view of the comet and … found that the faint tail had now extended itself sunwards for (I think) more than four degrees. I again suspected that it was not quite parallel with the brighter one, but am not sure on this point. I have noticed all along the bright tail is longer on its southern side, and also that the extremity of tail has a dark space which splits that portion nearly in two … (Stevenson, 1882: 56).

Although he obviously conducted further observations of this majestic comet, apparently Stevenson never published these (in MNRAS, or elsewhere).

We should note that the cut-off date of Stephenson’s reported observations was dictated by the departure date of the ship bound for England, transporting mail from New Zealand. This reminds us of what Professor Blaikney (1975) has termed ‘the tyranny of distance’, which was of special relevance for those geographically and intellectually isolated Antipodean astronomers involved in cometary astronomy (e.g. see Orchiston, 1997b).

Finally, perhaps we should not be surprised that Stephenson was the only New Zealand astronomer to publish internationally on the comet. Although not as ‘visible’ to the Auckland public as Professor S.J. Lambert FRAS, Stephenson had an international reputation, and was recognised as a serious observational astronomer—so much so that he was the only New Zealand astronomer invited by the visiting Americans in 1882 to join them in their compound in the Auckland Domain and conduct his own observations there of the 7 December transit of Venus (see Orchiston, 2004: 283).

5 DISCUSSION

5.1 C/1882 R1 and Cometary Photography

Pasachoff et al. (1996) have shown that the first comet that was successfully photographed was C/1858 L1 (Donati), but the English professional photographer William Usherwood (1821–1915) and the Harvard College Observatory astronomer, George Phillips Bond (1825–1865) were only able to obtain imprints of the head of this impressively bright comet.

Upon discussing Comet C/1881 K1 (Tebbutt) in her monumental and masterful A Popular History of Astronomy during the Nineteenth Century, the Irish chronicler of astronomical history, Agnes Mary Clerke (1842–1907; Brück, 1994; 2002), claims that “Cometary photography came to its earliest fruition with it; and cometary spectroscopy made a notable advance by means of it.” (Clerke, 1893: 429; our italics). This comet was discovered on 22 May 1881 by Australia’s foremost nineteenth century astronomer and comet expert John Tebbutt (Figure 8) of Windsor near Sydney (see Orchiston, 2017b: Chapter 9), and like his 1861 discovery (Orchiston, 2017b: Chapter 6) also was destined to become a ‘Great Comet’.

Clerke’s claim that Comet C/1881 K1 (Tebbutt) was the first for which a satisfactory photograph was obtained is indeed correct if we define ‘satisfactory’ as producing an image of the head and the tail.

It was only with the advent of the more sensitive dry gelatine plate and improvement in telescope drives that it became possible to successfully record the comparatively faint light from the tail of even the brightest of comets (see Clerke, 1893). Therefore, Comet C/1881 K1 (Tebbutt) arrived at just the right moment in this regard, and three different astronomers successfully took advantage of this. On 24 June, the British amateur astronomer, Andrew Common (1841–1903; Obituaries, 1904), took a 20-minute exposure but found … a result that I ought to have anticipated, but did not; this was that the rapid motion in declination, not being provided for, caused the image to be a trail on the plate some quarter of an inch long. As far as it went the picture was good—that is, it shows the nucleus, head, and part of the tail, more particularly that part, narrow and bright, that proceeded from the nucleus. (Common, 1881).

In New York, Dr Henry Draper (1837–1882; Whitney, 1971) also captured an image
of the comet (Draper, 1881a) this same evening:

I succeeded in photographing the Comet in Auriga on Friday night, June 24th, 1881. Since then I have taken several photographs of it. One made last night [date not specified] with an exposure of 2 hours and 42 minutes shows the tail about 10" long. There are many stars on the plate, some shining through the tail. (Draper 1881c; cf. Draper 1881b).

At Meudon Observatory near Paris, Pierre Jules Cesar Janssen (1824–1907; Launay, 2011) used a 51-cm f/3 reflector to obtain a 30-min exposure of the comet on 30 June (Janssen, 1881). The resulting photograph, which showed “... the structure of the tail with beautiful distinctness to a distance of 2½° from the head.” (Clerke, 1893: 428), was reproduced as Plate 8, Figure 1, in Astronomical Photography by Gerard de Vaucouleurs (1961). However, upon sending a copy of Janssen’s photograph to John Tebbutt, Scotland’s Astronomer, Royal Charles Piazz Smyth (1819–1900; Brück and Brück, 1988), queried its authenticity. He explained:

... M. Janssens negatives seem to have been too faint to print on paper; so he adopted the rather dangerous expedient of making a drawing from them, & then photographing that, which explains his stars being so round & his comet’s head so sharp... (Smyth, 1882).

Even a casual examination of the image in de Vaucouleurs’ book suggests that there are good grounds for accepting Smyth’s explanation.

Finally, we should note that after mentioning the motion of the comet shown on his photographs, Common (1881: 232) prophetically commented:

... these pictures are only interesting as an experiment, and unless we get a comet very much brighter and whose motion is more slow (and I hope we shall) the effort to get a useful picture will be of little avail.

A little over one year later that much-hoped-for comet actually appeared, and the Great September Comet of 1882 not only offered excellent photo opportunities (e.g. see Figure 13) but also inspired the extremely ambitious Astrophographic Catalogue and Carte du Ciel Project (Débarbat et al., 1988; Turner, 1912). In the process it also totally eclipsed the majesty of its 1881 predecessor.

5.1.2 Purported New Zealand Photographs of Comet C/1882 R1

With well-documented photographs of Comet C/1882 R1 emanating from South Africa (Gill, 1882) and India (Kapoor, 2020), we may wonder whether fellow British colony, New Zealand, with strong traditions in amateur astronomy and professional photography, also can boast photographs of this hallmark comet?

In fact, the collections of the Alexander Turnbull Library in Wellington include two 1882 photographs that show the Māori settlement of Parihaka and in the background snow-capped Mount Taranaki and the Great Comet of 1882. One of these photographs is reproduced here in Figure 14.

Mount Taranaki, which is also known as Mount Egmont, is a 2518-m (8260-foot) active stratovolcano near the western coast of the North Island of New Zealand, just south of the city of New Plymouth (Figure 1). Parihaka is a Māori settlement that is located due west of Mount Taranaki, between the mountain and the sea (see Figure 15).

During the 1880s, when C/1882 R1 appeared, Parihaka was the largest and one of the most important Māori settlements in New Zealand. Founded in 1867, by 1881 it had 2000 inhabitants (Parker, 2005: 52) and had come to symbolise peaceful resistance to the confiscation of Māori land by the New Zealand Government (New Zealand History). The photograph of Mount Taranaki and the Great September Comet was supposedly taken in October 1882, eleven months after Parihaka had been invaded by a force of 1600 volunteers and Constabulary Field Force troops on 5 November 1881 (Mackrell, 1985: 26–27). On that fateful day, when the soldiers entered Parihaka they were met by children who were dancing and offered them food. Sadly, the inhabitants were driven from their homes and two hundred leaders and objectors were arrested and imprisoned without trial in the chilly South Island city of Dunedin (Parker, 2005: 52).

One wonders whether the inhabitants of Parihaka on 5 November 1881 had viewed the Great Comets of 1880 (C/1880 C1) and 1881 (C/1881 K1) as omens of doom, or of hope for a better future. Prevailing nineteenth century Māori attitudes towards comets are discussed in Orchiston and Drummond (2019).

We believe that the photograph in Figure 14 was taken during the daytime and the comet was then painted in to represent the photographer’s recollection of the comet at night. Note that Parihaka is to the west of Mt Taranaki, so this picture is facing east, where the comet would have appeared in the dawn sky. From the elevation of the photographer, the curving road, and the background bush where the trees are, we suggest that this October 1882
The photograph was taken from a small hillock on the west side of the village (see Figure 16). If so, this places the comet’s azimuth at 91° (east), just north of the tip of the mountain which lies 19.8 km away (based on Google Earth).

Quite apart from the comet, it is obvious that the snow cover on Mount Taranaki also was added to the photograph—by October winter was well and truly passed, and other than in exceptional circumstances the mountain would never be heavily coated in snow at this time of year. Given its visual appeal, we wonder if this photograph, or a similar one, was used for the 1882 Christmas Card mentioned earlier in this research paper? What finer way to show off New Zealand to friends and relatives in the Northern Hemisphere denied a view of this spectacular comet than by displaying a picturesque Māori settlement in front of a beautiful mountain, complete with accompanying comet!

Retouching photographs of comets to portray the photographer’s visual recollection may have been a semi-common practice at this time. In Australia, an unnamed photographer took a picture of C/1882 R1, with a building at lower left. This photograph eventually found its way into the hands of professional astronomers at Mount Stromlo Observatory in Austra-
Wayne Orchiston, John Drummond and Gary Kronk  

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Figure 1: A photograph by T.S. Muir showing Parihaka, Mount Taranaki and the Great September Comet of 1882 (courtesy: Alexander Turnbull Library, Wellington; Reference: 1/2-003184; F).

Figure 15: A map showing Parihaka (red pointer), Mount Taranaki and New Plymouth (Google maps).

lia. A Mrs Wright, who forwarded the photograph, could only state that it was taken from Bombala, a small town in southern New South Wales. According to Ashbrook (1961: 331–332),

... the photograph has little or no scientific value because it has apparently been extensively retouched. The original print shows many fine brush marks in the comet tail, whose edges seem to have been sharpened.

Figure 16: A recent aerial photograph of Parihaka showing the suggested site from which the photograph was taken (map modification: John Drummond).
David Gill’s description (1882) of how easy it was for him to obtain quality images of Comet C/1882 R1 once he had access to suitable photographic equipment suggests that when at its best this comet was so bright that any Cape Town professional photographer with ‘standard equipment’ would have been able to secure successful photographs of it (if so inclined).

The same logic applies to New Zealand, and the excellent resource “Early New Zealand Photographers and their successors” documents the presence in 1882 of one or more professional photographers with the requisite equipment in all of the following towns: Auckland, Blenheim, Christchurch, Dunedin, Grey-mouth, Invercargill, Kumara, Lyttelton, Napier, New Plymouth, Oamaru, Thames and Wellington (for locations see Figure 1). Notwithstanding the sizable collections of historical photographs housed in many New Zealand libraries and museums, and the fact that some professional photographers actively collaborated with local astronomers to capture images of the 1882 transit of Venus (see Orchiston, 2004; 2016: Chapter 14) and the 1885 total solar eclipse (Orchiston and Rowe, 2017), it is remarkable that (as yet) no genuine New Zealand photographs of the Great September Comet of 1882 have come to light. We can but hope that this situation will change following the widespread dissemination of this research paper within New Zealand.

5.2 The Physics of Comet C/1882 R1

In this Subsection we will discuss the nucleus, tail and spectrum of C/1882 R1, and its orbit.

5.2.1 The Nucleus of Comet C/1882 R1

Telescopic observations of C/1882 R1 showed that over a period of just five weeks the nucleus went from a point-like structure to an elongation and then it split into separate fragments. On 17 September 1882, just after perihelion, the University of Michigan astronomer J. Martin Schaeberle (1853–1924) observed that the nucleus was elongated at 11.9” x 3.8” (Kronk, 2003: 507). The American amateur astronomer Edward Emerson Barnard (1857–1923) also noted this elongated nucleus on 27 September 1882, and said that it was elongated in the direction of the tail (Kronk, 2003: 507–508). On 2 October Henry Smith Pritchett (1857–1939) Professor of Astronomy and Mathematics at Washington University in St Louis (USA) stated that the nucleus was egg-shaped, and the following day the Belgian amateur astronomer François J. Terby (1846–1911) and the South African amateur astronomer Lindsay Atkins Eddie (1845–1913) independently reported the presence of two nuclei (Kronk, 2003: 508). On this same day, Schmidt (Athens Observatory) also noticed two nuclei (‘a’ and ‘b’ in Figure 17).

The nucleus continued to break apart, and by 5 October there were three components. On 8 October Professor Adalbert Krueger (1832–1896), Director of the Royal Prussian Observatory, said the two brightest components were separated by 13”, and two days later, on the 10th, accordingly to W.H. Finlay (from the Royal Observatory at the Cape of Good Hope) the distance had increased to 22” (Kronk, 2003: 508).

By late October 1882 reports stated there were up to six nuclei. Schaeberle described them as, “… like very small beads strung on a thread of worsted.” (wool yarn) (Kronk, 2003: 509) and Figure 18 is a drawing of the nucleus that was published by Young (1883). However, he cautions that this is merely a crude graphical representation in that...
... it fails entirely to give an idea of the shading and gradation of light. The head of the comet presented no definite outline what-ever, and the nucleus very little. The knots were mere condensations of brightness in the midst of diffuse light. (Young, 1883: 294).

By early November this 'string of beads' was 100° long. Two weeks later it was 123° long and becoming diffuse, and by early-December even experienced observers like John Tebbutt (1882a) were saying that these 'beads' were becoming lost in the coma, although Eddie reported that he saw some of them on 1 and 4 December (Kronk, 2003: 509). By 4 January 1883, the comet's extended 'nucleus' was 185° long, or 237,000 km long, based on the following equation (after Freedman et al., 2011: 9–10):

$$D = \alpha d/206,265$$  \hspace{1cm} (1)

where $D$ is linear size of the object, $\alpha$ is its angular size in arcseconds, and $d$ is the distance to the object. In one of his research papers Tebbutt (1883) specifically refers to this extended nucleus and the problem he encountered in deciding precisely which part of it he should observe when taking micrometric measurements.

It would appear that the New Zealand newspapers did not pick up news of the nuclear splitting of C/1882 R1 from overseas sources (or if they did chose to ignore this seemingly complicated feature), and apart from Stevenson, no New Zealand astronomers mentioned it. All Stevenson (1882: 54) had to say was that post-perihelion the nucleus was "... elongated in an east and west direction ...". He made no mention of the increasing number of nuclear fragments.

Of course cometary nuclear splitting was no novelty by 1882, especially after the celebrated short-period comet 3D/Biela was observed in 1832, was absent in 1838, and then presented two discrete nuclei in January 1847, soon after its recovery (for details, see Vsekhsyatskii, 1964: 173–174).

The Czech-American astronomer Zdenek Sekanina is an authority on cometary nuclear splitting and he has identified two different types: tidal and non-tidal splitting. He found that

... most comets that are known to have split did so nontidally ... and it has been recognized that there are major differences between the behavior of the products of tidal and nontidal fragmentation ... (Sekanina, 2000: L148).

Sekanina initially listed Comet C/1882 R1 as an example of a tidally split comet. Drawing on data derived from D/Shoemaker-Levy 9’s very close encounter with Jupiter and subsequent impact with the planet, Sekanina et al. (1998) developed a general fragmentation model that is equally applicable to Comet C/1882 R1 and its perihelion passage on 17 September 1882. During its very close encounter, the Sun’s tidal forces inflicted cracks and fissures throughout the nucleus of the comet which may have fragmented parts of it at the time. However, the nucleus did not break apart completely. Instead,

... separations of many individual fragments ... [were] achieved subsequently by stresses exerted on the structurally weakened object by rotation and possibly other forces (such as thermal) ... The likelihood that nucleus spin is involved in these long-term effects is corroborated by the derived separation velocities. They typically amount to a few meters per second, consistent with rotational velocities of bodies several kilometres in radius that are spinning with periods on the order of hours. (Sekanina and Chodas, 2002a: 769).

Back in 1978 Sekanina first published a fragmentation model for cometary nuclei, and this has been extensively tested over the intervening forty years or so. This model

... characterizes the conditions at splitting by up to five parameters: the time of separation, $t_s$, reckoned usually from the nearest perihelion time of the primary comet; the three RTN components of the separation velocity, $V_r$, $V_t$, and $V_n$; \^10 and the differential deceleration $\gamma$ of the secondary comet relative to the principal one. (Sekanina and Chodas, 2002a: 761).

The following year, Sekanina (1979) expanded his original study, and in 1982 he published a major review paper on this challenging topic (c.f. Sekanina, 1997; 2001). Then in 2007 Sekanina and Chodas introduced the concept of ‘cascading fragmentation’ to explain the continued non-tidal secondary post-perihelion fragmentation of a comet’s nucleus throughout its orbital path, and even at large heliocentric distances.

In a 2002 paper, Sekanina estimated the diameter of the nucleus of C/1882 R1 to be about 50 km, and with a rotation period before fragmentation of around 6 hours. He and his collaborator, Paul Chodas, determined that the primary fragmentation of the nucleus took place about 10 days after perihelion passage:

Comet C/1882 R1, unquestionably the most extensively observed sungrazer ever and by far the brightest during the past 200 years, was reported to have displayed up to six separate nuclear condensations starting a little less than 2 weeks after its peri-
helion passage (Kreutz 1888). By contrast, the comet had always exhibited a single nucleus condensation before perihelion and up to 10 days after perihelion (albeit somewhat elliptical at the end), as described in detail by Gill (1883). Because of the alignment of the fragment condensations in a train embedded in an elongated sheath of diffuse material, they were sometimes likened by the observer to a “string of pearls” or “beads on a thread of worsted.” (Sekanina and Chodas, 2007: 660).

Sekanina and Chodas (2007: 661) then elaborated on the outcome of nuclear splitting:

The role of tidally driven splitting in the immediate proximity of the Sun is to scatter the fragments into orbits, which, while having nearly identical elements $i$, and $q$, bring the fragments back to the Sun at greatly diverse times.

In discussing cometary nuclear splitting in general, long ago Sekanina (1982: 255) pointed out that

The behavior of split comets suggests that all fragments are rather massive objects that possess a certain degree of internal cohesion and some kind of temporary reservoir of ice and dust to continue to function as comets.

This basic description predated a succession of comet fly-bys, and is an over-simplification if we adopt a long-term view and accept the concept of cascading fragmentation. Sekanina and Chodas (2007: 660–661) pursue this model for Comet C/1882 R1 and suggest that the four main post-perihelion fragments of this comet

... if subjected to no further fragmentation ... [will] arrive at the Sun in the 25th to 28th centuries, over a period of more than 230 yr... [but] Since fragmentation of C/1882 R1 will in all probability continue during the intervening time, we predict that five to seven centuries from now observers will have a chance to witness new sun-grazer clusters, each approximately centered on the predicted arrival times.

5.2.2 The Tail of Comet C/1882 R1

The tail of C/1882 R1 was spectacular, and as Baumgardner et al. (2008) remind us,

... the spatial variability of a tail is determined by episodic changes in gas and dust source rates for neutral tails and/or by temporal changes in the solar wind for plasma tails. Thus, a single picture [or a drawing or visual observation] gives a time-history of the physics acting upon tail gases. For neutral gases escaping a comet nucleus, changes in solar radiation pressure are not an issue since they vary over long time scales (in the absence of a flare); however, a comet’s position and speed in an eccentric orbit do matter.

According to Kronk (2003: 503–515) the dust tail of Comet C/1882R1 increased in length after perihelion and reached its greatest length in mid-November 1882. At this stage Hopkins commented that it was 30° long. Others a week either side of Hopkins’ 15 November observation, stated it was 20° long (Eichler, 2013: 41). Taking a conservative figure of 25° for the length of the tail on 15 November and GUIDE’s Earth to C/1882 R1 distance of 223 × 10^{6} km, we can use Equation (1) to calculate the actual length of the tail in km. We determined that on 15 November the tail was about 97 × 10^{6} km long, or 0.65 AU.17

Apart from its impressive primary dust tail (e.g. see Figure 13), Comet C/1882 R1 was one of a comparatively select band of comets that exhibited distinctive ‘anti-tails’, which appear to point towards the Sun. In more recent times, one of the best-known of these was Comet C/1956 R1 (Arend-Roland), which was a remarkable spectacle in 1957 and exhibited an anti-tail that eventually reached 12° in length (Finson and Probstein, 1968; Hendrie, 1996).18 Comet C/1973 E1 (Kohoutek) was another bright comet that also possessed a notable anti-tail (Hendrie, 2000; Whipple, 1976), and an even earlier example, with a distinctly New Zealand association (it was independent-ly discovered by C.J. Westland) was Comet C/1914 S1 (Campbell).19

We now believe that the apparent sunward orientation of the anti-tail is merely an illusion caused by the actual positions of the comet and the Earth in their respective orbits relative to the Sun. As the ‘viewing angle’ changes so too does the apparent orientation of the two tails, and this is in keeping with Westland’s observations of C/1914 S1 (Campbell). Richter (1963: 101–103) presents a detailed examination of this phenomenon for Comet C/1956 R1 (Arend-Roland), and page 102 includes a diagram that illustrates clearly the illusion of a sunward-pointing tail.

5.2.3 The Spectrum of Comet C/1882 R1

Cometary spectroscopy was still in its infancy when C/1882 R1 first appeared (Orchiston, 2017b). The Italian professional astronomer Giovanni Battista Donati (1826–1873) is credited with being one of the first to obtain the spectrum of a comet. In 1864 he observed the nucleus of C/1864/N1 and detected three bright emission bands (Hearnshaw, 2014: 44) that we now know are produced by gases ejected from the comet and not produced by reflected sun-
light (e.g., see Jackson, 1982). Lines of sodium were found on C/1882 R1’s spectra on 18 September by Thollon and later by Russell, Millisevich and Tacchini (Kronk, 2003: 513). In addition, lines of Fe, Ni, and Cr were detected (Vsekhsvyatskii, 1964: 267). By 9 October 1882, the sodium lines were gone—leaving only carbon bands in the spectrum.20

5.2.4 The Orbit

Comet C/1882 R1 was perfectly positioned for observers in the Southern Hemisphere. The comet came from below the plane of the Solar System, looped around the Sun at perihelion, and then headed south again (see Figure 19).

As more observations were taken, the orbital elements of C/1882 R1 were calculated by various astronomers, and values for the period ranged between 39 and 4070 years! After the nucleus split into several pieces Kreutz computed a period of 772 years for the main fragment, C/1882 R1-B (Kronk, 2003: 515), while the Minor Planet Center gives 669 years for fragment C/1882 R1-A. Meanwhile, the different periods derived by Marsden and Williams (1996) for the different components of Comet C/1882 R1 following its perihelion fragmentation are listed in Table 2. In his discussion of C/1882 R1 Australia’s John Tebbutt (Orchiston, 2017b) noted that the orbital elements computed by both Kreutz and Frisby differed from his own elements, which were based on a longer arc of the orbit (Tebbutt, 1882a).

5.3 Comet C/1882 R1 and the Kreutz Family of ‘Sungrazers’

In the 1880s the German professional astronomer Hendrich Carl Friedrich Kreutz (1854–1907; Figure 20)

... studied many of the sungrazing comets, noted that several had similar orbital elements, and suggested their common origin might have been due to the breakup of some primordial comet near perihelion. In honor of his extensive work, the members of this group are referred to as Kreutz sungrazers. (Yeomans, 1991: 349).

Since Kreutz’s day several astronomers have intensively researched the Kreutz sungrazers, and they now total nine comets (see Table 2), along with >4000 ‘dwarf comets’ most of which have been discovered since the launch of the Solar and Heliospheric Observatory (SOHO) and the Solar Terrestrial Relations Observatory’s two probes (STEREO-A and B). The concept of ‘dwarf Kreutz sungrazers’ arose when analyses of images taken by coronagraphs on the SOLWIND and Solar Maximum Mission (SMM) between 1979 and 1989 revealed 15 sungrazing comets (see Marsden, 1989).

Sekanina and Kracht (2015a: 1) describe the Kreutz family of sungrazers as unique and ... by far the most prominent ensemble of closely related comets ... Dynamically, the
most peculiar attribute of its members is their extremely close approach to the Sun at perihelion, when the heliocentric distance in an overwhelming number of cases is well below $\sim 2R_\odot$ ($1R_\odot = 1$ solar radius = 0.0046548 AU) or just about 0.01 AU …

All Kreutz sungrazers move about the Sun in retrograde orbits, with an inclination in a range of 130°–150°. Their orbital periods are, to the extent we can state, based on a few quality data available, probably between $\sim 600$ and $\sim 1000$ yr.

In addition, their perihelion points, where known, lie within a very narrow range, of $L = 282.0 \pm 0.3°$ and $B = 35.3 \pm 0.1°$ (Marsden, 1967: 1171).

Various astronomers who observed Comet C/1882 R1 specifically noted the orbital similarity to two other nineteenth-century 'Great Comets', those of 1843 and 1880, and they wondered about the connection. For example, John Tebbutt (1882b: 368) wrote:

The circumstances are very suspicious, and constrain me to ask the question:—
Are the comets of 1668, 1843, 1880, and 1882 identical? and if so, is the period gradually diminishing, owing to the resistance offered to the comet's motion at perihelion by the denser strata of the solar corona? And yet, looking at Dr. Meyer's definitive investigation of the orbit of the comet of 1880, one can hardly entertain the supposition of identity.

Heinrich Kreutz (1888; 1891; 1901) “… made new determinations of the orbits of 1843 I, 1880 I, 1887 I, and four of the nuclei of 1882 II …” (Marsden, 1967: 1170), and realised that these could not be one and the same comet. So he looked for an ancient connection between the three nineteenth-century comets. Although Kreutz championed this idea, Agnes Clerke (1893) has pointed out that he was not the first to come up with the concept of comet families. The Dane Thomas Clausen (1801–1885) first suggested this in 1831, and it was developed further by Holland's Martin Hoek (1834–1863). More recently, British-born but American-based Brian Marsden (1937–2010; Figure 21) and Zdenek Sekanina (Figure 22) have taken up the challenge.

In 1966 the Czech astronomer L'ubor Kreút (1927–1994) found that all members of the Kreutz sungrazers can be divided into two distinct Subgroups, I and II (see Table 2), … in which the lines of nodes are separated by some 20°, and there are corresponding differences among the other elements … Presumably, the members of each subgroup are physically related more closely to each other than to the members of the other subgroup. (Marsden, 1967: 1178).

In 1967 Marsden published his first paper on the Kreutz sungrazers, and this quickly became a classic. He presented New orbit determinations … for the three most recently observed members of the Kreutz group: comets 1965 VIII, 1963 V, and 1945 VII … (Marsden, 1967: 1170).
Later, Comets C/1970 K1 (White–Ortiz–Bolelli) and C/2011 W3 (Lovejoy) were added, with the former comet being assigned to Subgroup Iia (see Figure 23). Meanwhile, most (but not all) of the dwarf comets belong to Subgroup I (Marsden, 1989; Sekanina, 2000; 2002).

As we see from Table 2, Comet C/1882 R1 was the first of the four major comets assigned to Subgroup II. Upon examining this comet and C/1965 S1 (Figure 24) Marsden (1967: 1170) concluded that it was

... virtually certain that these comets separated from each other at their previous perihelion passage, and it seems possible that they were then observed as the comet of 1106.

Subsequently, Sekanina and Chodas (2002a: 760; our italics) re-examined the relationship between these two comets, and their orbital calculations confirmed that

... the motion of comet C/1965 S1 (Ikeya-Seki) ... can be derived from the motion of its “sister” comet C/1882 R1 (Great September Comet) on the assumption that the two objects are fragments of a common parent that split in the year 1106, at the time when a very bright comet appeared near the Sun ...

In a later paper (Sekanina and Chodas, 2004: 626) they succinctly summarise their results:

(1) this fragmentation event was found to have occurred 18 ± 7 days after perihelion, on or about 1106 February 13 (old style), at a heliocentric distance of 0.75 ± 0.19 and 0.39 ± 0.10 AU below the ecliptic, and
(2) the two fragments separated from each other in, or close to, the parent’s orbital plane at a rate of about 7 ± 1 m s⁻¹, with Ikeya-Seki moving nearly in the antisolar direction relative to C/1882 R1.

Initially, tidal fragmentation of the parent comet of C/1882 R1 and C/1965 S1 was assumed to have occurred during or immediately after perihelion passage (Sekanina, 2000), but as we have just seen, Sekanina and Chodas (2002a: 760) showed that in fact it was non-tidal disintegration that produced these two comets, long after perihelion.

The first Kreutz Subgroup II comet discovered in the twentieth century was Comet C/1945 X1 (du Toit) which was detected at Harvard’s Boyden Observatory in Bloemfontein by the South African astronomer Daniel Stephanus du Toit (Figure 25) when he was examining photographic plates taken at the Observatory as part of a variable star program. Unlike the other Subgroup II Kreutz comets, at discovery this was a faint object of about photographic magnitude 7 (Kronk, 2009: 219–220). And although it was expected to be a brilliant
object at and after perihelion, it was not seen. At this stage we do not even know whether it survived perihelion passage or not.

We note that this comet is conspicuously absent from Figure 23, because its orbital parameters were not clear at the time that Marsden researched and wrote his 1989 paper, even though he announced that “… there can be little doubt now that this comet is a member of the sungrazing group.” (Marsden, 1967: 1176).

However, in an interesting twist, Sekanina and Kracht (2015b) published a paper titled “Was Comet C/1945 X1 (Du Toit) a dwarf, SOHO-like Kreutz sungrazer?”, and while they confirmed Marsden’s conclusion that C/1945 X1 had a common parent with C/1882 R1 and C/1965 S1, and they showed how the 1945 comet differed from all other Kreutz sungrazers in its L and B values (see Figure 26), they were unable to evaluate the true status of C/1945 X1 given the data at hand. Clearly, this is an on-going project, and we look forward to reading their final report in due course.

The ‘parent’ of the 1882, 1945 and 1965 Subgroup II sungrazers is thought to have been the Great Comet of CE February 1106. This idea was first proposed by Marsden (1967; 1989) and confirmed by Hasegawa and Nakano (2001). Much earlier, Kreutz (1891) had suggested that Comet C/1882 R1 was a later apparition of 1106 comet. So, what do we know about this ancestral comet?

According to Kronk (1999), The Great Comet of 1106 (X/1106 C1) was observed and written about from the British Isles, continental Europe, the Middle East and China and Japan. Available documentation indicates that it was first seen on 2 February in broad daylight, near the Sun. It became an evening object on 7 February, and was visible until mid-March. At its best it was a splendid object, with a tail that stretched for about 100°. Hasegawa and Nakano (2001) suggested that perihelion occurred on 26 January, which is consistent with the comet still being a daylight object on 2 February. Hasegawa and Nakano (2001: Table 3) published a crude ephemeris, and the first entry, dated 9 February, had the comet already 0.65 AU from the Sun and about 0.79 AU from Earth. Its magnitude at this time was estimated to be ~2.4, so it would have been considerably brighter at its best.

Sekanina and Chodas (2002a: 768) analysed the disintegration of the parent body of Comets C/1882 R1 and C/1965 S1, presumed to be Comet X/1106 C1, and found

... that the breakup occurred 18 ± 7 days after perihelion, [which] may come as a sur-

prise, considering that both C/1882 R1 and C/1965 S1 split within hours of perihelion. However, these events may not provide the best analog for the 1106 break-up.

They elaborate (ibid.):

... the concept of cascading, or runaway, fragmentation of the Kreutz comet system was introduced to explain the large number of SOHO sungrazers, products of num-


Figure 26: The line of apsides for seven bright Kreutz sungrazers and C/1945 X1. The plot of the perihelion longitude \( L_\pi \) against perihelion latitude \( B_\pi \) shows that C/1945 X1, represented by Marsden’s catalogued gravitational orbit, deviates significantly from the cluster of the bright sungrazers, whose lines of apsides are closely aligned. The asterisk marked ‘PERT.’ is the apsidal-line position for C/1945 X1 on the assumption that the comet is a fragment of a common parent with C/1882 R1, the difference being due entirely to the indirect planetary perturbations. For six comets the errors of the coordinates \( L_\pi, B_\pi \) are smaller than the size of the symbols; the estimated errors for C/1880 C1 and C/1945 X1 are depicted (after Sekanina and Kracht, 2015b: 3).
erous breakup events at large heliocentric distances. Thus, the separation of C/1882 R1 and C/1965 S1 between, say, 10 and 25 days after perihelion is certainly not unexpected in view of the distribution of fragmentation points along the orbit. Furthermore, nothing in our scenario prevents us from allowing the comet of 1106 to have fragmented profusely near its perihelion, days and weeks prior to the separation of the 1882 and 1965 sungrazers. Some of those fragments could have been too faint to be discovered from the ground. Some of the brighter ones could have been missed … Some are possibly among the known comets, for which available information is insufficient to prove their origin. And some may return in … the near future.

Note that Comet C/1970 K1 (White–Ortiz–Bolelli) is the sole representative of Subgroup Iia in Table 2, and originally Marsden (1989: 2320–2321) explained that

Unfortunately, there is no information whatever about the revolution period of comet 1970 VI, but if this is even roughly similar to those of the genuine Subgroup II members, the original orbit should be connectable to the circle … [shown here in Figure 23] in just two links—and it is. Comet 1106 was presumably not the previous apparition of comet 1970 VI.

Elsewhere in his 1989 paper Marsden comments: “One must reluctantly conclude that this comet separated from the 1882 II/1945 VII/1965 VIII parent at an earlier stage …” This was based on his categorizing it as the sole representative of Subgroup Iia.

Sekanina and Chodas (2002b: 1389) subsequently, examined the data on this comet and explored “… five possible origin and orbit scenarios …” They confirmed Marsden’s earlier suspicions: “We find that its parent was neither C/1965 S1 (Ikeya–Seki), nor C/1882 R1 (Great September Comet), nor the comet of 1106 …” They also proposed that

… C/1970 K1 separated from an unknown parent fragment, which itself broke off from the 1106 comet at the same time as, or shortly before, C/1882 R1 and C/1965 S1 were born. This postulated direct parent of White-Ortiz-Bolelli subsequently split into two at a heliocentric distance of some 150 AU around the mid-18th century, with C/1970 K1 separating from the rest of the mass at a rate of 3–5 m s⁻¹ in the general direction of the Sun and to the north of the parent’s orbital plane. (Sekanina and Chodas, 2004: 626).

They believe that the other fragment “… reached perihelion a few months later than White-Ortiz-Bolelli … [but was] missed on account of unfavorable observing conditions.” (ibid.)

Finally, we should note that Figure 23 tentatively traces all of the Kreutz sungrazers back to a major comet observed by Aristotle and others in 371 BCE. This “… was definitely a sungrazer … and an unsubstantiated claim by Ephorus indicates that he saw it split.” (Marsden, 1989: 2321). However, Marsden (ibid.) cautions that this scenario

… is obviously extremely speculative, and the innumerable free parameters that even it entails make it inappropriate to attempt a more rigorous computation.

This caution is well-founded, for one of the exciting things we encounter when tracking the history of Kreutz sungrazer studies is the ever-changing nature of the conclusions, especially as new sungrazing comets begin to appear and now that there is also a large population of dwarf sun-grazers to consider. It is as though each new research paper brings a new interpretation.

This happened, for instance, when Sekanina and Chodas (2012) analysed the first sungrazer of the twenty-first century, C/2011 W3 (Lovejoy) and the dwarf sungrazers. This appeared to mark the start of the expected ‘new generation’ of bright Kreutz sungrazers predicted in Sekanina and Chodas in 2007, but it presented

… a distinct complication for the classification of the bright sungrazers into subgroups: its perihelion distance is typical for subgroup I, but its angular elements do not fit any of the subgroups I, II, or Iia; thus, among the bright members of the Kreutz system, the orbit of C/2011 W3 is unique … (Sekanina and Chodas, 2012: 32).

To further complicate matters, its orbital parameters are also shared by a group of nearly 30 dwarf sungrazers, with ascending nodes between 310° and 335° and inclinations between 130° and 137° (see Figure 27).

Meanwhile, Sekanina and Chodas (2004) had already mentioned that although C/1963 R1 (Pereyra) is classified in Subgroup I, its orbital features are more closely aligned with comets in Subgroup II. We have also noted (see Figure 26) the anomalous values for L and B of Subgroup II comet C/1945 X1 (du Toit) and that C/1970 K1 (White-Ortiz-Bolelli) does not fit comfortably into Subgroup I or II so was assigned its own Subgroup, Iia (which, as Figure 27 reveals, it also shares with many dwarf sungrazers). Now we have C/2011 W3 (Lovejoy) in exactly the same position, which

… suggests that there may exist yet another subcategory of bright sungrazers that has never been considered in the evolutionary models of the Kreutz system. (Sekanina and Chodas, 2012: 9).
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Alternatively, this raises the very validity of the Subgroup concept, as Sekanina and Chodas (2012: 28) rightly point out, and if the Subgroups are to survive then they also need to comfortably accommodate all of the dwarf sungrazers. We await, with interest, the next instalment on this on-going saga.

Finally, there is the evolutionary history of the Kreutz sungrazers, which is now far from clear. Sekanina and Chodas (2007) introduced the concept of ‘cascading fragmentation’ and the ‘two superfragment model’ (Sekanina and Chodas, 2004; 2007) in order to try to explain the origins of all of the Kreutz sungrazers (including the dwarf sun-grazers). On the basis of recent studies by Sekanina and Chodas we realise that Figure 23 is an oversimplification. While we can still track Comets C/1882 R1 and C/1965 S1 (Ikeya-Seki), and possibly even C/1945 X1 (du Toit), back to the Great Comet C/1106 C1, the precise evolutionary paths of the other comets shown in this Figure, and C/2011 W3 (Lovejoy), are uncertain. But what Sekanina and Chodas (2004: 624) are now certain about is that the comet of 371 BCE seen by Aristotle and others was not a sungrazer (notwithstanding Marsden’s original claim) and cannot be identified at the progenitor of the Kreutz family of comets. As Marsden (1989: 2312) reminded us,

... only a very slight difference in the circumstances of the splitting of a Kreutz sungrazer at perihelion has an enormous effect on the times when the fragments return to perihelion.

Even if we can no longer, with certainty, identify the progenitor of all Kreutz sungrazing comets, the basics of the initial fragmentation process are reasonably well established:

At the onset, the entire volume of the massive progenitor comet becomes riddled with fractures and cracks as a result of the action of the solar tidal forces during one or more of its perihelion passages. Sooner or later this condition inevitably leads to a first breakup of the nucleus, an episode that occurs either close to perihelion ... or farther from the Sun ... With an initial mass (and size) distribution of fragments being thus established, further break-up events follow brought about by minor stresses from rotation (throughout the orbit), outgassing (only near the Sun), and temperature gradients ... This process continues episodically, in a cascading fashion, with each event releasing a new generation of fragments. As time goes by, an even greater number of fragments of ever smaller size populates orbits that are all fairly similar near the Sun. (Sekanina, 2002: 596).

However, on the basis of their more recent work, Sekanina and Chodas would emphasize the importance of thermal stress, which

... offers a plausible mechanism for cascading fragmentation of sungrazers, large or small, far away from the Sun. (Sekanina and Chodas, 2012: 22, their italics; see, also, page 26).

7 CONCLUDING REMARKS

In this paper we review the observations of the Great Comet of 1882, C/1882 R1, made from
New Zealand, and point out that the claim that the first New Zealand observations were made from Auckland on 2.7 September is incorrect. In fact, the first reported observations were from Wellington, and made on 9 September. Subsequently, many New Zealanders witnessed the comet as a daytime or an evening object, and although some wrote to local newspapers stating how brilliant it was and what a beautiful tail it displayed, the Auckland amateur astronomer J.T. Stevenson was the only New Zealander to publish an account of it in an international astronomical journal (in *Monthly Notices of the Royal Astronomical Society*).

We also summarise the history of cometary photography and critically examine a photograph that purportedly shows the comet above Mount Taranaki. However, we believe that the ‘comet’ was painted on the photograph in order to give the viewer an indication of what the comet looked like to the naked eye. We then explore the concept of nuclear splitting, as clearly portrayed by Comet C/1882 R1 soon after perihelion, and we proceed to examine this comet as the first documented example of a Kreutz sungrazer, and discuss how it is related to other comets in this unique—but somewhat confusing—family of comets.

Back in 2007, Sekanina and Chodas forecast the imminent arrival of a new group of Kreutz sungrazers, and the first of these appeared in 2011. We await, with interest, the arrival of the next Kreutz sungrazer, ever mindful that these comets represent a system where a single comet “… continues to break up over and over again, thus producing a complex hierarchy of fragments, both temporally and spatially.” (Sekanina, 2002: 597), and that “… continual fragmentation plays an important role in the life cycle of most, if not all, comets.” (Sekanina and Chodas, 2002a: 769).

### 8 NOTES

1. Comet C/1882 F1 (Wells) was a conspicuous naked eye object in the New Zealand sky from early June until late July (it reached maximum brightness of \( m_v = 0\text{–}1 \) on about 6 June). At its best, around 17 June, it displayed an impressive 40°–45° tail (Vsekhsvyatskii, 1964: 264–265).

2. Although Orchiston (2016: 399) assumed from his title that Professor S.J. Lambert was employed at Auckland University College, we could find no evidence of this in Auckland newspapers, or in histories of Auckland University and its predecessor. Instead, we found Professor Lambert advertising as a music teacher. Nonetheless, he had a passion for astronomy, reflected by the fact that he had been elected a Fellow of the Royal Astronomical Society in June 1873 (Anonymous, 1873: 461).

3. This report (and others like it) confirm the fact that the comet was first observed from New Zealand a few days earlier (e.g. on 9 September) and that there is no basis for Lynn’s claim that it was first viewed from New Zealand on 2.7 September.

4. John Tebbutt from Windsor, near Sydney, was fresh from discovering and observing the Great Comet of 1881 (C/1881 K1 Tebbutt). This appeared at a particularly opportune time in the history of astronomy and was able to make major contributions to cometary photography and to spectroscopy (Orchiston, 1999; 2017b: Chapter 9).

5. The first of these figures is similar to that published much earlier by W.E. Plummer (1889), Director of Liverpool Observatory in England, of about 300,000 miles. This equates to \( 480,000 \text{ km}, \) or \( 0.0032 \text{ AU} \).

6. British-born Sydney-based George Butterfield (1841–1910) had a strong interest in comets but he was not a research astronomer, and he did not carry out any scientifically useful observations. Rather his forté was popularising astronomy (Orchiston, 1997a), and he frequently attended astronomical society meetings “… where he discussed ‘current comets’ and displayed 3-D models of their orbits.” (Orchiston, 2017b: 258). Perhaps his main claim to fame would be that he produced Australia’s earliest-known planispheres (for details, see Orchiston 2003). Despite … his obvious commitment to astronomy, limited access to suitable instruments and occasional faux pas in his newspaper reports prevented Butterfield from making the major impact on … astronomy that his dedication and considerable efforts promised. (Orchiston, 2017b: 258).

7. The *New Zealand Herald* wrote that a report from the USA stated that a comet had been “discovered” close to the Sun on 24 September 1882 (RA 11h 19m 32s, Dec 00d 12m), from Nice. Dr Lewis Swift (Warner Observatory, Rochester, New York) commented that it was the same comet that was recently discovered in South America and the same one that Southern Hemisphere people had been observing.
Telescopic views “... showed a large comet with plenty of loose material.” (The Comet, 1882e).

8. The Reverend Dr Thomas Roseby (Orchiston, 2017b: 424–425) was born in Sydney (Australia) in 1844 and after a brilliant academic record as a student at the University of Sydney became a Congregational minister of religion. In 1872 he moved to Dunedin, New Zealand, where he was actively involved in astronomy (e.g. see Roseby, 1882–83). Roseby returned to Australia in 1885, but was only able to fully develop his long-time passion for observational astronomy and popularising astronomy after the founding of the New South Wales Branch of the British Astronomical Association in 1895 (see Orchiston, 1898).

Inspired by John Tebbutt, Roseby’s main observational interests were comets and double stars, which he observed from his observatory, and he published one cometary paper in Monthly Notices of the Royal Astronomical Society (Roseby, 1896). However, his principal contribution was the popularisation of astronomy (Orchiston, 1997a). Roseby died in Sydney in 1918.

9. The Reverend Best (ca. 1825–1900) was born in Ireland but trained in England as a Wesleyan Methodist minister. He then spent 31 years preaching in Ireland before emigrating to Dunedin, New Zealand, in 1879. From that date he “... laboured successfully in Dunedin, Christchurch, Thames, Auckland, and Napier, at which latter place, after forty-four years of ministerial duties, he was compelled to retire from active work owing to ill-health.” He died in Auckland eight years later, in November 1900 (The Rev. Edward Best, 1902).


11. British-born Seth-Smith was well-placed to lecture on astronomy, having graduated 14th wrangler in the Mathematical tripos at Cambridge in 1871. In 1873 he was called to the Bar and in 1881 emigrated to New Zealand. From 1883 to 1893 he was Chief Judge of the Native Land Court (Hugh Garden Seth Smith (1848–1935)).

12. The London-born Cambridge graduate Archdeacon Arthur Stock was New Zealand’s first professional astronomer—albeit in a part-time capacity, as he also was the Vicar at St Peter’s church in Wellington (Orchiston, 2017a). However, his astronomical interests went far beyond the bounds of the time-service functions of the Colonial Observation, so he maintained a well-equipped private observatory in the garden of his home, where he observed the Moon and planets, lunar occultations of planets, transits of Mercury and Venus, phenomena of Jupiter’s satellites, comets, southern double stars, and the enigmatic Eta Carina ... (Orchiston, 1998: 99–100).

As a regular observer of comets and the independent discoverer of the Great Comet of the previous year, C/1881 K1 (Tebbut), Stock was in an ideal position to comment on the fate of C/1882 R1 (Orchiston, 1999; 2016).

13. John Torrens Stevenson was a regular comet observer (Orchiston, 2016: 498): apart from C/1882 R1 he is recorded in newspapers as attempting to observe other comets (e.g., see The Comet, 1882h), and in reporting his observations of C/1882 R1 (Stevenson, 1882: 54) he specifically mentions “… other comets which I have seen ...” (although he does not list these).


15. The photographer T.S. Muir remains a mystery. In October 1881 he placed three advertisements in the Taranaki Herald announcing the imminent opening of his photographic studio, but thereafter there is no mention of him in the local newspapers, and there is no listing for him in the authoritative “Early New Zealand Photographers and their successors” web site.

16. The right-handed RTN coordinate system ... is centered on the parent object, referred to its orbit plane, and defined by the orthogonal directions radial away from the Sun, transverse in the orbit plane, and normal to the plane. (Sekanina and Chodos, 2002: 761).

17. Note that the longest-known cometary tail is that of Comet Hyakutake (C/1996 B2), which was >550 × 106 km (3.8 AU) (Jones et al., 2000: 574–576).

18. Comet C/1956 R1 (Arend-Roland) was an impressive naked-eye object in the New Zealand sky in 1957, and was the first comet with an anti-tail that the first author of this paper (WO) remembers observing. This comet, and an equally impressive Comet C/1957 P1 (Mrkos), which also was visible from New Zealand in 1957, provided a great incentive to study astronomy.

19. Charles James Westland (1875–1950) was a one-time north Canterbury farmer, who
became a professional astronomer through working at the Dominion Observatory in Wellington and then was Director of the geomagnetic Apia Observatory in the Cook Islands for nine years, before returning to farming in New Zealand (see Orchiston, 2016: 509–522). Elsewhere we have commented that

... like his well-known trans-Tasman contemporaries Robert Thorburn Ayton Innes and Charles J. Merfield, Westland was a prime example of an ‘ATP’, an amateur-turned professional (i.e. an amateur astronomer who gained international recognition and then joined the ranks of the professional astronomers; see Orchiston, 2015). But, unlike Innes and Merfield, Westland oiltive his vocation in professional science and so could also become a ‘PTA’, a professional-turned-amateur (Orchiston, 2016: 513).

20. As a matter of interest, when we began researching this paper in mid-July 2020, a similar thing was happening with Comet C/2020 F3 (NEOWISE).

21. On 18 September 1965, and just 15 minutes apart, the Japanese amateur astronomers Kaoru Ikeya (born 1943) and Tsutomu Seki (born 1930) independently discovered the comet that now bears their names. It was a telescopic object. At the time, Ikeya was living near the eastern shore of the main Japanese island of Honshu, while Seki was on the smaller island of Shikoku to the south.

22. Graeme Lindsay White, the first of the three discoverers of this comet, was a dedicated Australian amateur astronomer when he made his discovery. He then went on to complete a PhD in radio astronomy and enjoy a distinguished career in academic astronomy. Notwithstanding his astrophysical research interests, Graeme (see Figure 28) also had a passion for history of astronomy, and employed one of the authors of this paper (WO) to teach a compulsory History of Astronomy course in the University of Western Sydney’s part-time internet-based Master of Astronomy degree. When Graeme later transferred to James Cook in Townville, Australia, WO also accepted a position there, where he not only taught History of Astronomy in the internet Master of Astronomy degree, but also launched a successful part-time off-campus PhD program in History of Astronomy. After taking early retirement Graeme accepted an Adjunct Chair in the Centre for Astrophysics at the University of Southern Queensland in Australia (where WO also currently has an Adjunct Chair, and where the second author of this paper is enrolled for a History of Astronomy PhD).

9 ACKNOWLEDGEMENTS

We are grateful to Dr David Seargent (Australia), Gary Kronk (USA) and Therese de Young and Dr Ian Glass (South African Astronomical Observatory, Cape Town) for providing information relevant to this study, and to Professor Ramesh Kapoor (Indian Institute of Astrophysics, Bengaluru) for reading and commenting on the manuscript. We wish to thank the Alexander Turnbull Library (Wellington, New Zealand), AURA (USA), the Mitchell Library (Sydney, Australia) and NASA/ JPL (USA) for kindly providing Figures 7, 10, 11, 14, 19 and 24.

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Springer, co-author: Stella Cottam), Exploring the
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 magazine. 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 currently he is researching the history of cometary astronomy in New Zealand as a part-time off-campus internet-based PhD student in the Centre for Astrophysics at the University of Southern Queensland (Australia), co-supervised by Dr Carolyn Brown and the first author of this paper.

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.