TALES FROM INDIA: THE GREAT MARCH COMET OF 1843 (C/1843 D1)

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Abstract: This paper discusses the observations of the Great March Comet of 1843 made from India. The observers were at various locations and the newly formed observatories participated in the astronomical observations spread over a long phase of the apparition. Of great interest were the observations by Dr George Buist at the Colaba Observatory made on 5 and 6 March when the tail of the comet seemed to vibrate, with pulses of light appearing to shoot out longitudinally every 15 seconds. He said that this was also noticed by several other observers. Elsewhere, there were not many observations of the comet on 5 March, but there were several on 6 March. The phenomenon was reported from nowhere else and therefore it is difficult to say anything definite about it. Furthermore, around the time the comet was most spectacular, Sind was annexed by the British in the wake of the historic battles of Miani and Dubba in February–March 1843, and many people saw in the rise of the comet great misfortune befalling the country.

Keywords: Comet 1843 I, The Great March Comet (C/1843 D1), Sungrazing comets, H. Kreutz, Trevandrum Observatory, John Caldecott, Colaba Observatory, George Bruist, John Waterston, Reverend William S. Mackay, William Clerihew, Eta Argus, W.S. Jacob, the comet and Sind, Thomas John Newbold, Simon Hannay, Reverend Acland.

1 INTRODUCTION

In the Indian literature and chronicles, it is hard to come across references to the occurrence of unusual celestial events that the authors would have witnessed. A large number of eclipses do find mention in the inscriptions on metal plates and stone, starting from the middle of the first millennium (e.g. see Shylaja and Ganesha, 2016). However, there is hardly a reference to be found about the apparitions of comets. Comet sightings from India that feature in the historical accounts can be traced back to the fifteenth century only when stray references begin to find place in literary works and chronicles, and later in the travelogues and even in the scientific literature. Still the references are a handful only and they typically lack any detail, or represent real time observations of the events.

A brief account of the astronomical observations of comets made from the Indian region since antiquity and up to the end of the eighteenth century has been recently presented in Kapoor (2018). In the present paper we focus on the Great Comet of 1843 (1843 I, 1843a, C/1843 D1). This comet created sensation all through Europe and America, but was seen first in the southern sky. Its glorious phase earned it the epithet 'The Great March Comet'. This comet was observed in India by a few astronomy enthusiasts.

2 THE GREAT MARCH COMET OF 1843

Comet 1843 I (Figures 1, 2 and 3) is now known as C/1843 D1 and was truly a brilliant one. A Sungrazer, it became so spectacular that it outshone the planet Venus by about 100 times, probably reaching around visual magnitude -10^m, while its very long tail could be seen in daylight. It was first spotted on the evening of 6 February before it passed perihelion on 27.911 February (Kronk, 2003: 129–136). Hind (1852: 113) had the following to say when the Great March Comet of 1843 as it came to be known arose in the month of February that year:

> The finest comet of the present century was that which made its appearance at the end of February, 1843. On the 28th of that month it was observed in full daylight near the sun, at Guadaloupe y Calvo, in Mexico; at Portland, in the United States of America; on board the East India Company's ship, Owen Glendower, off the Cape of Good Hope; and at Parma, Bologna, Genoa, and other places in Italy.

Clerke (1908) provides a nice description of the appearance of the Comet 1843 I as observed from Europe. On 3 March, the comet's tail was quite long and measured 25°. In its 25 March issue *The Illustrated London News* (1843: 211–212) reported thus on the Great Comet:

> The public have this week been surprised by various announcements, on high authority, that a monster comet was to be seen bestriding the western heavens. The first to give a detailed notice on the appearance of this meteoric phenomenon in this country was the celebrated astronomer Sir J. Herschel, who described it as a comet of enormous magnitude being in the course of its progress through our system, and, at present, not far from its perihelion.

Figure 1: The Great March Comet (Grand meteoric phenomenon …, 1843).

In the pages of *The Times*, Sir John Herschel (1792–1871) constantly furnished information of interest to the public, and one of his letters is reproduced below:

> TO THE EDITOR OF THE TIMES.
>
> Sir — I wish to direct the attention of your astronomical readers to the fact, which, I think, hardly admits of a doubt, of a comet of enormous magnitude being in the course of its progress through our system, and, at present, not far from his perihelion. Its tail, for such I cannot doubt it to be, was conspicuously visible, last night, and the night before, as a vivid luminous streak, commencing close beneath the stars kappa and lambda Leporis, and thence, stretching obliquely westwards and downwards, between gamma and delta Eridani, till lost in the vapours of the horizon. The direction of it, prolonged on a celestial globe passes precisely through the place of the Sun, in the ecliptic at the present time, a circumstance which appears conclusive as to its cometic nature.
>
> As the portion of the tail, actually visible on Friday evening, was fully 30 degrees in length, and the head must have been beneath the horizon, which would add, at least 25 degrees to the length, it is evident that, if really a comet, it is one of first-rate magnitude; and if it be not one, it is some phenomenon beyond the earth's atmosphere of a nature even yet more remarkable.
>
> I have the honour to be, Sir,
> Your obedient servant,
>
> J. F. W. HERSCHEL.
> Collingwood, March 12 (Herschel, 1843b).

Figure 1 depicts the comet as it was featured in *The Illustrated London News* (1843: 211), and one may note the Orion-like pattern of the background stars at the top left. The tail below it apparently stretches over the constellation of Lepus. This is just about the situation pointed out by Sir John Herschel. *The Illustrated London News* (1843: 211–212) reproduced the substance of this letter. It also quoted from a letter by the British astronomer Sir James South (1785–1867), one of the founders of the Astronomical Society of London (from 1831, the Royal Astronomical Society), about the comet, as seen by him from the Observatory at Kensington:

> The brilliant train of light was seen here on Friday evening at a little after seven, and had very much the appearance of the tail of the comet of 1811 … More than 45 degrees of tail were measurable; stars of the fifth magnitude were visible through it by the naked eye, and with a 42-inch achromatic

Figure 2. Sketch of the comet as on 5 March by Captain G.R. Steains aboard a ship from Sydney, becalmed in 14.5° N, 36.50° W (*The Illustrated London News*, 1843: 279).

> of 2¾ inches aperture, those even of the 8th were perceptible …

For its part, *The Illustrated London News* (1843: 212) also published a hymn "On the occasion of the present astronomical visitation" by a "W.". A few lines are given below:

> Thou comest whence no mortal seer can know-
> Thou goest whither nothing human dreams-
> Thy mission, tho' so bright
> Is Speculation's gloom!
> We can but gaze upon the starry dust*
> Thy lightning wheels upturn

A sketch done on 5 March by Captain G.R. Steains aboard a ship from Sydney, becalmed in 14.5° N and 36.50° W, and reproduced in *The Illustrated London News* (1843: 279) shows also the crescent Moon nearby (Figure 2). From a run of the Horizons System (Jet Propulsion Laboratory, n.d.) and the sky from Your Sky, the depicted situation does correspond to the evening of 5 March, 21:00–22:00 UT, as at the specified location. As the Full Moon was on 16 March, Thursday, the painting in Figure 3, by Charles Piazzi Smyth (1819–1900), the Astronomer Royal for Scotland from 1846, apparently corresponds to the evening sky of the third week of March. The Comet was seen with a long tail even towards the end of March, but at the beginning of April it started to fade quickly. It was last seen on 19 April 1843.

Figure 3: A night-time view showing an eyewitness account of the Great Comet of 1843, painted by Charles Piazzi Smyth (1819–1900); Royal Museums Greenwich *Accession number BHC4148* (Wikimedia Commons).

This comet belongs to the Kreutz Sungrazing Group of Comets, named after Hendrich Carl Friedrich Kreutz (1854–1907) who made an in-depth study of the Great Comets of 1843, 1880 and 1882 and published papers about them between 1888 and 1902. The Sungrazing Comets are thought to have originated from one Great Comet that broke into several fragments when it ventured into the inner Solar System for the first time. Typically, these comets have small cores, just a few tens of metres or so, very small perihelia, ~0.01 au, and periods between 600 and 1000 years. For information on Kreutz Sungrazers, see Orchiston et al., 2020a: 646–651).

Several astronomers computed the orbit of Comet C/1843 D1 but the orbital elements calculated by Kreutz turned out to be the best fit and are listed in Table 1 (Minor Planet Center, n.d.).

Table 1: The orbital elements of the Comet C/1843 D1.

Parameter	Value
e (eccentricity)	0.999914
q (perihelion distance)	0.005527 au
i (angle of inclination)	144.3548°
Longitude of the ascending node	3.5272°
Argument of perihelion	82.6390°
t_p (time of perihelion passage)	1843 Feb. 27.91100000
Period	513.00 yr
Q (aphelion distance)	128.5293567 au

Observations of the Great March Comet of 1843 are described in detail in the books by Vsekhsvyatskii (1964) and Kronk (2003), and are discussed by Olson and Pasachoff (1998) and Cottam and Orchiston (2015). Here we bring together the Comet's tales from India. For this paper, the original names/spellings of the locations that figure in the present investigation are used, *vide* Figure 4 (made from Google My Maps).

3 MODERN OBSERVATORIES IN INDIA DURING THE EIGHTEENTH AND NINETEENTH CENTURIES

Madras Observatory was the first modern astronomical observatory to be established in India. Originally it was a private facility erected at Egmore in Madras (now Chennai) in 1786 by William Petrie (d. 1816), an officer with the East India Company (EIC; Kochhar, 1985a; 1985b). Early in 1789, Petrie prepared to proceed on leave and made an offer to gift his observatory to the Government. Michael Topping (1747–1796) saw merit in the proposal (see Phillimore, 1945: 171). The Directors of the EIC gave consent in 1790 for "… the Establishment of an Observatory at Madras … [that] would be of very great advantage to Science." In 1792 the Observatory was moved to its new premises at Nungambakkam designed by Topping and renamed Madras Observatory (see Figure 5).[1]

Madras Observatory initially came to serve as the point of origin for the work on the trigonometrical survey of southern India initiated by the East India Company. As was the norm for British colonial observatories at this time, research at the Madras Observatory focused on positional astronomy: using the transit telescope to determine the positions of bright stars. However, Solar System objects and events, including occultations of the stars and planets by the Moon, were also of interest. Meanwhile, from 1793 John Goldingham carried out systematic meteorological measurements. Madras Observatory also began offering a local time service.

Subsequently, a number of observatories were established in different parts of India during the nineteenth century, namely, at Colaba, Bombay (1823–1826), Lucknow (1831), Trevandrum (now Thiruvananthapuram; 1837), Vizagapatnam (1840), Dehra Dun (1878), Calcutta (1879) and Poona (1888).

An observatory was established in Bombay (now Mumbai) in 1826 by the EIC at the southern end of the island of Upper Colaba. The site

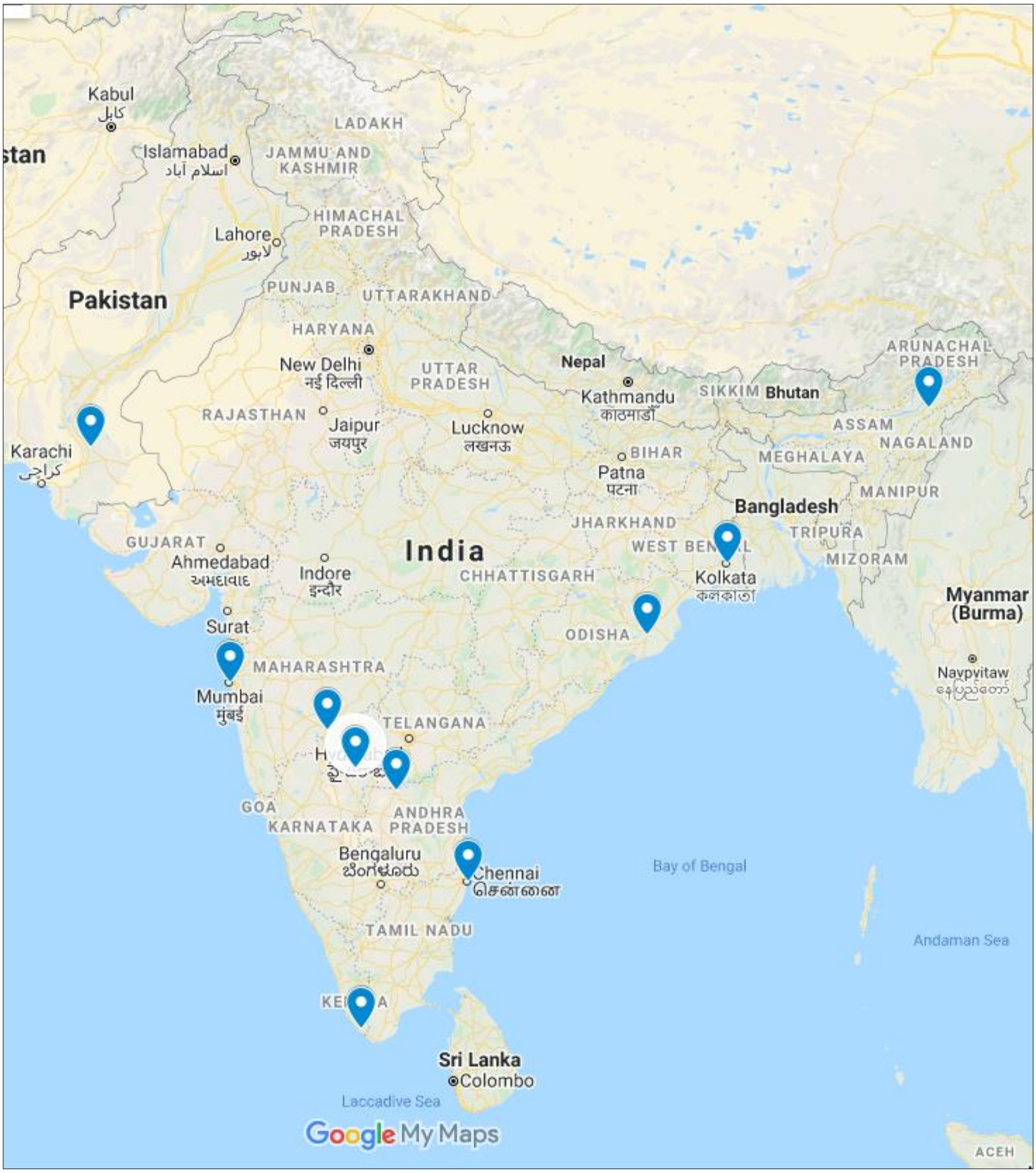


Figure 4: India mainland and the surrounding region, marked with the locations mentioned in the text. Clockwise from top: Sivasagar (Sibsagar), Kolkata (Calcutta), Cuttack, Chennai (Madras), Thiruvanthapuram (Trevandrum), Mumbai (Bombay) and Sindh (Sind, Scinde; in Pakistan). In the interiors, left to right are Sholapur, Shorapur and Kurnool; this map was made using an untitled map in Google My Maps).

had been selected in 1823 and the structures completed in 1826 under the supervision of John Curnin (d. 1849; Sen, 2014: Ch. 2), the EIC's Astronomer at Bombay since 1822. In fact, Curnin was also the first Astronomer at Colaba Observatory (Field, 1926: 3). The facility (Figure 6) initially consisted of a large transit room and two domes for the purpose of meteorological and astronomical observations and time-keeping (Orlebar, 1846; cf. Gawali et al., 2015: 110). Interestingly, John Curnin had made a request to the EIC to be permitted to buy for the Observatory the equatorial telescope that formerly belonged to King George III (1738–1820), *vide* the record *IOR/F/4/1032/28377* (Date: Mar 1826–Mar 1829) with the "British Library: Asian and African Studies".[2] However, that did not happen. There was a long spell of inactivity as the instruments at the disposal of Curnin were found to be faulty and had to be sent back to England (Schaffer, 2012: 152). From 1835, the Observatory also served

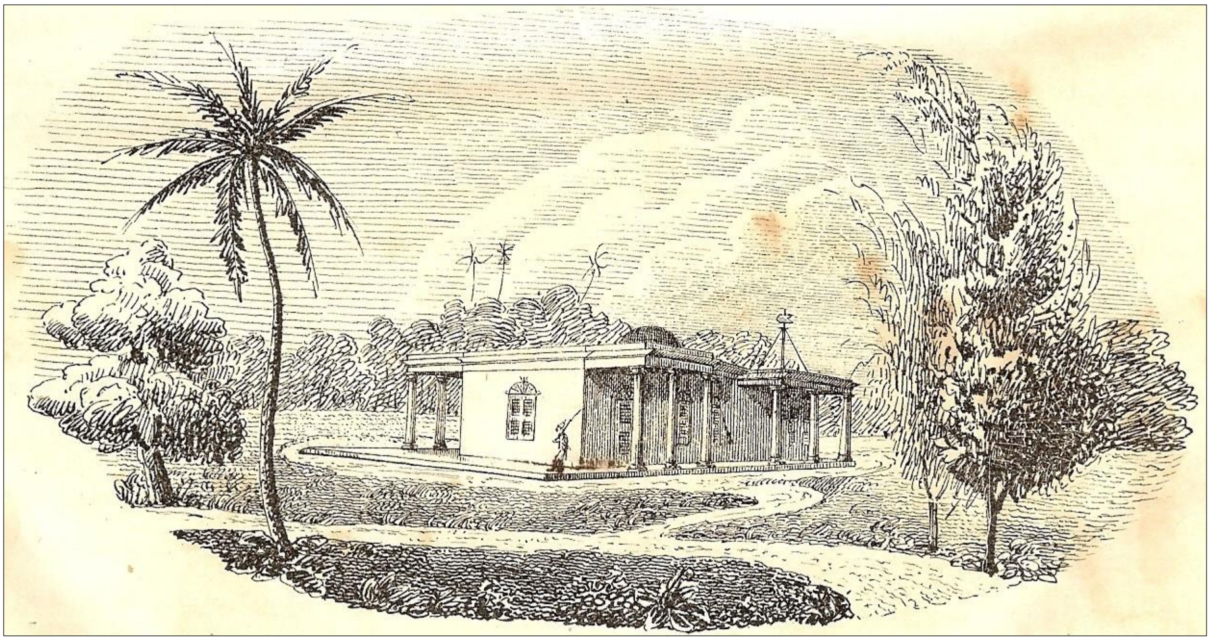


Figure 5. The Madras Observatory at Nungambakkam (from the cover of Taylor, 1838; courtesy: IIA Archives).

Figure 6: The Meteorological and Magnetic Observatory, Colaba, made up of a large transit room and two domes. This figure is from the cover of the provisional report on the meteorological observations made at Colaba, Bombay, for the year 1844 by Orlebar (1846). "The magnetic observations were carried out at the far left end of the photograph partially depicting a hut. The lighthouse and dome are seen in the background." (Gawali et al., 2015).

as a residence for Arthur Bedford Orlebar (1810 –1866) who was Professor of Natural History at Elphinstone College that had been founded in Bombay in 1835. There were a few instruments available to Orlebar and systematic observations in astronomy, meteorology and magnetism commenced in late 1841. Dr George Buist (1849: xli) succeeded Orlebar, and was in charge of the Observatory from January 1842 until March 1845.

Built in 1837 by Swathi Thirunal Rama Vurma (1813–1846; Figure 7), the Raja of Travancore, Trevandrum Observatory interests us in the present context. The Raja was a great patron of science and deeply interested in astronomy. In 1832, he met John Caldecott (1800–1849; Figure 8) at Alleppy, the British Commercial Agent to the Travancore Government and an amateur astronomer. He invited Caldecott to come to Trevandrum and establish a modern astronomical observatory.

The observatory (Figure 9) was built in 1837 on a laterite hill 3 km from the sea at an altitude of 195¾ feet above sea level. The building was constructed by Captain W.H. Horsley of the Madras Engineers. The Maharaja appointed Caldecott as the Director. In 1838, Caldecott left for England to obtain scientific instruments and he returned in April 1841 with a transit instrument by Dollond, two mural circles, an altitude and azimuth instrument, a 7-feet equatorial telescope by Dollond, chronometers and magnetic and meteorological instruments (Kurien, 2009: Ch. 3; Markham, 1878: 337). Caldecott is credited with having accumulated a large amount of astronomical, geomagnetic and meteorological data, which were never published.

The EIC had also established an observatory at Calcutta (now Kolkata) in 1825. It was a small observatory set up at the insistence of Valentine Blacker (1778–1826), the Surveyor General of India, to serve the Survey Department, beginning with an alt-azimuth circle and a transit telescope, a zenith tube and Kater's pendulum. Subsequently, it also came to possess an astronomical telescope. The astronomical observations carried out here included the transits of the Moon and eclipses of the Jovian satellites. The main activities, however, were time-keeping and meteorological observations.

Lucknow Observatory was established by Nasiruddin Hydar, King of Oudh (Awadh), with the intent of advancing science in India, and many observational programmes were undertaken by Major Richard Wilcox. His demise in 1848 led to the closing of the Observatory (Ansari, 2000: Ch. 12).

Readers are referred to Ansari (2000), Kochhar and Narlikar (1995), Markham (1878) and Rao et al. (2011) where detailed information on the various nineteenth century observatories of India are provided, while for an overview of the development of modern astronomy in India see Kochhar and Orchiston (2017).

During the early nineteenth century, the Indian Subcontinent saw major changes on the political and social front. The period saw the advent of the Indian Renaissance that brought the European science in Indian languages to the interested through the efforts of several prominent figures (Ansari, 2002). English education had already struck roots, and so did the shaping of the school curriculum and the publishing of low-priced school books in English and Indian languages. On the political front, the EIC had over the past hundred years brought a major part of India under its control.

Figure 7: Half-length portrait of Swathi Thirunal Rama Varma (1813–1846), Maharaja of the Kingdom of Travancore) (Stephen Crening; Wikimedia Commons).

Figure 8: An undated portrait of John Caldecott (http://indicatorloops.com/caldecott.htm).

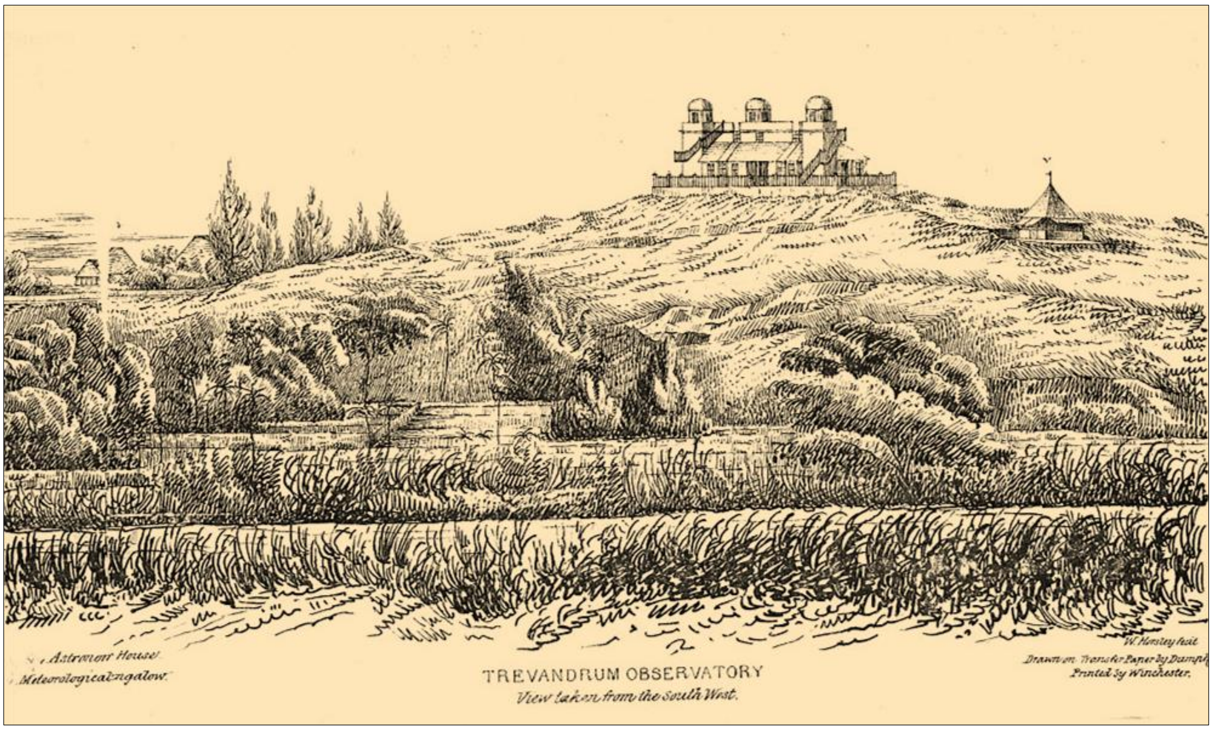


Figure 9: The Trevandrum Observatory (after Caldecott, 1837: 59).

This they divided into four administrative regions, in the form of the Presidencies of Bengal, Bombay, Madras and the North-West. However, the British dominance had begun to greatly overwhelm India's political, cultural and economic life.

4 THE OBSERVATIONS OF THE GREAT MARCH COMET OF 1843 IN INDIA

The Great March Comet was observed from many locations in India, including those observatories that were involved in astronomical observations.

4.1 Observations from Madras

In 1843, the Secretary to the Royal Astronomical Society (RAS) compiled abstracts of newspaper reports on the Great March Comet with interesting details that appeared in Volume 5 of the *Monthly Notices of the Royal Astronomical Society* (RAS, 1843). One of these was an extract from a Madras newspaper received by the Astronomer Royal that is notable for its astronomical content (RAS, 1843: 302):

> The Comet was first seen on the 2d of March, but the only part seen above the horizon was part of the tail, and that faintly.
>
> On the 3d and 4th the nucleus was distinctly visible to the naked eye: the tail was divided into two distinct branches, the one long, but faint, the other much shorter, broader and much brighter.
>
> On the 5th the tails had apparently united; but, on a careful examination, a less luminous band was detected between them.
>
> On the 6th several stars were visible through the tail which near the star τ *Ceti* was about 40′ in breadth. At this part it appeared through the telescope to consist of three luminous bands; the one next to the sun being broad and bright, the other two fainter and more narrow towards the nucleus. These bands were less distinct, and not more than a single separation could be detected. The nucleus appeared like a star of the fourth or fifth magnitude; its light was pale, and it was surrounded by a luminous halo of no great extent.

Unfortunately, the cited Madras newspaper is not named.

Surprisingly, we find no record or publication of the observations of this comet from Madras Observatory, although we know that earlier T.G. Taylor had written in detail about his observations of the Great Comet of 1831 (C/1831 A1), of which he has turned out to be an independent discoverer (Kapoor, 2011). However, observations of the Great Comet of 1845 (C/1844 Y1) were carried out at the Observatory, and the longitude of the Observatory was investigated.

4.2 Observations from Bombay

4.2.1 Dr George Buist

In Bombay, the observations of the Great Comet of 1843 were made at the Observatory at Colaba. The task was undertaken by Dr George Buist (Figure 10) who was then the Director of the Observatory.

In a paper that he presented on 12 April 1843 to the Bombay Branch of the Royal Asiatic Society Buist (1844: 252–254) stated that

> On the evening of the 4th March, a little after sunset a most extraordinary appearance presented itself in the sky, consisting of a vast beam of light inclining at an angle 45° towards the South; it was distant about 35° from the moon, which was to the northward. The right ascension was very near one hour; the end of the tail, which when first observed was about 20°, was nearly of the same declination with the moon; the comet itself had set, before its tail attracted notice. The tail was single for about half its length, appearing to exhibit a purplish black shadow at both edges, such as is sometimes perceptible in the bright beams of Aurora Borealis, for which it might, unless from its fixedness and position have been readily mistaken. Towards its upper extremity it seemed for a few nights to be divided by a thin line of shadow; this was not perceptible after the 10th.
>
> It had been observed so early as the 2nd and 3rd of the month at Madras and various other parts of India, but was not noted at Bombay. At Agra it was for a time believed to be an exhibition of Zodiacal light. The stars were perfectly visible through all parts of the tail.
>
> Bombay 4th March 1843. Altitude of the Summit of the Tail 10° pointing S.E.
> Bombay 4th March 1843. Azimuth of the Summit of the Tail 113° at 7h. 15' P.M.
> Bombay 4th March 1843. Azimuth of the Base of the Tail 104° at 7h. 15' P.M.
>
> 5th March, Sunday. The head was very distinctly visible above the horizon shortly after sunset, and left no doubt that it was a magnificently developed comet. Its splendor was however considerably impaired by the light of the moon; on the 5th and 6th the tail of the comet seemed to vibrate pulses of light appearing to shoot out longitudinally every 15 seconds. This appearance was observed by several individuals simultaneously, who were perfectly at one as to the interval of time between the pulses. There were no more noticed after the 7th, on which night they were only slightly apparent. The subjoined observations were made at the Bombay Government Observatory, Colaba, Lat 18° 53′ 52″ N. Lon. 4h 51′ 19″ E, by Kera Laxuman C. a young Brahmin, one of the assistants, who had been carefully instructed by Professor Orlebar. The instrument employed was an altitude and azimuth circle, the length of the telescope being 23 inches, with semi-diameter of the altitude and azimuth circles 6.5 and 8.5 inches respectively, made by W.T. Gilbert. This was placed on a large stone pillar based upon the ground, and terminating under the cupola of the Observatory, at an elevation of 75 feet above the mean level of the sea; the instrument like most of the others in the Astronomical Department of the Observatory, is by no means such as could be trusted for accurate or precise observations. The altitudes given in the subjoined are uncorrected for refraction, and the azimuths are measured from the South and not from the North, as the term generally means. The time given is Bombay mean time at the Observatory.
>
> The following observations were made at the Observatory on the evenings of 6th, 7th, &c. till the end of the month, at which latter date the comet became too obscure to be fit for observation.

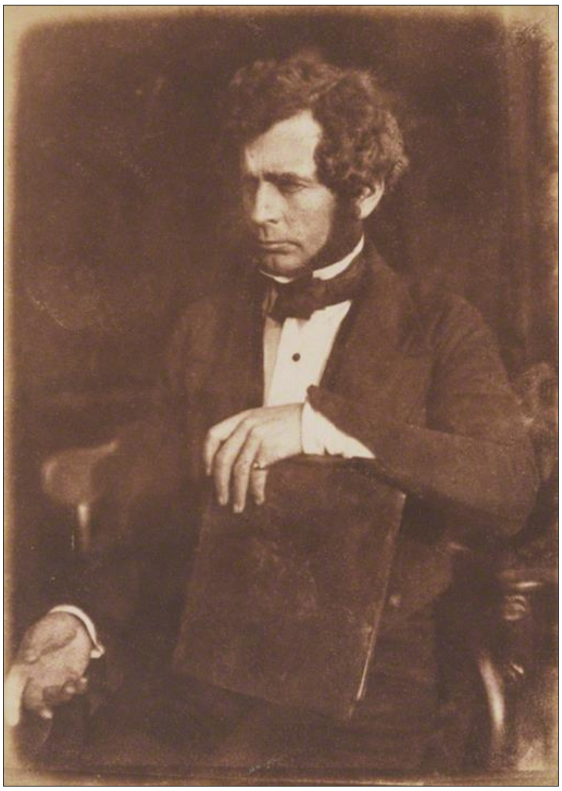


Figure 10: Dr George Buist, 1845; https://www.npg.org.uk/collections/search/portrait/mw00897/George-Buist).

The Table accompanying Buist's presentation gives the altitude and azimuth values of the comet for 16 days between 6 March and 31 March, at specified times. On certain dates, the length of the tail is given too. For instance, from 7 March to 17 March it was consistently 34° in length, decreasing to 20° by 31 March. Buist (1844: 254) further states:

> The Tail was observed till the 4th of April, on which it disappeared also.
>
> These observations were taken with great care, but the comet becoming obscure towards the end of the month, could

> not be distinctly seen in the telescope; the observations about that period therefore, should be considered right only within three minutes of arc.

For a few dates, Buist included brief remarks in the table; for instance, about the observations of 31 March, he says the comet's head disappeared completely. In his measurements, there are no distance measurements with respect to any bright stars in that part of the sky. On the comet's position, he talks about it only once: the right ascension being very near one hour. However, his most notable observation is this:

Figure 11: Dr John James Waterston, photographed in about 1870 (after Haldane, 1928: lvi).

> …. on the 5th and 6th the tail of the comet seemed to vibrate pulses of light appearing to shoot out longitudinally every 15 seconds. This appearance was observed by several individuals simultaneously …

As per the entries in the table in his communication, Buist (1844: 254) recorded a clear sky for 6 March. Having been involved with the meteorological observations at the Observatory, he would certainly note any thin passing clouds. Only a few days earlier, on 3 March the comet was reported to have shown up with a second tail, at an angle variously estimated between 10°–15° (Kronk, 2003: 131). The "pulses of light" observations made by Buist on 5 and 6 March were post-perihelion. There were only a few observers of the comet worldwide on 5 March, but many more on 6 March (Kronk, 2003: 132), and the phenomenon seen by Buist was reported from nowhere else. Therefore, it is difficult to say anything definite about this phenomenon, especially since he reports no enhancement in the comet's brightness. On 5 March, around the time of observation, say 14:00 UT, the Comet was 0.34 au from the Sun and moving away from it, and 0.842 au from the Earth, approaching it but was soon to start moving away. Two days later, on 7 March 14:00 UT, the heliocentric distance was 0.42 au, not so much of an increase in distance to cause a major fall in activity.

Some information about Dr Buist (1805–1860) can be found in the *Dictionary of National Biography, 1885–1900*. He was a Scottish journalist and also a science teacher. In 1839, he became Editor of *The Bombay Times and Journal of Commerce* and stayed with the paper for 20 years. Together with two other papers, these papers merged in 1861 and were named *The Times of India*. It was on the strength of his work that Buist was given the responsibility to revive the astronomical, magnetic and meteorological activity at Colaba Observatory in Bombay. He was a member of the Bombay Branch of the Royal Asiatic Society and he published several scientific papers in the Society's *Journal*. Buist was elected a Fellow of the Royal Society in 1846. His citation on the certificate of election (The Royal Society, 2021) reads:

> The Author of the history of the Afghan War; an Essay upon the Geology of the County of Perth, of various papers in the Journal of the Highland Societies Transactions; on the Geology of Asia; upon a new form of Barometer; on the Meteorology of Bombay &c &c. Distinguished for his acquaintance with the science of Meteorology, Geology & Magnetism; and literature generally.

Buist was also a Fellow of the Geological Society of London, and was the Secretary of the Bombay Geographical Society and the Founder and Resident Superintendent of the Reformatory School of Industry, Bombay.

4.2.2 Dr John Waterston

Dr John James Waterston (1811–1883; Figure 11) was a Scottish physicist, and was described by Pole (1845: 19) as the "Astronomical Instructor to the Indian Navy" but in reality he instructed naval cadets of the EIC in Bombay. He had varied interests, ranging from physical chemistry to astronomy and physiology, and had published a modification to Olbers' method of determining the distance of a comet from a set of three observations (Waterston, 1845c: 17–19).

When Waterston observed the Great Comet of 1845 (C/1844 Y1) from Bombay, he also referred to Comet C/1843 D1:

> The new year has brought us a celestial visitor which, by its splendid appearance in our southern sky, reminds us of the great comet of March 1843. There is the same disproportion between the tail and nucleus, but it is altogether on a reduced scale, the tail being only 10° long when first seen, and the nucleus shining with the brightness of a star of the fifth magnitude. The great comet of 1843, when first seen here, was visible in the midst of bright twilight, half an hour after sunset. It shone with the dull, red light of an ignited coal, and the immense tail seemed like a dense, white cloud, springing up from the horizon, sharply defined for about 20°, and in a few days it extended to 43°… (Waterston, 1845a: 208).

Waterston's primary research interest was the kinetic theory of gases. In 1839 he was posted to Bombay, and once the Grant Medical College was operational in 1845 he was able to pursue his work at the library, where he had access to the requisite scientific books and journals (Haldane, 1928: xxv). The paper reporting his research initially was rejected by the Royal Society when Waterston submitted it in 1845. Later, in 1891, it was resurrected by Lord Rayleigh from the Society's archives who realized its significance and he arranged for it to be published in the *Philosophical Transactions of the Royal Society* of London in 1892, after Waterston's death (Haldane, 1928: xxxv). Waterston resigned from his job in 1857 and returned to Edinburgh.

4.2.3 The Unidentified Observers

While describing observations of Comet C/1843 D1 Vsekhsvyatskii (1964: 167) mentions that

> In Bombay, a long bright ray was observed on the evening of 4 March pointing from below the western part of the horizon to the zenith … Starting 6 March, Clairaut (India) saw the tail of the comet; 11 March tail bifurcating.

The observers at Bombay and Clairaut are not identified, but in Clairaut it was probably William Clerihew, who was then visiting India (see below). Judging from their reports, the Bombay observer could have been either Dr George Buist or Dr John Waterston, although the respective descriptions of the comet given by these observers are at variance with Vsekhsvyatskii's account.

4.4 Observations from Bengal

4.4.1 William Clerihew

William Clerihew (1811–1870), an artist, architect and an amateur astronomer from Aberdeen observed the Comet C/1843 D1 from the southern sky during 6–30 March when visiting India. One may find some information about him in Simpson (n.d.). Clerihew earned fame as a topographical landscape artist. In 1839, he joined the Royal Institute of British Architects (RIBA) as an associate member. He made extensive travels to Asia during the 1840s and 1850s, and his paintings include various views of India and can be found on various art sites on the internet.

The month of March 1843 was the time when the comet shone at its peak. Information on the locations Clerihew made observations from is not clear. He made four studies, and, drawn in one of these is the comet's reflection in the waters of the southern Bay of Bengal with markings for determining Comet's altitude and azimuth (see Figure 12). From a note in Olson and Pasachoff (1998: 223), we learn that the drawing, made in pen in red and black ink with water colour, is dated 7 March and carries the inscription "Comet as observed from the Ship Justina/ in Lat 7.18S & Long 67.2E, about 7.15 pm/and on the fifth from its first appearance …" This location is in the Indian Ocean, midway on a line drawn from Madagascar to Sri Lanka. Clerke (1908: 104) noted that on 11 March, Clerihew was in Calcutta and noticed a secondary tail that the comet seemed to have just developed and that was about twice the length of the first tail, and inclined an angle of 18º relative to it. That implies that the *Justina* (with Clerihew aboard) reached Calcutta within four days from the aforementioned location in the Indian Ocean. Clerihew's observations from 6 March are referred to also in a communication in *Astronomische Nachrichten* by Sir John Herschel (1792–1871) dated 16 November 1843 where he mentions that

> An account of the Comet of March 1843 has just reached me from India from Mr. *Clerihew*, an Attaché of Dwarkamandh Tagore, whom he took out to teach Astronomy and Physics to a College of Native youth. (Herschel, 1844: 200).

John Herschel commented on Clerihew noticing the bifurcation of the tail of the comet: that there was a single tail on 6 March, with a second one developing on 11 March. And he had depicted the two tails in his report (see Figure 13). The new tail was a comparatively straight, slightly divergent train but almost devoid of structure. So, we believe that Clerihew was describing the plasma tail of the comet.

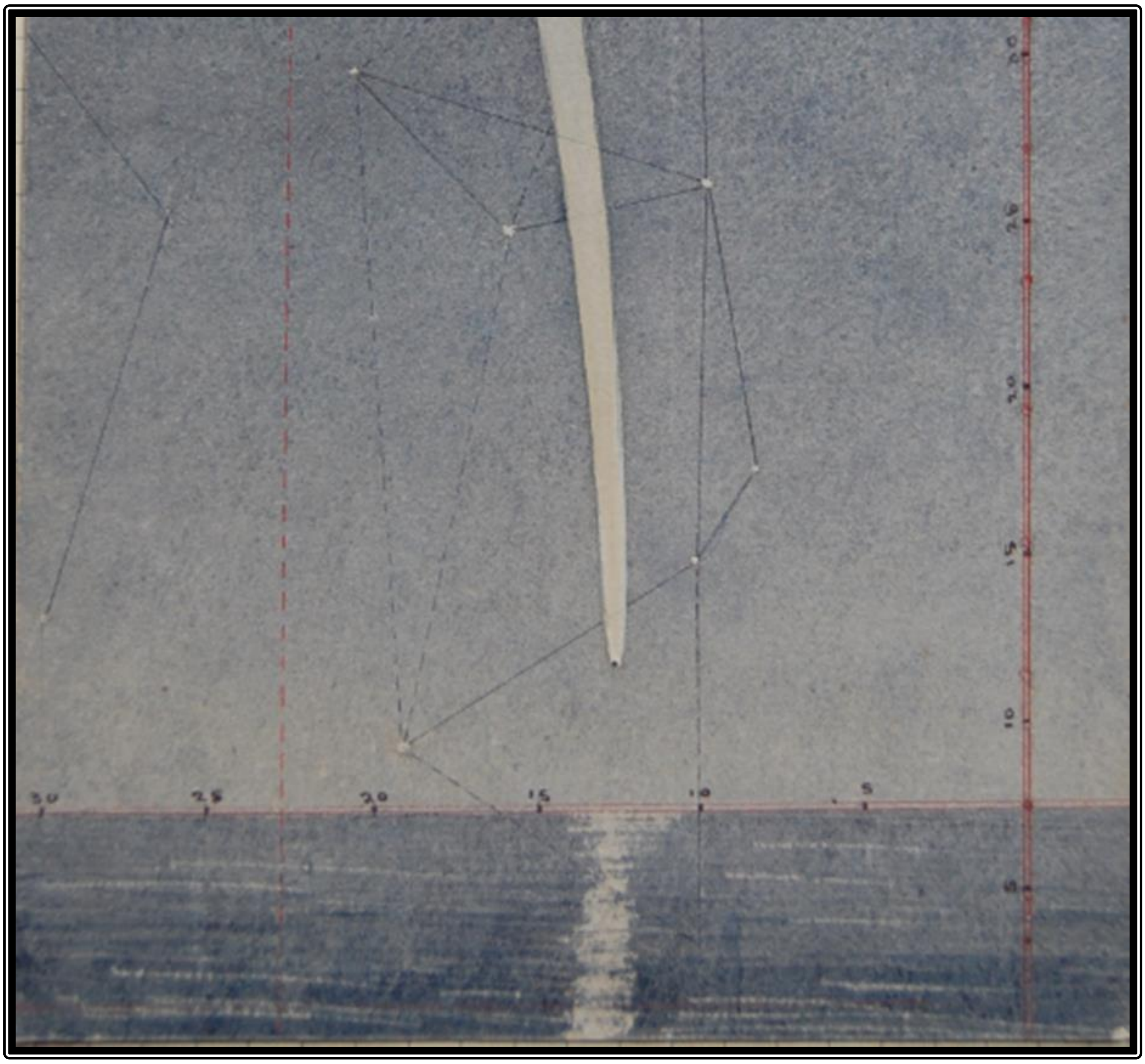


Figure 12: William Clerihew's watercolour study of the 1843 comet over the Bay of Bengal, drawn while on board the ship *Justina* (RAS Library, RAS ADD MS 183; https://twitter.com/astro_librarian/status/1200036329737924608; accessed 13 February 2021).

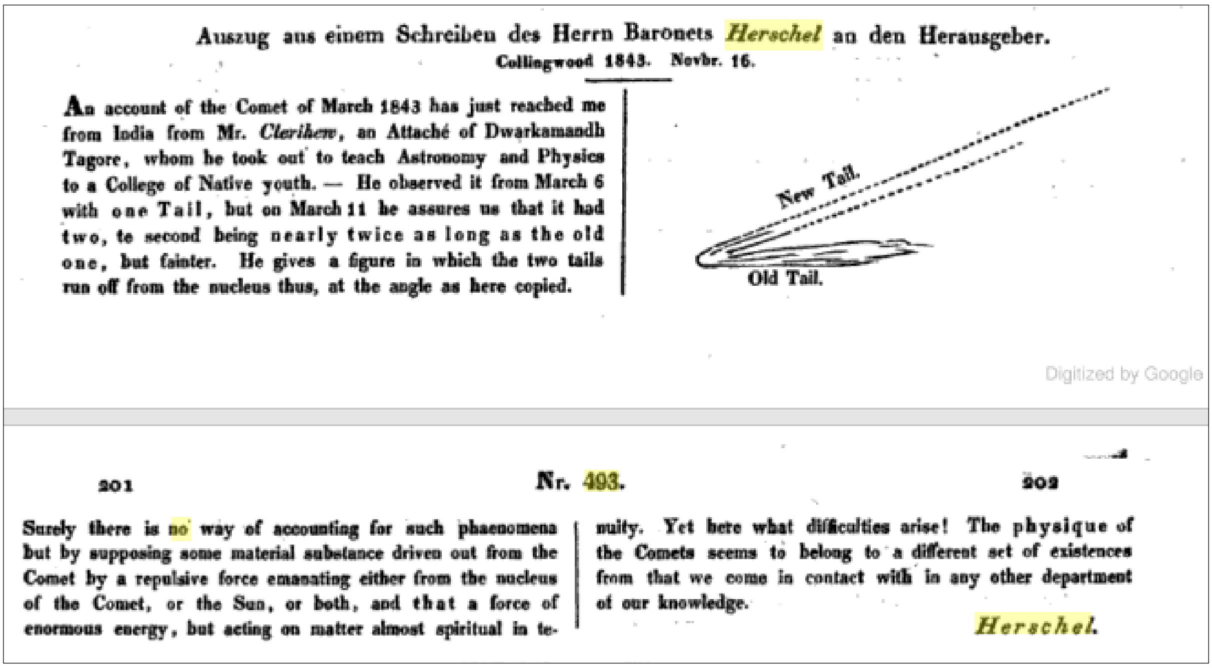
Herschel (1849: 367; his italics) wrote:

> The tail, subsequent to the 3d, was, generally speaking a single straight or slightly curved broad band of light, but on the 11th it is recorded by Mr. Clerihew, who observed it at Calcutta, to have shot forth a lateral tail nearly twice as long as the regular one but fainter, and making an angle of about 18° with its direction on the southern side. The projection of this ray (which was not seen either before or after the day in question) to so enormous a length, (nearly 100°) in a single day conveys an impression of the intensity of the forces acting to produce such a velocity of material transfer through space, such as no other natural phenomenon is capable of exciting. It is clear that *if we have to deal here with matter, such as we conceive it, viz. possessing inertia — at all*, it must be under the dominion of forces incomparably more energetic than gravitation.

Herschel (1844: 201) made his own guess as to the possible cause of the second tail in the following way:

> Surely there is no way of accounting for such phenomena but by supposing some material substance driven out from the Comet by a repulsive force emanating either from the Comet, or the Sun, or both, and that a force of enormous energy, but acting on matter almost spiritual in tenuity.

To recall, the first steamship from England to round the Cape of Good Hope and arrive at Indian shores was S.S. *Enterprise*, reaching Calcutta in December 1825. It took thirteen weeks, instead of the promised 10 weeks but made history with a momentous start for the future passages to India. In 1837, with the initiative of the EIC, there also began a connection through the Middle East, bringing down the travel time considerably (Marshall, 1997: Ch. 1). About



Auszug aus einem Schreiben des Herrn Baronets *Herschel* an den Herausgeber.

Collingwood 1843. Novbr. 16.

An account of the Comet of March 1843 has just reached me from India from Mr. *Clerihew*, an Attaché of Dwarkamandh Tagore, whom he took out to teach Astronomy and Physics to a College of Native youth. — He observed it from March 6 with one Tail, but on March 11 he assures us that it had two, te second being nearly twice as long as the old one, but fainter. He gives a figure in which the two tails run off from the nucleus thus, at the angle as here copied.

201 Nr. 493. 202

Surely there is no way of accounting for such phaenomena but by supposing some material substance driven out from the Comet by a repulsive force emanating either from the nucleus of the Comet, or the Sun, or both, and that a force of enormous energy, but acting on matter almost spiritual in tenuity. Yet here what difficulties arise! The physique of the Comets seems to belong to a different set of existences from that we come in contact with in any other department of our knowledge.

Herschel.

Figure 13: Screenshot of the pages 199–202 of Herschel's (1844) communication in the *Astronomische Nachrichten*.

the Ship *Justina* that Clerihew sailed on, most likely in late 1842, we find some information in India Shipping (1842: 449–452). It lists the many ships destined for Bombay, Madras and Bengal together with the probable dates of their sailing.

The *Justina* was a 500-ton vessel, and the trip of interest to us was apparently the one scheduled to sail from Portsmouth, a port city in South East England, for Bengal on 16 November 1842. Those were the times when overland mail from England to India was being routed via Suez and Aden to reach Bombay in 5 to 6 weeks, another week to Madras and from there, about 4 days to Calcutta. Clerihew seems to have rounded the Cape of Good Hope, going by the coordinates inscribed on his water colour of 7 March. The Suez Canal was to open much later, in 1869.

The name *Dwarkamandh Tagore* mentioned by Herschel (1844: 200) is Dwarkanath Tagore (1794–1846), one of the earliest entrepreneurs from Bengal and fondly remembered as 'Prince' (Figure 14). He was the grandfather of the poet laureate Rabindranath Tagore (1861–1941) and founder, along with Raja Rammohun Roy (1772–1833) and others, of the Brahmo Sabha in 1828 that evolved into the great socio-religious reform movement the *Brahmo Samaj*. Dwarkanath Tagore was one of the earliest Indian members of The Asiatic Society that had been founded in 1784 by Sir William Jones (1746–1794) in Calcutta. In the course of his first tour of Europe beginning January 1842 until his return in December 1842, he met several statesmen and persons of eminence (Kripalani, 1981: Ch. 8). However, there is no reference about him meeting Clerihew. In fact, the latter had been signed up in 1842 to teach astronomy and physics to the 'College of Native Youth in Calcutta'. Apparently, the two gentlemen had met only after Clerihew, in his first trip to the Indian Subcontinent, landed in Calcutta in March 1843. The phrase in Herschel's communication, "College of Native Youth in Calcutta", refers to the General Assembly's Institution established by the

Figure 14: A sketch of Dwarkanath Tagore, adopted from *The Illustrated London News* (1843: 399).

Reverend Dr Alexander Duff in 1830, that evolved to the present-day Scottish Church College. During his stay, Clerihew had painted continuously until he left India in 1845.

In 1843, the 9 May issue of Allen's *The Indian Mail* carried dispatches including from Calcutta (Allen, 1843: 8) where among other things, the Great March Comet is mentioned:

> The comet has been extremely brilliant in India. The Friend of India says, "We think our remembrance of the great comet of 1811 is distinct enough to admit of our saying, that its splendour was not to be compared with that of our present visitor. To such a length was its light drawn out on Monday evening, that it seemed impossible to believe it was a comet. It appeared more like a long streak of singularly luminous cloud – or a ray of the aurora borealis, somehow wandering from its proper region."

4.4.2 The Reverend Dr W.S. Mackay

From Calcutta, astronomical observations of the Great March Comet were made by The Reverend William Sinclair Mackay (1807–1865) of the Free Church of Scotland's Mission. In his letter of 10 June 1843 to Sir John Herschel, communicated to the Royal Astronomical Society by the latter, the Reverend Mackay (1843: 8) had this to say:

> The comet was first seen at Calcutta on the 5th of March, and continued visible until April 3. Distances from bright stars were observed, from which approximate right ascensions and declinations have been deduced.

Mackay had observed the comet with respect to the star Eta Argus in what was then the constellation of Argo Navis whose brightness he noticed had risen from between the first and second magnitude to the first magnitude reaching as bright as Canopus and "… in colour and size very much like Arcturus … Alpha Crucis looked quite dim beside it." Mackay wrote that "… this has been observed by several other persons to whom I pointed it out …" and wanted to know if Eta Argus was a known variable whose brightness had suddenly increased last March or if the change was noticed now only. This abrupt brightening up from a star "… between the first and second magnitude, to a first-rate first magnitude, which took place between 1837 and 1838 …" had been observed by Herschel since 1834 that began to diminish by the time he left the Cape of Good Hope in April 1838 (cf. Frew, 2004). In Herschel's own words, which followed Mackay's account, "… it would appear to be now making another start forward." (Herschel, 1843a).

There is not much information to find on The Reverend Dr William S. Mackay except for his missionary history in India as given by Hunter (1873). Dr Mackay was associated with the Bengal Mission of the Free Church of Scotland that was established in 1830. Calcutta was then the colonial capital of India. The Reverend Dr Alexander Duff (1806–1878) arrived in Calcutta in May 1830 as the first overseas missionary of the Church of Scotland in India. On 13 July 1830, he founded a school named the General Assembly's Institution in the city on Chitpur Road, with just five boys. Dr Mackay had an observatory built atop the building. The institution eventually evolved in 1908 into the present Scottish Church College (Anonymous, n.d.(a)). I intend to present more on Dr Mackay's astronomical activities in a later paper; however, see Kapoor (2021) about his observations of Comet C/1858 L1 (Donati) and computation of the orbital elements.

4.5 Observations from Trevandrum

John Caldecott (Figure 8), the Director of Trevandrum Observatory, observed the Comet C/1843 D1 throughout the month of March.

Caldecott (1843: 302–303) observed the comet with a 5-inch achromatic telescope of 7.5 feet focal length, that was made by Dollond for the Observatory. Caldecott presented precise positions of the comet in a table covering the period 6–19 March, and later for 26 March. In between, the weather was unfavourable for observing. Part of the tail could be sighted on 29 March and 31 March when openings in the clouds permitted. The sky cleared up on 6 April but by then the comet had gone beyond the reach of his telescope. Caldecott mentioned that the positions that the instrument gave were precise to a second of time in right ascension and to 15–20 arcsec in declination. He noted:

> The comet was first seen (partially only) on the 4th March, about half-past six P.M; but clouds over the head of it, which was besides very near the horizon, prevented any observations.
>
> On the 5th, a larger portion of the tail was visible, and it was evidently higher than the evening before; clouds, however, again hung over the head until it set. (Caldecott, 1843: 303).

On 6 March, while the sky was clear the comet "… presented a most magnificent appearance." (*ibid*.). Caldecott measured the tail with a sextant, by bringing down the image of a star seen near the faint end of the tail into contact with the comet's head and deduced it to be about 36º long. Seen through the telescope the nucleus of the comet's head appeared to be a well-defined planet-like disk. Caldecott estimated its size to be about 12 arcsec while the nebulosity around it was 45 arcsec. He noticed that

> The tail had a dark appearance along its axis, as if hollow; and at about halfway from the head, it even appeared to separate slightly into two parts, the upper one being rather longer than the other. (Caldecott, 1843: 303)

From a sextant measurement on 13 March, a more precise measurement gave a larger value for the length of the tail as 45º, the breadth as 33' at one third of its length from the head and as 60' at two-thirds its length.

From the observations made on 8, 13 and 18 March, Caldecott computed the orbital elements of the comet, and these are listed in Table 2.

One can find details on the life of John Caldecott on Richard Walding's (n.d.) webpage. See also Orchiston et al. (2020b) for information on some later activities of Trevandrum Observatory.

4.6 Observations by W.S. Jacob From a Ship

Lieutenant W.S. Jacob (1813–1862; Figure 15) observed Comet C/1843 D1 while on board the ship *Childe Harold* on her voyage from Bombay to London (Jacob, 1843). Before coming to the Madras Observatory, where he served as the Director from 1848 to 1858, Jacob had set up a small private observatory in Poona (now Pune) in 1842, with a 5-feet Dollond telescope. He had observed eclipses of the Jovian satellites and the rings of Saturn, and had published papers in the *Monthly Notices of the Royal Astronomical Society*. His main interest was in the binary stars, their orbits and catalogues. At Madras Observatory, Jacob added double stars to the research repertoire and was the first Director to publish papers on diverse objects in the Royal Astronomical Society journals, thus bringing the Observatory's work to a wide international audience (e.g., see Jacob, 1854; 1857).

In his account of Comet C/1843 D1, Jacob (1843: 295) wrote:

> The tail was first seen on the 3d of March, but a good view of it was not obtained till the 9th. On this evening, the nucleus seen in a night telescope appeared like a star of the sixth magnitude, and the following distances from α *Eridani* and α *Orionis* were measured with a sextant:

Time by watch h m		
8 15	40° 11′	Distance from α *Eridani*
16	12	"
25	8	"
26	10	"
18	56° 35′	Distance from α *Orionis*
19	34	"
21	34	"
23	34	"

> Watch fast on Greenwich mean time (by estimated longitude) $39^{s}.0$.
> The length of the tail 36°.

Table 2: Orbital elements of the Comet C/1843 D1.

Parameter	Value
Longitude of the Ascending Node	3° 7'
Inclination	35° 3'
Longitude of Perihelion	279° 6'
Perihelion Distance	0.0048 au
Time of Perihelion Passage,	Feb. 27.654, Trevandrum mean time.
Motion	Retrograde

Jacob inferred the position of the comet as R.A. = $I^{h}\ 17^{m}\ 9^{s}$, Decl. = –11° 59′ at $7^{h}\ 42^{m}$ GMT. The values are apparent and quite close to the corresponding ones derived using the Horizons software. Jacob was last able to see the nucleus on 5 April.

4.7 A War Comet over Sind

Here we make reference to the comet in Scinde (Sind, Sindh) in the wake of the First Anglo–Afghan War (1839–1842). From 1783

Figure 15: William Stephen Jacob (https://www.myjacobfamily.com/favershamjacobs/williamstephenjacob.htm).

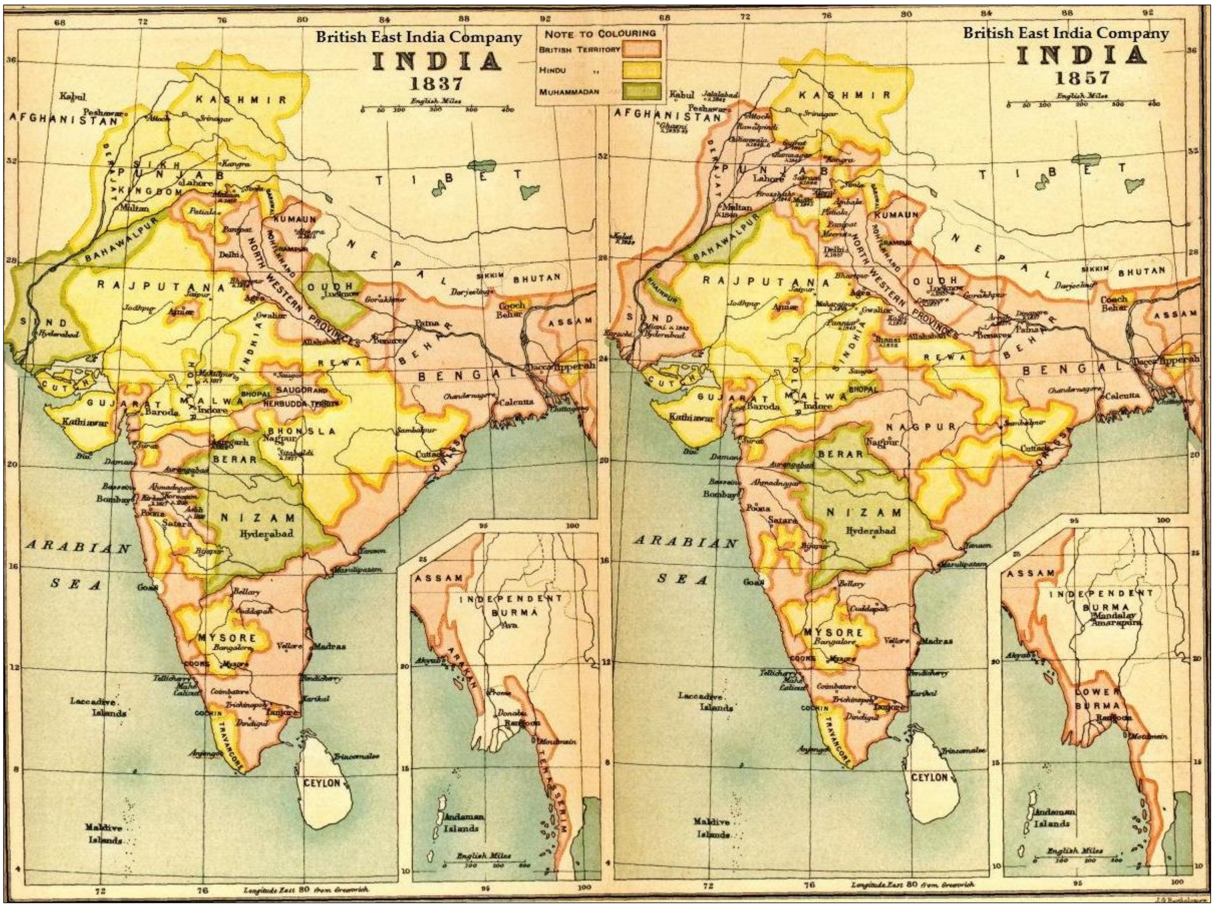


Figure 16: Expansion of The British EIC in India between 1837 and 1857. The Provence of Sind (Sindh, now in Pakistan) is on extreme left (Wikimedia Commons https://i.redd.it/oqqa55cm9rp01.png).

until 1843, Scinde, one of the four provinces of Pakistan in its south-eastern part, was under the rule of the Amirs of Talpur Baloch. Around the time that the Great March Comet of 1843 appeared, Scinde, then under the rule of Mir Muhammad Nasir Khan, had been at war with the British. The Amirs held the banks of the great Indus River that the Government of India had long-cherished a desire to gain control over for commercial communication into Afghanistan and Central Asia, as well as for strategic reasons (Figure 16). The Amirs, disunited among themselves, and despite their brave *Belooch* chiefs and warriors, were outnumbered by the forces of the EIC under General Sir Charles Napier in the historic battles of Meanee (Miani) on 17 February 1843 and Dubba on 24 March 1843, with heavy loss of life on both sides (Napier, 1845: 322; Ch. VI).

Soon after the battle of Meanee and as the Talpurs were subdued and the British forces were taking over, a 'formidable sign' appeared in the sky:

> On the 26th of the month Captain Brown took away Mīr Mīr Muhammad Khān on an elephant to the English camp to join the other Mīrs. And on the 1st of the next month (Saffar) Mīr Sóbdār Khān also was taken away in a *palankin*, from the fort, in which only the young Mīrs were now left behind. On the 3rd of the month Major Wright, of the 12th Bombay Infantry was appointed to relieve Colonel Pattle and remain in charge of the fort.
>
> On this very date, in the evening, a comet appeared in the heavens. Its head was to the west and its tail to the east. It remained for about a month and then gradually disappeared. The people considered it very unlucky and attributed the loss of Sind out of the hands of the Mīrs, to its inauspicious influence. (Fredunbeg, 1902: 234–235).

In this quotation, the date corresponding to the 3rd of Safar 1259 AH (in the Hijra Muslim Calendar) is 5 March 1843. That was when the tail was quite long. As Dr Buist noted, from 7 March to 17 March it was consistently 34° in length, decreasing to 20° by 31 March. Thus, the comet was conspicuous for several successive weeks. By appearing at such a tumultuous time it was considered formidable to influence the minds of all those who were fighting and bore the brunt of the war. There was no doubt that this was indeed 'a war comet'.

4.8 Observations from Kurnool

Here is an extract from Lieutenant Richard Baird Smith's Register of Indian and Asiatic Earthquakes of 1843. Baird Smith (1818–1861) was with the Bengal Engineers of the EIC. The Register includes a notice from Captain Newbold of the Madras Army, date-lined Kurnool, 23 February 1844 and referring to the occurrence of an Earthquake and the sighting of a comet around the same time:

> Kurnool, Long. 78° 7′ Lat. N. 15° 50′: approximate height above the sea 900 feet. April 1st 1843, about 5 A.M. awakened by the shock of an Earthquake, accompanied by a subterranean noise like that of the rumble of Artillery at a distance. It lasted only some seconds; the noise appeared to come from the North-East, and died away to the S.W. It appears to have been felt at Bellary, which is about seventy-three miles direct distance W.S.W. from Kurnool, about the same time. There was nothing particular in the state of the weather. The comet which I first observed here on the 4th of the preceding month, was then visible, and its advent had been accompanied by a sudden and unusual rise of the Tumbuddra, which had swept off the numerous native gardens in its bed, a catastrophe which both the Affghans and Hindoos of this place concurred in attributing to the inauspicious influence of the 'Tailed Star'. (Baird Smith, 1845: 612–613).

'Tumbuddra' above refers to the Tungabhadra River. Captain Thomas John Newbold (1807–1850), who reported the earthquake, was a commissioned ensign in the 23rd Regiment Madras Light Infantry in 1828. He soon obtained proficiency in Hindustani and Persian. Between 1843 and 1848 he was Assistant to the Agent to the Governor of Fort St. George at Kurnool and Bunganahilly (Hewins, n.d.). Described as traveller and orientalist, Newbold was elected a Fellow of the Royal Asiatic Society in 1841 and a Fellow of Royal Society in 1842. He authored forty-six scientific papers according to the records of the Royal Society, and Markham (1878: 212) has called him "… the most eminent of the Indian geological observers."

4.9 Observations from Sholapore

Another report about the aforementioned earthquake was from Sholapore (Sholapur, 17° 40′ Lat. N, 76° 3′ E Long.). This was the northernmost point where the shock was experienced (Baird Smith, 1845: 610–611). It quotes a letter dated 1 April 1843 to the *Bombay Times* that described in detail how the ground rocked. It also pointed to how people connected the earthquake and the March comet:

> All yesterday was remarkably sultry and oppressive, nor was there a breath of air all night, a very unusual thing here. What between the earthquake and comet, the people here are much perplexed, and wise Brahmins are prophesying wars, tumults, and famines, to the terror of the lieges.

4.10 Observations from Assam

4.10.1 Simon Fraser Hannay

Looking into Captain Simon Fraser Hannay's memoranda of earthquakes and other occurrences in Upper Assam over the period January 1839–September 1843 published in the *Journal of the Asiatic Society of Bengal*, we find a record of a comet, which was seen on the evening of 7 March 1843 at Sakenah (Hannay, 1843: 908). Captain Hannay gave positions of the comet's head taken with a common compass

Figure 17: Simon Fraser Hannay (https://www.6thgurkhas.org/the-regiment/1826-1856/).

as West 21° South, and of the Tail as West 47° South, adding that rain continued most of this month. That is 26° for tail length by just the azimuthal difference. To compare, the tail length on 7 March as estimated from diverse locations ranged from 26° to 43° (Kronk, 2003: 134). Just for a perspective, that evening, the Moon was high up in the sky with illumination ~30% (Full Moon was on 16 March). The observing site of Sakenah could not be identified.

A geologist, Captain Hannay (1801–1861; Figure 17) was with the 40th Bengal Native Infantry Regiment. In the larger colonial interest in the geological exploration of the North-East Frontier and prospective resources, he had been recording geological and mineralogical occurrences in particular, and earthquakes in the Assam valley. During the stipulated period, he listed the occurrence of 12 earthquakes, plus loud meteoric bursts in February 1841, on 4 April 1843 and on 23 August 1843 seen over Sibasagar and other places in Upper Assam, plus the comet in March 1843. He also recorded the solar eclipse of 4 March 1840, and noted that about an hour after the eclipse was over two earthquakes occurred in succession, being about 10 minutes apart. Hannay called the eclipse total but actually it was annular. The path of annularity fell largely over nearby Myanmar bypassing Sibasagar (26.983° N, 94.632° E) in the northwest where the eclipse was seen as partial, with a magnitude of 0.945 and obscuration 92.98%. Simon Hannay is credited as the founder of the Assam tea industry (Anonymous, n.d.(b)).

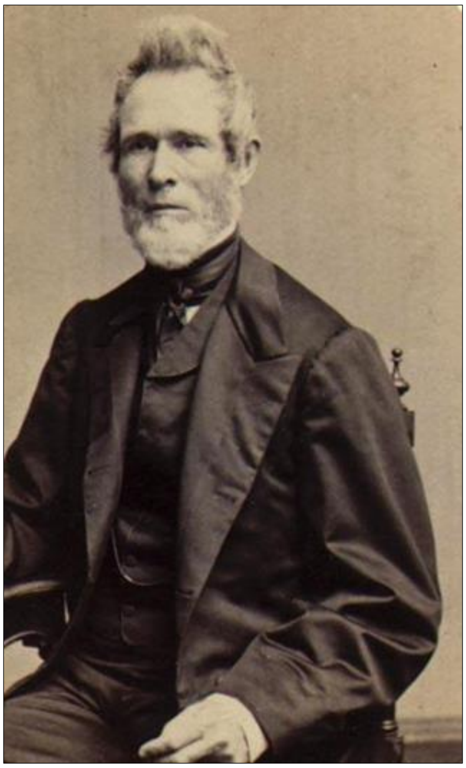


Figure 18: The Reverend Dr Nathan Brown (http://onlinesivasagar.com/literature/nathan-brown.htm).

4.10.2 The Reverend Dr Nathan Brown

In the same journal issue, right below the records by Captain Hannay, are listed some major phenomena of 1843 occurring in different parts of the world by the Reverend N. Brown, Missionary Assam (Figure 18). These include the appearance of the comet of 1843 and the loud meteoric burst over Sibasagar on 4 April 1843. About the comet, the Reverend Brown writes thus (Brown, 1843: 909):

> February 27. – The comet passed its Perihelion.
> March 3. – Comet seen at Sea 10° S Lat. 25° W Long.
> March 6. – Comet seen at Calcutta.

The Reverend Dr Nathan Brown (1807–1886) was an American Baptist Missionary and is best known for his work on the Assamese language, its grammar and the script, *vide* his “Grammatical Notes of Assamese language”. He had come over to Assam from Burma in 1836. From his brief report, we find that the Reverend was up-to-date on astronomical information.

4.11 Observations from Cuttack

Then there is an interesting observation by the Reverend Acland from Cuttack of a curiously shaped long cloud that he wrote about in a long letter to his children back in England. Early in the nineteenth century, the Society for the Propagation of the Gospel began to send missionaries to the new colonies, to India in 1814, to South Africa in 1820, to Australia in 1834 and so on. The Reverend Charles Acland (d. 1845) had been appointed in 1841 (United Society …, n.d.: 4 and 86). The Aclands left for India in March 1842 with the objective of disseminating the truths of the gospel. The 1843 edition of the *Bengal Directory* records their arrival in Calcutta on the ship *Malacca* in July 1842 (Families …). After landing, they visited a few places in northern India. The Reverend Acland had been appointed Chaplain at Poorie (Puri), Cuttack and Midnapore. All of the letters that the clergyman addressed to his children were later brought together in the form of a journal, titled *A Popular Account of the Manners and Customs of India* (Acland, 1847). Therein, he recounts witnessing the comet of 1843 early in the month of March from Cuttack (Acland, 1847: 59–60). The following description of the comet, towards the end of a rather long letter, is dated 4 March:

> I have just witnessed a magnificent sight; during the last month we have had such weather as the oldest inhabitant cannot recollect ever to have seen before at this time of the year. It is generally in February and March very hot and very dry. For the last month we have had almost incessant rain, with violent thunderstorms. The days are comparatively cool, and at night I am glad of two blankets. Rumours of an approaching famine began to float around, but at length the mystery was solved. About half-past six I thought I observed a curiously shaped long cloud, and as the sun went down and the twilight deepened it did not alter its appearance, but at about a quarter to seven proved to be a magnificent comet. The nucleus was plainly visible even with the naked eye, and equal in brightness to a small star. The tail was at least 45° in length, and inclined from W.S.W. to E.S.E. Had it been perpendicular it would have reached from the horizon half way up over

> our heads, the whole distance from the horizon to the zenith being 90°. The breadth of the extremity of the tail was about 2½°, and the posterior half was divided longitudinally by a dark line. The colour was that of a pale moonlight, but it would no doubt have appeared much more red if the moon had not been shining brightly at the time. There has been no comet equal to this in brilliancy and the length of the tail since the year 1759. I have hardly any books to refer to, but my idea is, that it is the same comet which appeared in 1264 and 1556, and was expected back in 1848. If so, its period of revolution is nearly 300 years. Its light was intense, being almost equal to the moon in brilliancy. The natives say it will burn the earth; they call it "jherra tarn," or "burnt star."
>
> The weather is most remarkable. We have incessant rain, with thunder and lightning every evening, and the clouds are too heavy to allow us to see the comet. The houses require fresh thatching every year. The lightning we have here I have never seen equalled in England; each flash spreads over one quarter of the visible heavens, whilst the roaring, or rather the deafening rattle, of the thunder is incessant. The comet re-appeared last night, though hardly so brilliant as it was a week ago.

The phrase "jherra tarn" should actually be "jharoo tara", i.e., broom star. Just before describing the magnificent sight in his letter, the Reverend Acland mentioned returning home on Friday morning implying that the observation was made on the evening of 3 March, at quarter to seven local time. His observations seem to be in order about the comet's tail length and width. Since no instrument is mentioned, the width was possibly inferred by a visual comparison with the Moon that was then up in the sky and in elongation not very far (Full Moon was on 16 March).

Over Cuttack (20° 28′ N, 85° 53′ E), the circumstances can be computed with the Horizons System for the local mean time of the observation. The relevant numbers are given in Table 3, where 'T-O-M' is the angle between the target (i.e. the comet), the observer and the Moon, and 'Illumin' is for the Moon's illumination.

5 CONCLUDING REMARKS: CHANGING IDEAS ABOUT THE NATURE OF COMETS DURING THE NINETEENTH CENTURY

The first decade of the nineteenth century witnessed the most crucial development in the art of orbit computations, spurred by the discovery of four minor planets between 1 January 1801 and 29 March 1807. The whole exercise of orbit determination used to be arduous. One would divide the orbit into degrees, and for each, the computations performed were a task too daunting. Subsequent to when the newly discovered Ceres was lost to the astronomers, in 1801 itself, Carl Gauss (1777–1855) presented a simple and quicker method of computing an elliptical orbit by using observations derived from an arc in the sky. This approach soon led to the recovery of the lost Ceres. Early in the nineteenth century, a few great comets appeared and as the astronomers began to check the past apparitions, some turned out to be periodic. After Edmund Halley, J.F. Encke successfully predicted in 1820 the return of a comet in 1822, now appropriately named 2P/Encke. Comet 1P/Halley's had visited the inner Solar System only a few years before the Great March Comet of 1843. By then, astronomers had improved observing techniques and were becoming more adept at computing orbits that included allowance for planetary perturbations.

The nature of the tail was still very speculative: was it an appendage or an emanation? Way back in 1687, Isaac Newton had devised a way to calculate the parabolic orbit of a comet from three successive observations and used it to determine the orbit of the comet of 1680 that he himself had observed. In the Book III, Problem XXI, Newton (1687: 489) made an insightful observation on the comet tails:

> … it is plain that the *phenomena* of the tails of comets depend upon the motions of their heads, and by no means upon the places of the heavens in which their heads are seen; and that, therefore, the tails of comets do not proceed from the refraction of the heavens, but from their own heads, which furnish the matter that forms the tail.

In 1812, the German physician and astronomer Heinrich Wilhelm Olbers (1758–1840) and in 1836 Friedrich W. Bessel (1784–1846) suggested that the comet tails were composed of solid particles that suffered a repulsive force in a direction away from the Sun (Festou et al., 2004: 4). In *A Treatise of Astronomy*, Sir John Herschel (1835: 283) too was wondering why

> No rational or even plausible account has yet been rendered of those immensely voluminous appendages which they bear about with them, and which are known by the name of their tails …

Initially the Great Comet of 1843 was mistaken for the zodiacal light by many observers. Dr Thomas Forster (1789–1860), astronomer and naturalist from Bruges who had observed the Comet on 18 and 20 March (Forster, 1843a: 269–270; 1843b: 42–47), and some other meteorologists doubted that the light regarded as the tail of the comet was nothing but the zodiacal light. This was refuted by Sir John Her-

Table 3: The post-sunset sky over Cuttack on 3 March 1843.

Object *	Date	UT	Azimuth	Altitude	T-O-M	Illumin.
Comet	03.03.1843	13:00	257.6°	0.5°	20.1°	4.6%
Moon	"	"	272.6°	14.9°		
Sun	"	"	266.2°	–9.7°		

* At the time, all the planets had set.

schel. In a letter of 31 March cited in Vincent and Mason (1844: 279–285) he asserted:

> … that on every evening when he had observed the comet, the zodiacal light had also been displayed in the most striking and perfectly characteristic manner, and occupying its usual place among the stars; while the comet, in no part of the extent of its tail, so much as touched upon the region occupied by it.

The best times the zodiacal light is seen are April–May after sunset and October–November before the sunrise, when it can be seen to extend up to 100° from the Sun. Subsequently, Forster (1843b) stated that

> It was only on the evening of the 29th that I saw a body which seemed to be the nucleus of the comet; but it was observed by other astronomers in more favourable locations. Now we don't doubt that it's a huge comet … (Forster, 1843b: 44; my English translation).

Outside the realm of the great treatises of astronomy and the journals, news magazines kept pace with the latest views on comets. In its 19 August 1843 issue, the *Chambers' Edinburgh Journal* (Chambers and Chambers, 1843: 247) carried a lucidly written article on comets that had originally appeared in the *Bombay Times*. The paper had its audience in Europe, and obviously, the context was the recently seen Great March Comet of 1843. The author is not named but the writing is professional and up-to-date on comets. The author might be Dr George Buist who had been associated with the paper since 1839. The article says that there are believed to be thousands of comets; 400 to 500 have been examined and catalogued, whereas a good number have escaped detection. In the matter of the comet of 1843, the writer noticed

> …. with such suddenness and brilliancy on the 4th of March, must have been in the sky for weeks approaching the sun … Comets generally consist of a large misty mass of light called the head; this is brightest towards the centre, where it presents the appearance of a star. It is seldom, however, that any solid body can be detected; stars having in most instances been observed through the brightest portion of the head or nucleus of the comet. The tail of the comet, as it is called, though preceding it in its course as often as it follows it, consists in a large mass of white hazy light, which proceeds apparently from the head, generally in the form of two streams or currents, which occasionally unite, but more frequently keep apart from each other. In the present comet they issue as a single beam, and so continue till they divide into two, considerably on towards the end of the tail … Comets are believed to consist entirely of thin masses of vapour, penetrated in every quarter by solar light, which they reflect, but yielding, in reality, none of their own. The densest portions of them are without solidity or form; the tail itself is in the last degree of attenuation.

The article talks about the "comet of Halley" that visits the Earth in 75 or 76 years and of Encke returning in three and half years, its last visit being in 1842. The author refers also to Biela's comet to be due again in 1844 that had earlier returned as two predicted comets in 1832. We are told of Lexell's Comet of 1770 and how it was affected by the gravitational influence of the planet Jupiter. The comets are gaseous and so attenuated that no perceptible effect would be produced even if they come in collision with the planets and it may be that the Earth may have passed through the tails of comets several times in the past. The article states that their nuclei have typical sizes of 30 to 3000 miles while the tails extend to hundreds of millions of miles.

About the nature of the tail, a communication in the *Eclectic Magazine* on comets that appeared in 1855 tells a lot. It was reproduced in the 16 October 1858 issue of the Indianapolis magazine *The Locomotive* (Volume 46: 3). After narrating the orbital computations of comets of 1264 and 1556 by many astronomers since Edmund Halley's first attempt, the article mentions that it is a curious fact, perhaps very little known, that the tail of the comet of 1843 actually struck the Earth:

> No sensible effect has been produced on any part of the solar system by the numerous comets that have swept through it. The cometary bodies have been affected by their approach to the planets; but neither the planets nor their satellites have been affected by the neighborhood of comets. This is probably owing to the extreme rarity of the nebulous matter of which comets are composed. It is so very thin that small stars have been seen through the centre of the heads of comets, without being in the slightest degree obscured. There is, therefore,

> very little matter in comets, and hence their approach to the earth does not produce any sensible effect on it … It is doubtful if any seriously disastrous result would follow were the earth and a comet to come even into contact. And it seems probable that the tail of a comet (the great comet of 1843) actually swept over the earth, with what sensible or injurious effect many of us can perhaps tell.

Herschel's *Outlines of Astronomy* was first published in 1849. Here, he outlines the idea of the comet tails through the concept of radiation pressure:

> 1st. That the matter of the nucleus of a comet is powerfully excited and dilated into a vaporous state by the action of the sun's rays, escaping in streams and jets at those points of its surface which oppose the least resistance, and in all probability throwing that surface or the nucleus itself into irregular motions by its reaction in the act of so escaping, and thus altering its direction.
> 2dly. That this process chiefly takes place in that portion of the nucleus which is turned towards the sun; the vapor escaping chiefly in that direction.
> 3dly. That when so emitted, it is prevented from proceeding in the direction originally impressed upon it, by some force directed *from* the sun, drifting it back and carrying it out to vast distances behind the nucleus, forming the tail or so much of the tail as can be considered as consisting of material substance. (Herschel, 1849: 352).

In the wake of the appearance of Comet C/1858 L1 (Donati) in 1858, Waterston too put forward his own thoughts on the formation of a comet's tail. He showed that if the tail were viewed as made up of molecules like in an uncondensable gas, the molecules can be quickly removed from the feeble attraction of the nucleus by the force of the heat of the Sun, predominantly acting in one direction (Waterston, 1859: 20).

In the ancient tales, a certain meteor shower has been referred to as the "Fiery tears of St. Lawrence" because a meteoric swarm was noticed to occur between 9 and 14 August, which is around the time of St. Lawrence's feast day on 10 August. That was the day that St. Lawrence was burned at the stake, in 258 CE (New Advent, 2011). Until the mid-nineteenth century, many believed meteors to be meteorological phenomena. It was Schiaparelli (1867) who first showed in 1866 the connection of a meteor stream to a comet by comparing their orbits. He gave the above-mentioned showers the name Perseids, called until then the August meteors (Hughes, 1995). He observed that the Perseid and the Leonid meteor shower streams coincided with the paths of the comets 109P/Swift-Tuttle and 55P/Temple-Tuttle, respectively. This indicated that comets were losing solid particles as they moved.

So, that is how astronomers were inching towards a proper understanding of comets. Photography and spectroscopy of celestial objects and events revolutionized astronomy. As Pasachoff et al. (1996) have shown, the Moon was the first celestial object to be photographed, in 1840. Solar photography began during the total solar eclipse of 28 July 1851 when the Prussian photographer Julius Berkowski used a daguerreotype plate to capture the eclipse from Königsberg. Comet C/1858 L1 (Donati) was the first comet to be photographed, on 27 September 1858 by William Usherwood (1820–1916) in England on a collodion-coated glass plate (prints untraceable) and by George Phillips Bond (1825–1865) on 28 September at Harvard with a 15-inch refractor. However, Comet C/1881 K1 (Tebbutt) was the first comet to be successfully photographed in its entirety (not just the head), by Andrew Ainslie Common (1841–1903) in England, Dr Henry Draper (1837–1882) in America and Jules Janssen (1824–1907) in France (see Orchiston, 2017: Chapter 9). Meanwhile, Giambatista Donati (1826–1873) was the first to photograph the spectrum of a comet, C/1864 N1 (Tempel), in 1864 (Pasachoff et al., 1996), a step that opened floodgates to research on the physics and chemistry of comets and the Solar System.

Astronomers' perception of comets therefore changed with time, but it was only recently that we came to learn the true nature of comets when in 1950 Fred Lawrence Whipple (1906–2004) presented a model of a comet's nucleus, the icy-conglomerate model (Whipple, 1950), also known as the 'dirty snowball' model. Even more recently, a major change in our understanding of the nature of comets commenced with the onset of space astronomy and cometary fly-bys and landings.

6 NOTES

1. On the south wall of the Madras Observatory, there is a granite slab with the following inscription in Latin:

   > *ASTRONOMIÆ consecratum sumptibus Societatis Anglicanæ in INDIA mercaturæ faciendæ favente CAROLO OAKELEY Bar:to Præfecto Præsidii Sancti Georgii A.D. MDCCXCII*

   meaning

   > English Society conducting trade in INDIA dedicating the expenses for Astronomy with the favour of Baronet CHARLES OAKLEY Commandant Fort St. George A.D. 1792

   and somewhat corresponding inscriptions

in Tamil Telugu and Hindustani also carved on the granite pier

> so that posterity may be informed a thousand years hence of the period when the Mathematical Sciences were first planted by British liberality in Asia. (see also Kapoor, 2020).

2. King George III had a strong inclination for natural philosophy. In 1769 he had an observatory built in Richmond Park so that he could observe the 3 June transit of Venus (Scott, 1885: 42). The new planet beyond the orbit of Saturn discovered by Sir William Herschel (1738–1822) on 13 March 1781 was initially named *Georgium Sidus* (George's Star) after Herschel's patron, King George III. The name Uranus was only used in Britain from around 1850.

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8 REFERENCES

Acland, C., 1847. *A Popular Account of the Manners and Customs of India*, London, John Murray.

Allen, W.H., 1843. *The Indian Mail, Volume 1, May–December*. London, Wm. H. Allen and Co.

Anonymous, n.d.(a). Scottish Church College: Glimpses of College History; excerpts from the article by Prof. Asit Kumar Sen, Secretary, 150th Year Celebration Committee published in the 150th Year commemorative volume 1980. Web site (http://www.scottishchurch.ac.in/docs/CollegeHistory.pdf; accessed 26 March 2020).

Anonymous, n.d.(b). The Peerage. A genealogical survey of the peerage of Britain as well as the Royal Families of Europe. Colonel Simon Fraser Hannay. Web site (http://www.thepeerage.com/p2235.htm#i22346; accessed 1 March 2021).

Ansari, S.M.R., 2000. Introduction of modern Western astronomy in India during 18–19 centuries. In Sen, S.N., and Shukla, K.S., *History of Astronomy in India*. New Delhi, Indian National Science Academy. Pp. 418–419.

Ansari, S.M.R., 2002. European astronomy in Indo–Persian writings. In Ansari, S.M.R. (ed.), *History of Oriental Astronomy*. Dordrecht, Kluwer (Proceedings of the IAU Joint Discussion-17, Kyoto, Japan, Aug. 25–26, 1997). Pp. 133–144.

Baird Smith, R., 1845. Register of Indian and Asiatic earthquakes for the year 1843. *Journal of the Asiatic Society of Bengal*, 14(2), 604–622.

Brown, N., 1843. Memorandum of various phenomena in 1843. *Journal of the Asiatic Society of Bengal*, 12(2), 909.

Buist, G., 1844. Observations on the comet of 1843; made at the Astronomical Observatory, Bombay. *Journal of the Bombay Branch of the Royal Asiatic Society*, 1, 252–254.

Buist, G., 1849. *Annals of India for the Year 1848*. Bombay, The Times Press.

Caldecott, J., 1837. Description of an observatory lately established at Trevandrum, by His Highness the Rajah of Travancore. *The Madras Journal of Literature and Science*, 6, 56–60.

Caldecott, J., 1843. Observations of the comet made at the Observatory of Trevendrum, accompanied by a drawing. *Monthly Notices of the Royal Astronomical Society*, 5, 302–304.

Caldecott, J., 1845. Observations of the Great Comet of 1844–5, made at the Observatory of Trevendrum. *Monthly Notices of the Royal Astronomical Society*, VI, 215–218.

Caldecott, J., 1846a. Eclipse of the Sun on Dec. 21, 1843, observed at Parratt, three miles North of the source of the Mahe River. *Memoirs of the Royal Astronomical Society*, 15, 171–178.

Caldecott, J., 1846b. Observations of the Great Comet of 1843 made at the Observatory of Trevendrum. *Memoirs of the Royal Astronomical Society*, 15, 229–231.

Chambers, W., and Chambers, R., 1843. Comets. *Chambers' Edinburgh Journal*, 11(603), 247–248.

Clerke, A.M., 1908. *A Popular History of Astronomy During the Nineteenth Century*, *Fourth Edition*. London, Adam and Charles Black.

Cottam, S., and Orchiston, W., 2015. *Eclipses, Transits, and Comets of the Nineteenth Century*. Cham (Switzer-

land), Springer.
Families in British India Society. Website (https://www.fibis.org; accessed 23 March 2021).
Festou, M.C., Keller, H. U., and Weaver, H.A., 2004. A brief conceptual history of cometary science. In Festou, M.C., Keller, H.U., and Weaver, H.A. (eds.), *Comets II*. Tucson, University of Arizona Press. Pp. 3–16.
Field, J.H., 1926. *Report on the Administration of the Meteorological Department of the Government of India in 1925–26, and a Note on the Long-Established Observatories of Madras and Bombay*. Simla, Government of India Press.
Forster, T., 1843a. Letter from T. Forster, Esq. dated Bruges, March 22,1843, on the Great Comet. *Monthly Notices of the Royal Astronomical Society*, V, 269; & second letter dated March 28, 1843. *Monthly Notices of the Royal Astronomical Society*, V, 269–270.
Forster, T., 1843b. *Essai sur l'Influence des Comètes sur les Phénomènes de la Terre*. Bruges, Vandecasteele-Werbrouck (in French).
Fredunbeg, M.K., 1902. *History of Sind*. *Volume II*. Karachi, Commissioner's Press.
Frew, D., 2004. The historical record of η Carinae. I. The visual light curve, 1595–2000. *Journal of Astronomical Data*, 10(6), 1–76.
Gawali, P.B., Doiphode, M.G., and Nimje, R.N., 2015. Colaba–Alibag Magnetic Observatory and Nanabhoy Moos: the influence of one over the other. *History of Geo- and Space Sciences*, 6, 107–131.
Grand meteoric phenomenon. – The comet. *The Illustrated London News*, 2 March 1843, page 211.
Haldane, J.S., 1928. *The Collected Scientific Papers of John James Waterston*. Edinburgh, Oliver and Boyd.
Hannay, S.F., 1843. Memoranda of earthquakes and other remarkable occurrences in Upper Assam, from January 1839 to September 1843. *Journal of the Asiatic Society of Bengal*, 12, 907–909.
Herschel, Sir J.F.W., 1835. *A Treatise on Astronomy*. Philadelphia, Carey, Lea & Blanchard.
Herschel, J., 1843a. The variability of Eta Argûs. *Monthly Notices of the Royal Astronomical Society*, 6, 9.
Herschel, J., 1843b. Notices of the Late Comet. To the Editor of the Times. *The Times*, 12 March. Pages 2–3.
Herschel, Sir J.F.W., 1844. Auszug aus einem schreiben des Herrn Baronets Herschel an den Herausgeber. *Astronomische Nachrichten*, 21, 200–201 (in German).
Herschel, Sir J.F.W., 1849. *Outlines of Astronomy*, London, Longman, Brown, Green and Longmans and John Taylor.
Hewins, W.A.S., n.d. Newbold, Thomas John (1807–1850). In *Dictionary of National Biography, 1885–1900*. *Volume 40.* (https://en.wikisource.org/wiki/Dictionary_of_National_Biography,_1885-1900/Newbold,_Thomas_John; accessed 26 March 2021).
Hind, J.R., 1852. *The Comets: A Descriptive Treatise Upon Those Bodies. With a Table of All the Calculated Comets from the Earliest Ages to the Present Time.* London, J.W. Parker & Son.
Hughes, D.W., 1995. The Perseid meteor shower. *Earth, Moon and Planets*, 68, 31–70.
Hunter, R., 1873. *History of the Missions of the Free Church of Scotland in India and Africa*. London, T. Nelson and Sons.
India Shipping. *The Asiatic Journal and Monthly Register for British and Foreign India, China and Australasia*. n.s. 39, September–December, 1842.
Jacob, W.S., 1843. An account of the comet as seen on board the ship Childe Harold on her voyage from Bombay to London. *Monthly Notices of the Royal Astronomical Society*, 5, 295–296.
Jacob, W.S., 1854. Places of Comet II. of 1854, as observed at Madras with the Lerebours Equatorial. *Monthly Notices of the Royal Astronomical Society*, 14, 246.
Jacob, W.S., 1857. Results of measurements of Saturn's satellites made at the Madras Observatory in 1856-7… *Monthly Notices of the Royal Astronomical Society*, 18, 1–3.
Jet Propulsion Laboratory, n.d.. *JPL Small-Body Database Browser* (https://ssd.jpl.nasa.gov/sbdb.cgi; accessed 26 March 2021).
Kapoor, R.C., 2011. Madras Observatory and the discovery of C/1831 A1 (The Great Comet of 1831). *Journal of Astronomical History and Heritage*, 14, 93–102.
Kapoor, R.C., 2018. Comet tales from India. 1: ancient to medieval. In Sôma, M., and Tanikawa, K. (eds.), *Proceedings of the Fifth Symposium on "Historical Records of Astronomy and Modern Science". Tokyo*, National Astronomical Observatory of Japan. Pp. 14–61.
Kapoor, R.C., 2020. Comet tales from India: The Great September Comet of 1882 (C/1882 R1). *Journal of Astronomical History and Heritage*, 23(2), 353–374.
Kapoor, R.C., 2021. Comet tales from India: Donati's Comet of 1858 (C/1858 L1). *Journal of Astronomical History and Heritage*, 24(1), 98–113.
Kochhar, R.K., 1985a. Madras Observatory: the beginning. *Bulletin of the Astronomical Society of India*, 13, 162–168.
Kochhar, R.K., 1985b. Madras Observatory – buildings and instruments. *Bulletin of the Astronomical Society of India*, 13, 287–302.
Kochhar, R.K., and Narlikar, J.V., 1995. *Astronomy in India: A Perspective*. New Delhi, Indian National Science Academy.
Kochhar, R.K., and Orchiston, W., 2017. The development of modern astronomy and emergence of astrophysics in India. In Nakamura, T., and Orchiston, W. (eds.), *The Emergence of Astrophysics in Asia: Opening a New Window on the Universe*. Cham (Switzerland), Springer. Pp. 705–770.
Kripalani, K., 1981. *Dwarkanath Tagore*, *A Forgotten Pioneer*, *A Life*. New Delhi, National Book Trust, India.
Kurien, P. 2009. *History of Astronomical Science in Kerala*. PhD Thesis, University of Kerala; Shodhganga, India (http://hdl.handle.net/10603/71693).

Kronk, G.W., 2003. *Cometography*: *A Catalogue of Comets. Volume 2: 1800–1899*. Cambridge, Cambridge University Press.
Locomotive, 1858. The Comet, *Locomotive*, 46(9), Indianapolis, Marion County, 16 October (https://newspapers.library.in.gov/?a=d&d=LO18581016.1.3&e=en-20-1-txt-txIN; accessed 26 March 2021).
Mackay, W.S., 1843. Letter to Sir John Herschel on the comet of 1843. *Monthly Notices of the Royal Astronomical Society*, 6, 8–9.
Markham, C.R., 1878. *The Indian Surveys*. *Second Edition*. London, W.H. Allen & Co.
Marshall, I., 1997. *Passage East*. Charlottesville, Howell Press.
Minor Planet Center, n.d. C/1843 D1 (Great March Comet). Web site (https://minorplanetcenter.net/db_search/show_object?utf8=%E2%9C%93&object_id=C%2F1843+D1; accessed 15 July 2021).
Napier, W.F.P., 1845*. The Conquest of Scinde, With Some Introductory Passages in the Life of Major-General Sir Charles James Napier. Part II*. London, T. & W. Boone.
New Advent, 2011. St. Lawrence, web site (http://www.newadvent.org/cathen/09089a.htm; accessed 4 December, 2011).
Newton, I., 1687/1846. *Newton's Principia*. New York, Daniel Adee.
Olson, R.J.M., and Pasachoff, J.M., 1998. *Fire in the Sky*: *Comets and Meteors, the Decisive Centuries, in British Art and Science.* Cambridge, Cambridge University Press.
Orchiston, W., 2017. *John Tebbutt: Rebuilding and Strengthening the Foundations of Australian Astronomy*. Cham (Switzerland), Springer.
Orchiston, W., Drummond, J., and Kronk, G., 2020a. Observations of the Great September Comet of 1882 (C/1882 R1) from New Zealand. *Journal of Astronomical History and Heritage*, 23, 628–658.
Orchiston, W., Drummond, J. and Shylaja, B.S., 2020b. Communication issues in war-time astronomy: independent Australian, Indian, New Zealand and South African discoveries of Comet C/1941 B2 (de Kock-Paraskevopoulos), *Journal of Astronomical History and Heritage*, 23(3), 659–674.
Orlebar, A.B., 1846. *Observations Made at the Magnetical and Meteorological Observatory, Bombay from April to December 1845*. Bombay, American Mission Press.
Pasachoff, J.M., Olson, R.J.M., and Hazen, M.L., 1996. The earliest comet photographs: Usherwood, Bond, and Donati 1858. *Journal for the History of Astronomy*, 27, 129–145.
Phillimore, R.H., 1945. *Historical Records of the Survey of India*. *Volume I: 18th Century*. Dehra Dun, Survey of India.
Pole, W., 1845. Collection of results from East Indian observatories of the Great Comet of 1844–5 (Wilmot's). *Monthly Notices of the Royal Astronomical Society*, 7, 19.
Rao, N. Kameswara, Vagiswari, A., and Birdie, C., 2011. Early pioneers of telescopic astronomy in India: G.V. Juggarow and his observatory. *Current Science*, 100(10), 1575–1581.
RAS, 1843. Abstract of newspaper accounts of the comet. *Monthly Notices of the Royal Astronomical Society*, V, 298–302.
Schaffer, S., 2012. The Bombay case: astronomers, instrument makers and the East India Company. *Journal for the History of Astronomy*, 43, 151–180.
Schiaparelli, G.V., 1867. Sur la relation qui existe entre les comètes et les étoiles filantes. *Astronomische Nachrichten*, 68, 331–332 (in French).
Scott, R.H., 1885. The history of the Kew Observatory. *Proceedings of the Royal Society of London*, 39, 37–86.
Sen, J., 2014. *Astronomy in India, 1784–1876*. London, Pickering and Chatto.
Shylaja, B.S., and Ganesha, G.K., 2016. *History of the Sky – On Stones*. Bengaluru, Infosys Foundation.
Simpson, I., n.d. Great Scots Aberdeenshire. Web site (https://www.reelprivatetoursofscotland.co.uk/great-scots/great-scots-aberdeenshire/; accessed March 2021).
Smith, G., 1899. *The Life of Alexander Duff, D.D., LL.D*. London, Hodder and Stoughton.
Taylor, T.G., 1838. *Results of Astronomical Observations Made at The Honourable The East India Company's Observatory at Madras* .... For the Years 1836 and 1837. Madras, Madras Observatory.
The Illustrated London News. Volume 2, January-June 1843.
The Locomotive (magazine), volume 46, 16 October 1858. Page 3.
The Royal Society, 1846. Record. EC - Certificates of election and candidature for Fellowship of the Royal Society. 1846 – Certificates of election 1846. Buist George, EC/1846/07 (https://catalogues.royalsociety.org/CalmView/Record.aspx?src=CalmView.Catalog&id=EC%2f1846%2f07; accessed 17.02.2021).
United Society …, n.d*. United Society for the Propagation of the Gospel.* Records 1718–1952. Australian Joint Copying Project, National Library of Australia, and State Library of New South Wales (https://www.nla.gov.au/sites/default/files/blogs/m_1201-1335_etc_united_society_for_the_propagation_of_the_gospel.pdf).
Vincent, C.W., and Mason J. (eds.), 1844. The Great Comet of 1843. In *The Year-book of Facts in Science and Art*. London, Simpkin, Marshall, and Company. Pp. 279–285.
Vsekhsvyatskii, S.K., 1964. *Physical Characteristics of Comets*. Jerusalem, Israel Program for Scientific Translations.
Walding, R., n.d. John Caldecott FRS. Web site (http://indicatorloops.com/caldecott.htm; accessed 26 February 2021).
Waterston, J.J., 1845a. Remarks on the comet; accompanied by a chart, making its course among the stars. Includ-

ing also, observations of the comet, made at the Madras Observatory, by T.G. Taylor, Esq.. *Monthly Notices of the Royal Astronomical Society*, 6, 207–209.
Waterston, J.J., 1845b. Observations of the second comet of Mauvais, accompanied by a chart of its progress among the stars. *Monthly Notices of the Royal Astronomical Society*, 6, 210.
Waterston, J.J., 1845c. On a direct method of determining the distance of a comet by three observations. *Monthly Notices of the Royal Astronomical Society*, 7, 17–19.
Waterston, J.J., 1858. Thoughts on the formation of the tail of a comet. *Monthly Notices of the Royal Astronomical Society*, 19, 29–30.
Whipple, F.L., 1950. A comet model. I. The acceleration of comet Encke. *The Astrophysical. Journal*, 111, 375–394.

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