ON OBSERVATIONS OF THE GREAT COMET OF 1807 (C/1807 R1) FROM INDIA

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Abstract: Captain John Warren, the Acting Astronomer at Madras Observatory between 1805 and 1811, observed the Great Comet of 1807 (now C/1807 R1) and computed its orbit. He wrote up his observations in a paper titled "An account of the comet, which appeared in the months of September, October and November 1807" and sent this to England, but it was not published at the time. This paper has now been published in this issue of the *Journal of Astronomical History and Heritage* (courtesy of the Royal Astronomical Society), and the present paper discusses Warren's observations and others made from the Indian Subcontinent. It turns out that Comet C/1807 R1 was first sighted on 20 September in Bengal, making this an independent discovery from India. Notably, this was the first comet observed at Madras Observatory following its inception.

Keywords: The Great Comet of 1807; Madras Observatory; John Warren; Royal Astronomical Society

1 INTRODUCTION

Captain John Warren (1769–1830) was Acting Astronomer of the Madras Observatory during 1805–1811 when the Astronomer, John Goldingham, went to England on leave. In the course of Warren's tenure, two Great Comets appeared in the sky, in 1807 and 1811. These created a sensation among astronomers internationally, and even generated concern among the general population, leaving an indelible imprint on many minds. Warren observed both comets while at Madras (now Chennai), and summarised his observations in the Madras MS Records. He wrote a detailed paper about the Great Comet of 1807, and sent this to the Royal Astronomical Society in 1809 (Ananthasubramaniam, 1991); the date of its receipt was 2 June 1809. For some unexplained reason this paper (Warren, 1808) was not published at the time, and it is now in the Archives of the Royal Astronomical Society (RAS MSS Madras 6). Its title is "An account of the comet, which appeared in the months of September, October and November 1807".

This paper supplements Warren's 1808 manuscript that we publish here for the first time (i.e. Warren, 2019). See Figure 1. However, a brief description of the early days of Madras Observatory and the equipment there is desirable because in his paper Warren regrets "… having no instrument at the observatory of sufficient powers of observation of this nature."

2 THE EARLY HISTORY OF MADRAS OBSERVATORY

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 (Kochhar, 1985a; 1985b). Petrie's intention, expressed years later in a memorandum of 4 September 1804 to the Governor of Madras was

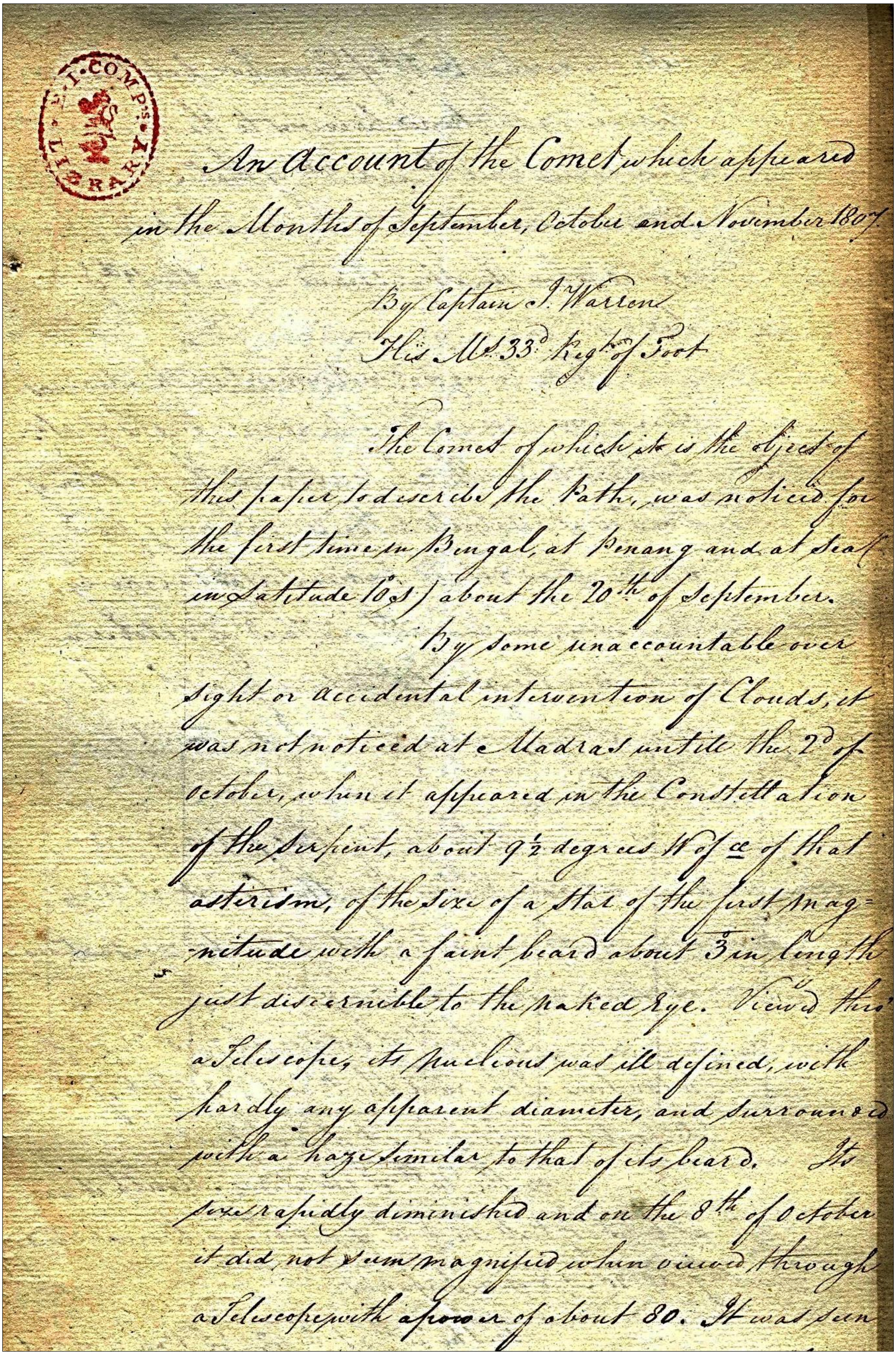
> … to provide navigational assistance to the company ships, and help determine the longitudes and latitudes of the company territories. (Madras MS Records: 76).

According to Kochhar (1985a, 1985b), Petrie possessed the following scientific instruments:

- three 2.75-inch achromatic telescopes of 42 inches focal length by John Dollond (1707–1761; King, 1979);
- an astronomical clock with compound pendulum by John Shelton (Clifton, 1995) similar to the one used by Lieutenant James Cook in his 1769 transit of Venus expedition (Howse and Hutchinson, 1969) and later, in 1900, moved to Kodaikanal Observatory—where it is still ticking (see Kochhar, 1987);
- a quadrant by John Bird (1709–1776; Hellman, 1932); and
- a 20-inch focal length transit instrument by John Stancliffe (Andrews, 1996: 231).

The longitude of the Observatory was determined from observations of eclipses of the Jovian satellites. The first observation on record, on page 164 in the MS Records at the Indian Institute of Astrophysics Archives, dates from 5 December 1786 and pertains to the determination of the coordinates of Masulipatam Fort Flagstaff from such observations.

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 (Phillimore, 1950) and the Observatory passed from Petrie into the hands of Topping. The Directors of the East India Company (EIC) gave consent in 1790 for "… the Establishment of an Observatory at Madras … [that] would be of very great advantage to Science." Topping was the Company's new Astronomer and Marine Surveyor. In 1792 the observatory was moved to new premises at Nungambakkam designed by Topping and renamed Madras Observatory (see Figure 2).



An Account of the Comet which appeared
in the Months of September, October and November 1807.

By Captain J. Warren
His Ms. 33d Regt. of Foot

The Comet of which it is the object of this paper to describe the Path, was noticed for the first time in Bengal, at Penang and at Sea (in Latitude 10°S) about the 20th of September.

By some unaccountable over sight or accidental intervention of Clouds, it was not noticed at Madras untill the 2d of October, when it appeared in the Constellation of the Serpent, about 9½ degrees N of α of that asterism, of the size of a Star of the first magnitude with a faint beard about 3° in length just discernible to the naked Eye. Viewed thro' a Telescope, its Nucleus was ill defined, with hardly any apparent diameter, and surrounded with a haze similar to that of its beard. Its size rapidly diminished and on the 8th of October it did not seem magnified when viewed through a Telescope with a power of about 80. It was seen

Figure 1: The title page of Warren's MS about the Great Comet of 1807 (courtesy: RAS Library and Archives).

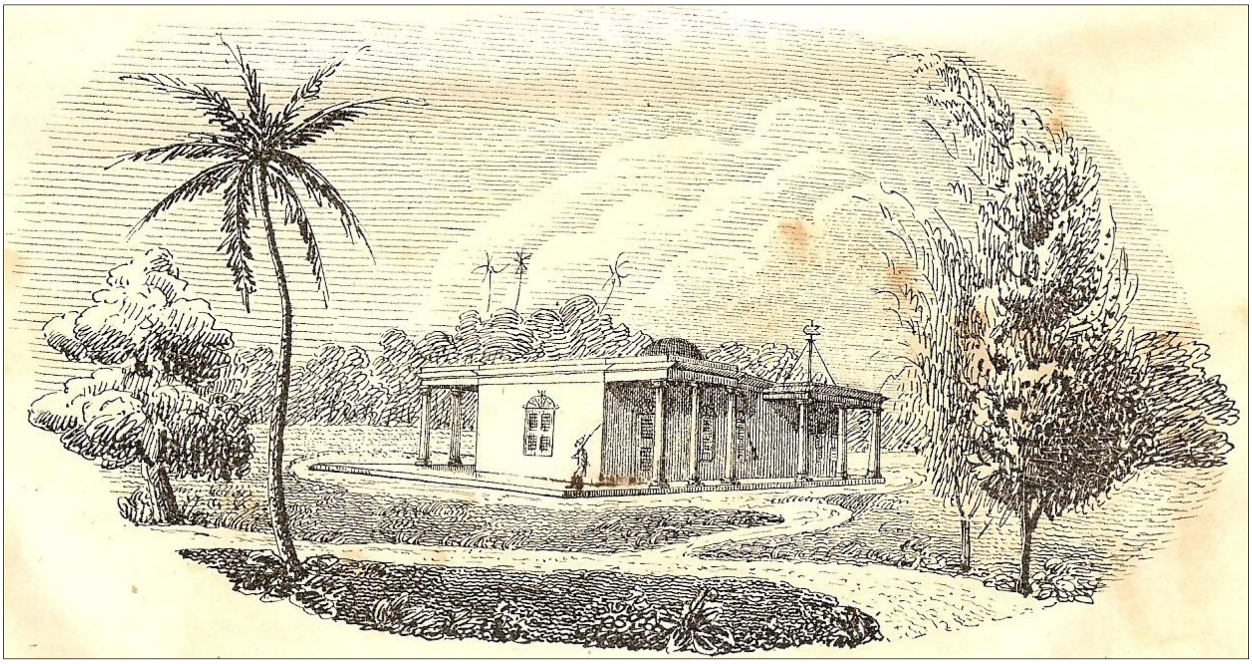


Figure 2: Madras Observatory at Numgambakkam (from the cover of Volume IV of Taylor (1838) (courtesy: Indian Institute of Astrophysics Archives).

Madras Observatory initially served as the reference meridian for the work on the trigonometric survey of southern India initiated by the East India Company. It was called the Great Trigonometrical Survey of India from 1818, and eventually would cover the entire Indian region. Thus, a precise determination of the Observatory's longitude was essential, from which longitudes in the Survey would be measured. Subsequent work at the Observatory was mainly positional astronomy: recording positions of bright stars on the celestial sphere. In 1793 Toppings' assistant John Goldingham (1767–1849) also began systematic meteorological measurements at the Observatory.

After Topping's death in 1796, Goldingham took charge as the Company's Astronomer and Marine Surveyor on the Coast. His tenure was in two phases: between 1796 and 1805, and from 1812 to 1830. In the intervening period, while he was away in England, Captain John Warren (1769–1830; Figure 3) took charge. Warren arrived in Calcutta in December 1793, and later was involved with the trigonometrical survey of the southern region (Kochhar, 1991).

Goldingham was succeeded by Thomas Glanvile Taylor (1804–1848) in 1830. He, too, maintained the meteorological measurements.

In 1804 Madras Observatory received a 12-in Troughton circular altazimuth instrument and a portable transit by Jesse Ramsden (1735–1800; Chapman, 1996; McConnell, 2007). Warren resigned in December 1811 and Goldingham resumed his duty on 17 February 1812. Phillimore (1950: 196) lists the only available instruments maintained around this time as a transit telescope by Stancliffe, a portable transit by Ramsden, three astronomical clocks, three Dollond telescopes and a circular instrument; Warren spoke very highly of this last-mentioned instrument.

Stellar positional measurements were not the only astronomical observations conducted at Madras Observatory. Solar System objects and events, and occultations of the fixed stars and planets by the Moon, also were of interest.

Madras Observatory also initiated a local time service. Since the local time (based on meridian transits of stars or the Sun) depended on longitude, for time-keeping it was necessary to choose a standard longitude for India. In 1802 Goldingham determined the latitude and longitude of Madras as 13° 5′ 24″ N and 80° 18′ 30″ E from observations of eclipses of Jupiter's satellites and culminations of the Moon. Subsequently, in 1807 Warren redefined the longitude as 80° 17′ 21″ E, and this remained the accepted value for almost a century, until 1905 (Phillimore, 1950: 195). Recall that Lambton had commenced the trigonometrical survey at Madras on 10 April 1802 when a baseline measurement relating to the longitude of Madras was made.

Warren also was concerned about the value of the latitude for Madras, and he made observations of zenith distances of selected stars from October 1806 to June 1807 with a zenith sector loaned to the Observatory by William Lambton (ibid.). As a result he refined the latitude by several arc-seconds.

For a biographical sketch of John Warren see Kochhar (1991), and for details on the development of modern astronomy in India see Kochhar and Orchiston (2017).

3 THE GREAT COMET OF 1807

According to Kronk (2003), the Great Comet of 1807 (C/1807 R1) was discovered by Castro Giovanni of Sicily in the evening twilight near the horizon in the west-southwest direction on 9 September 1807. Subsequent independent discoveries were from 21 September only, its observability being subject to the observer's latitude and interference from a brightening Moon (with Full Moon on 18 August and 16 September). The accomplished French astronomer Jean-Louis Pons (1761–1831) was the first to independently discover the comet, on 21 September. By then it was a bright comet, distinctively visible to the naked-eye, and it also was well observed by William Herschel. The comet was last observed on 27 March 1808 (ibid.). Details of the observations of the comet made elsewhere can be found in Kronk (2003) and Vsekhsvyatskii (1964).

Figure 3: John Warren, Acting Astronomer, Madras Observatory 1805-1812 (courtesy: Indian Institute of Astrophysics Archives).

The comet passed closest to the Earth on 26 September, at 1.1533 AU. In the month of October, it displayed two tails, a straight tail more than 6° long and a relatively shorter curved one. It continued to be a naked-eye object throughout the months of October, November, and even into December by which time it had dimmed.

4 JOHN WARREN AND THE GREAT COMET OF 1807

The Madras M.S. Records in the Indian Institute of Astrophysics Archives is a hand-written document of the Madras Observatory proceedings. It spans the period January 1794–October 1812, and runs to 218 pages. Included is the Report of Madras Observatory dated February 1809 by Captain John Warren, which on pages 78–79 briefly refers to the 1807 comet:

> In September, October and November 1807 the remarkable Comet appeared which had attracted so much of the attention of astronomers in Europe. Having no Instrument at the observatory of sufficient powers of observation of this nature, the acting astronomer was under the necessity to compensate by the number for the inaccuracy of his observations involving long and tedious calculations and approximations the power of which is well known to persons acquainted with those operations. The Paper on the movements and path of the Comet was submitted to Government early in 1808 was the result of two months calculations.

The soft copy of Warren's (1808) paper is spread over 21 jpeg images, and has four figures depicting the geometry of the situation. Warren begins by saying:

> The Comet of which it is the object of this paper to describe the path, was noticed for the first time in Bengal, at Penang and at Sea in latitude 10°s / about the 20th of September. By some unaccountable oversight or accidental intervention of Clouds, it was not noticed at Madras until the 2nd of October … There being no Instrument in the Madras observatory wherewith to take at once angles of altitude and azimuth, I ascertained the position of this Comet relatively to the neighboring fixed stars with an 8 Inch Radius Sextant made by Ramsden, I observed it from the 3rd of October until it became too faint to be to admit of a tolerable observation by means of an Instrument of so little power.

In the eighteenth century a Ramsden's sextant was a good navigation tool that enabled mariners to determine altitudes of celestial objects and ascertain their position at sea with accuracy. An example of such an instrument is shown in Figure 4.

Equipment apart, one needed accurate positions of fixed stars in the sky, with due corrections applied for precession and nutation. The most notable eighteenth century star catalogues were Flamsteed's *Historia Cœlestis Britannicæ* (1725); Lacaille's *Coelum Australe Stelliferum* (1742), a catalogue of 9766 southern stars; and Lalande's *Éphémérides des Mouvemens Célestes* … (1783). The latest, however, was Piazzi's first catalogue, *Praecipuarum Stellarum Inerrantium*, a catalogue of 6748 fixed stars that was published in 1803 (Lequeux, 2014; Thurmond, 2003). However, according to Kochhar (pers. comm., December 2018), at that time Madras Observatory did not possess any star catalogues, and for his part Warren (1808) does not mention using one.

Warren (ibid.) determined the orbit of the comet using spherical trigonometry and Kepler's laws. To deduce the six elements, at least three separate sets of angular observations of right ascension (α) and declination (δ) were necessary, and he used four consecutive observations, made on 3, 14 and 25 October and on 18 November. Calculations for a highly eccentric ellipse were normally quite involved, and since during the brief interval a comet was seen, the arc of an elliptical orbit had about the same curvature as that of a parabola, astronomers chose to work with that assumption (see Gregory, 1802: 393).

Using the Ramsden sextant, Warren measured the angular position of the comet with reference to two nearby fixed stars, using different reference stars on each occasion, and he duly recorded the local time of each observation. Corresponding to the date and the time of each observation, he derived and tabulated the right ascension, declination, geocentric longitude and geocentric latitude of the comet, the Sun's ecliptic longitude and elongations of the comet. Warren (1808) did not give the exact times of his last two observations. He then proceeded to look for a parabola that would represent the position of the comet in the sky at these respective epochs. Warren (ibid.) obtained a parabola from the first two observations, and stated:

> … if by applying the circumstances of the third observation, it is also found to answer then it will be the real path, or orbit of the Comet.

The deduced orbital elements are presented in the second table in Warren's manuscript. He also tabulated the orbital elements of the comet of 1684, about which he says "… is the only one that bears the least resemblance with ours." This comet is now designated C/1684 N1, and the elements are those given by Halley (1704–1705: 1886), but the time of perihelion passage differed. In fact, the given date is close to that cited later in 1874 by Neugebauer (see Kronk 1999: 378).

After fixing the orbit of the comet of 1807, Warren examined what would be the position of the comet at any given period before its perihelion, say, at 90° anomaly descending and the number of days that would elapse for it to move through this anomaly. One may read this in view of Gregory (1802: 399), who gives the time of passing from perihelion to 90° as $\sim q^{3/2}$. For the distance to the comet on 3 October, Warren deduced a figure 1.1386 AU. Apparently, he computed the absolute value and expressed it in terms of the unit of the Earth-Sun distance then in use, although he did not specify this. That value would have been the one arrived at following the most recent transit of Venus. Observations to determine the solar parallax during the 1769 transit were the most accurate then available, but the values ranged from 8.43″ to 8.80″. As the currently-accepted value for the solar parallax is 8.794148″ (Dick et al., 1998) and the Horizons software gives the corresponding figure for the distance as 1.159 (AU), we can appreciate Warren's result.

Warren (ibid.) deduced that if the comet were at its node on 21 June at noon, when the Earth had an anomaly of 8^s:29°:1′:15″ (which was the longitude of the ascending node), the comet would have eclipsed the Sun. The longitude was expressed in terms of signs, where $8^s \equiv 240°$. Warren ended his 1 January 1808 write-up by noting the observations that were made by his Indian assistant:

Figure 4: An eighteenth century Ramsden sextant (from NationalGeospatial-Intelligence Agency https://www.nga.mil/ABOUT/HISTORY/TIMEANDNAVIGATIONEXHIBIT/Pages/RamsdenSextant.aspx accessed 19.01.2019).

> Having been prevented by illness to observe after the 2nd of December the Bramin assistant Senivassachari continued to notice it. On the 8th of December at 7h P.M. he took roughly its distance from α Cygnii which was about 9°:47′ N.W. and from α Aquilae 35°:11′ NE.
>
> The last sight he had of it was on the 13th after which the light of the Moon prevented his perceiving it any longer.

Warren's regret in not having access to suitable equipment is somewhat puzzling since we know that by 1807 Madras Observatory already possessed three Dollond refractors, a Bird quadrant and a Stancliffe transit telescope. Sextant measurements are not considered very accurate, for, at very least the instrument should be securely mounted. However, given Warren's

Table 1: The orbital elements of the Great Comet of 1807.

Elements	Warren (1808)	Bessel (1810)
Perihelion Distance (*q*)	0.61305	0.64612382
Longitude of the Perihelion Distance		9.8103157,5
Eccentricity (*e*)	1.0	0.99548781
Semi-major axis		143,195
Inclination of orbit (*i*)	63°: 40′: 51″	63°: 10′: 28.1″
Longitude of the Ascending Node (Ω)*	8s: 29°: 1′: 15″	266°: 47′: 11.45″
Place of perihelion (ω)*	8s: 26°: 13: 40	4°: 7′: 30.49"
Time of Passage (Greenwich time)	September 16d: 21h: 2′: 36″	September 18.745366 (for Paris)
Motion	Direct	
Period		1,713.5 years
* Note that Warren's longitudes are expressed in terms of signs (where $8^s \equiv 240°$).		

involvement in the trigonometrical survey, it is not surprising that he was able to give the comet's angular separations from reference stars to the last second of an arc, and the time of the observations to one-tenth of a second. Warren's observational data may yet be useful in any future attempt to further refine the comet's orbit elements.

5 DISCUSSION

5.1 Determining Cometary Orbits in the Early 1800s

Ever since Newton published his *Principia* (1687, Book III, Problem XXI), where he devised a way to calculate a (parabolic) orbit of a comet from three successive observations and used it to compute the orbit of the comet of 1680 (that he had observed), astronomers worked hard to improve the algorithm. They also worked to incorporate the gravitational influences of Jupiter and Saturn, and later Uranus, on a comet's motion.

The first decade of the nineteenth century witnessed the most crucial development in the art of orbit computations, spurred on by the discovery of four minor planets between 1 January 1801 and 29 March 1807 (see Cunningham, 2016; 2017a; 2017b; 2017c; 2017d). The whole exercise of orbit determination used to be arduous. One would divide the orbit into degrees, and for each degree the computations performed were daunting. Then in 1801 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 (Gauss, 1809). This approach soon led to the recovery of a 'lost' Ceres.

As for the Great Comet of 1807, a number of astronomers, including the German Friedrich Bessel (1784–1846), worked out their methods and calculated parabolic orbits based on observations made in October 1807 and incorporating the effects of perturbations. These led to different dates for the perihelion passage. From computations based on observations that extended to 24 February 1808, Bessel found that the orbit was elliptical, with perihelion on 19 September, and a period of 1953 years. Later Bessel (1810) refined the orbital elements on the basis of the observations made between 22 September 1807 and 27 March 1808, which confirmed that the orbit was elliptical, but with a period of 1713.5 years.

The orbital elements that Warren (1808) calculated were close to Bessel's 1810 values, differing mainly in the time of perihelion passage and in the eccentricity (*e*)—see Table 1.

When Bessel (1810: v) presented his calculations, he also made a significant claim for the Great Comet of 1807:

> This is the only comet, with the exception of Halley's Comet whose return was confirmed by its numerous apparitions, that one can assert with certainty to be moving in an elliptical orbit. (My English translation.)

That comets moved in highly eccentric orbits was an accepted norm, but at that time the only comet that was known to move in an elliptical orbit was 1P/Halley. After Edmund Halley (1656–1742), Johann Franz Encke (1791–1865) was the first to report another periodic comet. He rightly concluded that the comets first seen in January 1786, November 1795, October 1805, and November 1818 were one and the same. In 1820 he predicted its return in May 1822, determining a perihelion date of 24 May and a period of 3.32 years. The comet was first detected at Parramatta Observatory in Australia (Saunders, 2004: 185–186), and passed perihelion only about half a day earlier than predicted. The comet has the shortest known period of any comet and is appropriately named 2P/Encke.

5.2 Other Indian Observations of the Great Comet of 1807

There were a few other reported sightings of the comet in September and October 1807 made from Calcutta and Madras.

Sandeman (1868: 181–182) reported:

> THURSDAY October 8, 1807
>
> In our Extra Gazette of the 3rd instant, we had the honor to announce to our readers the appearance of a Comet, and our determination to submit, to their perusal, such information regarding the place and course

of the phenomenon, as we might be able to obtain from men of science, The Comet was undoubtedly seen on the 21st of September, and, we have reason to believe, at an earlier date, but though seen, it seems to have excited very little of the curiosity of those who beheld it, and was not generally observed before the 2nd of October, when the appearance of the star was so luminous as to attract the almost universal notice of the Settlement. On the 3rd of October the Comet was al-so visible, and on that day was observed with a view to ascertain with a reflecting sextant its angular distance from two given stars. The dimness of the specular and other causes prevented the success of the observation, and, on the 4th and 5th of October, the Comet was entirely obscured by the clouds. We have reason to believe that the place of the Comet was ascertained by the result of an observation taken on Tuesday night, but of this fact we are not certain, any more than of a vague opinion which has been stated to us, that the Comet is now receding from the Sun.

If any arguments were wanting to convince our Countrymen of the propriety of establishing a public observatory at this place, we think that the appearance of this Comet, and the unprepared state in which our men of science have (necessarily) been found on the occasion, would be sufficient to bring home conviction to the minds of our most skeptical readers. On this subject there are, however, no sceptics, and we are well aware that the want of an observatory must be ascribed, not to any disinclination on the part of the Settlement to furnish the trifling contributions which the support of such an establishment might eventually require, but merely to that simple, though common, cause of impediment to the progress of all improvement, *the disinclination of individuals to propose a measure which it belongs to the public to carry into effect*. [His italics.]

At Bombay, a public observatory has, we believe, been already projected by the Literary Society of that place. At Madras (fortunately for the interests of science) a public observatory already exists; and we shall be sorry to find our own is the only presidency in India, which can be reproached with the absence of an establishment at once so useful and so little expensive, that the charges for erecting it, as well as for furnishing the necessary apparatus, might be more than defrayed by the proceeds of one, or, at the most, of two lotteries.

Since we wrote the preceding paragraphs we have received certain information that the place of the Comet has been ascertained. The velocity and direction are still unknown.

There was also a report in *The Asiatic Annual Register* (1811: 13) in the section titled "Bengal Occurrences, 1807":

> Oct. 6 - ... For some days past a comet made its appearance. It disappears from the horizon early in the evening. The natives assert, that it portends a scarcity of grain, from its baleful effects on the atmosphere.

In the same *Register*, the section on "Madras Occurrences, 1807" also carried a description of the comet on page 124. There also was a mention of the comet in a London magazine, *The Literary Panorama*:

> Comet. – Madras, October 7. – For several evenings past an unusual luminous appearance, supposed to be a comet, has been seen in the west. It disappears about 8 P.M. Its progress is rapid, and it seems to be fast approaching the sun. It will be remembered that a comet appeared in Europe a few months ago. (Taylor, 1808: 359).

Note that the aforementioned Bombay Literary Society was founded in November 1804 along the lines of the Asiatic Society of Bengal (1784) to promote scientific discussions. In 1805 it started a library, a museum and an astronomical observatory (Sangwan, 2000: 19). In Bombay, the East India Company only established a facility for astronomical observations and time-keeping much later, at Colaba, in 1823. The East India Company also established an observatory at Calcutta in 1825 in the Surveyor General's Office in Chowringhee. This was championed by the Surveyor General of India V. Blacker (1778–1826), and would serve the Survey Department (see Sen, 2016: 46–53, 62–63).

5.3 The Great Comet of 1807: An Independent Discovery From India

As Kronk (2003) notes, the Great Comet of 1807 should have been spotted from the southern hemisphere weeks before it was discovered from Europe. Around the time of its discovery, the comet was a low declination object but with a solar elongation of about 35°, it would have been easier to spot from a location like Madras (Full Moon on 16 September, 16 October, etc.). In the MS Records, the date of Warren's first observation of the comet is not given, but in his manuscript Warren (1808) notes that

> The Comet might have been seen when at its Perihelion; for then its Elongation was 32°:49′:21″ and its distance as 11.26 which is a little more than what it was on the 23rd of Nov. when it was still discernible to the naked eye. As it passed its node on the 17th of Sept at 20h:5′ when its Elongation was 34°: 42′:56″ and its distance somewhat less than the above, it must have been distinctly visible; and so it seems was the case since it was noticed at several places about the 20th of that month …

The Horizons System uses Bessel's refined elements of 1810 and one cannot miss noting their similarity to Warren's values. For the perihelion date of 16 September, the Horizons System gives the corresponding elongation as 33°.63 and also shows the comet having passed its node on 17 September at around 17 UT. All through the months of September, October and November, the comet trailed the Sun. The ephemeris of the comet generated for September 1807 presents an interesting perspective: its *r* and *Δ* values (heliocentric and geocentric distances in AU) changed only a little through the month, from 0.726 and 1.248 on 3 September to 0.709 and 1.158 on 3 October. On 9 September—the day of its discovery in Europe—its altitude in the Madras sky at sunset would have been ~20°; ~26° on 16 September and ~28° on 20 September. The comet then rose in altitude as days passed. Meanwhile, Venus was an evening object, and could be seen nearby. From the decreasing *r* and *Δ* values through the dates above, and the fact that it passed its closest by the Earth on 26 September at just 1.153 AU, one can infer how the comet would have gradually brightened during the month, affected only by a waxing Moon. Then through the latter half of October and November the brightness would decrease since *r* was increasing.

Phillimore (1950: 195) cites a flattering comment about Warren made by Justice Andrew Scott:

> I do not conceive that either Captain Warren's merit or his labour are so generally understood as they deserve to be. He sent me his paper on Zenith Distances & on the Comet to peruse … When the result of what he has done … comes to be known in Europe … Captain Warren will be found entitled to praise. If he were to give up his position at the Observatory at this time, I know of no one who could supply his place.

Warren and Sandeman (1868) independently refer to the first sightings of the 1807 comet being made from Bengal on 20 and 21 September respectively, which would imply that the comet was independently discovered from India. Those who observed the comet on the respective dates are nowhere named. In the days when communication with Europe happened through dispatches carried by ships, it would be months before Warren would learn about the comet's discovery in Europe, and *vice versa*.

It is important to note that at this time there was no set procedure to follow after the discovery of a new comet at a location far from Europe. Referring to a geographically isolated Australia in pre-telegraphic days, Orchiston (1997, and pers. comm., 2011) terms the situation a 'tyranny of distance' in the matter of independent comet discoveries made there. But more importantly, the disparity between amateur and professional astronomy stood out during the nineteenth century and may have played a key role in choosing whether or not to publish cometary observations. Professional astronomers were expected to do positional astronomy, not to search for, or follow, new comets—an activity reserved for amateurs—notwithstanding popular perceptions to the contrary. It is possible that this philosophy and the administrative changes then being effected at Madras (Phillimore, 1950: 299) caused Warren to refrain from making further observations of the 1807 comet. Then, a little later, he did not bother to write a paper on the Great Comet of 1811 that he observed and wrote about in the Madras MS Records.

5.4 Warren's Later Astronomical Studies

John Warren resigned from Madras Observatory in December 1811 (Phillimore, 1950: 196), and in 1814 he embarked upon a study of the south Indian astronomical chronological system. This culminated in a volume titled *A Collection of Memoirs on the Various Modes According to which the Nations of the Southern Parts of India Divide Time*, alternatively named *Kāla Samkalita* (in Warren's words, *The Doctrine of Times*), which was published in 1825 by the College Press in Madras (Warren, 1825). As Warren says, this work discusses three main subjects: (1) the Tamil solar year, that rests on Aryabhatta's *Ariyā Siddhānta* (but the latter may have based it on the *Sūrya Siddhānta*); (2) the luni-solar year, as per the *Sūriyah* Siddhānta; and (3) the the *Mahom-medan Kalendar*, as per the *Arabic* system. There is a copy of this book in the Indian Institute of Astrophysics Archives, and on page 9 it contains an interesting statement:

> *Ramissuara*m [this is now known as Rameswaram or Pamban], is a small Island, situated between Ceylon and the Continent of India, at the entrance of Palk's passage in the Streights of Manaar, *and is famous for its ancient Pagoda and Observatory*. [Our italics.]

The 'Pagoda' is the Ramanathaswamy Temple, one of the most sacred Hindu religious sites in all India and a major pilgrimage destination, but Warren's mention of an 'Observatory' is puzzling. Perhaps he was referring to Mt. Gandamadana near the town of Rameswaram. This is the most elevated site on this small low-lying island, and

> It is believed that this was the hillock from whose summit Lord Rama observed Lanka and conceived the idea of constructing a bridge between India and Lanka. A temple commemorates the exact site. (Pamban Island, n.d.).

6 CONCLUDING REMARKS

Records indicate that the Great Comet of 1807 was the first comet observed from Madras Observatory following its construction at Nungambakkam in 1792. Subsequently, John Warren also observed the Great Comet of 1811 (C/1811 F1), but his observations were very brief and were not published at the time. However, I discuss them in a separate paper (Kapoor, 2019) in this issue of the *Journal of Astronomical History and Heritage.*

The next comet that definitely was observed from Madras Observatory was the Great Comet of 1831 (C/1831 A1), which was tracked by Thomas Glanville Taylor. Going by his date of the first sighting, Taylor has been identified as an independent discoverer of this comet (Kapoor, 2011).

It is possible that one other comet was observed from Madras Observatory between 1811 and 1831. This was Comet C/1821 B1 (Nicollet-Pons), which was discovered on 21 January (Kronk, 2003: 54). John Goldingham was the Director of Madras Observatory at the time. A report dated 1 March 1821 in *The Asiatic Journal* (1821) mentions a comet seen in Madras during the previous four or five days. It was an evening object, and as the sky got dark it could be seen a few degrees above the horizon near γ Pegasi and northward of Jupiter but above it. The comet was said to be fading each day, and moving westwards. It is not clear if it was observed from Madras Observatory. Meanwhile, a report dated 10 March 1821 mentions that this comet, also "… has been seen by many respectable persons in Bombay …"

7 ACKNOWLEDGEMENTS

I am grateful to the Royal Astronomical Society (RAS) for making available from the RAS Archives scans of John Warren's unpublished manuscript *MSS Madras 6* and for permission for it to be published in *JAHH*. RAS Librarian Dr Sian Posser was very helpful in cross-checks with the original John Warren manuscript. I also thank the Director of the Indian Institute of Astrophysics (IIA) for permission to use John Warren's unpublished account of the Great Comet of 1807 contained in the Madras MS Records with the IIA Archives, and Drs Christina Birdie and A. Vagiswari while at the IIA Library.

Thanks also are due to the anonymous referees for their constructive comments. This work has gratefully made use of NASA's Astrophysics Data System; the "On-Line Solar System Data Service" of the Jet Propulsion Laboratory (2017); the web sites of John Walker and Juhani Kaukoranta and Raahen lukio; and other reference material found on the Internet.

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