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MADRAS OBSERVATORY AND THE DISCOVERY OF C/1831 A1 (THE GREAT COMET OF 1831)

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Abstract: In this paper we present excerpts from the records at the Indian Institute of Astrophysics Archives that show that T.G. Taylor, an astronomer at the Madras Observatory, was an independent discoverer of the Great Comet of 1831 (C/1831 A1) on 7.00972 January 1831 UT, although John Herapath who first observed the comet from Hounslow Heath (England) on January 7.25 is generally credited with the discovery. Taylor continued to observe the comet until 20 February 1831, and his observations were duly published by the Madras Observatory in 1832.

Key words: The Great Comet of 1831; Madras Observatory; T.G. Taylor

1 INTRODUCTION

This paper documents the discovery of the Great Comet C/1831 A1 (1830 II, 1831 a) by the Madras Observatory astronomer T.G. Taylor on 7.00972 January UT, even though he has not been credited with this discovery (e.g. see Kronk, 2003; Vsekhsvyatskii, 1964).[1] Rather, as a prominent naked eye object this comet was noticed in many different places at about the same time, but the first *reported* observation was made by the English physicist, John Herapath, on 7.25 January UT, or at about 6 a.m., from Hounslow Heath in England. He noted that it had a head as bright as a star of the second magnitude and a white tail that was 1°- 2° in length, while the head "… was of the same colour as the tail, but, in proportion, far more splendid." (Herapath, 1831). Observing from Boston, R.T. Paine independently discovered the comet on 7.42 January UT, and it was subsequently reported by others (see Kronk, 2003; Vsekhsvyatskii, 1964). When G. Santini first saw the comet on 8 January from Padova it was visible to the unaided eye and it remained so for much of the month of January. N. Cacciatore saw the comet from Palermo on the morning of 23 January, when it had a bright nuclear condensation about 20″ across embedded in a 3′ nebulosity, with a tail 3° long. The comet had passed perihelion on 28.1604 December 1830, and it was closest to the Earth on 9 December 1830 (at 0.6856 AU) and on 16 February 1831 (at 0.5335 AU) (JPL Small-Body Database Browser). According to Kronk (2003), the last-known observation of this comet was made on 19.8 March 1831.

In this paper, we provide background information about the Madras Observatory and biodata on T.G. Taylor before discussing his observations of the comet.

2 A SHORT HISTORY OF THE MADRAS OBSERVATORY

Although sporadic observations of certain astronomical events were recorded during the seventeenth and eighteenth centuries, the earliest scientific astronomical observatory in India was established in 1786.[2] This was a private facility erected at Egmore in Madras (now Chennai) by William Petrie (d. 1816), an officer with the East India Company (see Kochhar, 1985a). Petrie's intention, expressed years later in a memorandum of 4 September 1804 to the Governor of Madras

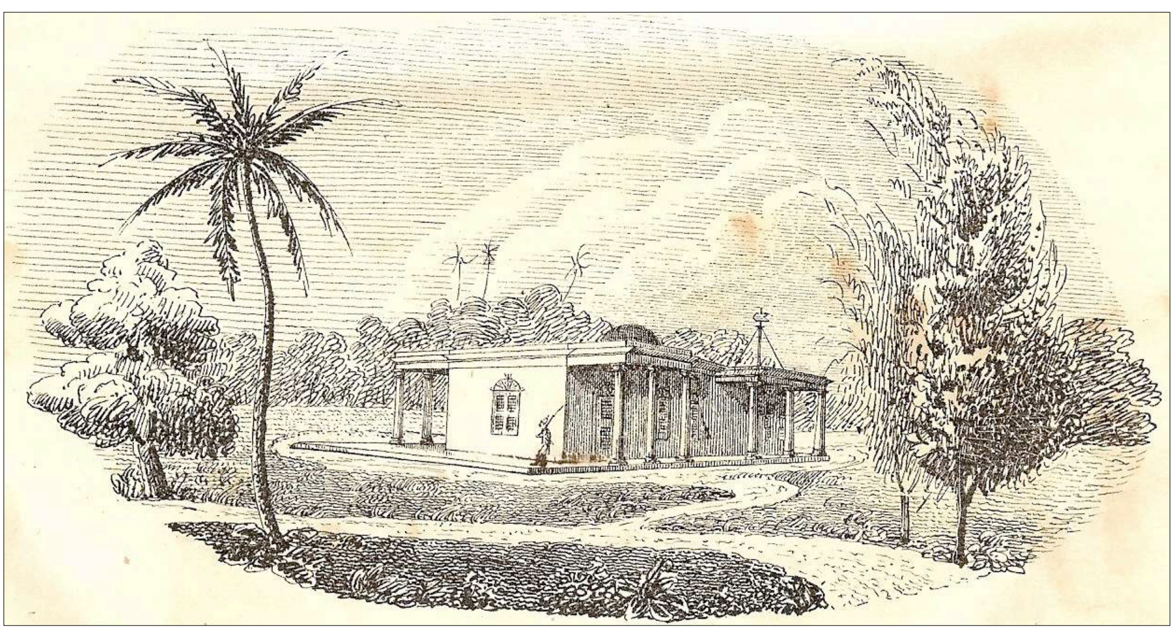


Figure 1: The Madras Observatory at Nungambakkam (from the cover of Taylor, 1838a; courtesy: IIA Archives).

was "… to provide navigational assistance to the company ships, and help determine the longitudes and latitudes of the company territories." (IIA Madras MS Records: 76). He possessed three 2¾-inch achromatic telescopes of 3½ feet focal length by John Dollond; an astronomical clock with compound pendulum by John Shelton (similar to the one used by James Cook during the 1769 transit of Venus), which was moved to the Kodaikanal Observatory in 1900 and is still functioning; a quadrant by John Bird; and a 20-inch transit instrument by Stancliffe (see Kochhar, 1985a; 1985b). The longitudes were determined from observations of Jovian satellite phenomena. The first observation on record, on page 164 in the MS Observations at the IIA Archives, dates to 5 December 1786 and pertains to the determination of the coordinates of Masulipatam Fort Flagstaff from such observations. In 1789, the East India Company took over Petrie's observatory, and it was moved in 1792 to new premises at Nungambakkam, designed by the Company's new astronomer and marine surveyor Michael Topping (1747–1796), and renamed Madras Observatory (Figure 1). In 1810, its ownership changed yet again when it became an official colonial government observatory, under the control of the Surveyor General of Madras (Kochhar, 1991b). Madras Observatory therefore has a long history (see Ananthasubramanian, 1991), but this was "... a chequered history for more than one hundred years …" (Kochhar, 1985b: 288). The noted geographer Sir Clements Markham (1878: 340) later had this to say about the Observatory in his work *A Memoir on the Indian Surveys*:

> The Madras Observatory is now the sole permanent point for astronomical work in India, and the only successor of the famous establishments founded by Jai Sing. It has been presided over by a succession of six able and accomplished astronomers, it has produced results which entitle it to take rank with the observatories of Europe, and its present Director is engaged in the prosecution of labours which are of great importance to astronomical science.

The Director referred to above was Norman R Pogson (1829–1891), who served in that capacity from 1861 until 1891. Madras Observatory eventually evolved into the present-day Indian Institute of Astrophysics.

As we have seen, in 1789 the Observatory passed from Petrie's private ownership to the East India Company and Michael Topping's Directorship; Topping also 'inherited' John Goldingham (1765/66–1849; Kochhar, 1985b), who initially was Petrie's assistant. Prior to his Madras Observatory appointment Topping had already undertaken a much-needed survey of the maritime-unfriendly Coromandal coast, and during 1786-1787 he determined the latitude and longitude of a number of different locations. In 1794 and 1795, Goldingham and Topping determined the longitude of Masulipatam, using observations of Jovian satellite eclipses (Taylor, 1832). The Madras Observatory then became the reference meridian for the trigonometrical survey of southern India which was initiated by the East India Company. From 1818 it was called the Great Trigonometrical Survey of India, and was intended to cover the entire Indian region (Kochhar, 1991a). A precise determination of the longitude of the Madras Observatory was thus essential, so that longitudes required during the survey could be measured. William Lambton began the survey at Madras on 10 April 1802 when a baseline measurement relating to the longitude of Madras was made (Bappu, 1986).

In 1793 Goldingham commenced systematic meteorological measurements at the Observatory. He maintained a meteorological register for barometric pressure, which was measured at sunrise, 10 am, noon, 2 pm, sunset and 9 pm from 1796 until 1825, but with a gap through 1808-1812 during his years of absence (*Hundred Years* …, 1976). Following Topping's untimely death in 1796 Goldingham served as Director for two discrete intervals, 1796-1805 and 1812-1830, and during the intervening period, while he was away to England, Captain John Warren (1769–1830) took charge. Goldingham was eventually succeeded by Thomas Glanville Taylor (1804–1848) in 1830. He, too, maintained the meteorological observations, and the tradition was duly followed by successive astronomers, with the series carrying entries for thermometer readings, rain gauge, wind and weather was published over the years. It was under Taylor's direction that high altitude meteorological observations were carried out at a bungalow built for the purpose atop Dodabetta at a height of 8640 feet (2633 m) in the Nilgiri hills. Observations began in February 1847, with an Osler anemometer, a barometer, thermometers and rain gauges. The measurements were taken at 9:40 am and 3:40 pm, the supposed hours of maxima and minima, and continued until 1858 (Markham, 1878: 280-281). More recently, this robust suite of historic Madras Observatory meteorological records has been utilized by climatologists to measure fluctuations in the El Niño southern oscillation phenomenon across the Indian Ocean basin and the Indian summer monsoon (e.g. see Allan et al., 2002).

In 1804 the Madras Observatory received a 12-inch Troughton circular altazimuth instrument, and in 1830 it acquired a 5-foot transit instrument, a 4 feet mural circle and a 5-foot equatorial telescope, all by Dollond. Once in office, Taylor lost no time installing these instruments (Kochhar, 1985b), and he provides information about this in the Observatory's publications (Taylor, 1832: Preface). For example, he says this about the transit telescope:

> The five feet Achromatic is exceptionally well and steadily mounted on a mahogany frame armed with brass, and being supplied with two graduated circles and a long axis moving on a graduated arc, it has occasionally been employed as an equatorial in making rough observations out of the meridian in addition to its other uses in observing Occultations and Eclipses. (ibid.).

The introduction of these new instruments enabled work of greater astronomical relevance and precision to be carried out at the Observatory.

As was the norm for British colonial observatories at this time, research at the Madras Observatory focused on positional astronomy, and the transit telescope was used to accurately determine the positions of bright stars. The culmination of these early efforts was the preparation by Taylor of the famous catalogue of 11,015 stars in the southern sky, epoch 1 January 1835, entitled *A General Catalogue of the Principal Fixed Stars from Observations Made at The Honourable The East India Company's Observatory at Madras in the Years 1830-1843* (Taylor, 1844). Taylor's catalogue was supplemented by further observations made between 1849 and 1853 of 1440 stars selected from the British Association Catalogue, and these were reduced to 1 January 1850 by his successor W.S. Jacob (1813–1862) and published in 1854 (see Worster and Jacob, 1854). The 'Madras Catalogue', as it came to be known, was acclaimed by the Astronomer Royal, George Biddel Airy, in his 1854 address to the Royal Astronomical Society:

> I must characterise the Madras Catalogue of our late member, T.G. Taylor, as the greatest catalogue of modern times. In the number of observations and the number and distribution of stars, and the circumstance that the observations were made, reduced, combined, and printed, at the same place and under the same superintendence, it bears the palm from all others. But this was the fruit of an endowed observatory, the work of an astronomer and competent assistants, whose strength was not exhausted by any other employment. After this come such works as Groombridge's Catalogue ... (Airy, 1854: 145).

Taylor's zeal in this pursuit is reflected in the following comments that he included in the *Results of Astronomical Observations Vol. IV …*:

> At the outset of my Astronomical career at Madras, it occurred to me that one of the most useful purposes to which I could devote the Madras Instruments was that of determining the places of a large catalogue of Stars limiting the number of observations to an extent that might leave me sure to two or three tenth of a second of time for the Right Ascension, and, to two seconds of space for the Declination ... (Taylor, 1838a: 85).

The Madras Catalogue was subsequently revised by the Nautical Almanac in 1893 (see Kochhar, 1991b).

However, these stellar positional measurements were not the only astronomical observations conducted at the Madras Observatory. Solar system objects and events, and occultations of stars and planets by the Moon were also of interest. Goldingham's observational work was predominantly devoted to eclipses of the Jovian satellites, and these were published in five different volumes of the Observatory's publications, namely, *Astronomical Observations*, *Madras 1825-1827* … (4 volumes) and *Madras Observatory Papers* (1827). These volumes also included observations of eclipses of the Sun (on 1 February 1813, 16 July 1814, 15 May 1817 and 3 March, 1825) and of the Moon (the total eclipse of 22 August 1812). Goldingham (1827) also communicated a paper to the Astronomical Society of London on the longitude of Madras determined from observations of eclipses of the first and second satellites of Jupiter made between 1817 and 1826.

Quite apart from its astronomical research, the Madras Observatory also provided a local time service (see Kochhar, 1991a). Since the local time (based on the transit of stars or the Sun) depends on the longitude of a place, for time-keeping purposes a standard longitude is chosen for a region, a state or a country. In 1802 Goldingham fixed the latitude and longitude of the Madras Observatory at 13° 05′ 24″ N and 80° 18′ 30″ E, respectively from eclipses of Jovian satellites and culminations of the Moon (although that was not the final word, for further longitude determinations were subsequently made). That started the first use of the current time zone, with the day beginning at midnight. The clock at the Observatory was linked to a gun at Fort St. George that was fired at 8 p.m. every evening for the purposes of time-keeping and to serve as the standard time. A similar service was provided for ships in Bombay Harbour by the Colaba Observatory, which was founded in 1823 by the East India Company (see *Hundred Years* …, 1976). For civil purposes , a strandard time was assigned for India much later by rounding off to 5 hours 30 minutes ahead of Greenwich Mean Time. Pogson (1867) notes in his report on the Observatory's activities for the year 1 May 1865-30 April 1866 that

> The Madras mean time of the flash of the 8 p.m. gun has been carefully noted, and published as formerly, to facilitate the rating of chronometers in the Roads. It is intended as early as possible to carry out the long contemplated telegraphic discharge of the Fort and Mount guns, and the erection of three sympathetic electrical clocks, for the convenience of the public in various parts of Madras.

Late in the nineteenth century an Indian Observatories Committee formed in England to assess the work of the Madras Observatory deliberated upon its future. In 1882 Pogson had proposed the acquisition of a 20-inch telescope for solar and stellar photography and spectroscopy, with this new facility preferably to be located at a southern hill station. Subsequently the emphasis veered towards observations of the Sun in the tropical Indian skies, and a quest began to find a suitable site. At a meeting held in 1893, the Committee decided to establish a solar physics facility at Kodaikanal in the Palani Hills, but deferred making a decision to establish a permanent astronomical observatory at a suitable location. By 1899, Charles Michie Smith had shifted the astronomical activities from Madras to Kodaikanal, and equipped with new instruments, clear skies and a favourable ambience at an altitude of 2343m the Kodaikanal Observatory began work, centered on solar astronomy (Bappu, 2000). Henceforth, the Madras Observatory focused on meteorological work, and the only astronomical work that continued there—up until 1931—was conducted in order to provide a time service. Today, Indian Standard Time (IST) is taken to be UT + 5.5 hrs, which is solar time at a longitude of 82.5° E, a location that is a little west of Mirzapur, near Allahabad.

We have seen above how in 1802 the Madras Observatory came to serve as the reference meridian for the trigonometrical survey of India (Markham, 1878). Of the other non-astronomical work, mention must be made of the Observatory's participation in the Göttinger Magnetischer Verein (Göttingen Magnetic Union), the world-wide network of 53 magnetic observatories (including 18 non-European ones) initiated by Alexander von Humboldt, Carl Gauss and Wilhem Weber to record variations in the intensity and direction of the Earth's magnetic field. Simultaneous readings were taken off the magnetometers every five minutes on specific days during 1836-1841. In addition to the Madras Observatory, other Indian observatories that participated in this international collaboration were located at Shimla and Trivandrum (now Thiruvananthapuram). The results were collated and subsequently published by Gauss and Weber (see Gubbins and Herrero-Bervera, 2007: 729-733). Taylor (1837a) even published his observations in *The Journal of The Asiatic Society of Bengal*. He began by observing "Notwithstanding the value which has of late years been attached to observations of the Magnetic dip and Intensity, I may, I believe, safely state, that the whole of British India has failed to put on record a single good act of experiments to this end …", and from his observations made on 26 April 1837 he provided a value of the Dip of 6° 52′ 30″. He further noted that "During the present century, I cannot find that any observations for Dip have been made at *Madras*, but there is one result on record dated 1775, when Abercrombie found it to be 5° 15′ N; if this result can be trusted, it would appear that the Dip is on the increase at the rate of 1′ 34″ in a year." This was also the first publication on geomagnetism from India. Jointly with John Caldecott (1800–1849), Taylor also carried out geomagnetic observations at several other places in the region, but these were never published (see Sthanapati, 2010). Caldecott, a British Commercial Agent to the Travancore Government, was an amateur astronomer who became the Director of a modern astronomical observatory established in 1837 by Rama Vurma (Swathi Thirunal), the Raja of Travancore. The Raja was a great patron of science, and was deeply interested in astronomy. Magnetic observations at Madras were also continued in later years (e.g. see Pogson (1884) for further details).

Taylor's Directorship ended in 1848, and it is only fair to say that the Madras Observatory flourished under subsequent Directors. His successor was W.S. Jacob (1813–1862) who, before moving to the Madras Observatory had set up a small private observatory housing a 5 feet Dollond equatorial at Poona (now Pune) in 1842. Jacob had observed eclipses of Jovian satellites and the rings of Saturn, and he had published two papers in the *Memoirs of the Royal Astronomical Society*. His main interest was in cataloguing binary stars, and investigating their orbits. At the Madras Observatory during the years 1848-1858 he added double stars to the research repertoire. Jacob followed Taylor's lead and published papers in the prestigious *Monthly Notices of the Royal Astronomical Society*, thus bringing the Observatory's work to a wide international audience (e.g. see Jacob, 1854; 1857). Norman Pogson (1829–1891), who was Director from 1861 to 1891, started his career as an astronomer at George Bishop's South Villa Observatory in London, where he trained under J.R. Hind, and then enjoyed fruitful periods at the Radcliffe Observatory and at the Hartwell Observatory. Although his name is well known as the founder of the modern definition of the logarithmic magnitude scale, while at the Madras Observatory he also used the new eight-inch Cooke equatorial to discover five new asteroids and five variable stars (Bappu, 1986; also see Kapoor, 2010). In addition, in 1867 his Indian assistant, C. Ragoonatha Charry, discovered that R Reticuli was a variable star (Bappu, 1986; Markham 1878; see, also, Kameswara Rao et al., 2009).

3 THOMAS GLANVILLE TAYLOR: A BIOGRAPHICAL SKETCH

Information about T.G. Taylor in the IIA Archives is rather sparse at present, and the Institute does not even have a portrait of him. In his book, *Records of the Anglo-Norman House of Glanville from 1050 to 1880*, Glanville-Richards (1882: 121-145) states that Thomas Glanville Taylor was born in Ashburton (England) on 22 November 1804 to Thomas Taylor, Deputy Astronomer at the Royal Observatory, Greenwich,

> … and after studying some time at the Royal Observatory under his father, during which period he gave every aid in his power to Colonel Sabine when he was engaged in his experiments "for determining the difference in the number of vibrations made by an invariable pendulum," and also much aided the same gentleman in his still more difficult and delicate investigation respecting "the reduction to a vacuum of the vibrations of an invariable pendulum."
>
> Mr. T. Glanville Taylor also assisted Mr. Groombridge with the reduction of his "Catalogue of Stars within 50° of the North Pole." His ability and zeal were so much approved of by the celebrated Astronomer Royal, John Pond, Esq., F.R.S., that at that gentleman's recommendation Mr. T. Glanville Taylor was appointed in 1830 Astronomer at Madras; while in that position, he published his "Astronomical Observations" in five volumes, besides which he made a very extensive series of Meteorological and Magnetic Observations in different parts of India.

Taylor was elected a Fellow of the Royal Society on 10 February 1842. He was also a Fellow of the Royal Astronomical Society. Further details on T.G. Taylor are found in Markham (1878: 329-330) and in the write-up of Agnes Mary Clerke (1885-1900) in the *Dictionary of National Biography*, where it is stated that he died at Southampton on 4 May 1848.

4 TAYLOR'S OBSERVATIONS OF THE 1831 COMET

While at the Madras Observatory, Thomas Glanville Taylor was an independent discoverer of the Great Comet of 1831. He discovered this comet on the same day as John Herapath, but several hours earlier (in fact on 7.00972 January 1831 UT), and continued to observe it until 20 February. He subsequently published his observations in a volume titled *Results of Astronomical Observations Made at The Honourable The East India Company's Observatory at Madras, Vol. I. for the Year 1831* (Taylor, 1832). His account of the astronomical observations is preceded by some comments on the state of his equipment:

> In the foregoing statements I have endeavoured to represent as nearly the case would permit the degree of accuracy attained in each particular species of Observation, but in the present case, the Observations of an ill defined object, made with a Telescope supported upon a wooden stand, and that too in the open air; subject to flexure from its own weight, and to tremor from every breath of air which may happen to blow, render it desirable that the whole of the particulars of each observation should be stated, accordingly the following is copied from the book "Miscellaneous Observations" (Taylor, 1832: 95).

Taylor's account of the cometary observations begins thus:

> 1831, 7th January at 4h 50m. A.M. Saw a Comet toward the East about 20 degrees high but approaching twilight prevented observation.
>
> 8th January, 5h. A.M. Adjusted the five feet Achromatic by Dollond as an Equatoreal, saw the Comet with a power of 60 but it was too faint to allow the field being illuminated, the following observations were made, at the time of its occupying the centre of the field of view.

Using Antares as a reference star, Taylor recorded the Sidereal Time, and the Horary Circle and Declination Circle measures at 5h A.M. local time, and remarked that the comet was "Very faint, tail 4° long observations not to be depended upon to 5m." For the given sidereal time of 12h 52m on 8 January, the UT is 00 24m, while Taylor's observation on 7 January at 4h 50m would correspond to 00 14 UT. Meanwhile, back in England, Herapath's (1831) longitude was 00° 21′ W, and since Hounslow Heath was located very close to the Prime Meridian his mean solar time is almost the same as UT.

Using η *Serpentis* as the comparison star on 9 January, Taylor observed the comet at '5h A.M.' He provided a similar tabulation to that mentioned above, and remarked that "The Comet appeared very distinct notwithstanding its being situated within 30° of the Moon."

The positions of the comet relative to various comparison stars on different dates are presented in tabular form from 8 January onwards. On 11 January Taylor remarked that "Clouds prevented any Observation." then he tabulated the positions of the comet during the period 12-16 January, 19 and 20 January and 23 January, adding

> The prevalence of haze and the presence of the Moon, added to the diminishing brightness of the Comet, prevented observation after the 23rd of January till the 19th of February, on the latter day as well as on the 20th I was fortunate enough to obtain meridional observations with the Transit instrument and Mural Circle, but these being made without illuminating the wires, in consequence of extreme faintness of the Comet, cannot be depended upon to 1 or 2 minutes of space.

On both 19 and 20 February, Taylor recorded the comet as "Very faint".

Towards the end of this series of observations Taylor explained why the telescope support was so rickety:

> It is necessary I should here remark that the instrument was removed every day after the observations were made, to the inside of the Observatory and brought out again early in the morning for adjustment previously to the above observations being made, in performing the adjustment, no pains was taken to adjust the Azimuth Circle, which will account for the changes which are found from day to day in the Index error. The Sidereal time set down is the *true* Sidereal time, found every morning by the Transit of Spica Virginis over the wires of the Mural Circle, the Transit Instrument not having been erected at this time. Employing the Sidereal time in conjunction with the Apparent Places of η and ζ Ophiuchi computed from the Astronomical Society's Tables we obtain the *true* Altitude and Azimuth, which being compared with the *observed* (the Altitude being corrected for refraction) gives the Index Error in Altitude and Azimuth which we can now apply to the observed Altitude and Azimuth of the Comet as follows.

From the true altitudes and azimuths, Taylor provided a table listing the mean time, and the RA and NPD of the comet for the period 8 January–20 February 1831. It is notable that the positions Taylor reported were close to those we generated for the comet using JPL's 'Horizons On-Line Ephemeris System'. Taylor did not include the Comet's orbital elements in his report, but for reference purposes they are provided here: the orbit was parabolic, with q = 0.125887 AU and i = 135°.2630. The reader should also note that Full Moon occurred on 29 December, 28 January and 26 February.

In Figure 2, we reproduce a few pages from Taylor's (1832) report extracted from the IIA Archives.

Taylor did not provide drawings to illustrate the appearance of the comet on different dates, and unfortunately the book that he refers to, *Miscellaneous Observations*, can no longer be traced.

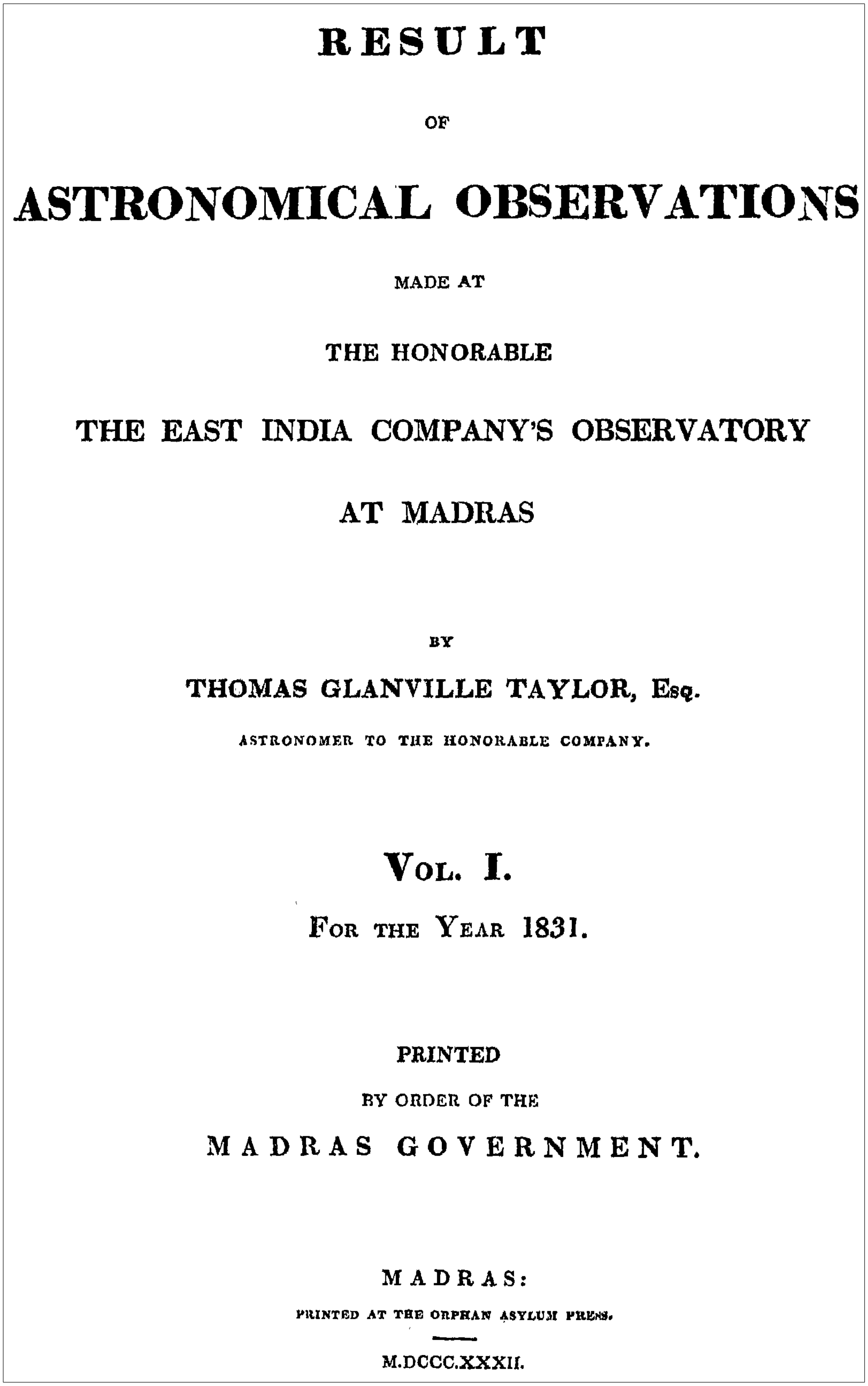
5 DISCUSSION

The Great Comet of 1831 was not the first comet to attract the attention of the Madras Observatory astronomers, for the IIA Archives contain references to observations of the first two great comets of the nineteenth century, namely, those of 1807 (C/1807 R1) and 1811 (C/1811 F1). Both were observed by John Warren, who was Acting Astronomer at the Observatory during the years 1805-1812 while the astronomer, John Goldingham, was away on leave to England.[3]

The Great Comet of 1807 was discovered by Parisi, an Augustinian monk, on 9 September, and eight days later independently by J.L. Pons (Hind, 1852). Kronk (2003) credits Castro Giovanni of Sicily with having discovered it in the evening twilight near the horizon in the west-southwest direction on September 9.7. It was a bright comet, distinctively visible to the naked eye, and was well observed by William Herschel. It passed perihelion on September 19.2389; q=0.646124 AU. In October it showed up with two tails, a straight one >6° long and a relatively shorter curved one. It remained a naked-eye object throughout the months of October, November and even into December by which time it had dimmed. It was last observed on 27 March 1808 (Kronk, 2003). In a 218-page hand-written document in the IIA Archives titled 'Madras M.S. Records' spanning January 1794-October 1812 we find the Report of the Observatory dated February 1809, written by Captain John Warren (1769–1830), where the comet is briefly referred to on pages 78-79. The following passage in the Report describes the observations of the comet made at the Observatory:

> 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 date of Warren's first observation of the comet is not written down and so remains unknown. In those days, communication with overseas astronomers occurred through dispatches carried by ships, so it would have been many months before Warren learned about the independent discovery of this comet in Europe or elsewhere. Around the time of discovery, the comet was a low declination object (September 3: –21° 29′; September 9: –18° 01′; September 15: –13° 27′; 12:00 UT; http://ssd.jpl.nasa.gov/) with a solar elongation of 34°-35°, and therefore was easier to spot from a location like Madras. Note that Full Moon occurred on September 16, October 16, and so on. All through the months of September, October and November, the comet trailed the Sun. As Kronk (2003) says, this comet



RESULT

OF

ASTRONOMICAL OBSERVATIONS

MADE AT

THE HONORABLE

THE EAST INDIA COMPANY'S OBSERVATORY

AT MADRAS

BY

THOMAS GLANVILLE TAYLOR, Esq.

ASTRONOMER TO THE HONORABLE COMPANY.

VOL. I.

FOR THE YEAR 1831.

PRINTED

BY ORDER OF THE

MADRAS GOVERNMENT.

MADRAS:

PRINTED AT THE ORPHAN ASYLUM PRESS.

M.DCCC.XXXII.

Figure 2: The title page of *Results of Astronomical Observations Made at The Honourable The East India Company's Observatory at Madras. Vol. I. For the Year 1831* (Taylor, 1832), followed by the first page listing data from Taylor's account of his observations of the Great Comet of 1831 (courtesy: IIA Archives).

96 RESULTS FROM OBSERVATIONS, 1831.

1831, 7th January at 4h. 50m. A. M. Saw a Comet towards the East about 20 degrees high but approaching twilight prevented observation.

8th January, 5h. A. M. Adjusted the five feet Achromatic by Dollond as an Equatoreal, saw the Comet with a power of 60 but it was too faint to allow the field being illuminated, the following observations were made, at the time of its occupying the centre of the field of view.

	Sidereal Time.	Horary Circle.	Declination Circle.	REMARKS.
	h. m. s.	h. m. s.	° ′	
Comet............	12 52 0	4 36 0	11 50 S.	Very faint, tail 4° long
	13 2 0	4 25 30	11 43 —	observations not to be depended upon to 5m.
Antares..........	12 58 0	3 19 0	————	
	13 5 40	3 12 0	25 15 S.	

9th January at 5h. A. M.

	Sidereal Time.	Horary Circle.	Declination Circle.	REMARKS.
	h. m. s.	h. m. s.	° ′ ″	
Comet............	12 22 41	6 58 45	10 52 10 S.	The Comet appeared very
	12 24 54	7 0 50	10 52 30 —	distinct notwithstanding
	12 25 59	7 1 58		its being situated within
	12 26 48	7 2 50		30° of the Moon.
η Serpentis.......	12 31 53	7 32 0	14 33 30 S.	
	12 34 21	7 34 20		The wires did not require
	12 35 50	7 35 55	14 33 20 —	illumination.

1831, January 10.—In consequence of the difficulty attending the adjustment of the Instrument as an Equatoreal I have availed myself of a suspension spirit level which belongs to the Telescope, to adjust it as an Altitude and Azimuth Instrument; the error of adjustment of the vertical Axis cannot I imagine exceed 20 or 30 seconds.

1831	Sidereal Time.	Altitude.	Azimuth from North Meridian.	Azimuth from South.
	h. m. s.	° ′ ″	h. m. s.	° ′ ″
10th January.....	12 11 14	9 25 30	6 44 10	78 57 30
	12 14 30	10 9 0	6 45 5	78 43 45
	12 17 27	10 53 0	6 45 50	78 30 00
Comet...........	12 19 44	11 24 30	6 46 35	78 21 15
	12 21 18	11 46 10	6 46 55	78 16 15
	12 23 52	12 24 0	6 47 45	78 3 45

should probably have been spotted from the southern hemisphere weeks before it was discovered from Europe. We are inclined to feel Warren might have been the first to spot this comet, or at least that he first observed it very soon after its initial discovery, although we cannot ignore the fact that this was also the period of the monsoons over Tamil Nadu. At the time he penned his reports—which now form part of the Madras MS Records—Warren knew that the comet had been keenly pursued in Europe. For some unknown reason Warren's paper, "An account of the Comet which appeared in the months of September, October and November 1807", was never published, and it is now part of the RAS Archives MS. It describes the Madras Observatory observations in detail (see Ananthasubramanian, 1991).

Similarly, in the Madras M.S. Records (1794-1812) on pages 143-144 we come across a letter dated 27 April 1811 written by Warren to the Acting Surveyor General informing him of the sighting of a nebulosity on the evening of the 25 April, before he came to know that this was in fact the Great Comet of 1811. This comet had been discovered on the evening of 25 March by Honoré Flaugergues at Viviers, and was in the constellation of Argo Navis (the Ship of the Argonauts).[4] These observations are discussed more fully in the present author's ongoing work on comets observed from India.[1]

During the early decades of the nineteenth century there were other Great Comets visible in 1819, 1823 and 1830, but the next one recorded at the Madras Observatory was the Great Comet of 1831.

It may be asked why Taylor did not send a report on his observations of the 1831 comet to Greenwich, and publish this in the *Philosophical Transactions of the Royal Society*, or the newly-formed *Monthly Notices of the Royal Astronomical Society*? For an astronomer adept at using telescopes and exploring the night sky, Taylor would know what astronomical discoveries meant. Coming from Greenwich, he would also know the importance of publishing his observations quickly and in an appropriate forum, but in the case of the 1831 comet it seems that he did not realize that he was the first to observe it, so there was no need—let alone urgency—to publicize this 'non-discovery' internationally. In this context, Jacob's Preface to the Madras Observatory publication, *Astronomical Observations made at the Honourable The East India Company's Observatory at Madras for the Years 1848-1852*, *Vol. 8* (Worster and Jacob, 1853) seems to be relevant when he says that he has "… followed his predecessor's plan in printing the results only, on account of the voluminousness of the original observations; but exact copies will be deposited at the India House, and will doubtlessly be there accessible to all parties wishing to examine them."

Taylor's first paper in the *Monthly Notices of the Royal Astronomical Society* only appeared in 1837 (on his observations of Halley's Comet; see Taylor, 1837), and prior to this date he only wrote up his astronomical observations for the Madras Observatory's in-house publication. Thus, the 5-page report on his observations of the Great Comet of 1831 lies hidden within the voluminous *Results of Astronomical Observations Made at The Honourable The East India Company's Observatory at Madras. Vol. I for the Year 1831* (Taylor, 1832). In the Preface to this Volume, Taylor writes about his arrival at the Madras Observatory on 15 September 1830, before describing the transit telescope and the mural circle. Then with the aid of extensive tables he presents the various astronomical observations made with these instruments during the year 1831. Apart from his report on the 1831 comet, these observations included measurements of the Sun's diameter in passing the Meridian;[5] the apparent Right Ascensions and North Polar Distances of the planets and of the Moon; an eclipse of the Moon on 26 February 1831; eclipses of the Jovian satellites in 1831; the latitude of the Madras Observatory; and a long table with 'Places of the Fixed Stars'. This table contains 2881 stars. One of these stars (no. 390) is η Argus, which was listed at magnitude 2 on the basis of six different observations made in 1831. It also appears in *Results of Astronomical Observations Made at The Honourable The East India Company's Observatory at Madras. Vol. II for the Years 1832 and 1833* (Taylor, 1833) as star no. 1281, and still at magnitude 2, judging from six observations made in 1833. Edmond Halley first recorded η Argus in 1677 from the island of St Helena as a star of the 4th magnitude, and he suspected it to be a variable. In the 1820s, η Argus began to brighten, but Taylor's initial observations are made some years before 'The Great Eruption' which extended from about 1837 to 1857 (Frew, 2004). In subsequent Madras Observatory publications, particularly those dating to 1837-1838 and April 1843 (when η Argus rivaled Sirius in brightness), Taylor catalogues fainter stars in Argo Navis but says nothing about the brightening of η Argus. In *Vol. VII* he merely includes η Argus in a list showing the mean places of 97 principal fixed stars (Taylor, 1848).

It is not clear if the individual volumes of astronomical observations made at the Madras Observatory were indeed sent to India House for safe-keeping soon after their publication. Even if they were, Taylor's discovery of the Great Comet of 1831 and his subsequent observations of it remained unknown to most overseas astronomers. Consequently, Taylor never received the credit he deserved as the discoverer of this comet, and up till now this honour has been awarded to John Herapath.

Back in the nineteenth century the accepted procedure if one wished to claim discovery priority for a new comet was to immediately submit a report that included the comet's precise position to a recognized professional observatory, located preferably in Europe, Britain or the USA, which was then responsible for publicizing the discovery. When such discoveries were made far from Europe or North America this sometimes disadvantaged those exposed to the so-called 'tyranny of distance'. Thus, several Australian astronomers who discovered comets in the days before the international telegraph were never formally credited with their discoveries (see Orchiston, 1997), just like T.G. Taylor and the Great Comet of 1831. In the case of this particular comet, Orchiston (personal communication, 2011) also offers the following comments:

> Maybe amateur-professional astronomy differences during the nineteenth century also played a key role in Taylor's decision not to publish his 1831 comet observations in *Monthly Notices*. At this time, professional astronomers were expected to do positional astronomy, not to search for and track new comets—which was the

role of the amateur—despite public perceptions to the contrary. A good example was the vitriol heaped upon Sydney Observatory and its hard-working Director, William Scott, because it was the well-known local amateur astronomer, John Tebbutt, and not Scott who discovered the Great Comet of 1861, C/1861 K1. (e.g. see Orchiston, 1998).

6 CONCLUDING REMARKS

As we have documented in this paper, Madras Observatory Director Thomas Glanville Taylor deserves full credit for the independent discovery of Comet C/1831 A1, but international astronomers have long remained unaware of this because Taylor did not realize the significance of his observations and therefore chose to publish them in the Observatory's own relatively-obscure monograph series instead of in the high-profile pages of the prestigious *Monthly Notices of the Royal Astronomical Society* or the *Memoirs of the Royal Astronomical Society*.

Interestingly, Taylor observed the celebrated Halley's Comet and other comets in later years and published his results both in the Madras Observatory publications and in the two journals of the Royal Astronomical Society. Halley's Comet was first recovered in this greatly-awaited apparition by Father E. Dumouchel at the Collegio Romano in Rome on August 5.12 1835 (see Kronk, 2003), and was observed by Taylor (1836; 1837b; 1838b) at the Madras Observatory from 30 August 1835 until 5 February, 1836 and subsequently on 3 April 1836 with the Dollond 5-feet achromat mounted as an equatorial.

Another comet, designated C/1839 X1, was discovered in the constellation of Virgo on 2 December 1839 by J.G. Galle from Berlin (Vsekhsvyatskii, 1964),[6] and was independently discovered by T.G. Taylor at the Madras Observatory on 6 January 1840, as noted by Vsekhvyatskii (ibid.). Meanwhile, R. Snow also independently discovered this comet on 29 December 1839, and made further observations from Ashurst on 30 December and from Dulwich on 6 and 7 January 1840. In the IIA Archives, we find a record of Taylor's (1848) observations of this comet:

> 1840, January 4th, at 5 A.M. saw a Nebulous appearance between α and β Ophiuchi but it became obscured by twilight before I could bring a telescope to bear upon it. January 5th, at 5 A.M. the same appearance as yesterday, but was again unsuccessful in observing its appearance with a telescope, to the unassisted eye it appeared to be a Comet with a tail about 3 deg long directed from the Sun. January 6th, having adjusted the 5 feet Achromatic to act as an Equatorial, several observations of the Comet were made …'

In the various notes accompanying his table summarizing the observations made between 6 and 28 January, Taylor comments that on 6 January the comet was visible through the twilight. On 8 January it was visible through the twilight, with a better-defined nucleus. The appearance remained nearly the same until 17 January, and on then 18th he noted that the comet was "… necessarily very faint by reason of Moonlight." By 25 January the comet had faded, but on the 28th he commented that "The Morning beautifully clear, and the Comet rather brighter than on the 25th."

The great comet of 1844-5, C/1844 Y1, widely referred to as Wilmot's Comet, was observed in India from three observatories, Bombay, Madras (by T.G. Taylor) and Trivandrum (by J. Caldecott). These and some other observations made in India will be subject of a later communication.

7 NOTES

1. This study is merely part of the author's ongoing research into cometary sightings and observations made from India from antiquity through to 1960, where available data—however minimal—permit the identification of each comet. Of special interest are those comets that have received little attention or no notice at all in the more recent cometary literature.
2. We specifically use the term 'scientific observatory' here because there were much earlier traditional Indian observatories (e.g. see Sharma 1985).
3. According to Kochhar (1991b), Goldingham returned from leave in October 1811, not in 1812.
4. Note that in 1752 the French astronomer Nicolas Louis de Lacaille had split this large constellation into the separate constellations of Carina, Puppis and Vela.
5. Assuming the Sun to be spherical, Taylor derived a value of 16′ 0.15″ for the solar semi-diameter, when viewed from the Earth's mean distance from the Sun.
6. According to Kronk (2003), the correct date is December 3.20, in the morning.

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