THE MADRAS OBSERVATORY, 1792–1931

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ABSTRACT

An astronomical observatory, the first of its kind in the East, was established at Madras by the East India Company in the year 1792. It has been presided over by a sucession of able and accomplished astronomers, and during more than a century of its existence, it has produced valuable results which entitle it to rank with the observatories of Europe of the period. With the establishment of the Solar Observatory at Kodaikanal in the year 1899, astronomical work ceased at this observatory. It is to be noted that the Great Trigonometrical Survey of India started in 1802, one of the most extensive such surveys in history, namely the topographical survey of the vast sub-continent of India from the meridian of this observatory.

RÉSUMÉ

Un observatoire astronomique, le premier de son genre en Inde Orientale, a été établi à Madras en 1792 par la Compagnie de l'Inde Orientale. Cet observatoire a été dirigé tout en long de son histoire par une succession d'astronomes compétents et accomplis. L'observatoire a produit pendant plus d'un siècle d'importants résultats qui lui valurent d'être reconnu au même titre que les observatoires européens de l'époque. Toute activité astronomique à l'observatoire cessa en 1899 avec la fondation de l'observatoire solaire de Kodaikanal. Il est à noter que l'un des relevés topographiques les plus étendus du sous-continent indien, le Grand Relevé Trigonométrique de l'Inde, commença en 1802 à partir du méridien de l'observatoire de Madras.

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An astronomical observatory, the first of its kind in the East, was established at Madras in the year 1792, (199 years ago), by the East India Company. Michael Topping, the Marine Surveyor, was appointed the first Astronomer of the observatory. During 1786–87, Topping had determined the latitude and the longitude of many stations along the east coast, by astronomical observations. William Petrie, a member of the Governor's Council who was also an amateur astronomer, had a private observatory in his residence and had John Goldingham as his assistant to make the astronomical observations. When he proceeded on leave to England in 1789, he handed over his observatory to the Company, and Goldingham joined Topping as his assistant.

The earliest astronomical observations made at Madras as seen from old records are as follows: In July 1755 Thomas Howe determined the longitude of Fort St George from the eclipses of the first satellite of Jupiter. In 1761 Major Hirst observed the transit of Venus at Fort St George. The details of the above observations are not traceable.

Topping designed and constructed a building to house the observatory at Nungambakkam on the banks of a small river Cooum. It consisted of a single room, 40 feet long by 20 feet broad and 15 feet high with massive walls over two feet in thickness. The floor rested on beams supported entirely by the walls and detached from the instrumental basement which consisted of a solid pyramidal mass of masonry, 37 feet long by 6 feet wide at its upper surface, 6 feet in depth and 45 feet long by 12 feet below. A conical granite pillar weighing more than 10 tons rested on this mass, 4 feet in diameter at the base tapering to 2 feet at its height of 18 feet. On this was mounted a 12 inch altazimuth by Troughton. The small transit and the transit circle rested on granite supports each weighing about 2.5 tons. The observatory had the following instruments also: two astronomical quadrants, one of these by Bird, two large three-and-a-half-feet achromatic telescopes with triple object glasses by Dollond, two astronomical clocks with compound pendulums, one a most excellent timekeeper by Shelton. With these primitive instruments work started on meridian observations on January 9th, 1793, in keeping with the tradition of the work carried out at the observatories in Europe of the period.

Topping was a capable astronomer and surveyor. He introduced the practice of making corresponding observations at different stations for determining the longitude with greater precision. His strenuous survey work left him little time for his newly founded observatory, which was practically in charge of his assistant Goldingham. On his untimely death in 1796, Goldingham succeeded him as astronomer. Goldingham also held the post of Government Architect and Editor of the *Government Gazette*, during the early part of his tenure of the observatory. He was also the first Superintendent of the Engineering School. He determined the longitude of the observatory from the eclipse of Jupiter's satellites and Moon culminations and got a value of 80°18′30″E. Col. William Lambton, in 1802, started his Great Trigonometrical Survey of this vast sub-continent from this meridian, thus making this observatory the "Greenwich" of India.

Goldingham proceeded on leave to England from 1805 to 1810. During this period Lt. John Warren of the Survey of India held charge of the observatory. He made a precise determination of the longitude and got a value of 80°17′21″E. During 1806–07, from a careful observation of zenith distances and corrected declinations of 52 stars near the zenith of Madras, he determined the latitude with precision. He also studied the Great Comet which appeared from September 1807 to March 1808 and his paper appears to be the only detailed description available about this comet. He also published a valuable treatise "Kala Sankalita" on Hindu astronomy.

Goldingham resumed charge of the observatory in 1812. The records of the first 19 years of the observatory were simply copied out and forwarded to the Board of

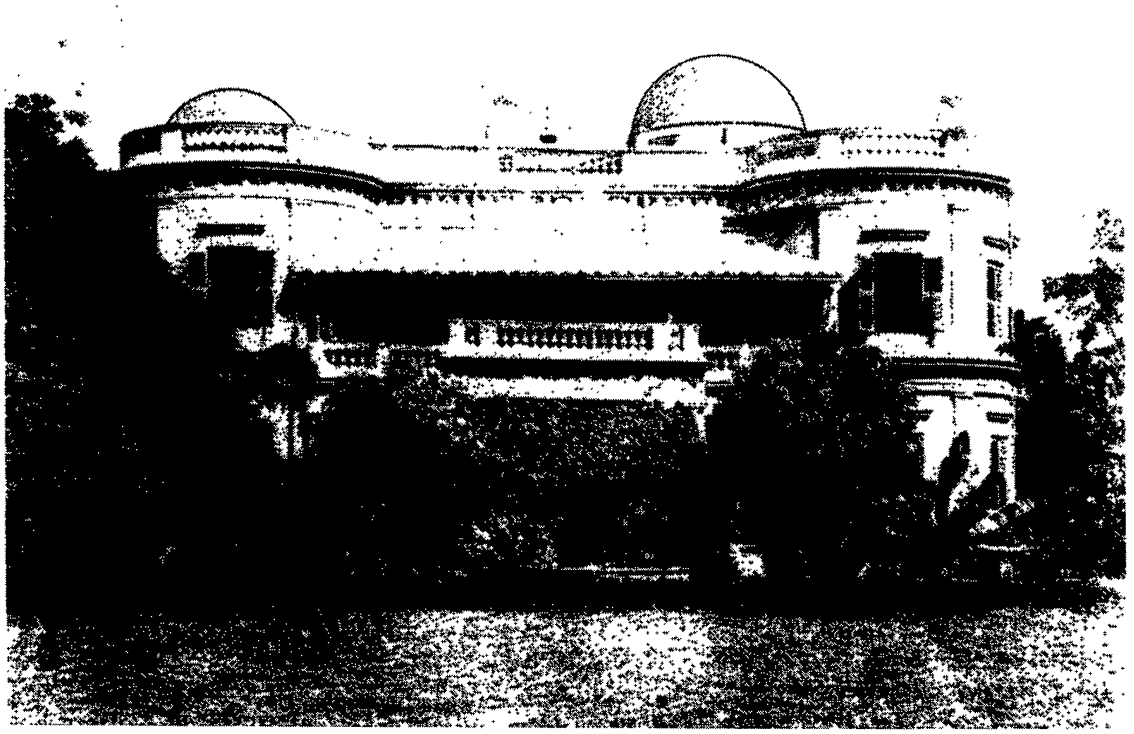

FIG. 1—Madras Observatory in 1930. The two domes and the anemometer tower are on top.

Directors in manuscript form. The observations from 1812 to 1825 were published in two volumes as 3 and 4 containing the observations of the Sun, Moon and planets and brighter stars. Included in these are also his observations on the length of the pendulum at Madras and at Bencoolan near the equator, the velocity of sound, meteorological phenomena, determination of the longitude of Madras with the discussion of the longitudes of Calcutta and Bombay. Some of these papers had appeared in the *Philosophical Transactions* also. Goldingham retired in 1830.

T.G. Taylor of the Royal Greenwich Observatory succeeded Goldingham as astronomer. He obtained a five-foot transit instrument and a five-foot mural circle both by Dollond, with object glasses of 3.75 inches aperture. These were fixed on existing granite piers, the former as far east and the latter as far to the west as the basement would allow, on opposite sides of the central conical pillar, which was retained in position as a huge counterpoise, though no longer used as a support for any instrument. With these instruments Taylor measured the positions of about 11,000 stars between the years 1831 and 1842. His observations were published in five volumes.

Given below is an interesting extract from his Volume IV:

The observations on the meridian were made principally by the native (namely Indian) assistants and those out of the meridian exclusively by me. In allowing the meridional observations to be made by the assistants I have been careful frequently to re-examine their bisections with the mural circle and to compare the clock errors from their observations with the transit instrument with those determined from my own, when in no case have I found that their bisections were less accurate than I could have made myself and the difference between our estimation of time has seldom amounted to two-tenths of a second. The observations of the sun (which have always proved unsatisfactory) still continue to exhibit the same want of consistency, and my endeavour to discover the cause has, I regret to state, not in the least degree proved successful. The observations of the planet Mars and the stars situated near to its path for the purpose of 'Parallax' have now been continued for three successive oppositions and the necessary comparisons between these and the corresponding observations at the Cape of Good Hope Observatory have been instituted, without, I fear, having in the least advanced the object of enquiry: this result as well as of other observations of measuring angular distances with the mural circle, tends to show that, although a single observation may be depended upon to 1 or 2″, still the tenth or twentieth part of this amount – which is the present object of enquiry – can only be attained by almost an unlimited number of observations. On comparing the places of 2066 stars which are here given with G. Piazzi's Catalogue, a result similar to that noticed in Volume III (occurring between the Catalogue there given when compared with Piazzi) was here too apparent; in consequence of which I have gone back to the Catalogue given in Volume II. After combining all these results (containing about 7600 stars) there still appears a tendency to exhibit a General Proper Motion of the Fixed Stars, which can be explained by supposing a motion of the solar system towards the north Pole of the Ecliptic. Whether the data from which this conclusion has been drawn shall appear sufficient or no – I would beg for the present to claim a little indulgence – until a comparison of the table of refractions employed by Piazzi (now with me) with those at present in use shall have been instituted – and a re-examination of latitudes undertaken; this done, I shall be prepared either to announce this important and somewhat unexpected result, with more precision and certainty.

Taylor detected that every division of degrees in the mural circle is situated in advance of its proper place relative to the diameter 0–180 degrees and in that some cases the combined errors amounted to nearly 10 arc seconds. He worked out the error of division of each degree elaborately and with precision and published the same in Volume V under the heading "Error of division of the Madras Mural Circle and Error of division of each degree of the Madras Mural Circle." Taylor got a value of 80°14′20″E for the longitude of the observatory.

A.M.W. Downing, who has revised and edited "Taylor's General Catalogue of Stars for the Equinox 1835.0 from observations made at the Madras Observatory during the years 1831–1842", says, "My examination of the Madras Observations has led me to form a very high opinion of Taylor and of the work which he accomplished in the face of enormous difficulties."

In 1848 Capt. W.S. Jacob took charge of the observatory. With the transit instrument and mural circle he revised 1440 stars of the British Association Catalogue between 1849 and 1852 and published the results in the second series of Madras Observations. In 1850 he was occupied in revising and perfecting Taylor's

Catalogue and a study on the orbits of Alpha Centauri and other double stars and prepared a catalogue of 144 double stars. A number of observations made in collaboration with Maj. W.K. Worster, but only partially reduced to apparent places, formed another Catalogue of about 2200 stars for the epoch 1855.0. A selection of 317 of these stars suspected of large proper motions was published in the *Memoirs* of the Royal Astronomical Society. Airy had suggested a transit circle for the Royal Observatory in place of the two instruments for determining the absolute right ascension and polar distances and a magnificent transit circle was obtained in 1850. In 1855 Capt. Jacob recommended the purchase of a similar instrument from Messrs. Troughton and Simms for the Madras Observatory. After Capt. Jacob, Maj. J.F. Tennant was in charge of the observatory for a short period from 1859 until 1861.

Meanwhile a magnetic establishment was added to the observatory. The buildings were enlarged to accommodate the necessary instruments. Eastward was added, first a covered passage 20 feet long by eight feet broad, leading to the dip-circle room, which measured 16 feet by 26 feet; next a magnetic room, 45 feet by 15 feet in which the bi-filar, vertical force and declination magnetometers were placed. About 30 feet eastward was another small room used for periodical determination of the absolute horizontal force.

N.R. Pogson was appointed Astronomer in 1861. He was in charge of Dr Lee's observatory at Hartwell and he was well known as an observer of variable stars and discoverer of many asteroids. He is also well known for introducing the system of stellar magnitudes in which the magnitude difference between two stars is 2.5 times the ratio of their intensities. The buildings now consisted of two blocks, one comprising the old building with the recent additions – a long, narrow structure extending 196 feet from east to west and 25 feet from north to south, and the other being the residence of the Astronomer, facing southeast, about 120 yards south-west of the former and covering a space of 75 feet by 50 feet.

The new transit instrument by Troughton and Simms with an object glass 5.5 inches and focal length 50 inches, obtained by Capt. Jacob, was set up by Pogson with the help of F. Doderet, a German instrument maker. The meridian circle occupied the same position as Taylor's instrument, looking through the same slits in the roof and walls, which had been enlarged from 15 to 22 inches wide.

The partially completed Catalogue (by Jacob) of 2200 stars, chiefly selected from Taylor's Madras Catalogue and that of the British Association observed between 1853 and 1858 containing 10,000 observations, was completed. This also contained 1331 observations of the Sun, 345 of the Moon, 1650 of planets, 333 of asteroids, 25 of Donati's Comet of 1868, observations of Mars at its oppositions of 1854 and 1856, Moon culminations for determination of longitude and a number of occultations of planets and fixed stars. Hourly meteorological observations from 1851 to 1860 and hourly magnetic observations from 1846 to 1855 were also

completed. Due recognition was thus made to the work of his predecessors who conscientiously exerted themselves for the attainment of such results as were within their very limited instrumental means.

In April 1861, Pogson discovered an asteroid (number 67) and named it "Asia" in honour of the first discovery in this part of the world. The solar eclipse of July 7, 1861, and the transit of Mercury on November 11, 1861, were duly observed. Another asteroid, 80 Sappho, was discovered in May 1864. A second series of differential right ascensions of Mars was observed for the investigation of solar parallax. The new equatorial by Troughton and Simms with an object glass of 8.5 inches, was mounted in 1866 on the granite pillar, and another asteroid, 87 Sylvia, was discovered. In 1867 the discovery of the variable star R Reticuli by Pogson's assistant C. Ragoonathachary is memorable as the first astronomical discovery by an Indian. (He was also the first Indian to be elected as a Fellow of the Royal Astronomical Society.) In 1868, the total eclipse of the Sun on August 18 was observed at Masulipatnam. At this eclipse Pogson and his assistants studied the prominence, and polarization of the light of the corona, and they made micrometric measurements of the bright lines in the corona. The remarkable discovery of the helium line in the Sun was made at this eclipse by Janssen. Another total eclipse of the Sun was observed at Avanashi in Coimbatore on December 12, 1871, and valuable photographs were obtained.

In 1869, Sir George Airy, Astronomer Royal, suggested that, for the future operations of the Madras observatory, a "Code of Instructions" may be prepared. Accordingly a code was drawn by Col. Walker, the Surveyor General, with the assistance of N.R. Pogson and approved by the Government. It is in nine sections:

1 Meridian observations to be taken of a certain number of standard stars in the northern and southern hemispheres, for the purpose of harmonising and connecting together the positive determinations of Greenwich, Madras, Cape of Good Hope and Australian observations, with a view to the eventual preparation of an accurate catalogue of star's places from the combined observations of all these observatories.
2 Meridian observations to be taken of all stars down to the sixth magnitude, between North Polar Distance 60° and 110°.
3 Meridian observations to be taken of all stars used for geodetical purposes in the course of the operations of the Great Trigonometrical Survey.
4 Meridian observations to be taken of all minor planets (asteroids) within the range of the instrument (10.5 magnitude), whenever they are in opposition south of the equator.
5 Equatorial observations to be taken of the planet Mars at every successive opposition, in combination of the observations which have already been made by Mr Pogson for the investigation of the constant of solar parallax.
6 Magnetic and meteorological observations to be continued on the system introduced by Mr Pogson in 1861.
7 Provision for time determination for shipping, and notices of approaching stormy weather etc.

8 The publications should be issued in annual volumes, and annual Reports should be submitted to the Government of Madras and sent to the Astronomer Royal, whose criticisms should be invited. Monthly tabular statements of arrears of reduction and publication should be submitted.

9 Special investigation may be undertaken by the Astronomer, but they should not interfere with the regular routine of the observations, nor retard the work of reduction and publication.

An excellent electrical clock by Shepard was obtained in 1872. The invention of a new telegraph apparatus by G.K. Winter of the Telegraph Department and the construction of a telegraph line between the observatory and Fort St George, together with the new electrical clock, enabled the firing of the time-gun at Fort St George daily at noon and 8 p.m. with great accuracy, by which the error and rate of a ship's chronometer were determined. Time signals were exchanged between Madras and Singapore by submarine cable to determine the difference in longitude between these two places.

In 1872, three additional rooms for celestial photography were built upon the roof of the transit circle room, just in time to secure photographs of the annular eclipse of the Sun on June 6, 1872. The fine silver glass 9-inch reflector by John Browning used by Col. Tennant at Guntoor at the total eclipse on August 18, 1868, and also at the total eclipse on December 12, 1871, was mounted on the large granite pillar. With this, the annular eclipse of the Sun on June 6, 1872, was observed at Madras and the flash spectrum was photographed for the first time at such an eclipse. In December 1872, Biela's Comet was detected by Pogson. This comet had split into two parts in 1846, 150,000 miles apart, each complete with a short tail of its own, and they were again seen in 1852 but 1,250,000 miles apart.

The observatory building, which was now enlarged, contained in all 18 rooms, eight on the ground floor, seven on the first floor and three on the top. The ever-increasing and already extensive valuable library occupied two rooms on the ground floor, and another room contained the electrical clock and telegraph appliances used for giving time signals to local shipping and all telegraph stations in India. On the top was a small anemograph room and a 16 foot circular room with a revolving dome containing an 8-inch equatorial by Troughton and Simms and another small room housing the 6-inch equatorial by Lerebours and Secretan.

A catalogue of 3000 stars from 23,500 observations made with the meridian circle was completed in 1874. The catalogue contains a number of southern stars not previously observed elsewhere, chiefly between 110° to 150° of north polar distance. Meridional observations of the Moon from 1862 to 1872 also finds a place. An atlas of telescopic stars consisting of over 120 maps, including all stars down to the 12th magnitude was finished in 1873.

To investigate the constant of solar parallax by means of the planet Mars in opposition is one method of ascertaining the Sun's true distance from the Earth.

The requisite observations for this method can be made to the best advantage only at a tropical observatory, and Madras was particularly suggested by the Astronomer Royal. Pogson took five series of observations in this connection in 1862, 1864, 1867, 1871 and 1873 respectively. The results of the observations of the fixed stars made with the meridian circle at the Madras Observatory by N.R. Pogson have been published in about eight volumes.

An extract from Volume 6 regarding the latitude of the observatory: "In the first volume of the present series it is mentioned that the latitude of the observatory is uncertain by nearly 1″. A fresh determination of latitude has not been undertaken yet." Hence the corrections to the North Polar Distance (NPD) given in the volumes:

1 G.P.L. Conyngham of the Great Trigonometrical Survey by Zenith sector observations in 1891: 13°04′08″.77 ± 0″.067.
2 From approximate reduction of three circumpolar stars between 1862 and 1867: a) From 110 observations of Polaris: 13°04′08″.64; b) From 116 observations of 51 Cephei: 13°4′08″.68; c) From 79 observations of RPL 150: ditto.

The assumed latitude is 13°04′08″.1 and hence the probable correction to be applied to the observations so far published of the NPD is approximately – 0″.6. This may not be final, since it is doubtful whether a thoroughly satisfactory determination of latitude can be made by means of circumpolar stars at a place situated near the equator.

Another extract of interest from Volume VIII:

> One point that comes out clearly as a result of the investigation of meridian errors is that, for satisfactory work in low latitudes, it is necessary to have either a much larger list of polar stars whose positions are accurately determined or to have a good meridian mark. There are many nights here where good observations can be got of stars at a considerable altitude, though it is quite impossible to get any observation of stars below the Pole or even within 10° above the Pole, and on a good many other nights, the stars below the Pole are so unsteady that they at times appear to dance backwards and forwards across the wires. In the great majority of observations of polar stars, the transits were taken only over three wires and in many cases there was a considerable divergence between the times given by different wires. With highly trained observers, it is probable that better results would have been obtained by using the R.A. micrometer and observing a number of transits over the middle wire, but with the observers available this would have only led to increased errors, for it was found necessary even to give up the use of PD micrometer.

(By PD was meant "polar distance".)

All the work indicated under the "Code of Instructions" mentioned previously were carried out meticulously. But Pogson wanted to undertake a Southern Survey, in extension of Prof. Argelander's great Northern Survey, but this had to be abandoned, because of the refusal of the India office to sanction a European

deputy. So the best course, according to him, was to increase the meridian observations by the addition of as many new stars of more than 120 degrees polar distance as could be found, not less than of eighth magnitude. His untimely death in 1891 put an end to all his plans.

C. Michie Smith, who succeeded Pogson, continued the meridian work. He also prepared a Catalogue of Stars for the epoch 1875 from Pogson's observations of 1862–1887. From elaborate data obtained from precise observations in 1897, he got a value of 80°14′54″.2 for the longitude of the observatory. Although by this time telegraph lines connecting Greenwich with Madras were used for determining the longitude with greater precision, the values obtained by different observers, using different intermediate stations between Madras and Greenwich, varied considerably, leaving this method of doubtful value. (During the International Longitude Programme of 1933, when wireless signals were used, the observatory was not in existence.) In the year 1899 Michie Smith moved over to Kodaikanal, when he took over as Director of the newly founded Solar Physics Observatory in addition to the Madras Observatory. Though meridian work ceased at Madras, routine astronomical observations for regulating Indian Standard Time continued until the year 1931, when the observatory was closed down.

The observatory buildings have since been completely demolished. In a small enclosure in its compound, you find the huge granite pillar on which the first astronomical telescope in India was mounted, in its original position, with a few other relics. A recent inscription on the pillar marks the exact position of the "Madras Meridian", and it stands as a mute witness to the observatory's past glory. You also wonder how such valuable astronomical work was done at this spot for more than a century in the past, now surrounded by sky-scraper buildings and other obstructions, with the added atmospheric pollution characteristic of a modern metropolis of five million inhabitants!

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