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Mission impossible: William Scott and the first Sydney Observatory directorship

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Abstract
The Reverend William Scott (1825-1917) was the founding Director of the Sydney Observatory, and succeeded in acquiring state-of-the art astronomical instruments, establishing a network of country meteorological stations, and conducting a range of astronomical observations. He also worked to promote popular interest in astronomy, and immersed himself in the scientific culture of New South Wales. This paper examines Scott's achievements in astronomy and meteorology, the reasons for his premature resignation in 1862, and the search for his successor.

Key Words: *William Scott, Sydney Observatory, Government Astronomer of NSW*

1 INTRODUCTION

The 1850s witnessed a blossoming of astronomy in Australia, with the founding of professional observatories at Williamstown (see Figure 1 for Australian localities mentioned in the text) and Sydney (Haynes *et al.*, 1996; Orchiston, 1988a) and the emergence of two notable amateur astronomers, Francis Abbott in Hobart (Orchiston, 1992) and John Tebbutt in Windsor (Haynes *et al.*, 1996).

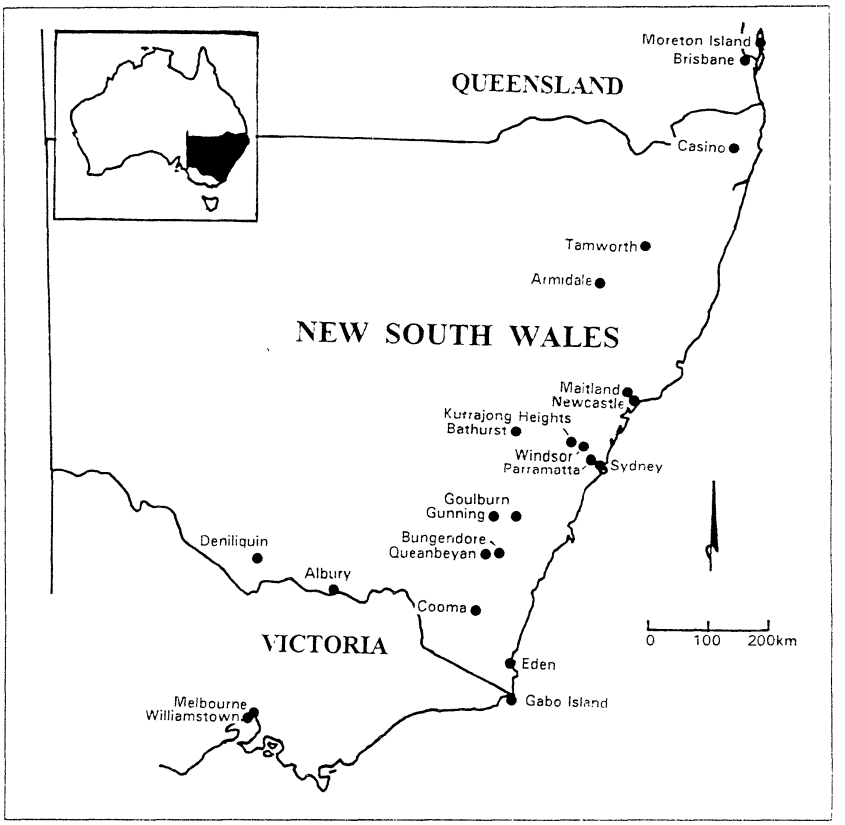

Figure 1. Australian localities mentioned in the text.

Sydney Observatory was the third colonial observatory to be founded in New South Wales (Baracchi, 1914), and grew from the ashes of the Parramatta Observatory which had closed in 1847 (Saunders, 1990). The history of the Sydney Observatory has been reviewed by Baracchi (1914), Orchiston (1988b), and Wood (1958, 1982, 1983), amongst others.

Two individuals were largely instrumental in the founding of the Sydney Observatory, Captain Phillip Parker King (Orchiston, 1988d) and Sir William Denison, the Governor-General of New South Wales (Currey, 1972). In 1855 October, Denison wrote to Sir George Airy, the Astronomer Royal, asking him to select a suitable person to serve as both founding director of the Observatory and Government Astronomer of New South Wales. The post was accepted by the Reverend William Scott (see Colonial Astronomer, 1857), who was later to write: "Regarding it as a life appointment, as in all other national observatories, I abandoned a more lucrative position with all prospects of preferment in Cambridge." (Scott, 1861j). His annual salary was £500 (Wood, 1958).

This paper, which expands on Orchiston (1988c), is about Scott's term as Government Astronomer of New South Wales, and examines the early history of the Sydney Observatory, factors leading to Scott's premature resignation in 1862, and relations between Scott and Tebbutt. It is the story of the trials and tribulations of a British scientist with limited observational experience who ended up directing a fledgling colonial observatory far from the astronomical centres of Britain, Europe, and North America.

2 WILLIAM SCOTT: A BIOGRAPHICAL SKETCH

The Reverend William Scott (Figure 2) was born at Hartland in North Devon on 1825 October 8 and completed his B.A. degree at Cambridge University in 1848, "... taking honours as Third Wrangler at the same time as the late Isaac Todhunter, the well-known

Figure 2. Reverend William Scott, M.A. 1825-1917. (After Russell, 1892)

mathematician." (Houghton, 1917). He was made a deacon in 1849 and was ordained a priest in 1850. In 1851 he received his M.A. degree. That same year he married a widow with three sons, and Cable (1976) claims that it was these newly-inherited family responsibilities which prompted Scott to become a successful mathematics coach. Scott (1860j), however, provides another perspective on his flight from the church, describing how he tended

> ... the death beds of men and women dying in the full conviction and rejoicing in the truth of those Doctrines which I there taught but have now learned to disbelieve. It was this gradually increasing change of belief, which I kept down as much as I could and scarcely dared acknowledge to myself, that made me eager to give up the Clerical professional altogether, as I have now done. I regard the system of Divinity adopted by the Christian Churches as almost wholly of human intervention .... Now I do not want to shake your faith or destroy your peace of mind, as mine has been for many a year, but I do want you to believe that a man's salvation does not depend on theories about things which he cannot possibly understand ....

Whatever the facts of the matter, in 1853 Scott went on to publish a small textbook titled *Elementary Treatise on Plane Co-ordinate Geometry* (Lynn, 1904), and when offered the Sydney Observatory post in early 1856 was a Mathematical Lecturer at Sidney Sussex College, Cambridge (Scott, 1860a).

Scott officially commenced duties as Government Astronomer of New South Wales on 1856 April 16 (Scott, 1859c), and spent much of the next two months at the Royal Observatory, Greenwich,

> ... where he received every assistance from the Astronomer Royal in completing his knowledge of practical Astronomy, and in making himself familiar with the most recent improvements in the construction and use of Astronomical Instruments. (Scott, 1860a:iii).

In addition, he made himself "... familiar with the routine of an observatory ..." (Scott, 1859c). In this regard it is significant that Airy selected a non-astronomer for the post, especially given his earlier antagonism towards astronomy in Sydney (see Orchiston 1988d).

On 1856 July 1, William Scott, his pregnant wife and their three sons sailed from England, reaching Sydney on October 31 (ibid.). A daughter who was born in September died during the voyage (Scott, 1859a). In 1858 July, Scott was blessed with a second daughter, but she died just five months later, prompting him to lament: "There is something in the air of Sydney peculiarly fatal to young children though it is healthy enough in general." (ibid.). In 1860, a third daughter was born (Scott, 1860g).

After resigning from the Sydney Observatory post in 1862, Scott turned to teaching and took over the Cook's River Collegiate school in Sydney (Our first astronomer, 1915). From 1865 to 1878 he was Warden of St Paul's College at the University of Sydney, and given his earlier disenchantment with religion it is all the more remarkable that he then committed the remainder of his working life to the ministry (Lynn, 1904), serving at Bungendore, Gunning and Queanbeyan. After his retirement in 1882, Scott and his wife visited England and then settled at Kurrajong Heights north-west of Sydney where they had purchased an orchard in 1860 (Our first astronomer, 1915). Scott lived in good health to the ripe old age of 91, dying at Chatswood, Sydney, on 1917 March 29 (Houghton, 1917). He was survived by a son and two daughters, and had an estate worth nearly £7,500 (Cable, 1976).

Despite his short career as a professional astronomer, Scott retained an active interest in science, serving as Honorary Secretary of the Royal Society of New South Wales from 1867 to 1874 and as Treasurer for a number of years (Maiden, 1918).

However, his only significant involvement in astronomy during this period was as part of Russell's 1874 transit of Venus programme, when he led the Sydney Observatory group based at Eden that successfully observed the transit (see Russell, 1883, 1892; Scott, 1874).

3 THE SYDNEY OBSERVATORY YEARS: A RECORD OF ACHIEVEMENT IN COLONIAL SCIENCE

3.1 Necessary Groundwork

When Scott arrived in Sydney in 1856 October, he immediately set to work by confirming the site for the Observatory at Fort Phillip recommended by Denison (see Scott, 1859c) and advising on the plans drawn up by a previous Colonial Architect. The final design merely marked the end-point in a lengthy period of negotiation which saw the building grow from a small simple time ball station to a substantial stone structure costing £7,000 (see Orchiston, 1988d). The Colonial Architect actually superintended the construction of the building, which commenced in 1857 May, with Scott (1859c) providing input only when 'scientific requirements' were concerned. The result was an imposing stone building which for the first time in a major Sydney building combined two different architectural streams:

> The first was the Italian High Renaissance *palazzo* mode for banks, clubs and town houses popularized by Charles Barry in London during the 1830s .... The second was the picturesquely asymmetrical "Italian villa" form – a form which became common for stately free-standing mansions. (Kerr, 1991:21-22).

The building was completed in 1859 January, and comprised an equatorial dome, transit room, time ball tower, and astronomer's residence (Figure 3).

Scott (1859c:293) was careful to point out that

> ... having had a sufficient sum placed at my disposal for the establishment of an Observatory on a good and substantial scale, I have felt it my duty not to be led by false economy to proportion the building to the present state of the instruments at my disposal, but to erect an Observatory sufficiently comprehensive and commodious to satisfy all the astronomical requirements of the colony for the next century.

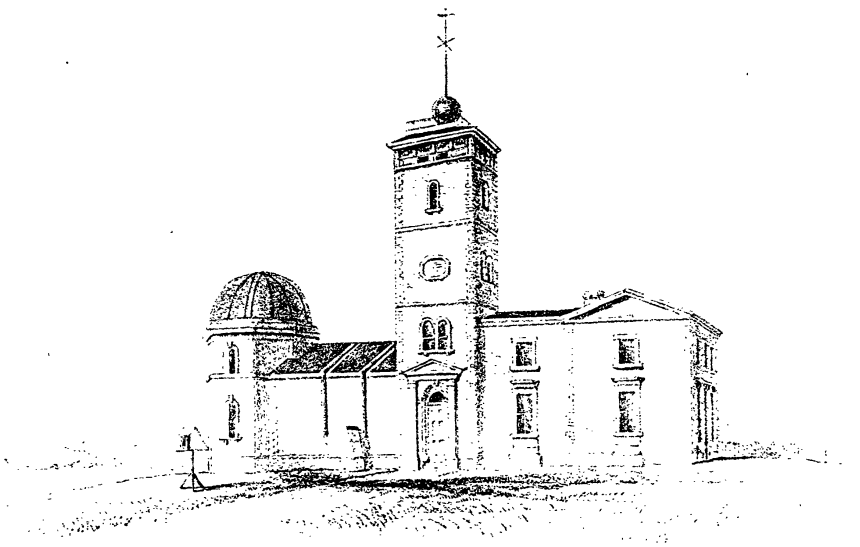

Figure 3. The Sydney Observatory in 1859. (After Scott, 1860a)

In this regard, he was openly challenging Cassini's views on observatory architecture: that all possible funds should be expended on the instruments and that the building itself should be kept as simple and undecorated as possible (see Donnelly, 1973). But to Haynes *et al.* (1996:52), this elegant building "... signalled something more than wealth; it testified to the Colony's aspirations to the Renaissance tradition of learning, a marriage of science and the arts."

The floor plan of the Observatory also differed markedly from most other observatories constructed prior to 1860 (e.g. see plans in Donnelly, 1973). If there was one major architectural drawback it was the time ball tower which, in the original plan, was already "objectionably high". Its construction took place while Scott was away from the Observatory, and he returned to find it even taller than anticipated (Scott, 1861a)! It was 17.7 m high, and consequently a sizeable portion of the eastern sky was inaccessible from the western dome. Scott was mortified.

While the building was being erected, Scott began planning the programmes of the Observatory which, as was common practice at the time, were to encompass astronomy, meteorology, geomagnetism, and tidal studies. He also saw that the Observatory would have an important educational role.

His first duty was to assess the equipment at his disposal and so he gathered together the remaining instruments from the Parramatta Observatory that King had placed in storage after that institution closed (Scott, 1859b). There were two chronometers, and four different astronomical clocks, two of which were of little value (Scott, 1859c). Scott also discovered a mural circle 61 cm in diameter and a 9.5-cm aperture transit telescope, both by Troughton (ibid.); a second transit telescope (manufacturer unknown); a 41 cm diameter repeating circle by Reichenbach; an 8.3-cm aperture refracting telescope by Banks; a sextant; a smaller refracting telescope; and assorted magnetic and meteorological instruments (for a full listing see Table 2 in Orchiston, 1988d). Originally, the storage cases had also included a defective 9.5-cm aperture transit circle by Jones, with a circle 1.07 m in diameter (Scott, 1860a), but in 1855 Denison had sent this to England and asked Airy to supervise its repair (Wood, 1958). Scott found the remaining instruments "... so bad that I can do nothing with them ..." (Scott, 1859a), describing the Banks equatorial as:

> ... a portable Telescope, with an equatorial mounting and wire Micrometer, but the instability of its original mounting had been so much increased by use, that it was impossible to make any micrometrical measurements with it. (Scott, 1860a:v).

A first-class equatorial telescope was vital for the Observatory's non-meridian work, and Scott (1860g) did well to convince the Government to commit the not inconsiderable sum of £800 for the purchase of a new 18.4-cm Merz refractor. At the time, Merz of Germany was one of the leading manufacturers of astronomical telescopes (Brachner, 1987; Chance, 1937). While the largest instruments in the world were the 38-cm refractors at the Pulkovo and Harvard College Observatories (Welther, 1984) and apertures in excess of 18.4 cm were not uncommon by 1860 (see King, 1979), the new Sydney telescope would still be capable of useful work.

A reliable astronomical clock was also essential, and after further appraisal Scott decided that only one of the ex-Parramatta Observatory clocks (the one by Hardy) was reliable. He therefore proceeded to order a new clock, by Frodsham (Scott, 1861a).

Scott (1859c, 1861o) also sent off letters to the Royal Astronomical Society and astronomers at the Chilean National Observatory (Santiago) and the Royal Observatory at the Cape of Good Hope, requesting publications so that he could establish an astronomical library, and soliciting ideas on suitable research projects. He even took the unusual step of appealing, in one of his papers in *Monthly Notices of the Royal*

Astronomical Society, for "... any suggestions from your Society as to the best mode of co-operating (when my new instrument arrives) with the astronomers of Europe and America." (Scott, 1861q).

At the very end of 1858, Scott (1858c) succeeded in increasing the staff of the Observatory when 22 year old Henry Chamberlain Russell was appointed as a 'computer' on a salary of £200. Despite being a recent B.A. graduate from the University of Sydney and their top student in mathematics and physics, Scott (ibid.) felt that Russell "... will have much to learn before he can be considered fully official ...", and in writing to a clerical colleague in England the following year described him as "... rather a slow coach but steady and hard working." (Scott, 1859a). Given this assessment, Scott must have been surprised to see Russell emerge as a major figure in New South Wales science later in the century (see Bhathal, 1991).

Finally, Scott also succeeded in forming an Observatory Board, comprising the Governor-General, Colonial Secretary, Surveyor General, Professor of Mathematics at the University of Sydney, and the Commanders of any Royal Navy warships which happened to be in the harbour at the time of a meeting (Wood, 1958). At the first meeting of the Board, on 1858 December 2, Scott had obtained support for the purchase of the Merz telescope and for Russell's appointment.

3.2 Observational Astronomy

By 1858 June, construction of the Observatory building was sufficiently advanced for the time service to be initiated, even though Scott was concerned about several defects of the transit instrument "... which destroyed all confidence in the results furnished by it." (Scott, 1859c:295)! It was only by taking the mean of a considerable number of star transits that "... even a tolerable approximation to the time could be obtained." (Scott, 1860a:v). It became the practice to raise the time ball to the top of the mast on the time ball tower at five minutes before 1300 h each day and drop it precisely on the hour. Given the Observatory's elevated situation, this signal was readily observable by people in the nearby port and fledgling settlement (Tebbutt, 1866).

The transit telescope was also used to observe the Moon and Moon-culminating stars, in order to determine the longitude of the Observatory. The first value published was 10 h 04 m 49 s.0 East of Greenwich based upon just 21 observations but, as Scott (1859c:296) was quick to point, "This determination is, of course, unsatisfactory, owing to the defects of the transit-instrument ...". As if to emphasize the point, he produced a significantly-different figure of 10 h 04 m 59 s.86 in 1859, following the return of the repaired Jones transit circle (Scott, 1860m). Further observations were made in 1860 and 1861, and when these were combined with those of 1859, Scott (1862g) derived a mean value for the longitude of the Sydney Observatory of 10 h 04 m 45 s.79 (cf. Scott, 1862a). Later in the century, this figure was the subject of considerable debate (see Russell, 1878; Tebbutt, 1878, 1880).

Scott (1860m) also investigated the latitude of the Observatory, and observations of 24 different southern stars produced a figure of 33 ° 51 ' 41 ".1 South. Further observations (Scott, 1860a) led to a slightly revised value of 33 ° 51 ' 40 ".8 South, and only a minor correction to this figure was thought necessary in 1861 (Scott, 1862a).

Apart from the transit telescope, the only other astronomical instrument which Scott initially could use for observational astronomy was the old 8.3-cm refractor, until the arrival of the Merz telescope in 1861 May. He decided to follow international custom and use both telescopes to observe "phenomena of an occasional nature" such as comets, eclipses, transits of Mercury and lunar occultations. He also decided (Scott 1861a; 1861i) to investigate some of the double stars that had been observed by Sir John Herschel (1847). Let us review Scott's observations.

The first major comet to appear in Sydney skies following Scott's appointment was C/1858 L1 (Donati), which was visible from the middle of October. Scott (1858a) reported in the *Sydney Morning Herald* that he had made several attempts to determine

its position using the old Parramatta Observatory refractor, "... but the results are not such as could be published in any degree of satisfaction." He also used the sextant to take distances between the comet and selected stars, but again felt the results were too imprecise to be used in any orbital computation. In a follow-up article published three days later (Scott, 1858b), he lamented the circumstances in which he found himself:

> ... possessing no instrumental means of determining the comet's position with accuracy, I can expect no greater weight to be attached to my remarks than to those of any amateur astronomer similarly situated.

In 1860 July, a new Great Comet (C/1860 M1) was reported from various localities in Australia, and Scott caught his first fleeting glimpse of it on July 9 just before it was obscured by clouds. At the time is was "... a brilliant object, and being near the horizon its tail extended upwards at an angle of about 60 °." (Scott, 1860c:359). In a marked departure from 1858, he used the old Parramatta Observatory refractor and its ring micrometer to obtain positions of the comet on six different evenings between July 12 and 18 (inclusive) and these were subsequently published in *Monthly Notices of the Royal Astronomical Society* (ibid.). Scott reports that throughout this series of observations

> ... I have not been able to distinguish any marked peculiarity in its appearance. There was a decided brilliant nucleus, but not sufficiently well defined to form a good subject for observation, around which the light appeared diffused very uniformly. (ibid.)

Further observations followed until August 18 (see Scott, 1861a), and in all Scott made 140 different positional measures of this comet on nine different nights in July and August. Some of these are published in Scott (1860l).

As Scott continued to observe this comet, he shared this experience with the readers of the *Sydney Morning Herald*. His first account appeared on July 16 (Scott, 1860e) and reported that the comet was moving eastward in right ascension and southward in declination at a rate of about 3 degrees per day. In a follow-up letter, published on July 23, he noted (Scott, 1860n) that the comet had remained a naked-eye object until the 18th. In this same letter, Scott supplied those who wished to attempt their own orbital computations with positional data for three different nights, but he was later obliged to provide a correction to one of the values and an apology for any confusion which this may have caused (Scott, 1860b).

While Scott's account of this comet usefully supplemented those provided by other professional astronomers, by far the most significant cometary observations that he made were of the Great Comet of 1861, now known as Comet C/1861 J1 (Tebbutt) (see Orchiston, 1998).

On 1861 May 13 the Windsor amateur astronomer, John Tebbutt, discovered what was destined to become one of the major comets of the nineteenth century (Figure 4). Even before he had confirmed the discovery, Tebbutt (1908) sent a letter off to the Sydney Observatory, and as a result this comet was to occupy Scott's attention for more than a month (see Scott, 1862a).

When he received Tebbutt's letter on May 22, Scott was busy installing the new Merz refractor (see Figure 5), and he was forced to use the old Parramatta Observatory telescope to obtain an approximate position. Two days later, he adapted the micrometer that came with the new telescope to the Parramatta refractor and was able to obtain an accurate position of the comet's head (Scott, 1861l). Further micrometric observations were made on May 27 and 30. By June 4 the Merz refractor was operational, and from June 8 to 26 (inclusive) Scott obtained positions on 12 different evenings and published these in *Monthly Notices of the Royal Astronomical Society* (Scott, 1861p). He also made information on the comet available to the local public through the *Sydney Morning*

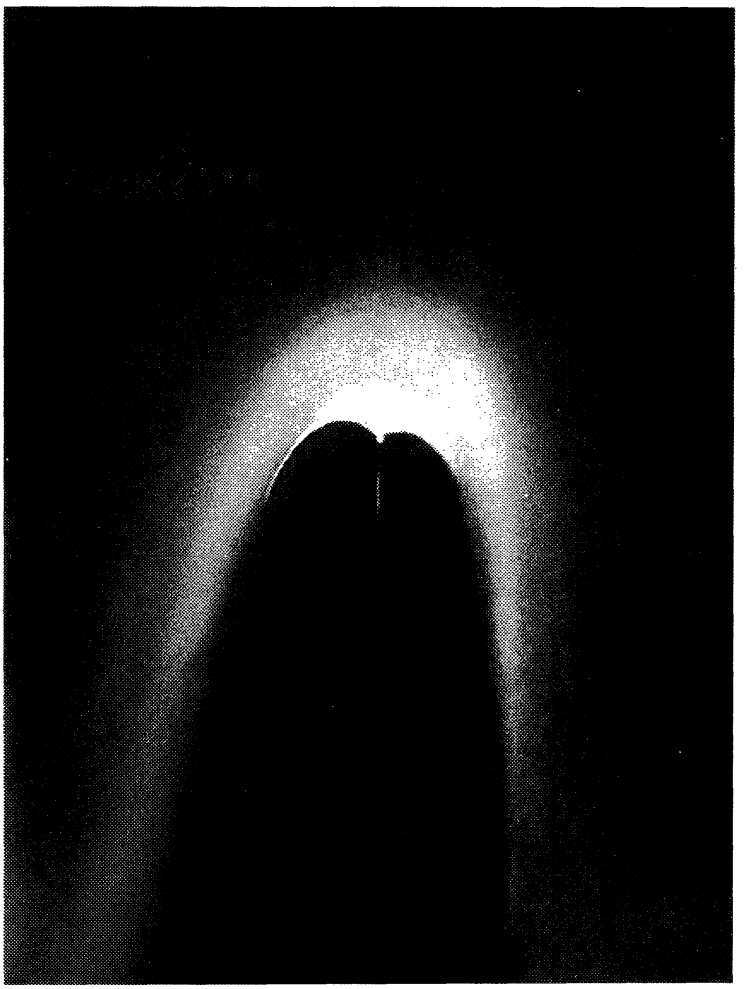

Figure 4. Head of Comet C/1861 (Tebbutt). (After Guillemin, 1877:Frontispiece)

Herald newspaper, and on May 31 reported his positional observations of May 24, 27, and 29, and noted that on the 27th he had "... detected the existence of a tail, very faint and diffused, pointing nearly to the south pole." (Scott, 1861m). On June 17, he published an account in *The Empire*, describing the tail as then 18 degrees in length (Scott, 1861t).

These attempts to share observations of the comet with the public ultimately backfired when an anonymous writer using the pseudonym 'Orion' criticized Scott for not providing enough "... *popular* information respecting the new comet ...", including its period, the nature of its orbit, and its location and day-by-day motion in the sky. He also asked Scott to

> ... give us a brief outline of the theories of Lardner, Arago, and others on "Cometary Influences", showing that no possible danger can arise to our earth from their presence, and thus allay or prevent the terror of the alarmist. (Orion, 1861).

On June 22 Scott responded to 'Orion', and in the process included an account of the tail:

> The most remarkable feature I have noticed is the formation of the tail; the usual diverging brush-like appearance extends for about eight degrees ... and

> beyond it extends a narrow stream of light in the same direction, and reaching to about ten degrees further ... (Scott, 1861r).

Immediately following Scott's letter in the *Sydney Morning Herald* was another anonymous one, this time by 'F.C.B.' (1861) supporting Scott and the work of the Sydney Observatory.

Yet another attack on Scott appeared in the *Sydney Morning Herald* on June 26, but written in an rather novel way. In a letter titled "The Comet's Grievance", a correspondent using the name 'Comet of 1861' writes:

> It is not often that I honour the people of New South Wales with a visit, but after the extremely shabby manner in which I have been treated by the local astronomers, I take good care that my future visitations shall be "far between". Through my influence, I have kept the elements clear, in order to allow your "scientific few" to have their eyes on me to make their observations of my onward progress, yet nothing has officially appeared in print about me....
>
> My object, in appearing in this hemisphere, was to put the ability of your local (paid and amateur) astronomers to the test, in order to give them an opportunity of furnishing an interesting dissertation to the common people, but my object and wishes were frustrated. I must confess that had it not been for the "amateur" at Windsor, in all probability my visit would have passed off unreported. Mr. Tebbutt has my thanks for informing Mr. Scott of my visit and whereabouts. At the same time it is very humiliating for a great man so often to play "second fiddle". (Comet of 1861, 1861).

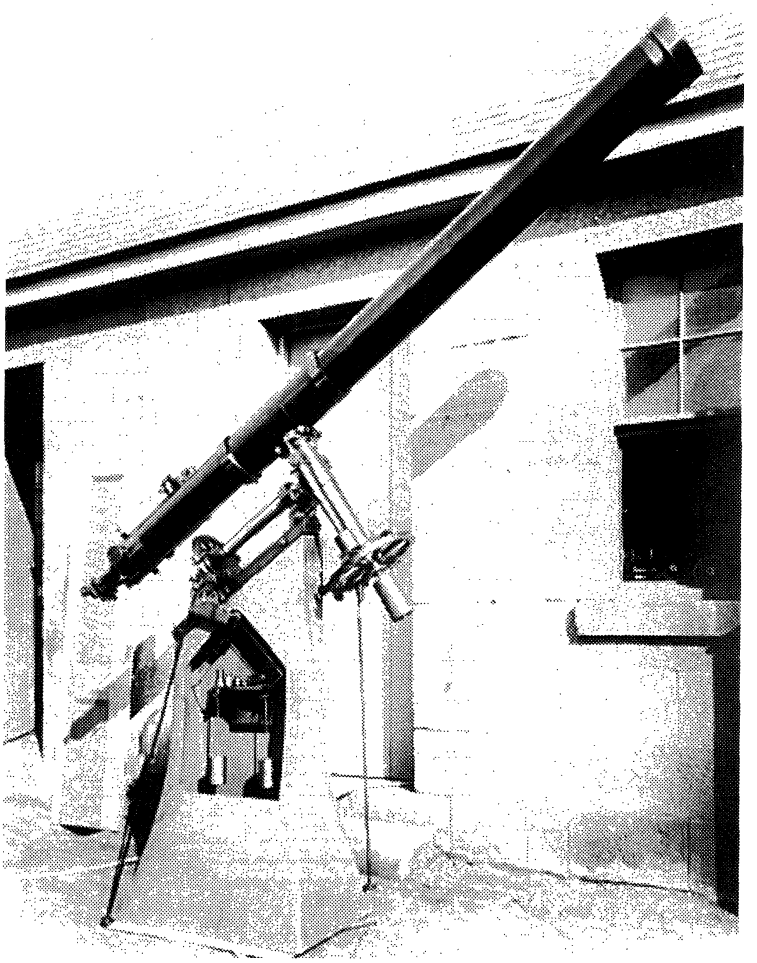

Figure 5. The 18.4-cm Merz refractor. (Photograph courtesy Royal Astronomical Society)

As might be expected, this letter elicited a stern reply from Scott (1861s). He pointed out that he had submitted papers on the comet to overseas journals (e.g. see Scott, 1861p) and saw no point in reproducing their full contents in the local media, there being "... but two or three persons in the colony to whom they could be of any service ..." (Scott, 1861s). Despite this, he included the comet's orbital elements which he had calculated and, as Table 1 indicates, these are very similar to the elements published earlier by Tebbutt (1861) and subsequently by Hawkins (1861), Kreutz (1880) and White (1861). What Scott did not do, despite Orion's prompting, was provide a popular account of the various theories about comets.

Table 1. Orbital elements of Comet C/1861 J1 (Tebbutt) according to different computers

Computer	Tebbutt	Scott	Hawkins	White	Kreutz
Perihelion passage, June	13.7253	11.6892	11.75	11.2035	12.0068
Perihelion distance (in AU)	0.82033	0.82218	0.82215	0.82156	0.82238
Longitude of ascending node	280°00'44"	278°57'52"	279°01'41"	278°58'36"	280°12'39"
Inclination of the orbit	86°18'42"	85°38'11"	85°37'46"	85°25'42"	85°26'27"
Distance of perihelion from node		29°42'58"	29°38'59"		29°54' 35"
Heliocentric motion	Direct	Direct	Direct	Direct	Direct

In the same issue of the *Sydney Morning Herald* was a second letter from 'F.C.B.' (1861b) supporting Scott against the attack by the 'Comet of 1861', and less than a week later, 'X.X.' (1861) added his support.

The departure of the comet from southern skies did not end the media interest in it, and on 2 July Scott (1861u) brought his entire suite of positional observations together in *The Empire* for anyone who wished to use them for their own orbital computations. He then prepared a synthesis of all of his own observations and descriptions, and details of the initial discovery by Tebbutt, and presented this paper at a meeting of the Philosophical Society of New South Wales. Since the Society had not begun publishing its *Transactions* at this time, Scott's paper was reproduced in its entirety in both *The Empire* and the *Sydney Morning Herald* (e.g. see Philosophical Society, 1861) on July 18. Thus ended Scott's investigation of Comet C/1861 J1 (Tebbutt).

The fourth comet that Scott observed was P2/Encke in 1862. Because of cloudy and hazy weather, he was only able to obtain micrometric positions on February 23 and 24, and noted that the comet at best was "... very indistinct and ill defined." His twelve micrometric positions, involving two different comparison stars, were published in *Monthly Notices of the Royal Astronomical Society* (Scott, 1862h).

Undoubtedly, the most significant astronomical event to grace Sydney skies soon after Scott's arrival was the total solar eclipse of 1857 March 26. Such eclipses offered astronomers all-too-brief opportunities to study prominences, the solar chromosphere and corona, and Baily's Beads, and the 1857 event was eagerly awaited by Scott and other local astronomers. And as the first total solar eclipse visible from Sydney since European settlement, it also attracted considerable public interest. The event was scheduled to begin at 05 h 55 m 12 s local time, about 13 minutes before sunrise, and end at 07 h 53 m 49 s. Totality was restricted to just 1 m 32 s, starting at 06 h 51 m 19 s (Scott, 1857a).

Both Scott (ibid.) and Tebbutt (1857a, 1857b) discussed the event beforehand in the *Sydney Morning Herald*, but in Scott's case it is somewhat surprising that he neglected to warn people of the inherent dangers of directly viewing the partially eclipsed Sun with the unshielded eye. As it turned out, all this publicity was to little avail for the day dawned cloudy. Armed with Governor-General Denison's equatorial telescope,

Scott (1857b) was stationed at the South Head Lighthouse, but all he saw were fourteen minutes of the partial phase shortly after the Sun rose. The Sun was completely obscured by clouds during totality.

Four years later, on 1861 January 11, there wasScott a partial solar eclipse (Scott, 1861k), which Scott observed. Because there was some cloud cover, he was unable to obtain precise contact times or carry out micrometric measurements of the eclipsed portion of the Sun's disk. Despite this, he forwarded an account to England, including 16 temperature readings extending over a 2 h 20 m period (Scott, 1861q).

Another solar-related event that drew Scott's attention was his first ever observation of a transit of Mercury. This occurred on 1861 November 12, and was recorded in Sydney, Melbourne and Adelaide (Observations in Australia ..., 1861). In Sydney, Scott (1861n) observed the second ingress contact and then followed Mercury as "... a well-defined circular black spot, slowly traversing the disc." During the transit, he succeeded in obtaining a few micrometric measurements of the planet's position relative to the solar limb.

According to Tebbutt (1866), after the arrival of the Merz refractor Scott added lunar occultations and southern double stars to his observing programme, although there is no evidence that he published any results of these investigations. We do know that from 1861 February Tebbutt was computing the local occurrence times of lunar occultations for Sydney Observatory (see Scott, 1861f), so that Scott could observe these events if he wished to.

The renovated ex-Parramatta Observatory transit circle arrived back in Sydney towards the end of 1858 December, and in 1859 June Scott began to make regular observations with it (Tebbutt, 1904). His project was a survey of stars culminating near the zenith at Sydney, and the very numerous results appeared in four successive annual monographs produced by the Observatory and published by the Government (Scott, 1860a, 1861a, 1862a, 1865). Tebbutt (1866:59) reports that even though

> The transit circle is described as only a second-class instrument ... considering the care and skill employed in the use of it, the volumes referred to will be found to be a very valuable contribution to science.

Although the Sydney survey proved complementary to the survey of stars near the south celestial pole conducted by the Royal Observatory at the Cape of Good Hope, Dewhirst (1985) has used the benefit of hindsight to query the utility of many of these types of programmes.

One other notable celestial observation that Scott made was of his first aurora australis in 1859 August (Scott, 1859e). The observation itself was only important because of Scott's foray into solar-terrestrial relations less than one year later:

> There has been detected a connection between Solar spots and magnetic variations, and the Aurora is due to or accompanied by magnetic disturbances. There is probably a similar connection between its appearance and solar spots – but I have not met with any statement of such connection having been observed. (Scott, 1860h).

As Haynes *et al.* (1996:53) have pointed out, this important deduction was largely overlooked at the time, but it was "... to have a major impact on radio communications, radio astronomy and geomagnetic work in the next century."

3.3 Astronomical Education

Denison also saw the role of the Sydney Observatory as "... to provide service, including education, to the community ..." (Wood, 1958:30), and Scott responded to this whenever possible by sending the Sydney newspapers information on astronomical objects or events of likely popular interest. In addition to the articles already referred to about

comets, eclipses, the transit of Mercury and the aurora, he also wrote about a second partial solar eclipse in 1861 (Scott, 1861b) and compass errors in iron sailing ships (Scott, 1860f).

Scott also offered to take astronomy to interested members of the general public by conducting formal classes at the Observatory, and although he managed to attract a small group, "... no one persisted to the stage of undertaking useful amateur work for which he was willing to provide facilities ..." (Wood, 1958:10). In contrast, he found a captive audience at the University of Sydney where he was appointed Mathematics Examiner, but he was far from impressed by the standard: "... there are about 25 men or rather boys and their Mathematical reading in no case extends beyond mild mechanics." (Scott, 1859a).

3.4 Religion and Astronomy

As we have noted, by the time he accepted the Sydney posting, Scott had become disenchanted with Christian religion, yet in what could be described as his only foray into 'theoretical astronomy', he brings science and religion to bear on the vexed question of life in the universe. In an interesting review paper (Scott, 1859d) published in *The Sydney Magazine of Science and Art* under the authorship of 'Rev. W. Scott, M.A.', with no mention of his Sydney Observatory affiliation, he explained that

> Some are kept back from the subject by the amount of reading requisite for its full consideration; others by fear that their astronomical knowledge will hardly enable them to understand all the arguments employed in the discussion; others again finding such great names ranged on opposite sides feel it impossible to come to any conclusion on a question on which such authorities are unable to agree. (Scott, 1859d:131).

These considerations did not deter Scott, who proceeded to discuss the following four questions:

1. Are the other planets of the Solar System occupied by living beings?
2. Are the stars associated with planetary systems, and if so, are their planets inhabited by living beings?
3. Are the Sun and stars also inhabited?
4. Are there among the inhabitants (if any) of those bodies, reasonable beings equal or superior to man?

After reviewing the available scientific evidence, Scott concluded that life is likely to exist on some of the planets in our Solar System; that some stars are accompanied by planets; and that some of these are also inhabited. In sympathy with a theory championed by Sir William Herschel, he believed that the Sun may also be inhabited and, that being the case, he saw not reason why other stars should not be. Finally, in examining the question of intelligent human life, he concluded: "... if the celestial bodies are inhabited at all there is a strong probability of their being inhabited by beings analogous to ourselves." (Scott, 1859d:134).

In completing his interesting review, Scott compared and contrasted the conflicting viewpoints of science and religion, pointing out that

> Revealed religion ... although it allows of the existence of animal life in innumerable worlds, is yet opposed in some degree to the existence of a race resembling ourselves in their higher faculties and in their relation to the Creator. (Scott, 1859d:136).

While both scientific and religious viewpoints were cleverly presented, the reader is left wondering exactly where Scott's true sentiments lay!

3.5 Meteorology

As was the custom with many professional observatories at this time, the Sydney Observatory was also involved in disciplines other than astronomy, and meteorology undoubtedly was the most important of these. In a newly-settled colony, meteorology had a special place, and Scott was very aware of this:

> Our little observatories [= meteorological stations] scattered about the colony, besides collecting data on which the future Newton of meteorology may, perhaps, ground his great harmony of the wind and clouds, besides distinguishing between the characteristics of different localities in such a manner as to guide the sickly in his search for a climate suitable for his constitution, the engineer in providing the water supply for our towns and cities, the agriculturist and gardener in the cultivation of particular crops and plants, will do something also towards the encouraging a habit of thought, and promoting the pursuit of science in the colony. (Scott, 1857d:129).

Soon after his arrival in Sydney, he began planning the Observatory's meteorological programme which involved the establishment of a network of country stations throughout the colony.

His first task was to unpack the twelve sets of meteorological instruments (see Table 2) which had previously been ordered from England (Wood, 1958), and to decide on the siting of his meteorological stations. By 1857 October, the following locations (see Figure 1) had been chosen: Albury, Armidale, Bathurst, Cooma, Deniliquin, Goulburn, Maitland and Parramatta, plus the lighthouses at Gabo Island, Moreton Island (Brisbane) and Newcastle (Scott, 1857d). In addition to the lighthouses, country stations were to be located in such varied institutions as a parsonage, a school, a jail, and a hospital!

Table 2: Meteorological instruments used at the Sydney Observatory and at each of the country meteorological stations (after Scott 1857c).

1.	Barometer with attached Thermometer
2.	Wet and Dry Bulb Thermometers
3.	Daniell's Hygrometer
4.	Negretti and Zambra's Self-registering Maximum Thermometer
5.	Solar Radiation Thermometer
6.	Rutherford's Minimum Thermometer
7.	Terrestrial Radiation Thermometer
8.	Rain Gauge
9.	Double Gold Leaf Electroscope
10.	Wind Vane

Scott (1857c) also prepared detailed instructions for his country meteorological observers. They were to read all of the instruments three times daily, at 0900 h, 1500 h, and 2100 h, and also were expected to note

> ... any phenomena which are probably occasioned by the state of the atmosphere, such as epidemic diseases, blights, extraordinary numbers of insects, changes in the times of flowering of plants, &c. (Scott, 1857c:9).

By mid-1858, Scott (1859c) had spent considerable time visiting all of the country stations, and had installed the meteorological instruments and instructed the observers in their duties. In addition to his personal visits, this exercise involved him in a voluminous correspondence (Wood, 1958).

On 1858 August 11, Scott (1858d) provided his first meteorological 'progress report' to the Philosophical Society of New South Wales, noting that the reduction and

copying of the data from all stations in the Sydney Observatory network involved about forty-eight hours of intensive work each month (ibid.; cf. Scott, 1859a). A direct result of this considerable expenditure of effort and energy was that summaries of the observations taken at the country meteorological stations were published each month in the *Sydney Morning Herald*, while reports from Sydney Observatory itself appeared weekly. These latter listed daily values for barometric pressure; maximum and minimum shade temperatures; maximum sun temperature; humidity; rainfall; and wind direction and force, and cloud cover, at 0900 h, 1500 h, and 2100 h; together with general remarks about the overall weather. By 1859 (Scott, 1860a), there were 12 meteorological stations involved in the Sydney Observatory meteorological network (the Observatory included), the lighthouse station at Gabo Island having been taken over by the Victorian Government (Scott, 1958d).

With the passage of time, there were on-going problems with the country meteorological network caused by a combination of equipment breakages and the use of unskilled and, in some cases, unreliable observers. By 1860 October the situation had become intolerable, and Scott recommended that eight sets of instruments should to be transferred to government telegraph stations where a part of the telegraph clerk's duty would be to take the meteorological observations and transmit monthly returns to the Observatory. This was implemented in 1861, and led to some wholesale changes to the actual location of country stations (see Table 3): the Rockhampton station was closed down on October 1, and the instruments at Maitland Gaol were transferred to the Newcastle Telegraph office and those at Parramatta to the Telegraph Station at Windsor. Wood (1958:8) believes that these new arrangements involving the telegraph stations "... played an important part in developing Australian meteorological services."

Table 3. The Sydney Observatory meteorological network, 1858-1862. (After Scott 1859d, 1861a, 1862a and 1865)

Station	1858	1860	1861	1862
Albury	x	x	x	x
Armidale	x	x	x	x
Bathurst	x	x	x	x
Brisbane	x	x	x	
Casino	(x)	x	x	x
Cooma	x	x	x	x
Deniliquin	x	x	x	x
Goulburn	x	x	x	x
Maitland	x	x	(x)	
Newcastle	(x)		(x)	x
Parramatta	x	x	(x)	
Rockhampton		x	(x)	
Sydney	x	x	x	x
Windsor			(x)	x

Key: (x) = part of year only

3.6 Tidal Studies

In 1860, Scott arranged with the Harbour Master for daily tidal readings and seawater temperature measurements to be taken at Woolloomooloo Bay in Sydney Harbour (Scott, 1861a; Wood, 1958).

3.7 Magnetic Studies

In addition to his administrative commitments and his astronomical, meteorological, and tidal studies, Scott somehow thought that he would find the time and energy to conduct a magnetic survey of the colony (Cable, 1976), and in 1860 the Government approved the

purchase of an inclinometer and a unifilar magnetometer. In writing to Major-General Sabine about these acquisitions, Scott (1860k) pointed out that because a geomagnetic observatory had recently been set up by Neumayer in Melbourne (see Perdrix, 1990; Weiderkehr, 1988) a full magnetic facility would not be needed in Sydney.

4 SCOTT'S PREMATURE RESIGNATION

By accepting the Sydney appointment, Scott inherited a 'mission impossible'. The meridian and non-meridian astronomical programmes alone generated more work than a staff of just two could easily cope with (Scott, 1859c), but Scott also had to contend with an ambitious meteorological programme which demanded incessant correspondence and frequent travel. He was not alone in this regard, for Dewhirst (1985) has shown that chronic understaffing was also a common feature of British professional observatories at this time.

The inhuman workload eventually impacted on Scott's health. In 1860 April he was much bothered by colds "... brought on by observing at night in a draught which is sometimes in winter enough to cut one in two ..." (Scott, 1860g), and during the year his health continued to deteriorate. By 1861 he was totally disillusioned, as other matters continued to trouble him deeply.

For instance, he was only too willing to point out that he was by training a mathematician and not an astronomer, and was therefore "... a novice in practical astronomy ..." (Scott, 1861q). Indeed, as he indicated in a letter to Airy (Scott, 1861c), he had never even made a serious astronomical observation before coming to Sydney! Given this background, it is perhaps not surprising that he experienced considerable difficulty making the transition from academic to observer. He seemed ill at ease with the Observatory's instruments (Scott, 1861g), although the arrival of the Merz refractor did, for a short while, at least inspire him "... with new spirit." (Scott, 1861d).

Appropriate staffing of the Observatory would have rectified this situation to some degree, but Russell did not offer this prospect. Although Scott found him an adequate computer, he would have preferred someone who was also an experienced observer (Scott, 1862c). Russell was, after all, in his own mould, an academic who had come to the Observatory straight out of university.

What was needed was a 'practical astronomer', with obvious mathematical skills, and Scott saw Tebbutt (Figure 6) as the ideal solution to his problems and as his ultimate successor. Soon after his arrival in Sydney, Scott had struck up a friendship with the amateur astronomer from Windsor (Tebbutt, 1875), and with the passage of time this proved to be mutually beneficial. While Scott (1860h) was happy to provide Tebbutt with advice on possible observational programmes and made him welcome at the Observatory (Tebbutt, 1859-63), Tebbutt for his part furnished Scott with eclipse and occultation predictions (see Scott, 1861e) and with other astronomical information (particularly about comets). Scott (1860d) also welcomed "... at any time suggestions or information that you may be inclined to send; as my time is so much occupied that I find little time for reading, and many important novelties may escape my notice."

As early as 1860 April, Scott was thinking of premature retirement, and he saw Tebbutt as part of his plans. He was impressed with Tebbutt's knowledge, enthusiasm, and mathematical skills (Scott, 1860i, 1861e), and prophesied a brilliant future for the young amateur astronomer from Windsor:

> With your enthusiastic love of Astronomy mathematical ability and industry you might become one of the distinguished Astronomers of the age in fact Australia's first Astronomer ... Why not come to Sydney give some proof of your powers at the University; work as an amateur at the Observatory (The Equatorial would be at your disposal) and take possession of my place when I give it up, which I hope to do in a few years? (Scott, 1860h).

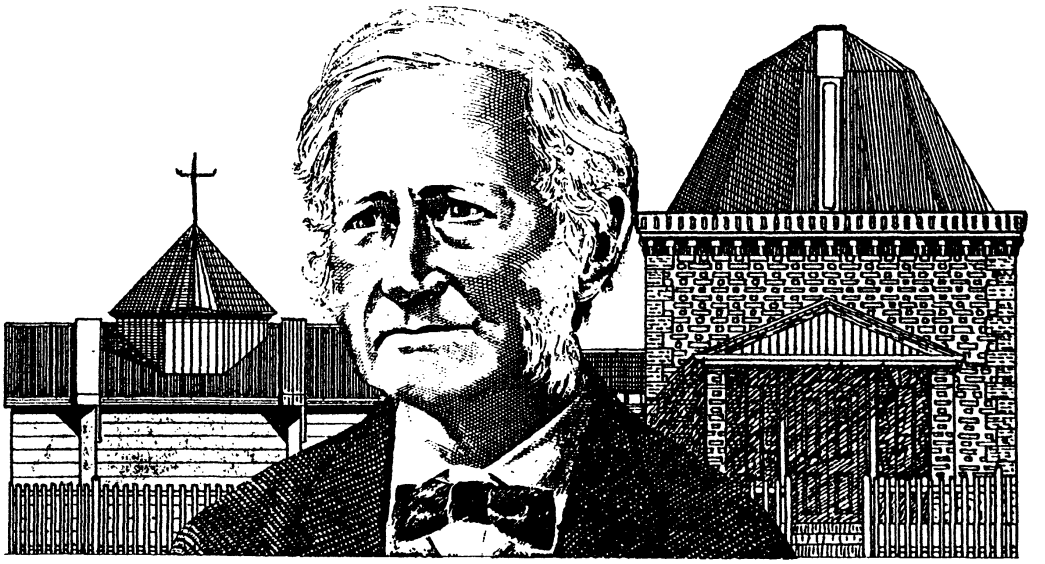

Figure 6. John Tebbutt, 1834-1916.

Circumstances prompted him to take this scenario a step further at the end of 1861:

> Will you now allow me to ask you in confidence these two questions which you may be assured I would not ask without reason.
>
> 1. Would you be prepared, four or five years hence, to accept, if offered, the appointment which I now hold.
> 2. Would you object to take the office and Salary (£300) of Computer, on a more independent footing than that which the present computer occupies, with the understanding that you should succeed to my post when vacant.
>
> I should be greatly obliged if you will explain to me as candidly as you think proper what are your feelings with regard to these two questions. (Scott, 1861h).

In order to accomplish the latter staffing change, Russell would be offered employment elsewhere in the Public Service, in a post "... equivalent to that which he now holds." (Scott, 1862c). Much to Scott's frustration, Tebbutt turned down the offers, preferring instead "... an unofficial life ..." when it came to astronomy (N.S.W., 1893).

In addition, Scott was very disappointed with the lack of serious interest shown in his astronomy classes (Scott, 1860a, 1861j), and he also resented the mounting public criticism that was directed towards his person and the Observatory. Following the discovery of Comet C/1861 J1 by Tebbutt, he wrote to McClear at the Royal Observatory, Cape of Good Hope: "[I] ... am continually attacked in the public papers for not making more a plaything of the Observatory. The late Comet's appearance called forth attack innumerable especially for not being the first to observe it." (Scott, 1861d). But public concerns went far beyond the comet, judging from the following letter written by the influential J. Dunmore Lang in 1860:

> Our Astronomer ... is certainly not a very Scientific character for when he was found fault with through the press of the day for not giving notice of an Eclipse or not having seen it himself, made some lame apology that he did not understand well astronomy. When he ... got the appointment in London as

> astronomer to go out here, he told the one high in office that he did not understand all the points and difficulties of the office He was comforted by the same official, replying that all he would require to do to be master of all that was necessary for the appointment could be gathered from books which he could very easily procure and consult. What ignorance this displayed to give such an important & highly interesting a post to one entirely ignorant of the Duties of Astronomers .... (Lang, 1860).

While this is a private letter and questions Airy's competence, the views presented were hardly flattering to Scott and he expressed some of his frustration in the following letter to a non-astronomical colleague in England: "... people are always expecting me to write to the papers announcing some grand discoveries, but I have not made any just yet and don't much like manufacturing them to the public taste." (Scott, 1860g).

As we have already seen, Scott also encountered on-going problems with both equipment and personnel associated with the country meteorological network, and it was only after the system was rationalised in 1861 that some of these were eliminated.

Cable (1976) has suggested that Scott may also have become discouraged following the departure of Denison as Governor-General in 1860 (Currey, 1972). Denison certainly had a special interest in astronomy (e.g. see Denison, 1858; Obituary, 1872; Scott, 1857b), and was a very public champion of the Observatory. While that situation prevailed Scott was able to make good progress, despite his own troubles and the underlying concerns that some citizens had regarding his competence and the cost-effectiveness of a colonial observatory. That the Government was prepared to outlay considerable funds for the new Merz refractor, the Frodsham clock, repair of the old transit circle, and purchase of numerous sets of meteorological instruments, reflects Denison's support and runs counter to Tebbutt's (1904) much later claim that "Mr. Scott encountered great difficulty in securing proper instruments for the new establishment under his direction." However, Russell also had concerns about the Observatory's initial instrumentation:

> Sir William Denison made a serious mistake when he spent £7000 on the Building and handed a number of almost useless instruments to Mr Scott expecting him to work with them. Long before this with a good transit circle we should have had a long catalogue of star positions of real value. (Russell, 1876).

After Denison's departure, Scott did indeed become immersed in the petty bureaucracy which can become so much a part of Government, and eventually reminded the Colonial Secretary that he was appointed by the Home Government (in England) "... without any intimation that I should at any time be dependent on the legislation of the Colony." (Scott, 1861j). In early 1862 he discovered that payment for the new Merz telescope had been disallowed because the invoice was presented in the year after the vote was allocated (Scott, 1862b). This led him to worry about other financial allocations to the Observatory, and over the next three months several letters were dispatched to the Colonial Secretary and the Auditor General, some of them marked 'Great Urgency'. These must have been trying times for Scott as he contemplated his resignation.

Finally, Scott (1861o, 1861q) sorely felt his geographical isolation from the main centres of astronomical activity, in Europe, Britain, and the United States. It would seem that the only compensation he found was the close friendship that he struck up with Tebbutt.

Despite this, Scott eventually found the overall situation intolerable, and on 1862 May 9 penned his letter of resignation:

> I have the honour to inform you that four years of close application to my duties have so affected my sight, as to convince me that I could not much longer continue to perform those duties in a manner satisfactory to myself. I have therefore thought it my duty to resign my appointment as soon as I should be able to do so without altogether ruining myself by so doing. Such an opportunity has just now occurred and ... I shall be unable to attend fully to my official duties later than the end of July next. (Scott, 1862d).

When he turned down the offer of employment in 1861 December, Tebbutt could hardly have imagined that the office of Government Astronomer of New South Wales would be vacant a mere five months later, rather than in five years as Scott had anticipated!

The search was now on for a new Government Astronomer, and although Scott had accepted a teaching post at the Cook's River Collegiate school owned by the Reverend W H Savigny (Cable, 1976), he agreed to maintain an on-going supervisory brief over the Observatory while Russell attended to the day-to-day running of the institution (Parliament of New South Wales, 1862).

5 THE QUEST FOR A NEW GOVERNMENT ASTRONOMER

In a letter to the Colonial Secretary dated 1862 June 5, Scott (1862e) stressed that applicants must be competent mathematicians; have extensive observational experience, particularly with a large equatorial telescope; and be prepared to do most, or even all, of the observing.

Scott was impressed with Tebbutt's high public profile (mainly through his discovery of the Great Comet of 1861) and with his business acumen, mathematical skills, observational experience, commitment to astronomical research and education, and sympathy for meteorology (see Orchiston, 1988c). Accordingly, he once again recommended Tebbutt for the post (Tebbutt, 1875).

In an account of the proceedings of the New South Wales Legislative Council for 1862 October 29 published in *The Empire*, the Colonial Secretary, Mr Cowper, was quizzed about Scott's resignation and the search for a new Government Astronomer. After comments by a Mr Dalgleish about John Tebbutt's observations and discoveries, Cowper responded:

> As to Mr Tebbutt, he had only to say the Government would be happy to give that gentleman the position; but he had refused it over and over again. (Parliament of New South Wales, 1862).

When pressed further by Dalgleish on whether it was the office of Astronomer or Assistant Astronomer (i.e. Russell's post) that Tebbutt had been offered, Cowper elaborated: "... he had repeatedly refused the offer of assistant, and had as much as said that he would not accept the office of astronomer." (ibid.).

Others besides Scott (1862f) then tried to talk Tebbutt into changing his mind. One of these was the Sydney optical instrument-maker, Angelo Tornaghi (see Maguire, 1985), who was later to provide the Windsor Observatory with a transit telescope and other equipment:

> I wish you would accept the place of Colonial Astronomer, as you are the only only [*sic*] compitent for it is well known. trusting you will axept the ofar. I know the Revd Scott is very anseous you should and so am I many others besides. (Tornaghi, 1862).

While Tornaghi may win no prizes for spelling and punctuation, his sentiments are clear. They did not, however, bring about the desired result. At a later date doubt was cast as

to whether Tebbutt really was offered the vacant directorship (Tebbutt, 1908), but Scott's own public testimony put the matter beyond dispute:

> Mr. Tebbutt always had my friendly sympathy in his work, but the only occasion on which I had an opportunity of encouraging him was when I resigned my office of Astronomer in 1862, and recommended the Colonial Secretary to appoint him in my place. This recommendation, no doubt, would have been acted on had not Mr. Tebbutt communicated to Mr. Cowper, through me, his unwillingness to accept the appointment. (Scott, 1875).

With Tebbutt's continued refusal, the New South Wales Government turned once more to England for assistance, and in due course Airy and Sir John Herschel arranged for a mathematician and astronomer named George Robarts Smalley to replace Scott. Yet another Cambridge graduate (see Wood, 1976), Smalley arrived at the Sydney Observatory on 1864 January 7.

6 CONCLUSION

This study illustrates the colonial domination that England maintained in New South Wales astronomy during the middle of last century, and the trials and tribulations to be faced by appointing an inappropriate Englishman to establish a professional astronomical observatory in Australia.

Under the circumstances, we can only be impressed by Scott's remarkable record of achievement in his six short years as Government Astronomer of New South Wales. He spent just five-and-a-half of these in Australia, and during that time obtained a state-of-the-art equatorial telescope and astronomical clock, determined the latitude and longitude of the Sydney Observatory, prepared a catalogue of zenith stars as seen from Sydney, published important observations of Comet C/1861 J1 (Tebbutt), carried out a range of other useful positional observations, established a network of meteorological stations throughout New South Wales, published four volumes totalling 854 pages reporting the astronomical and meteorological observations made at the Observatory, and brought information on these two disciplines to the people of Sydney by way of local newspapers. Through dedication, hard work, and political acumen, Scott was able to establish a firm foundation for Sydney Observatory, one which Russell was able to build on later in the century.

What is even more remarkable, Scott was able to achieve all this despite on-going problems. He endured an intolerable work load, found the public service difficult to deal with at times, and was ill equipped to accommodate or counter public criticism (much of it unwarranted) directed at both his person and the Observatory. Nor was he happy with Russell's background or his performance as 'Computer', and he was frustrated when Tebbutt refused to accept a position at the Observatory or to succeed him as Director and Government Astronomer of New South Wales.

While Henry Russell and Dr Harley Wood are traditionally held up as the two outstanding Government Astronomers of New South Wales (e.g. see Bhathal and White, 1991; Haynes *et al.*, 1996; Nightingale, 1958; Orchiston, 1988b; Robertson, 1985), Scott's contribution has not hitherto been fully documented. His achievements during the critical formative years of the Sydney Observatory were remarkable and deserve to be more widely recognized.

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TL = *Letters to J. Tebbutt*. Bound manuscript letters in the Mitchell Library, Sydney.

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