

HIGHLIGHTING OUR INTERNATIONAL ASTRONOMICAL HERITAGE: TASMANIAN RELICS OF THE 1874 TRANSIT OF VENUS

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Abstract: Through the presence of two 1874 American transit of Venus stations, Tasmania played a key role in determining a value for the astronomical unit. But what makes these two stations even more important is that to this day they preserve relics associated with these historic observations. In this paper we summarise the surviving evidence found at Barrack Square in Hobart, and then revisit the Campbell Town site and provide a new interpretation of the field evidence preserved there. This is a revision of the problematic interpretation that was presented in Orchiston and Buchanan (2004), and is based upon more recent investigations.

Keywords: transit of Venus, US 1874 transit parties, Tasmania, Barrack Square, 'The Grange', Queen Victoria Museum and Art Gallery

1 INTRODUCTION

Observing the 1874 transit of Venus was a major international enterprise that helped solve one of nineteenth century astronomy's leading challenges: to derive a realistic value for the solar parallax and hence for the astronomical unit (i.e. the Earth-Sun distance).

The United States organised eight 1874 transit stations (Dick et al., 1998), and two of these were in Australia, where—weather permitting—the entire transit would be visible. Both U.S. transit stations were in the island state of Tasmania to the south of the Australian mainland. One was in Hobart, the Tasmanian capital (Orchiston, 2004), and the other was in Campbell Town (Orchiston and Buchanan, 1993; 2004),¹ a town ~130 km north of Hobart (for Tasmanian localities mentioned in the text see Figure 1).

Both transit stations relied upon photographic and micrometric observations and consequently utilised the same instrumentation: a horizontal photographic telescope (Figures 2 and 3), a Stackpole broken-tube transit telescope (Figure 4), a 5-in (12.7-cm) equatorially-mounted Alvan Clark refractor (Figure 5), a Howard sidereal clock

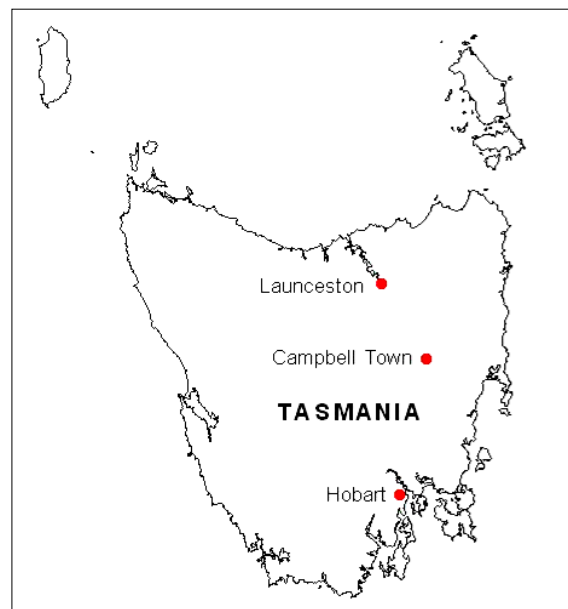


Figure 1: A map of the Australian island state of Tasmania showing locations mentioned in the text (map: Wayne Orchiston).

and Negus and Porter chronometers.² The Clark refractor, the transit telescope and the plate-holder that formed part of the photographic telescope all were housed in prefabricated 'Equator-

While there are no photographs or plans of the Campbell Town transit station, both exist for the Hobart transit station and are shown in Figures 6 and 7. Meanwhile, the personnel at the two transit stations are listed in Table 1.

2 TASMANIAN OBSERVATIONS OF THE TRANSIT

At Campbell Town the day of the transit, 9 December 1874, dawned cloudy, and soon it was raining heavily. However, about forty minutes after first contact³ the rain suddenly stopped, and Venus could be seen on the face of the Sun. The photographers began exposing their plates, and continued doing this for the rest of the transit, except for those intervals when rain or heavy clouds returned. Dick (2003: 259) reveals that only 55 useable photographs were obtained, from the 120 images that were exposed on the day (The transit of Venus, 1874a). In addition, Raymond used the Clark telescope to try to observe the third contact, but clouds made Venus appear "... pear-shaped ...; limb of Sun unsteady; not a satisfactory observation ..." (Newcomb, 1880: 154). Despite the unpromis-



Figure 6: One of a stereo pair of photographs of part of the Hobart 1874 transit station, showing (left to right) the 'Transit House', heliostat drive, heliostat pier, and part of the wooden superstructure protecting the measuring rod (leading to the 'Photographic House'). In the background is the 'soldiers' monument' (courtesy: W.L. Crowther Library, Tasmania Archives and Heritage Office, ADRI:AUTAS001125299032).

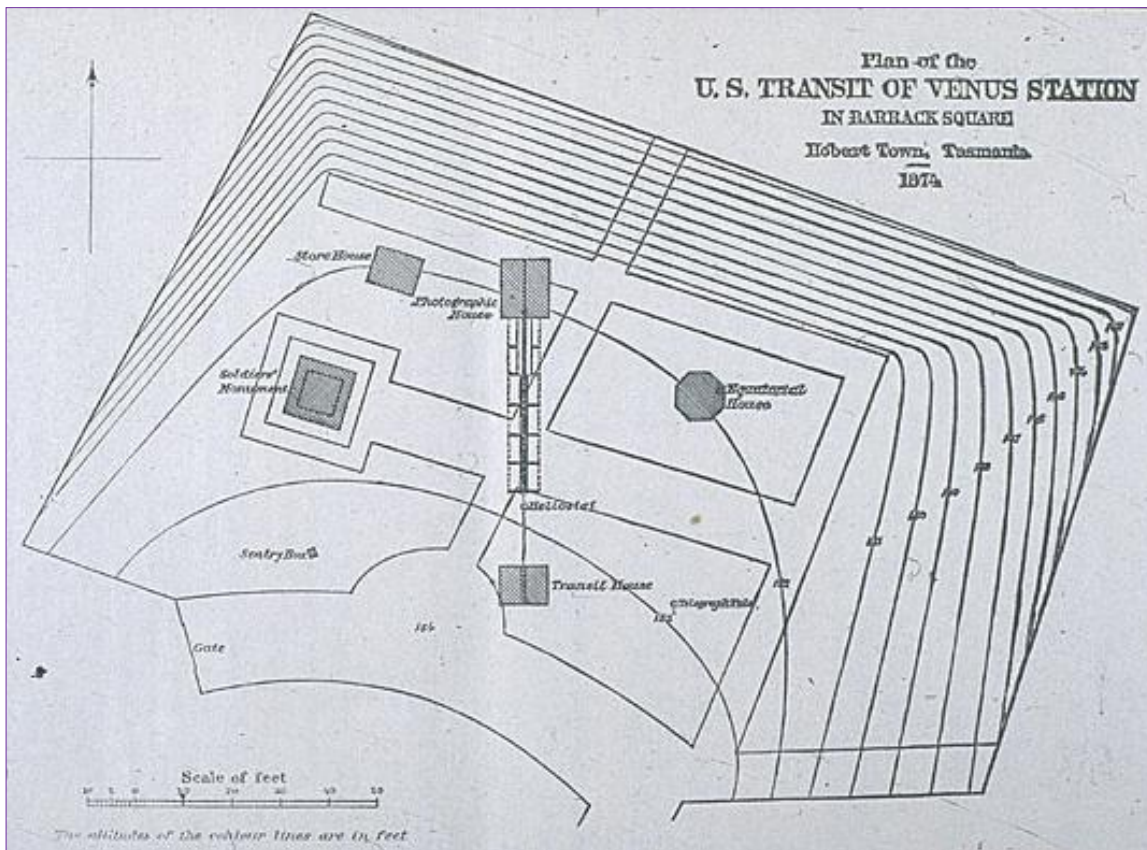


Figure 7: The Barrack Square transit station in Hobart, showing (left to right) the soldiers' monument, a store house, the Transit House, and above it the photoheliograph, and the Equatorial House (after Dick, 2003).

Table 1: The personnel at the two Tasmanian 1874 transit stations.

Personnel	Hobart	Campbell Town
Astronomer (in charge)	Professor William Harkness (1837–1903)	Captain Charles Walker Raymond (1842–1913)
Assistant astronomer	Leonard Waldo (1853–1929)	Lieutenant Samuel Escue Tillman (1847–1942)
Number of photographers	Three	Three
Number of local assistants	Four	Three (includes Alfred Barrett Biggs, 1825–1900)

ing start to the day, by the end of the transit Raymond felt that he "... had seized victory out of the jaws of defeat." (The transit of Venus, 1874b).

In Hobart transit day also was a disaster initially, but three hours into the transit the sky cleared enough for observations to begin. Altogether thirty-nine photographs were taken of Venus on the Sun's disk, then

... the quick exposure apparatus was brought into use, and 74 pictures, including a photograph of the last contact, were taken between 10 minutes to 4 and 12 minutes past 4, when the final contact took place. (The transit of Venus, 1874b).

Another local newspaper elaborates slightly:

The American party at the Barracks succeeded in taking 160 photographs by the wet collodion process, of which 113 were considered *first-rate*. (The transit of Venus, 1874a; our italics).

These figures refer to all photographs taken, but Dick (2003: 257–259) notes that just 39 of these

Table 2: Photographs from 1874 American transit stations used in deriving a value for the solar parallax (adapted from Dick et al., 1998: 246).

Transit Station	Number	% of Total
Vladivostok (Russia)	13	3.71
Nagasaki (Japan)	60	17.14
Peking (China)	90	25.71
Kerguelen Island (Indian Ocean)	26	7.43
Campbell Town (Australia)	55	15.71
Hobart (Australia)	39	11.14
Queenstown (New Zealand)	59	16.86
Chatham Islands (New Zealand)	8	2.29
Total	350	99.99

were used in the final analysis. Clouds were quite dense by the time of the fourth contact, and Harkness could not see either of the egress contacts through the Clark telescope. Nonetheless, a local newspaper reported that he was "... very well satisfied with the results that were obtained, taking into consideration the unfavourable state of the weather." (The transit of Venus, 1874a). This contrasts with Newcomb's (1880) evaluation, which suggests that Harkness was profoundly disappointed with the overall scientific outcome of the expedition.

Now came the analysis of all of the observations, and the Americans relied on the photographic record. The task of measuring the plates obtained at the eight 1874 transit stations fell to U.S. Naval Observatory astronomer, William Harkness (1837–1903). Although the plates yielded "excellent results" for the interval when Venus was on the Sun's disk, photographs of the ingress and egress were of "no value", because of the black drop effect (Harkness, 1883).

Measurements of all of the American photographs were completed by the end of 1877, and then came the laborious task of establishing the longitudes of the transit stations. When this was accomplished, the official report of the 1874 American transit program was to have been published in a succession of volumes, but funding restrictions only allowed the appearance of the first of these (Newcomb, 1880). Unfortunately, this contained none of the results, as these were planned for subsequent volumes.

Further delays occurred, and in the end it was David Peck Todd (1855–1939) from the Nautical Almanac Office who published a provisional American value of $8.883 \pm 0.034''$ (Todd, 1881). The two Australian transit stations played an important role in contributing to this result: ~27% of the photographs used in deriving this solar parallax came from Hobart and Campbell Town (see Table 2). Nonetheless, Todd's result remained contentious,⁴ because of certain concerns about the quality of the photographic images. These showed some limb-darkening, and there was also a difficulty in establishing plate scales (see Lankford, 1984).

Notwithstanding the importance of the 1874 transit of Venus as an international scientific enterprise, there are few tangible remains at the sites of the various American observing sites. Tasmania is a notable exception, however, as there are field remains in both Hobart and Campbell Town. In addition, the Queen Victoria Museum and Art Gallery in Launceston holds the only surviving photograph of the transit from any of the 1874 US transit stations. These important elements of our international astronomical heritage are discussed below.

3 THE TASMANIAN RELICS

3.1 The 'Observatory Paddock' at Campbell Town

At Campbell Town, the 1874 observations took place in what today is colloquially referred to as the 'Observatory Paddock', which is to the north and slightly east of Dr Valentine's homestead (see Figure 8). This more or less level paddock contains field evidence of three different features, that from their nature and positioning one would automatically assume relate to the 'Transit House', the heliostat pier (and drive) and the 'Photographic House'.

The most northerly of the three fetures is a solid brick pier that is rectangular in cross-section (see the right hand column in Figure 8), measures 717 mm × 616 mm, and extends 775 mm above ground level. There is no doubt that this is the transit telescope pier (see Raymond, n.d.; Newcomb, 1880). Approximately 38 m to the south there is a low two-tiered concrete and cement foundation which only extends ~15 cm



Figure 8: The 'Observatory Paddock', looking due north, and showing (from foreground to distance) a post hole, a concrete and cement foundation and the brick transit telescope pier. Close-ups of each of these are shown on the right (photographs: Alex Buchanan and Wayne Orchiston).

above ground level and measures 1.47×1.07 m, with the long axis oriented E-W. The most southerly field evidence is an area of cobblestones measuring approximately 3.05×3.35 m. Very near its southern boundary there is a conspicuous stone-lined depression that is the right diameter to accommodate the larger of the gatepost piers that were associated with the photographic telescope (see Section 3.2 below). Moreover, this depression is 12 m from the low concrete foundation, which just happens to be the distance that separated the two photographic telescope piers at the 1874 US transit stations. Initially, Orchiston and Buchanan (2004) tentatively identified the three structures from north to south as representing the locations of the 'Transit House', the 'Photographic House' and the heliostat pier (and drive) respectively. But they point-ed out that

... even if we accept the above identifications ... there is still a problem, and that is the anomalous positioning of the transit telescope pier.

We have no 1874 photographs of the Campbell Town transit station or site descriptions by Raymond (n.d.) or Newcomb (1880) to judge from, so we must be guided by the configurations of other Southern Hemisphere US 1874 transit stations. Scaled layouts of the Hobart and Queenstown [New Zealand] ... transit stations show a consistent pattern of N-S aligned Photographic House, heliostat pier, and Transit House, in that precise order, with the pier of the transit telescope positioned 4.9 metres and 4.2 metres to the south of the heliostat pier respectively. A photograph of the 1874 Nagasaki transit station ... shows the middle of the Transit House ~4.7 metres from the heliostat pier, while Koorts (2003: 201) lists 4.27 metres as the distance of "... a typical southern station of an American observation post in 1882." If these figures are indicative, then the transit pier at Campbell Town should be anywhere from 4 to 5 metres *south* of the heliostat pier hole, not far to the north of this feature and the Photographic House foundation as is in fact the case. (Orchiston and Buchanan, 2004: 39–40; our italics).



Figure 9: Investigation of the two more southerly structures in the 'Observatory Paddock'. 'The Grange' homestead is just visible in the background, through the trees (photograph: Wayne Orchiston).

We then concluded:

If the transit telescope pier is *in situ*, and has not been relocated since 1875 February (when the Americans sailed from Hobart), its current position cannot easily be explained. In fact it makes absolutely no sense ... (Orchiston and Buchanan, 2004: 40).

Thus in 2005 and 2006, two of us (AB and WO) teamed up with Gary Price (the co-owner of 'The Grange') and Professor Tony Sprent (University of Tasmania) to investigate this anomaly. First, we carried out an exploratory sondage that clearly established that the transit telescope pier was still in its original position. Next we carried out sondages at the other two field 'structures' (e.g. see Figure 9), but we could not find any evidence that clearly linked them to the 1874 transit station. To the contrary, the most southerly site coincided with the remains of a cow shed, where the conspicuous post-hole could be associated with one side of a cow bale. We could not identify a function for the foundation to the north of this cow shed, and we concluded that the fact these two locations were separated by 12.2 m, the precise separation of the two piers associated with the photoheliograph, was no more than an amazing coincidence.

We also concluded that the only field evidence of the 1874 transit station surviving in the 'Observatory Paddock' was the transit telescope

foundation, and that any evidence that originally existed of the heliostat pier and drive and the 'Photographic House' would have been destroyed when site works were carried out in the northern section of this paddock in the early twentieth century and when the adjacent land was subdivided and houses were erected there.

3.2 The Photographic Telescope Piers at Campbell Town

When the Americans abandoned the Campbell Town transit station, they left the two photographic telescope piers *in situ*, and when the senior author last visited Campbell Town, in 2005, they served at the time as two rather novel gateposts at the entrance to 'The Grange' property from the Midland Highway (see Figure 10).

Reference to scaled drawings of the photographic telescope revealed that the heliostat pier was slightly larger in diameter than the pier in the 'Photographic House' that supported the plate-holder, and this was reflected when we measured the sizes of the two gate posts: the right hand gate post in Figure 10 had an external diameter of 309-mm and is the pier from the 'Photographic House', while the left-hand gate post, with an external diameter of 356-mm, was the pier that supported the heliostat. Both piers were made of riveted 9.5-mm steel plate. The date when they were relocated from the 'Obser-



Figure 10: Entrance to 'The Grange' homestead in 2005, showing the two photographic telescope piers serving as novel gate posts (photograph: Wayne Orchiston).

vatory Paddock' to the driveway entrance of 'The Grange' has not been documented, but Dr Valentine was a keen amateur astronomer, so it must have post-dated his death, which occurred in 1876, less than two years after the transit.

3.3 The Equatorial House at Campbell Town

Although the relative positions of the 'Photographic House', heliostat piers and 'Transit House' are predictable at the US 1874 transit stations, there was no 'standard position' for the 'Equatorial House'. Sometimes it was located due east or west of the 'Transit House', while at other times it was located between the 'Transit House' and the 'Photographic House', but to the east or west, as in Hobart (see Figure 7). Furthermore, because the Clark refractor sat directly on the floor of the Equatorial House and did not require a pier or foundation, we cannot expect to find any field evidence of the location of the 'Equatorial House' in the 'Observatory Paddock' at Campbell Town.

Yet we do know the current location of the 1874 'Equatorial House' at Campbell Town. Dr Valentine was a keen amateur astronomer, so when the Americans left Campbell Town they expressed their thanks for his genial hospitality by giving him the 'Equatorial House'. Valentine installed a 21.6-cm (8.5-in) Browning-With reflector in this observatory, and when he died soon after, in 1876, this instrument passed to Alfred Barrett Biggs (who had also assisted the American astronomers at Campbell Town). Subsequently, the 'Equatorial House' was converted into a summer house and was relocated to near

the tennis court at 'The Grange', where it remains to this day (see Figure 11).

Currently it comprises five of the original eight octagonal wall units, constructed of Oregon Pine (*Pseudotsuga menziesii*) bottom plates, wall plates, studs and diagonal bracing, and clad with vertical planks of Sugar Pine (*Pinus lambertiana*). Both species of trees are endemic to the USA, and in the nineteenth century were common in the mountains of Oregon and California. Some of the pieces of framing timber have incised Roman numerals, that helped facilitate easy and rapid erection of these prefabricated buildings at the transit stations. One wall has a window, which mirrors exactly that shown on a photograph of the U.S. 1882 Equatorial House at the Santa Cruz transit station.

The nature of the triangular wooden domes that surmounted the 1874 Equatorial Houses is well documented, but at some stage the Campbell Town dome was removed and replaced by a more rustic roof which during the 1960s was clad with shingles. However, the basic design of the summer house, and the presence of a circular steel dome ring around the wooden plate above the octagonal wall units (see Figure 12) clearly betray its astronomical origins. The dome ring is 3-m in diameter, and made of 15 individual neatly-butted lengths of track, each with an inverted U-shaped cross-section.

Figure 13 shows the current location of the summer house, The Grange Homestead, the driveway in from the Midland Highway and the various structures in the 'Observatory Paddock'.



Figure 11 (left): The summer house at 'The Grange' showing the remains of the 'Equatorial House' and the distinctive window associated with the U.S. 1874 and 1882 transit station Equatorial Houses (photograph: Wayne Orchiston).

Figure 12 (right): A close-up showing the expanded wall plate carrying the metal track upon which the dome originally rotated (photograph: Alex Buchanan).



Figure 13: An aerial photograph of 'The Grange' homestead in 2006, showing the US 1874 transit of Venus relics and other structures (map: Tony Sprent).

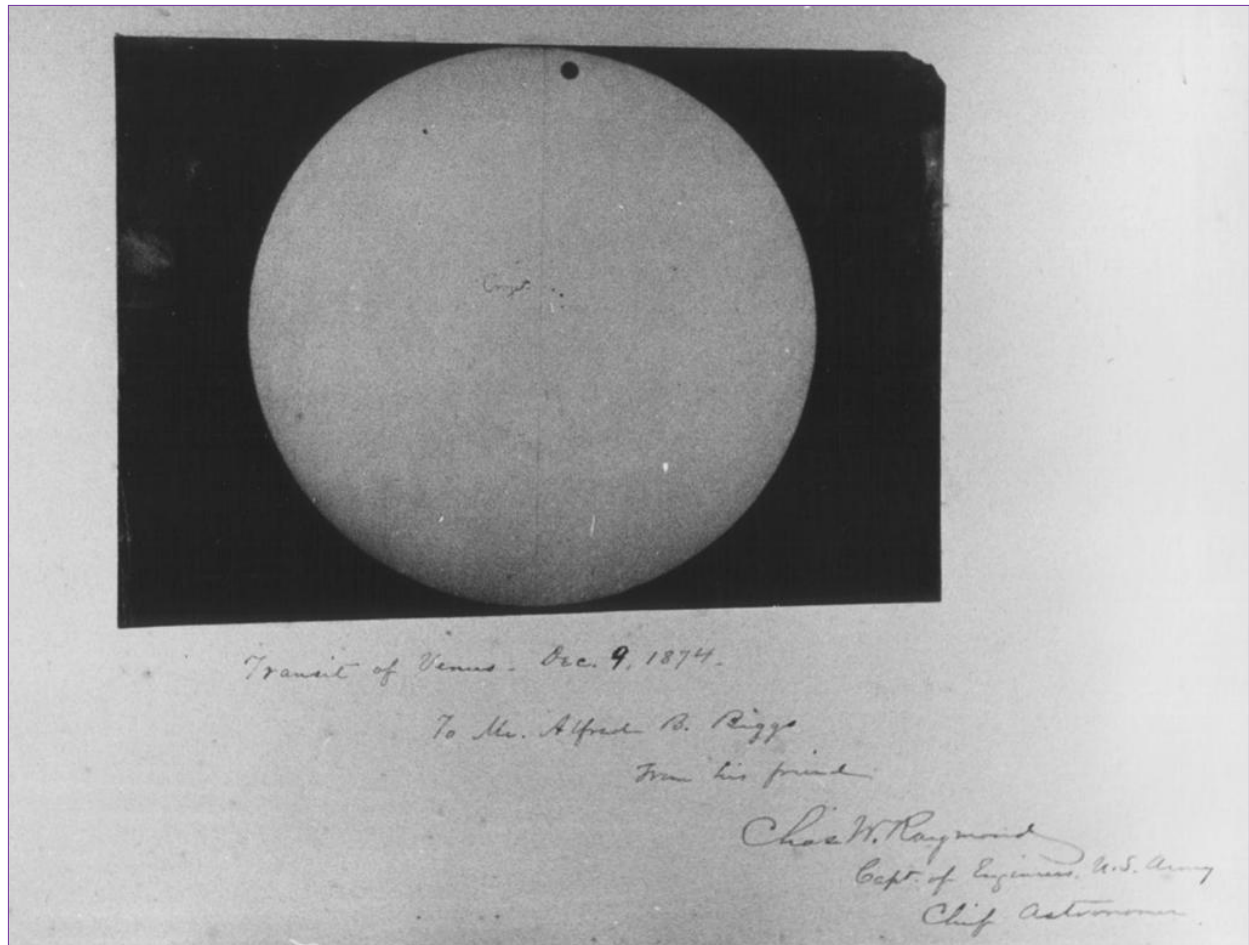


Figure 14: A print of one of the photographs of the 1874 transit of Venus taken at Campbell Town when the transit was in progress (courtesy: Queen Victoria Museum and Art Gallery).

3.4 The Photograph of the Transit at the Queen Victoria Museum and Art Gallery in Launceston

Back in the 1990s when researching the records and surviving relics relating to all of the U.S. 1874 transit stations, the then Historian at the U.S. Naval Observatory, Dr Steven Dick, and Wayne Orchiston were surprised to find that none of the original plates exposed at the eight transit stations has survived. The search then was on for surviving prints made from any of these plates, and their second surprise occurred when they discovered that only one such print is known to exist. This is in the Queen Victoria Museum and Art Gallery in Launceston, Tasmania, and is shown in Figure 14.

During the transit, the Campbell Town party succeeded in taking 55 photographs of Venus silhouetted on the solar disk and 77 photographs of the egress contacts, and the print in the Launceston Museum is from one of the 'disk' photographs.

Local school-teacher, Alfred Barrett Biggs (Figure 15), was one of the three volunteers, and he assisted in the Photographic House during the transit. The leader of the transit party,

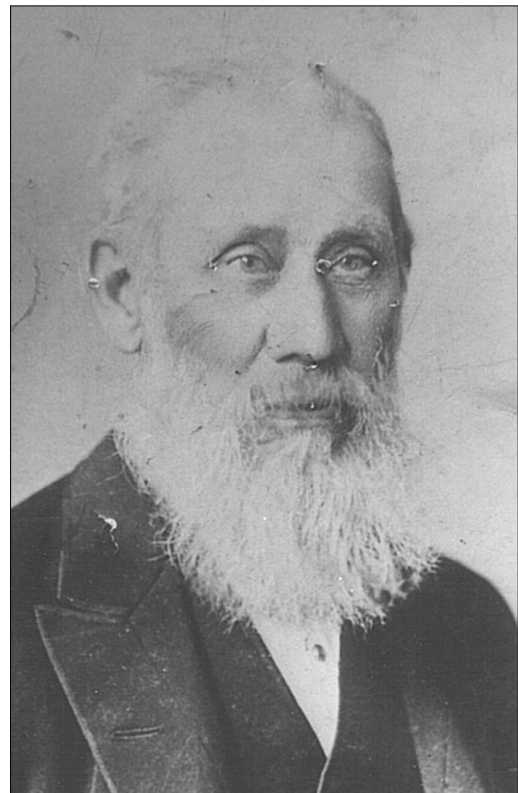


Figure 15: Alfred Barrett Biggs, 1825–1900 (Orchiston Collection).



Figure 16: Photograph taken in 1885 showing the 'soldiers' monument' and the transit of Venus heliostat pier, which is still *in situ* (courtesy: W.L. Crowther Library, Tasmania Archives and Heritage Office).

Captain C.W. Raymond, sent him this photograph as a mark of his appreciation, and it contains the accompanying inscription:

Transit of Venus. Dec. 9, 1874.
To Mr. Alfred B. Biggs
From his friend
Chas. W. Raymond
Capt. of Engineers, U.S. Army
Chief Astronomer

Biggs probably was sent this photograph when the transit party was back in the USA, but immediately after the transit he was given the prefabricated wooden 'Transit House' and he subsequently erected this at his observatory complex in Launceston—see Orchiston (1985) for details. Despite extensive searches of historical photographic collections throughout Australia, no image of this small roll-off roof observatory building could be located, and the structure itself does not appear to have survived.

3.5 The Photographic Telescope Pier in Hobart

Barrack Square in Hobart, where the other Tasmanian U.S. 1874 transit station was located, is now part of a military base, but in a secluded area there is a conspicuous monument to British soldiers who died in the Maori Wars in New Zealand during the nineteenth century, and nearby is one of the two Photographic Telescope piers (see Figure 16). Two of the authors (AB

and WO) paid a brief visit in 2005 but did not have a chance to measure the diameter of this pier to determine whether it was the plate-holder pier or the heliostat pier, but if Figures 6 and 16 and the site plan shown in Figure 7 are any indication, this would appear to be the heliostat pier, which is still located in its original position.

4 CONCLUDING REMARKS

The island state of Tasmania, to the south of the Australian mainland, has a special claim to fame in the international history of the US 1874 transit of Venus expeditions. 'The Grange' at Campbell Town has pre-eminent status in this regard as home to both horizontal photographic telescope piers, an *in situ* brick pier that once supported the transit telescope and the remains of the Equatorial House (which now masquerades as a summer house). Meanwhile, Barrack Square in the Tasmanian capital, Hobart, boasts one surviving photographic telescope pier (that supported the heliostat), and this is still located in its original position. While field relics like these at other American 1874 and 1882 transit of Venus stations were still extant in the mid-twentieth century (e.g. see Koorts, 2003), these Tasmanian relics would appear to be the only ones that have survived through to the present day. But Tasmania has even greater significance, because the collections of the Queen Victoria

Museum and Art Gallery in Launceston include what would appear to be the only surviving print of any of the glass plates that were exposed at the eight US transit stations in 1874, and this assumes even greater importance given that not one of these plates has survived.

However, this study shows the importance of carrying out thorough investigations of historic astronomical sites and relics. Because of the known association of the 'Observatory Paddock' in Campbell Town with the 1874 US transit party, our initial supposedly-logical assumptions were made concerning the identification of the field monuments that were located there. However, further analyses showed most of these assumptions to be false, and that little remains in this paddock that is indeed associated with the 1874 transit (the only genuine relic being the transit telescope foundation). Instead, most of the original evidence was lost when the paddock was modified during the twentieth century and when the adjacent land—where the Photographic and Equatorial Houses are presumed to have been located—became a residential block and a house was constructed there.

Having said that, Tasmania still has a special place in the history of astronomy, and despite the passage of more than a decade, we can do little better than to repeat our earlier conclusion:

Tasmania ... has a unique collection of 1874 transit of Venus relics. These are of international significance, and constitute part of our nineteenth century world astronomical heritage. As such, it is essential that their importance is fully recognized, and that they receive appropriate attention from those trained in the care and maintenance of historical and industrial archaeological remains. (Orchiston and Buchanan, 2004: 42).

5 NOTES

1. Actually this transit party was assigned to the Crozet Islands in the southern Indian Ocean, but when they arrived there inclement weather prevented a landing so the transit team continued on to Hobart, Tasmania, where they accepted an offer of hospitality from Dr William Valentine (1808/1809–1876) and established their transit station at his luxurious home, 'The Grange', in Campbell Town (see Orchiston and Buchanan, 1993).
2. For technical details of these instruments see Harkness (1877); Newcomb (1880); Orchiston and Buchanan (1993); and Orchiston (2004).
3. Following international convention, the two ingress contacts are referred to as 'first contact' and 'second contact', and the two egress contacts as 'third contact' and 'fourth contact', in that order.
4. We should note that Todd's result also differs somewhat from the currently-accepted figure of $8.794148 \pm 0.000007''$.

6 ACKNOWLEDGEMENTS

We are grateful to Robert Walch (Walch Optics, Hobart) for helping with the survey that led to the preparation of Figure 13, and the W.L. Crowther Library, Tasmania Archives and Heritage Office, (Hobart) and the Queen Victoria Museum and Art Gallery (Launceston) for kindly supplying Figures 6, 14 and 16.

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Professor Wayne Orchiston was born in New Zealand in 1943 and works as a Senior Researcher at the National Astronomical Research Institute of Thailand and is an Adjunct Professor of Astronomy at the University of Southern Queensland in Toowoomba, Australia. He has a special interest in the historic transits of Venus, and in 2000 he was the founding Chairman of the IAU Working Group on

Transits of Venus. He has published extensively on the 1769, 1874 and 1882 transits, and in 2014 he and former Ph.D. student, Stella Cottam, published the book *Eclipses, Transits and Comets of the Nineteenth Century: How America's Perception of the Sky Changed* (Springer). Wayne also has published on the history of meteoritics, historic solar eclipses and the development of solar physics, historic telescopes and observatories, the history of cometary and asteroid astronomy, and the history of radio astronomy. He is a co-founder and the current Editor of the *Journal of Astronomical History and Heritage*, and in 2013 the IAU named minor planet 48471 Orchiston after him.

Alex Buchanan was born in New Zealand in 1944, and is a retired botanist who formerly worked at the Tasmanian Herbarium, which is a section of the Tasmanian Museum and Art Gallery, in Hobart. His interest in the history of the natural sciences in Tasmania led him into several fields, including early botanical collections and Tasmanian astronomical history. His involvement in the

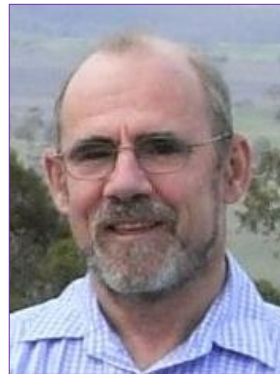


study of the Campbell Town transit of Venus site began over thirty years ago, and culminated in the publication of two earlier papers, both written jointly with Wayne Orchiston. One appeared in this journal, and the other in the *Australian Journal of Astronomy*.

Gary Price and his wife June Tyzack purchased The Grange in Campbell Town in February 1999 and immediately set about trying to discover the rich history of this place. When tracing the history of the house and its original owner, Dr Valentine, it became increasingly obvious that the man himself was much more than just the local doctor. Dr Valentine's importance and involvement in bringing the U.S. transit of Venus observers to The Grange was immediately apparent and it became a quest to discover the mysteries that surround this event. Gary and June are pleased to remain as 'custodians' of what remains.



Dr Tony Sprent has a Ph.D. in physics, and taught surveying and spatial science at the University of Tasmania for 35 years before retiring in 2003. He is currently an Adjunct Senior Lecturer in the School of Mathematics and Physics at the University. After graduating, he was closely involved with the design of high precision scientific instrumentation for various Tasmanian organisations. During this time, he became involved with a not-for-profit organisation, TADTAS, concerned with the design and construction of technical aids for people with disabilities, in 2004 becoming Chairperson of its Board of Management. In addition, he is currently the site engineer with the University of Tasmania's new 1.3-m optical telescope being erected at Bisdee Tier near Melton Mowbray. For relaxation, Tony sings with the Tasmanian Symphony Orchestra Chorus. In 2011 he was appointed as a Member of the Order of Australia (AM) for his contributions to the development of technical aids for people with disabilities, spatial science and astronomy.



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