

4.2.2 Selecting the Observation Site

In selecting the observation site, Dr. Erwin Knipping (1844–1922), a meteorologist and a staff member of the Central Meteorological Observatory, Geographical Bureau, Ministry of Home Affairs (hereafter, Dr. Knipping), strongly recommended the coastal area of Niigata Prefecture. This area boasted the highest ratio of fine afternoon weather in August in Japan. Unfortunately, no way could be found to safely transport a large number of delicate and heavy instruments to Niigata within a short time frame. Moreover, many other factors had to be taken into account when staying in an unfamiliar country for more than a month.

Therefore, on July 15, Prof. Todd and Dr. Knipping toured northward by train in the vicinity of Nasu, Shirakawa, Utsunomiya and Nikko in search of a suitable observation site. Dr. Holland, Lieutenant W. H. H. Southerland (1852–1933), USS Monocacy (hereafter, Lt. Southerland), Masayuki Nakagawa (1848–1897), Director of the Naval Observatory, Naval Hydrographic Department, Ministry of the Navy (hereafter, M. Nakagawa) and Dr. William C. Whitney (1841–1904), Interpreter, Legation of the United States of America to Japan (hereafter, Dr. Whitney), accompanied them.

The team considered 13 factors, and scores were given to each of the eight candidate sites, as shown in Table 4-3*. Shirakawa achieved the highest score and was selected as the observation site. The observation station was set up on the premises of the Shirakawa Castle ruins. It was located 1,230 ft above sea level, 12

Table 4-3 **Scores of Eight Candidate Sites**

Influencing Conditions	Relative Weight	Niigata		Fukushima	Tochigi				
		Niigata	Nagaoka	Shirakawa	Yaita	Nasu	Kuroiso	Utsunomiya	Nikko
Meteorology	90	70	75	60	50	50	50	65	40
Accessibility	30	10	10	20	25	25	25	30	15
Healthfulness	30	25	25	30	25	25	25	25	30
Proximity to large town	20	20	20	15	5	5	5	20	10
Convenience of living	10	10	10	10	5	5	5	10	10
Building materials	15	15	15	15	5	5	5	15	15
Workmen	20	20	20	20	10	10	10	20	20
Telegraphic communication	15	10	10	15	10	10	10	15	10
Water for photography	20	20	20	15	15	15	15	20	20
Proximity to Tokyo	10	0	0	10	10	10	10	10	5
Geodetic position determined	10	0	0	5	5	5	5	0	0
Proximity to central line	15	5	15	15	15	15	15	0	5
Proximity to other parties	15	5	10	15	15	15	0	0	15
Total	300	210	230	275	195	195	180	230	195

* *Report of the American Eclipse Expedition to Japan, 1887, Part I* (final report), p. 7. *The David Peck Todd Papers*.

miles north of the eclipse's central line, and about a quarter mile from the railway station, Shirakawa town (population 10,000), and the telegraph station (Figure 4-9, 4-10, and 4-11).



Figure 4-9



Figure 4-10

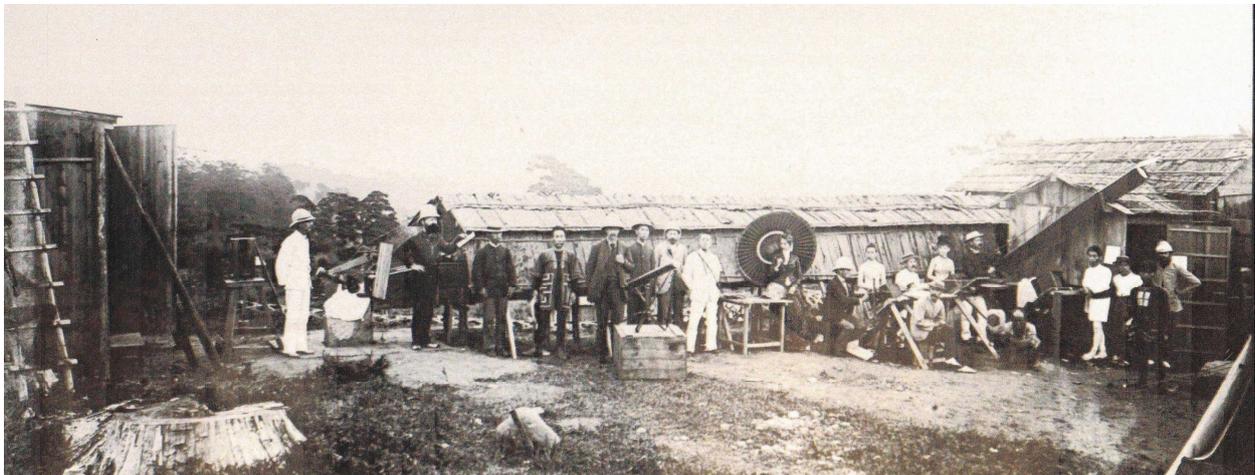


Figure 4-11

The Todd-Bingham Picture Collection, MS 496E, Manuscripts & Archives, Yale University Library.

- 4-9 Panoramic view of the Shirakawa Castle ruins. (The castle buildings had been burnt down during the civil war before the Meiji Restoration of 1868.)
- 4-10 Campsite of the expedition party on the premises of the Shirakawa Castle ruins.
- 4-11 Photograph taken shortly after the eclipse ended.

<Persons in the photo>

From left: Henry S. Palmer (Chief of the 1874 British Transit of Venus Expedition to New Zealand, who settled in Japan in 1887. He came to Shirakawa to meet Prof. Todd.); Prof. Todd; (most probably) Viscount Masakoto Abe (son of the last Shirakawa feudal lord before the Meiji Restoration); a Japanese man (unknown); Dr. Holland; Keizaburo Ashino; General Counselor Greathouse; Dairoku Kikuchi (President of the College of Science, Imperial University); Mrs. Todd; Dr. McCartee; Dr. King; (front) Dr. Ames; (back) Prof. Hitchcock; Mrs. Hitchcock; Lt. Southerland; four Japanese men (unknown); J. Pemberton.

<Instruments and facilities shown in the photo>

From left: Transit house, heliostat, horizontal photoheliograph (covered with cedar-bark sunshade), photographic house.

4.3 Horizontal Photoheliograph

Among the instruments the American Expedition brought to Japan, Prof. Todd was primarily engaged in operating the horizontal photoheliograph and the heliostat. They were one of eight pairs of horizontal photoheliographs and heliostats manufactured by Alvan Clark & Sons and used for the Transit of Venus Expeditions of both 1874 and 1882, conducted by the American Transit of Venus Commission (Dick, Orchiston, & Love, 1998, p. 231).

The photoheliograph is fixed in a horizontal position in the plane of the meridian, instead of being made to move as the sun moves. The heliostat has a plane mirror placed slightly distant from and in front of the objective lens, and is driven by clockwork. It revolves slowly so as to keep the beam of light from the sun horizontally reflected onto the objective lens. These instruments were initially designed for wet plates. Figures 4-12, 4-13, and 4-14 show the general plan of the horizontal photoheliograph, heliostat, and transit.

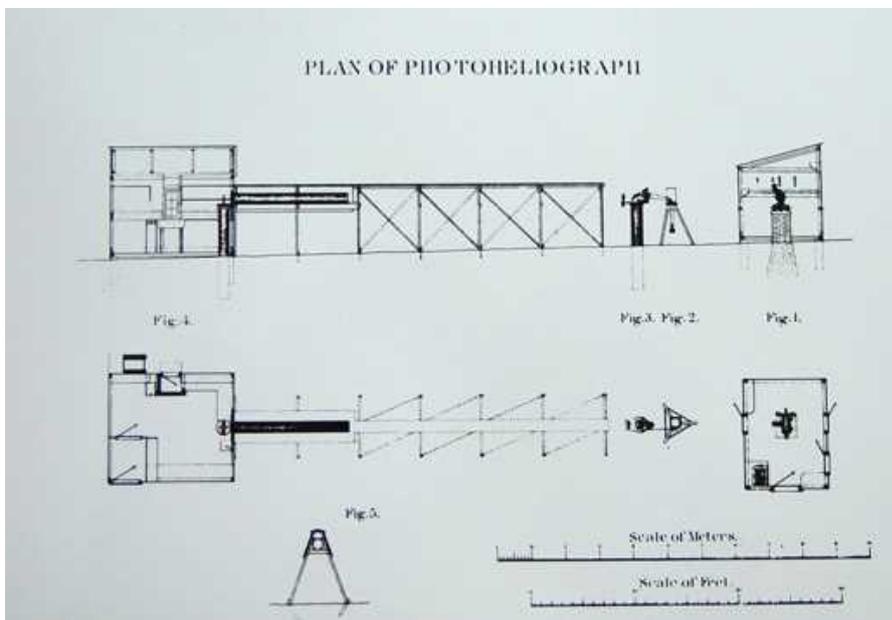


Figure 4-12
From right:
transit house,
heliostat (weight clockwork),
horizontal photoheliograph,
photographic house (plate pier).

Courtesy of Chuck Bueter;
www.transitofvenus.org.

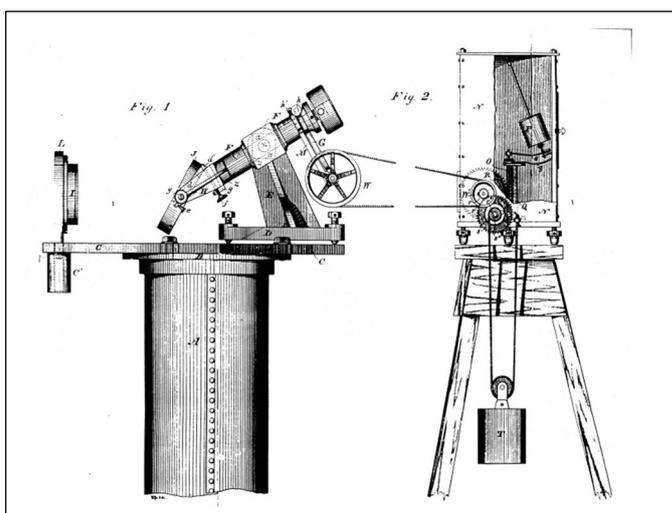


Figure 4-13 Diagram of Heliostat (with Clockwork)
by Robert Havlik.

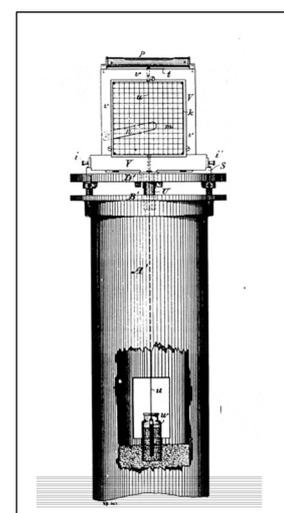


Figure 4-14 Diagram of Plate Holder Pier
with a Reticule
by Robert Havlik.

Courtesy of Chuck Bueter; www.transitofvenus.org.

Dry plates were already prevalent in the U.S. by 1887, which allowed astronomers to obtain better celestial images with shorter exposure times than ever before. Prof. Pickering preferred to use dry plates in Japan^{*}. Prof. Todd, however, thought that “*wet plates would be in many ways preferable to dry ones for the partial phase*” (Todd and Holland, 1888, p. 6) and selected the horizontal photoheliograph and heliostat.

Details and Arrangement of Horizontal Photoheliograph, Heliostat, Plates in 1887

Table 4-4

Horizontal Photoheliograph		
Focal length	472.6 in–472.9 in	
Objective glass	5 in	
Wooden light-proof tube (for corona photographs)	20 in × 20 in × 37.5 ft	<ul style="list-style-type: none"> • Interior coated a dead black for light proof. • 15 diaphragms (to prevent accidental fogging of the plates by scattered light). • Exposing shutter (attached to the smallest diaphragm nearest the objective). • Hinged shutter (to shield the mirror from the sun except at the instant of exposure).
Wooden Shade (Covered with cedar-bark)	Built over the wooden tube, 6 ft high	
Heliostat		
Mirror	7 in	Unsilvered (for partial phase)
	7 in	Silvered (for corona, coated by J. A. Brashear)
Weight clockwork		
Pier	Stone	
Plates		
Wet plates 7 in × 7 in	Partial phase (about 100 photos)	<ul style="list-style-type: none"> • Exposures every 15 seconds (for some minutes immediately before and after totality). • Coated with sugar preservative (to keep the films sensitized for 2–4 hours before exposure, thus enabling rapid manipulation). • Plumb line lamp (lowered in front of the plate to illuminate the ends of the line and make them visible when the crescents became very slender). • Small exposing shutter (to briefly expose the lantern-flame to the plate immediately after the crescent exposure).
Dry plates 17 in × 20 in	Totality (8–10 photos) Image of the sun 4.5 in	Exposures vary, 1–15 seconds.
Plate-holder pier		<ul style="list-style-type: none"> • Pier: six stones (12 in × 12 in × 2½ ft) were laid up in cement, in three layers, crosswise, with a central space for the suspension of the plumb line. • Pier top: Iron plate for supporting the brass plate holder.

^{*} Letter from Prof. Pickering to Prof. Todd, dated May 23, 1887. *The David Peck Todd Papers*.

While it is unclear why Prof. Todd used wet plates, I believe he placed great trust both in them and his chosen instruments. On Dec. 6, 1882, he successfully photographed the transit of Venus at the Lick Observatory with a horizontal photoheliograph and heliostat manufactured by Alvan Clark and Sons. 147 wet plates were exposed, and no less than 125 plates were available for micrometric measurements (Todd, 1883, p. 135).

Since corona photographs were also to be taken, though with dry plates, a 37.5 ft light-proof tube with an exposing-shutter and 15 diaphragms was specially built. Shortly before totality, the unsilvered mirror ordinarily mounted in the heliostat frame was to be replaced with a silvered mirror. Table 4-4 shows details of the equipment employed in Japan.

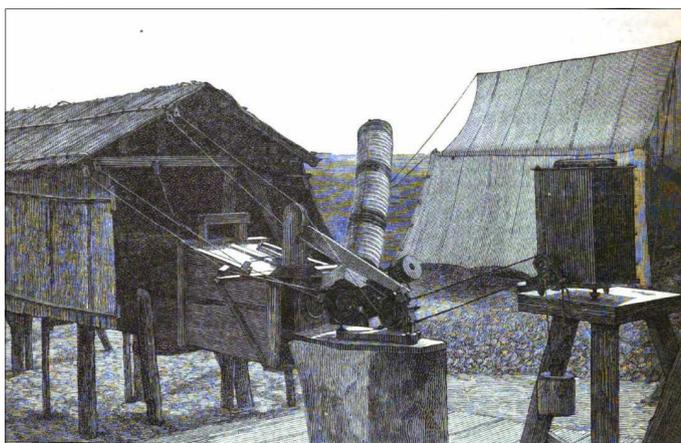


Figure 4-15 Illustration of the System in
Frank Leslie's Popular Monthly, Vol. XXVII, No. 4, April 1889.
www. hathitrust.org.

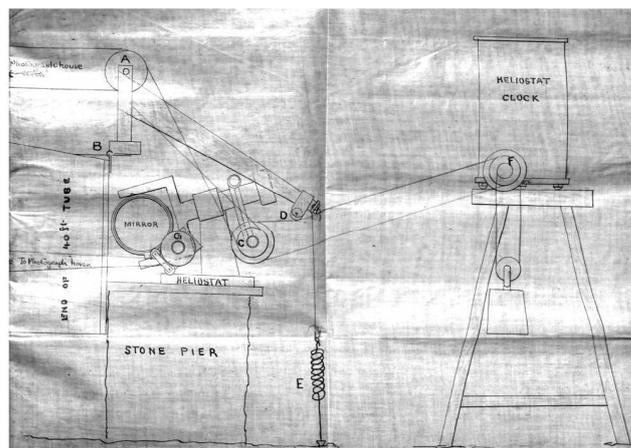


Figure 4-16 System Plan.
Report of J. Pemberton, dated Sept. 10, 1887.
The David Peck Todd Papers, MS 496B,
Manuscripts & Archives, Yale University Library.

To ensure that the astronomer in charge of making exposures had total control over adjusting the reflecting mirror, a system shown in Figures 4-15 and 4-16 was specially designed by J. Pemberton for use with the heliostat. This system allowed the reflecting mirror mounted in the heliostat frame to be moved (both in right ascension and declination). Motion was achieved by directly manipulating the tangent screws with cords that lead (with pulleys) to the photographic house (about 40 ft away). Thus, the image of the sun could be properly positioned on the photosensitive plate without great difficulty (Figure 4-16)^{*1}. (Refer to Appendix III for details of other instruments, etc., used at the station.)



Figure 4-17
Weather Map for
Aug. 19, 1887, Central
Meteorological
Observatory.
*The David Peck Todd
Papers*, MS 496B,
Manuscripts & Archives,
Yale University Library.

On the morning on August 19, the sky was perfectly clear, and everybody was sure that observations would be successful^{*2}. As the time of first contact approached, clouds began to form, which entirely obscured the sun for the first half hour of the eclipse. A brief interval of partly cloudless sky occurred about midway between first and second contact, giving the team an opportunity to expose 11 plates with the photoheliograph. Five of these showed images of the sun, but they were not technically perfect. A drop of silver solution had come into contact with the surface

^{*1} Expedition report entitled *Some account of work in connection with U.S. Eclipse Expedition to Japan in charge of Professor D. P. Todd* by J. Pemberton, dated Sept. 10, 1887. *The David Peck Todd Papers*.

^{*2} Prof. Todd's diary, Aug. 19. *The David Peck Todd Papers*.

of the reticle plate, which marred the appearance of subsequent plates ^{*1}.

4.4 Significant Support by the Japanese Government

On July 12, in response to requests from both Minister Kuki and Minister Hubbard, Minister Inoue sent official letters to Aritomo Yamagata, Minister of Home Affairs, Tsugumichi Saigo, Minister of the Navy, and Arinori Mori, Minister of Education. They were asked to extend their cordial support and cooperation to Prof. Todd and his staff (The Ministry of Foreign Affairs, 1887, 14th and 15th pictures).

Prof. Todd enthusiastically visited not only Japanese ministers but also other very important persons such as the President of Japan Railway Company, the Tokyo Metropolitan Police Commissioner, the Governors of Tokyo Prefecture and Kanagawa Prefecture, etc., and solicited their support ^{*2}.

As materials in *The David Peck Todd Papers* clearly show, a very active and cooperative relationship existed between the Japanese government and the American Expedition, and to a greater degree than previously assumed.

4.4.1 Cooperation with the Japanese Naval Observatory

1. M. Nakagawa accompanied Prof. Todd on his reconnaissance tour to the north (4.2.2). He spent most of his time with Prof. Todd in Shirakawa station, both providing support and learning from him and his staff about the observation techniques being employed.
2. Information on the instruments that the American Expedition brought to Japan was made available to the Naval observatory.
3. Responding to an enthusiastic request from the Naval Observatory to make joint observations, Prof. Todd proposed the Naval Observatory to exchange longitude-signals between Shirakawa station and the Naval Observatory in Tokyo. This was undertaken on five nights, with favorable results obtained on 3 nights (Appendix IV) (The Hydrographic Office, Ministry of the Navy, 1887, pp. 17–35).
4. Prof. Todd asked Rear Admiral Narayoshi Yanagi (1832–1891), Director of the Naval Hydrographic Department, Ministry of the Navy (hereafter, Rear Admiral Yanagi), to lend him several astronomical instruments, books, and miscellaneous materials from the Naval Observatory. This request was accepted by Rear Admiral Yanagi. (Refer to Appendix III for details.)
5. The photographic prints of the partial phases taken by Prof. Todd were sent to Rear Admiral Yanagi through the U.S. Legation in Tokyo ^{*3}.
6. On October 7, 1887, some observation reports (including one on the longitude-signal exchanges) compiled by the Naval Observatory and the photographs (albumen prints) of the partial phases taken at the Naval Observatory in Tokyo were sent by Rear Admiral Yanagi to Prof.



Figure 4-18

Photo taken 1 minute and 10 seconds before the maximum eclipse at the Naval Observatory, Tokyo. *The David Peck Todd Papers*, MS 496B, Manuscripts & Archives, Yale University Library.

^{*1} Aug. 19 report in *Record of Operations in the Photographic House* by W. R. Hitchcock. *The David Peck Todd Papers*.

^{*2} From July 13 to July 15, Prof. Todd's Diary. *The David Peck Todd Papers*.

^{*3} The originals have not yet been identified among the materials in *The David Peck Todd Papers* or *The Todd-Bingham Picture Collection*.

Todd (Figure 4-18)^{*1}. Those reports were photographed and introduced in his final report. (Refer to Appendix IV for details.)

4.4.2 Support from the Geographic Bureau, Ministry of Home Affairs

1. The instruction manuals for the “Amateur Oriented Eclipse Observation Event” were distributed by the Ministry mainly to local government offices and police stations in the designated areas. After the event, the observation reports were collected by the Ministry in collaboration with the Ministry of Education.
2. The observation reports collected by the Ministry were sent to Prof. Todd. (Refer to 5 and Appendix II for details.)
3. Domestic meteorological information was provided by the Central Meteorological Observatory to Prof. Todd. Their official meteorological reports (*Monthly and Yearly Means, Extremes and Sums for 1883, 1884, 1885*) and a triangulation map of Japan (surveyed 1878–1882) were also offered to him.
4. Dr. Knipping accompanied Prof. Todd on his reconnaissance tour to the north and offered meteorological advice (4.2.2).
5. On Dec. 2, 1887, Ikunosuke Arai (1836-1909), Director of the Tokyo Observatory, and the Central Meteorological Observatory, and chief of the Tokyo Observatory Eclipse Expedition to Mt. Yo-meiji, Niigata Prefecture (hereafter, I. Arai), sent the corona photographs taken at the Mt. Yo-meiji observation station to Prof. Todd^{*2}.

4.4.3 Support from the Ministry of Education

1. The “Amateur Oriented Eclipse Observation Event” was held under the supervision of Dairoku Kikuchi (1855–1917), President of the College of Science, Imperial University (hereafter, President Kikuchi). The instruction manuals were distributed by the Ministry mainly to elementary and middle schools. Later, observation reports were collected by the Ministry in collaboration with the Ministry of Home Affairs. (Refer to 5 for details.)
2. Hiromoto Watanabe (1848–1901), Chancellor of Imperial University, assigned Keizaburo Ashino (1866–1941), a student at the College of Science, Imperial University (hereafter, K. Ashino) to Prof. Todd to act as an interpreter & assistant at the Shirakawa observation station.
3. Several books were loaned to Prof. Todd from the College of Science Library.
4. On Sept. 12, two days before Prof. Todd’s departure from Japan, Shuji Isawa (1851–1917)^{*3}, Chief of the Bureau of Compilation, Ministry of Education (hereafter, S. Isawa), handed his eclipse observation report and a photograph of his corona sketch (albumen print) directly to Prof. Todd (Isawa-1–10, Appendix II). He observed the eclipse with I. Arai at the Mt. Yo-meiji observation station, Niigata Prefecture. His sketch was highly appreciated by Prof. Todd and introduced in his eclipse observation report submitted to *Nature* (Todd, The Total Eclipse of Last August in Japan, 1887, P. 610).

^{*1} Nine photographs have been preserved in *The David Peck Todd Papers*.

^{*2} They have not yet been identified among the materials in *The David Peck Todd Papers* or *The Todd-Bingham Picture Collection*.

^{*3} From 1875 to 1879, he was sent to the United States by the Ministry of Education to study teacher training.

4.4.4 Support from the Ministry of War

1. Iwao Oyama (1845–1916), Minister of War, granted Prof. Todd permission to occupy the premises of the Shirakawa Castle ruins, which were under the control of the Ministry of War.
2. Five military-tents were loaned to Prof. Todd, so that he and his key staff could remain on the castle premises for the duration of their stay.
3. A topographic map of the area around the Shirakawa Castle ruins and Shirakawa town was created by the Ministry and offered to Prof. Todd.

4.4.5 Support from the Ministry of Communications

1. A free telegraph line was connected from the Shirakawa Telegraph Station to the American Expedition station.
2. A Morse recording instrument for time signals was loaned to Prof. Todd.
3. Hidesuke Igarashi (1859–1933), Engineer, Ministry of Communications, and Professor at Tokyo Telegraph School, was assigned to handle telegraph line arrangements and Morse recording operations.

4.4.6 Other Support

The mayor of West-Shirakawa District sent police officers to the Shirakawa Castle ruins to guard the observation party and its equipment.

5 “Amateur Oriented Eclipse Observation Event”

5.1 Purpose of the Event

In the late 19th century, the origin and structure of the corona were still under discussion. While much effort had been made to reveal its mysteries, the photographic technology of the period was inadequate to take clear photographs of the outer corona. The total phase did not last long enough to allow the plates to expose the excessively faint light of the outer corona. Therefore, Prof. Todd was sure that sketches of the outer corona, even if drawn by untrained observers, would be of value for astronomical research (Todd, 1889, p. 505). In addition, he thought it important to secure numerous observers in various places. Should the weather be unfavorable in some places, good results might be obtained elsewhere (Boston Herald, 1888).

The sunspot minimum of solar cycle 11 occurred in 1878. During the total eclipse of July 29, the long streamers of the outer corona, extending out zodiacally on both the west and east sides of the sun, were independently discovered by Prof. Newcomb and Prof. Samuel Langley (1834–1906). This initiated a discussion on the connection between the extent of the corona and sunspot activity (Todd, M. L., 1894, p. 59). Observing this phenomenon from a terrestrial meteorological viewpoint was also considered worthwhile. Prof. Newcomb was very interested in collecting data on the duration of totality which would be helpful in more accurately predicting the motions of the moon (The U.S. Naval Observatory, 1870, p. 10).

Prof. Todd had successful experience of conducting a small-scale “Amateur Oriented Eclipse Observation Event” in Texas in 1878, under the direction of Prof. Newcomb (The U.S. Naval Observatory, 1880, pp. 329–366). I believe he wanted to hold a similar event in Japan, but his expedition budget was too limited. He thus proposed it to the Japanese government.

5.2 “Amateur Oriented Eclipse Observation Event”

Prof. Todd, President Kikuchi and K. Ashino played key roles in conducting the event. The instruction manuals were initially prepared in English by Prof. Todd. *Instructions for the Observation of the Duration of Totality* was prepared with full reference to *Instructions for the Observation of the Total Eclipse of August 7, 1869, by Observers without Telescopes Near the Limits of Totality*, written by Prof. Newcomb and issued by the U.S. Naval Observatory^{*1}. Similarly, *Instructions for Drawing the Corona* was compiled with close reference to *Instructions for Observing the Total Solar Eclipse of July 29, 1878*, written by William Harkness (1837–1903), Professor of Mathematics, U.S. Naval Observatory, and issued by the U.S. Naval Observatory^{*2}. The manuals were then translated into Japanese by K. Ashino, under the supervision of President Kikuchi. These were printed by Imperial University (Todd, 1889, p. 505), and distributed to the designated areas. Despite the adverse weather, the event was successful, and a large number of observation reports were collected (Toyo Gakugei-sha, 1887, Sept. 25, p. 570).

The letter from Dr. Whitney to Prof. Todd, dated Sept. 13 (*The David Peck Todd Papers*), clearly suggests an advance agreement between the Japanese Government and Prof. Todd to send the reports collected by the Ministry of Home Affairs to Prof. Todd for his astronomical research. I. Arai was responsible for this work. It is estimated, however, that he sent these reports to the U.S. Legation in Tokyo in late May or early June 1888. Their delivery was delayed because he had been preparing the official eclipse observation report for submission to the Minister of Home Affairs (The Tokyo Observatory, Geographical Bureau, Home Department, 1888). The volunteers’ observation reports were used in the preparation of this report. Only after completion of his report would I. Arai have begun preparations for sending the volunteers’ observation reports to Prof. Todd.

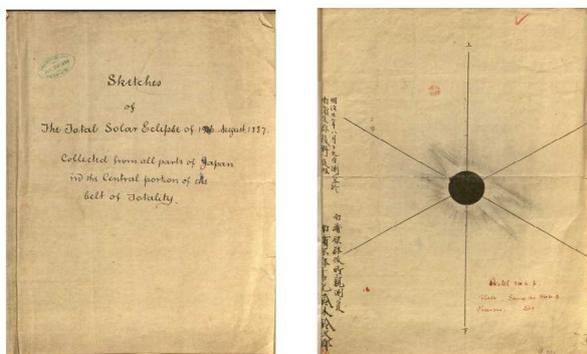


Figure 5-1 Front Cover and Corona Sketch.

The David Peck Todd Papers, MS 496B,
Manuscripts & Archives, Yale University Library.

All the corona reports were bound into a booklet. A front cover with a title handwritten by I. Arai was attached, and the reports were then sent to the U.S. Legation. There, some other retouches were added in English for the convenience of Prof. Todd, such as sequential numbers, names of volunteers, their occupations, names of observed places, etc. (Figure 5-1). Measurements of the duration of totality were edited in tabular form by I. Arai, then retyped in English in the U.S. Legation. Two kinds of table, one for durations near the northern limit

of the path of totality and the other for those near the southern limit, were separately prepared. I. Arai also provided a map showing observation sites. (Refer to Appendix II for details.)

On June 29, 1888, the long-awaited reports were finally shipped to Prof. Todd. They reached him at the Amherst College Observatory on July 23, 1888.

^{*1} “Appendix F. Observations of the duration of totality and of other phenomena made by amateur observers.” (The U.S. Naval Observatory, 1870, p. 15).

^{*2} “Section I. Observations with the Naked Eye.” pp. 7–9; “Section V. Telescope Observations.” pp. 15–20 (The U.S. Naval Observatory, 1880).

Six volunteer groups sent their observation reports directly to the U.S. Legation. Yo-kyun and Sadatoki Kimura, brothers aged 15 and 12, were one of such groups. They observed the eclipse in the castle town of Aizu, Fukushima Prefecture, site of the most disastrous battle of the 1868 civil war. The duration of totality, the unstable weather conditions, and the surrounding scenery during the eclipse were enthusiastically detailed in their report. (Refer to D-1– D-1-4, Appendix II.) Prof. Todd was very impressed by their report and had it translated by a Japanese student at Amherst College.

Once he had seen all the noticeably high-quality reports with his own eyes, Prof. Todd praised them as “the most important astronomical contributions of the Japan Expedition*.”

5.3 Results of the “Amateur Oriented Eclipse Observation Event”

Including S. Isawa’s report handed directly to Prof. Todd, a total number of 83 corona sketches are preserved in *The David Peck Todd Papers*, along with 105 reports of the duration of totality.

Integrating the observation reports located in the Mitaka Library, NAOJ, with those in *The David Peck Todd Papers*, the results of the 1887 “Amateur Oriented Eclipse Observation Event” in Japan are as follows.

Results of the 1887 “Amateur Oriented Eclipse Observation Event” in Japan

Table 5-1

	Manuscripts & Archives Yale University Library	Mitaka Library NAOJ	Total
Corona Sketches	83	94	177
Duration of Totality Reports	105	51	156
Observation Teams	165	95	255 deleted: 5 overlapping teams
Observers	195	184	370 deleted: 9 overlapping observers

Some images of the observation reports preserved in the Mitaka Library, NAOJ, are shown below.

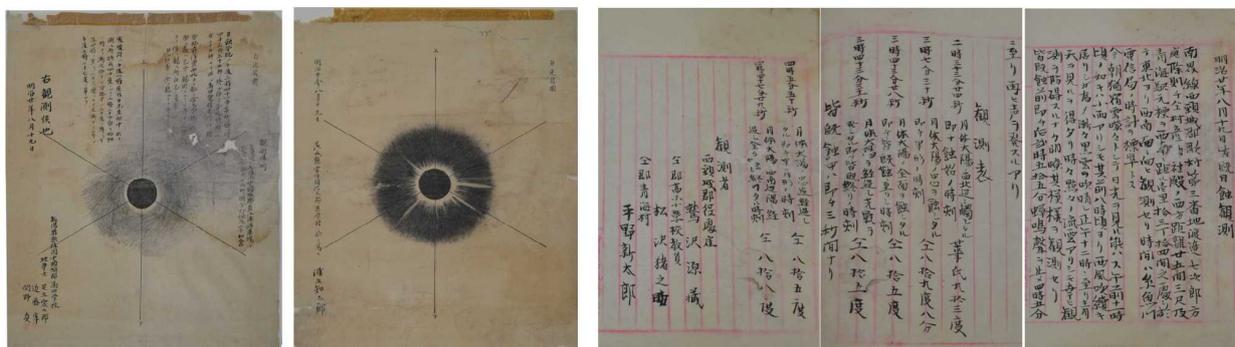


Figure 5-2 Corona Sketches.

Duration of Totality Report.

Courtesy of Mitaka Library, NAOJ.

* Note on the work of the American Eclipse Expedition to Japan 1887, written by Prof. Todd and sent to Prof. Dana, one of the Bache Trustees, on Nov. 13, 1888. *The David Peck Todd Papers*.



Figure 5-3 Observed Sites

Shadow Path: EmapWin

- Pink: place designated for corona drawings.
(Dark pink: report located in Mitaka Library, NAOJ; Light pink: report located in *The David Peck Todd Papers*.)
- Green: place designated for observation of the duration of totality.
(Dark green: report located in Mitaka Library, NAOJ; Light green: report located in *The David Peck Todd Papers*.)
- Blue: outside path of totality.
(Dark blue: report located in Mitaka Library, NAOJ; Light blue: report located in *The David Peck Todd Papers*.)

6 Final Report

6.1 Preliminary Report

Judging from the letter sent by Dr. Holland to Prof. Todd on Feb. 14, 1888 (*The David Peck Todd Papers*), *Preliminary Report (Unofficial)* (Todd & Holland, 1888) was presumably published in early February 1888. It is unlikely, however, that this preliminary report would have been published at all if Prof. Todd had received the amateur observers' reports collected by the Ministry of Home Affairs more promptly.

After returning home on October 13, 1887^{*1}, Prof. Todd must have been looking forward to their arrival. On January 1, 1889, a total solar eclipse was to occur in the U.S. mainland and Manitoba, Canada. To compensate for his failure in Japan, Prof. Todd planned to observe the eclipse in California, as the chief of the Naval Observatory Eclipse Expedition^{*2}. He also planned to hold an "Amateur Oriented Eclipse Observation Event" both in the U.S. and in Canada. To obtain the necessary funds and to realize this plan, it was crucial for Prof. Todd to publish the official expedition report and to promote his accomplishments in Japan in advance. He could not be certain, however, of when the Japanese observers' reports would arrive. Prof. Todd must have had no alternative but to publish a preliminary report to avoid losing the opportunity to achieve his plans.

^{*1} Prof. and Mrs. Todd left Japan on Sep. 14, 1887.

^{*2} This plan went unrealized, however, as Congress only granted funds about 10 days before the eclipse. (New York Herald, 1889).

6.2 Final Report

On April 12, 1889, the final report entitled *Report of the American Eclipse Expedition to Japan, 1887. Part I* was completed and submitted to Prof. Newcomb. A synopsis of the final report is shown in Appendix IV.

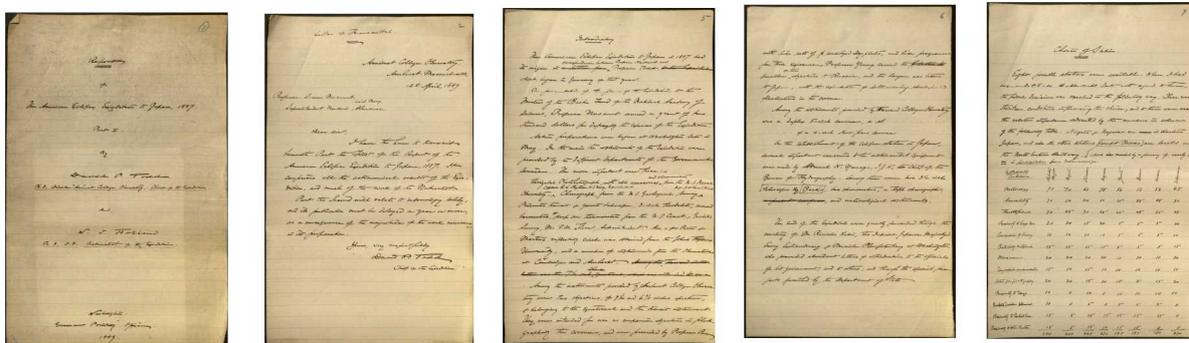


Figure 6-1

(Back-up copy hand-written by Prof. Todd.)

Report of the American Eclipse Expedition to Japan, 1887. Part I.

By David Peck Todd, Ph.D., Director of Amherst College Observatory, Chief of the Expedition.

And W. J. Holland Ph.D., D.D., Naturalist of the Expedition.

The David Peck Todd Papers, MS 496B, Manuscripts & Archives, Yale University Library.

6.3 Was the Final Report Officially Published?

In submitting the final report to Prof. Newcomb, Prof. Todd took for granted that it would be printed by the Government Printing Office and quickly published. However, I have not yet located a printed copy. Moreover, there is no evidence that *Part II*, Dr. Holland's entomological report, was ever published.

A summary of the American Expedition had already been presented in the preliminary report, as well as in several articles submitted by Prof. Todd to *Nature*, *The Observatory*, etc. The total solar eclipse of Jan. 1, 1889 was observed by many scientific parties and numerous corona photographs were secured. Astronomers' attention had already shifted to these latest eclipse observations and moreover to the coming total solar eclipse of Dec. 22 that year. In light of this context, I believe it possible that Prof. Newcomb considered the report to be outdated and so left it unpublished.

7 Significance of the 1887 American Eclipse Expedition to Japan

7.1 "Amateur Oriented Eclipse Observation Event"

Undoubtedly the most significant achievement of the American Expedition in Japan was Prof. Todd's involvement in the "Amateur Oriented Eclipse Observation Event." This was not only the first public astronomical event in Japan, but also the first astronomical event conducted by the Japanese government in collaboration with a foreign astronomer. Despite only a twenty-year history of modernization in Japan, and despite the brief three-week period allowed for preparations, the event was carried out successfully.

Hundreds of Japanese amateurs participated voluntarily in an astronomical event for the first time in their lives and produced high-quality reports. Their corona sketches are particularly valuable because many depict considerably similar features. The 1887 eclipse occurred two years before the sunspot

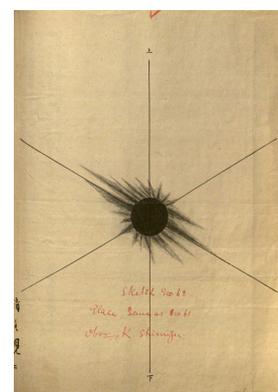


Figure 7-1

Sketch by K. Shimizu
(Tone District, Gunma Pref.).
The David Peck Todd Papers,
MS 496B, Manuscripts &
Archives, Yale University Library.

minimum in 1889. Many corona sketches feature long streamers extending outward along the solar equatorial plane, which was a pronounced sign of sunspot decrease. In addition, the sketches (except S. Isawa's) are originals rather than duplications with lithographs, engravings, or photographs.

I regard these sketches as highly valuable historical materials in modern astronomy. I also consider that, given his leading role in holding the "Amateur Oriented Eclipse Observation Event" in Japan, Prof. Todd's standing in modern astronomical history deserves to be re-evaluated.

7.2 The Legacy of the 1887 American Eclipse Expedition for Prof. Todd

The success of the "Amateur Oriented Eclipse Observation Event" in Japan was well appreciated by the Bache trustees^{*1} and the National Academy of Sciences. This gave Prof. Todd another opportunity to hold an "Amateur Oriented Eclipse Observation Event" on Jan. 1, 1889. The Bache trustees provided a \$125 grant, and 500 copies of instruction manuals were distributed to suitable residents, railway station employees, Signal Corps soldiers, etc., within the belt of totality^{*2}. Blessed with fine weather, the event proved to be a great success.

Prof. Todd was successful not only in smoothly conducting the American Expedition in Japan, but also in cultivating a harmonious relationship with Japanese officials. He proved himself capable of conducting an expedition in a remote, culturally distinct country. His administrative ability also led to him receiving yet another chance to conduct an eclipse expedition, specifically to Angora on the occasion of the total solar eclipse of Dec. 22, 1889, with funds of \$5,000 granted by Congress (Todd, M. L., 1894, p. 178).

7.3 The Legacy of the 1887 American Eclipse Expedition in Japan

The American Expedition to Japan in 1887 left a significant legacy in Japan. Japanese government officials, especially those in the Ministries of the Navy, Education, and Home Affairs, were positively involved in the operations undertaken by Prof. Todd and his colleagues (4.4). Their astronomical knowledge was highly appreciated by Prof. Todd, and consequently, an equal relationship based on mutual respect developed between them. In *Frank Leslie's Popular Monthly*, issued in April 1889, Prof. Todd stated "*The observatories of Tokyo, of which there were three, claimed our attention. They have an excellent outfit of European instruments, and have since consolidated their forces; so that Japan may now keep pace with sister nations in astronomical research*" (Todd, 1889, p. 508). I believe this relationship further inspired Japanese officials and motivated them to enhance their interest in modern science.

It is easy to imagine that their experience of the total solar eclipse exerted a strong impact on residents within the belt of totality. In particular, it offered the amateur volunteers a unique opportunity to get directly involved in modern astronomy. Despite having no experience of astronomical observation, they tackled this task and accomplished it brilliantly. Their successful memories, I also believe, remained unfaded and encouraged them to enhance their own interest in modern science.

^{*1} Letter from Prof. Todd to Prof. Dana, dated Nov. 13, 1888. *The David Peck Todd Papers*.

^{*2} Letter from the Treasurer of the National Academy of Sciences to Prof. Todd, dated Dec. 29, 1888. *The David Peck Todd Papers*.

8 Conclusion

On the occasion of the total solar eclipse of August 19, 1887, the American Eclipse Expedition led by Prof. Todd visited Japan and established their observation station in Shirakawa, Fukushima Prefecture. Unfortunately, they failed to observe the eclipse owing to adverse weather conditions, and so a detailed study of Prof. Todd and his team has not previously been undertaken. In 2019, I located an abundance of their original materials in *The David Peck Todd Papers* and *The Todd-Bingham Picture Collection*, preserved in Yale University Library's Manuscript and Archives. Through close examination of those materials, a comprehensive picture of the expedition was established.

The American Expedition was carried out under the auspices of the Bache Fund trustees and the National Academy of Sciences. Supported by \$2,000 granted to Prof. Newcomb, Prof Todd volunteered to conduct the expedition. His mission was to take photographs of the partial and total phases of the eclipse with a horizontal photoheliograph and a heliostat, and to secure corona drawings and reports on the duration of totality.

The limited funds available brought Prof. Todd an unexpected opportunity to develop a cooperative relationship with the Japanese government. Great assistance was rendered by the various Ministries to the expedition. Furthermore, an exchange of longitude-signals was jointly conducted between Shirakawa station and the Naval Observatory in Tokyo. In fact, the Director of the Naval Observatory almost stayed in Shirakawa with Prof. Todd both to support him and to learn from him and his staff the technological details of their instruments, etc. Through these joint works, an equal relationship based on mutual respect grew up between the two parties, which stimulated the scientific interest of Japanese government officials.

The most notable collaboration was the "Amateur Oriented Eclipse Observation Event" proposed by Prof. Todd and conducted chiefly by the Ministries of Education and Home Affairs. This was the first public astronomical event held in Japan. Despite unstable weather conditions, some 370 amateur volunteers succeeded in observing the eclipse and produced 177 corona sketches and 156 reports of the duration of totality. Of these, 83 corona sketches and 105 reports of the duration of totality collected by the Ministry of Home Affairs were sent to Prof. Todd for his astronomical research.

The event had a significant impact on residents within the belt of totality. Amateur observers had a great opportunity to be involved in the modern astronomical event, which would have further stimulated their interest in modern science.

These amateur corona sketches are particularly valuable in the history of modern astronomy, as a number of sketches depict long streamers extending zodiacally. These clearly demonstrate that sunspot numbers were decreasing toward the 1889 minimum.

The success of the "Amateur Oriented Eclipse Observation Event" in Japan gave Prof. Todd another opportunity to hold a comparable event in the U.S. and Manitoba, Canada on Jan. 1, 1889, under the auspices of the Bache Fund trustees. In addition, his demonstrated ability to smoothly manage an expedition in a remote country in cooperation with its domestic government led to yet another opportunity to observe the total solar eclipse in Angora on Dec. 22 in the same year.

Despite the failure of their eclipse observation, the 1887 American Eclipse Expedition to Japan left a significant legacy both in Japan and for modern astronomy. From this perspective, Prof. Todd and his accomplishments certainly deserve to be re-evaluated.

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