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Selene's Two Faces

From 17th Century Drawings to Spacecraft Imaging

Edited by

Carmen Pérez González

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Contents

CHAPTER 3

Japanese Lunar Drawings, Maps and Photographs before the 1870s

Tsuko Nakamura

1 Introduction

Since the seventh century, the Japanese astronomy was under the exclusive influence from China until the first encounter with Europeans in 1543. Traditional Chinese astronomy was characterized by the Yin-yang natural philosophy, astrology and the calendar making and improvement, whereas it took little interest in the scientific structure of the cosmos and physical nature of celestial bodies.[1]

In 1613 the captain John Saris (c.1580-1643) of the British East India Company sailed to Japan and visited the first Shogun Iyeyasu Tokugawa (1543-1616) to request establishing a bilateral trade relation. As one of numerous tributes, Saris offered to Iyeyasu a telescope with a gold-coated tube on a silver mount[2], which was the earliest telescope ever imported into Japan. Considering that a few years were necessary at that time for a sailing ship to reach Japan from Europe via the Cape of Good Hope, this is a typical example of quick cultural transfer.[3] Although historical documents record that a considerable number of telescopes were brought to Japan during the first half of the 17th century by Spanish, Portuguese, Dutch and British traders, none of them seem to have survived, including the Saris' one.

Even after the first introduction of a telescope of 1613 (the telescope was then called *to-o megane* in Japanese, meaning a far-seeing glass), Japanese astronomers had long shown no interest in directing telescopes to celestial bodies to know their true character. This was caused by a long-standing tradition inherited from Chinese astronomy. The primary duties of professional astronomers of this time, who served at the Emperor's court, were routine

1 Shigeru Nakayama, *A History of Japanese Astronomy* (Cambridge: Harvard University Press, 1969).
2 M. Earnest Satow, *The Voyage of Captain John Saris to Japan* (London: The Hakluyt Society, 1900).
3 Engel Sluiter, "The first known telescopes carried to America, Asia, and the Arctic, 1614-39." *Journal for the History of Astronomy* 28 (1997): 141-145.

 | DOI 10.1163/9789004298873_005

astronomical calculations for the yearly issue of the calendar, and the visual sky watching for astrological divination and its reporting to the court. Their indifference to the astronomical use of telescopes was probably also due to that most then telescopes had neither high magnifying powers nor good glass quality enough to scrutinize the surfaces of the Moon and planets.[4] Moreover, telescopes were so expensive that the ordinary people of that period could not afford to enjoy astronomical observations as a hobby.

2 Early Use of Telescopes for Astronomical Observations

From the seventh century through the middle of the 17th century, the Japanese had continued to issue calendars simply based on the Chinese luni-solar calendrical theory. However, in the 1680s Harumi Shibukawa, previously a master of the Shogun's *go*-game championship, proposed an original calendrical theory, and in 1684 it was eventually adopted by the Shogunal government as the official national calendar, called the Jokyo calendar. Thanks to this achievement, Shibukawa was nominated to be the first Shogunal astronomer.

He was also eager to improve old Chinese and Korean star maps and catalogues by re-observing star positions with an armillary sphere. As a result he added 61 new constellations comprising 308 stars to the traditional Chinese constellation system. In this respect, Shibukawa can be regarded as the first Japanese who practiced astronomy as science. To identify barely visible stars in his established constellations, he used a telescope.[5] Although according to his writing, he must have pointed his telescope to the Moon as well, but neither such a record nor a drawing is left.

In 1720 a historic decree was issued by the eighth Shogun Yoshimune Tokugawa, announcing that the Shogunate lifted the century-long import ban of the Western books relating to the Christianity.[6] This was because Yoshimune, the owner of rational and scientific spirit, had recognized the importance of European science and technology through the books translated into Chinese by the Jesuit missionaries in China. Yoshimune ordered an optician based at Nagasaki

4 Tsuko Nakamura, "The earliest telescope preserved in Japan," *Journal of Astronomical History and Heritage*, 11/3 (2008), 203-212.

5 Tateki Tani, *Tani Jinzan's Jinki Roku* II (Tani Jinzan's Dialogues with Shibukawa Harumi, II) (Tokyo: publisher unknown, 1910). In Japanese.

6 e.g., Richard Mason and John Caiger, *A History of Japan,* revised edition (Tokyo: Tuttle Publications, 1997).

to produce a special large telescope for astronomical use and he himself observed the Moon, the Sun, and planets with it.

Due to the Yoshimune's epoch-making political decision, non-authoritative Japanese citizens could also soon have chances to learn the knowledge of Western astronomy, via Chinese-translated books (the Japanese then had not yet acquired the ability of reading European languages). Outcomes of Western astronomy that most impressed the Japanese were such as the Copernican heliocentricism, advanced European observational instrumentation, and telescopic drawings of celestial bodies. As far as we know, it was Goryu Asada that first sketched the Moon through a telescope.

Asada used to be a medical doctor who served a daimyo governing a small local fief as his official physician. Asada was so enthusiastic in studying Western astronomy that he implored resignation from his position, but could not obtain permission. So one night he finally fled to the largest commercial city of Japan, Osaka, changed his old name into Goryu Asada, and started a private school for teaching Western astronomy and medical science. This school attracted many talented students, where with their master they eagerly studied advanced Western astronomy, as represented by the Kepler's elliptic motion theory of planets.[7]

In parallel with theoretical astronomy, Asada and his disciples also payed special attention to the astronomical instruments invented by Tycho Brahe whose drawings had been included in Chinese-translated books, and telescopes for astronomical observations. In the Asada's letter draft of 1779 directed to an unknown recipient,[8] he explains his sighting the Moon in detail, with a primitive sketch of the half moon (Figure 3.1).

Asada used an Italian reflector telescope. He describes as follows:

> The terminator of the bright and dark sides for the half moon is much more complicatedly rugged than in the visual observation; There exist a lot of circular features (craters) that look like flat-bottomed kettles or ponds whose western sides are rimmed by the dark shadow; Some circular features have hills or shadowed peaks in the center; Although the lunar surface resembles the Earth's mountains and seas, there seems to

7 Shigeru Nakayama, "Asada Goryu", *Dictionary of Scientific Biography* 1 (New York: Charles Scribner's Sons, 1970). Thomas Hockey, *Biographical Encyclopedia of Astronomers* (New York: Springer Publishing, 2009).

8 Toshio Kage, *Collected Works of Asada Goryu,* Letter No.10 (Ed. T. Kage, in Japanese) (Oita: Historical Documents Office, 1999).

FIGURE 3.1
A primitive sketch of the Moon with comments, drawn by Asada in 1770.
Note: Kage 1999.

> be no soil, no water, no vapor; Rather it looks like the surface of a crushed copper craft or the human skin suffered from small pox; etc.

It is interesting to note that Asada attempted to estimate the depth of a crater utilizing the width of the rim shadow. But after all, Asada's main concern was to apply the knowledge of Western astronomy to the improvement of the luni-solar calendar, but not to reveal the physical nature of celestial bodies. In honor of Asada's astronomical achievements and contribution, the nomenclature committee of the International Astronomical Union named a small lunar crater Asada. The image on the next page shows a photograph of that crater taken by the Japanese Lunar Orbiter Kaguya of JAXA in 2008 (Figure 3.2).

3 Lunar Observations by Telescope Makers

The early telescopes invented in Europe consisted of a convex and a concave lenses (the Dutch-type or Galilean telescope) or two convex lenses (the Keplerian telescope). In the latter half of the 17th century, however, the Schyrlean telescope became much more popular, devised by Anton M. Schyrle of Reita in

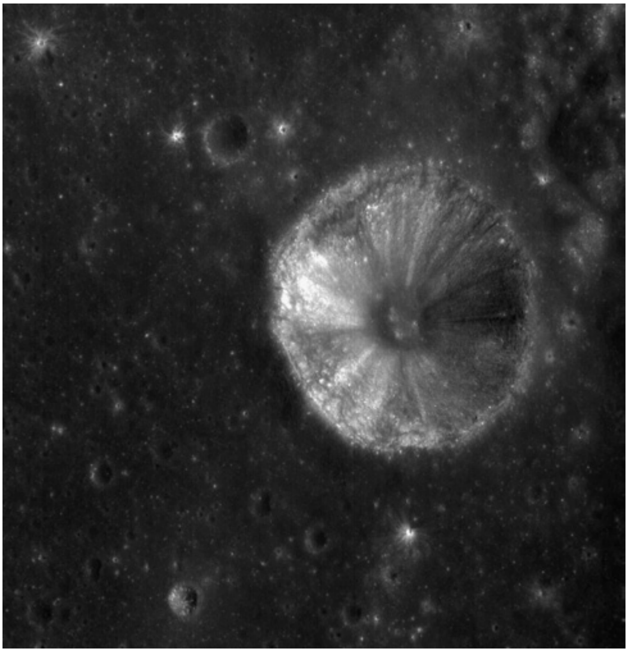

FIGURE 3.2
Asada crater on the Moon, photographed by the Kaguya Lunar Orbiter in 2008. The diameter measures 12 km, located at the position of 7.30N and 49.90E.
COURTESY OF JAXA/SELENE, JAPAN.

1645.[9] A typical Schyrlean telescope comprises four convex lenses (the eyepiece having three lenses) and is characterized by a wider field of view, giving erect images. From the middle of the 17th century, non-European telescopes with four convex lenses, similar to the Schyrlean type, had already been fabricated probably in the southern coastal part of the continental China, though it is unclear whether the Jesuit missionaries taught the production technique to the Chinese people or they invented it by themselves. The oldest of such telescopes, made in 1650 or before, is preserved at the Tokugawa Fine Art Museum, Nagoya.[10] It is certain that production of four-convex-lens telescopes had already started at Nagasaki around the end of the 17th century. Since then, this lens configuration became the standard of the Japanese telescopes, but without particular technical innovation until the 1870s.

9 Henry C. King, *The History of the Telescope* (New York: Dover Publications, 1979); Inge Keil, *Augustanus Opticus: Johann Wiesel (1583-1662) und 200 Jahre optisches Handwerk in Augusburg* (Berlin: Akademie Verlag, 2000).

10 Nakamura, "The earliest telescope preserved in Japan," 203-212.

3.1 *The Iwahashi Family*

Zenbei Iwahashi of Osaka was the only optical artisan who succeeded in launching the telescope making on a commercial basis from around 1790. His good customers were the Shogunal astronomers, land-surveyors for fiefs of daimyos, rich and curious merchants in large cities, and captains of trading and whale catcher boats. Accordingly, one can now find out several tens of Iwahashi telescopes preserved at museums and private collectors, whose typical magnifying power was 10-15. As the drawing tube of Iwahashi's telescopes is characterized by eye-catching colorful painting, they are still popular at antique auctions worldwide. The Iwahashi family continued their telescope business over five generations, till the end of the 19th century.

To promote his telescopic sales, Zenbei held Star Party twice in 1793 by inviting well-known scholars and intellectuals who lived in the then capital of Japan, Kyoto, to show them the Sun, the Moon, planets, and the Milky Way through his telescopes. With the same purpose in mind, he also published in 1802 a rotating planisphere and a booklet explaining how to use it, along with the introductory knowledge of astronomy. In the book Zenbei included his telescopic observations of celestial bodies.[11] Figure 3.3 shows his sketches of the crescent moon. Because of the drawing tradition at that time in Japan and the wood-cut printing publication, both figures are far from realistic but depicted in a pattern-like style.

But from the left of the figure, one can understand that Zenbei was most impressed by conspicuous ray craters like Tycho Brahe and Copernicus, and the shadowed darkness of the lunar mare regions.

3.2 *Reflector Maker Kunitomo*

Tobei Kunitomo was born in 1778 at a local village called Kunitomo near Kyoto, where the residents had all been engaged in gun works. In his 40s, Kunitomo had established his status as a skillful and talented master of the Shogunal gunsmith. In addition to musketry and artillery weapons, he devised various mechanical gadgets over his career, such as air guns, air-pumped lanterns, automatic archeries, prototypes of the bicycle and the flying glider, and so forth.

All Japanese telescopes produced before Kunitomo's times were refractors with lacquered paper or wooden tubes. When Kunitomo stayed at Edo, the shogun's capital (old Tokyo), during 1817-1822, he happened to encounter a portable Gregorian telescope imported from Britain. The owner of the telescope, one of the leading daimyos, permitted Kunitomo to take a look at the telescope

11 Zenbei Iwahashi, *Heitenngi Zukai* (Illustrated Explanation of Planisphere and Introduction to Astronomy, in Japanese) (Osaka: publisher unknown, 1801).

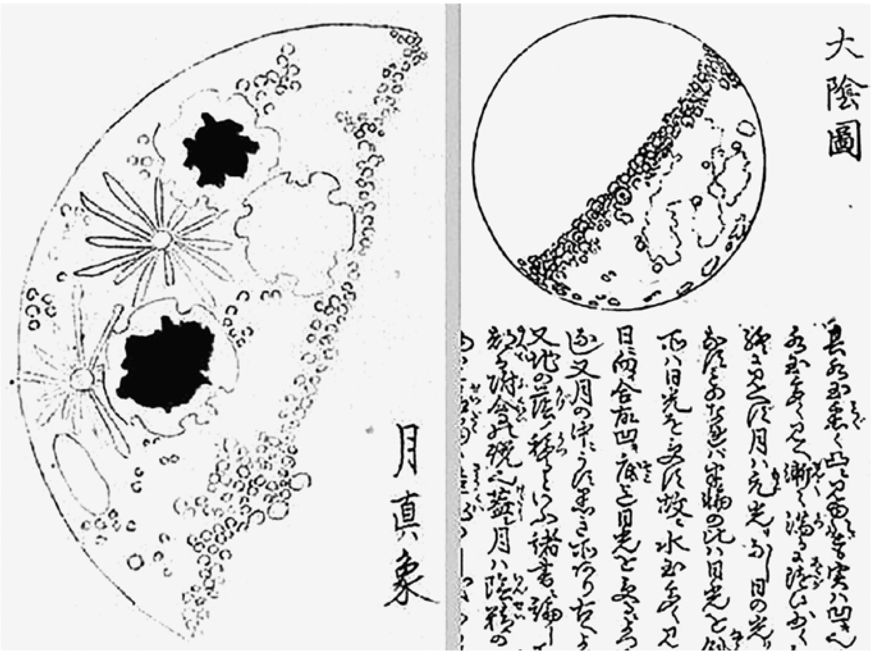

FIGURE 3.3 Lunar sketches of the Moon by Zenbei Iwahashi in 1793 (*Heitengi Zukai* 1802).

and measure sizes of its main parts, as he knew well Kunitomo's talent and curiosity to the Western instruments. It is very likely that this experience gave a strong impact to Kunitmo as a specialist of metal work, because he had never seen before such a telescope all parts of which were made of brass and bronze.

After Kunitomo's return to his home village, he was inundated with administrative duties of the gunsmith union for more than ten years. Around 1832, however, he suddenly began to cope with developing a Gregorian telescope on his own. Following a few years' painstaking trials and errors, Kunitomo finally succeeded in completing his first product in 1834, now preserved at the Ueda City Museum of Nagano prefecture (Figure 3.4).

It still provides fairly clear images of the Moon and planets at the magnifying power of 50-60, and a Foucault's test of the primary bronze mirror revealed a reasonably good parabolic surface.[12] So far, four telescopes including the first one of Ueda are known to survive, though the documents and letters relating to Kunitomo indicate that he produced at least several similar telescopes for

12 Yoshio Tomita, Tsuko Nakamura, et al., "Investigation of the Gregorian telescopes made by the gunsmith Tobei Kunitomo in the 1830s", *Kokuritsu Tenmondaihou* (National Astronomical Observatory Report) 4 (1998): 9-41, in Japanese (abstract in English).

FIGURE 3.4
The first Gregorian reflector telescope produced by Tobei Kunitomo.
COURTESY OF UEDA CITY MUSEUM.

selling them. An interesting thing is that, Foucault tests of the existing four telescopes showed that all the primary mirrors had the parabolic surface close to that of modern telescopes.[13] This fact indicates that, contrary to the past skeptical opinions, Kunitomo had surely established the knowhow in paraboloid polishing of the bronze mirror.

If that is the case, this finding brings about a puzzling question about how Kunitomo could master the means of the parabolic mirror polishing. There was no such technical background at all in Japan of the Kunitomo's era, other than producing traditional refractor telescopes by combining eye-glass-like lenses. Since he was basically an uneducated artisan from the countryside, he could of course read neither Dutch books imported at Nagasaki, nor had he intellectual tutors who were familiar with the knowledge of European science and technology.[14] Because of the reasons, his accomplishment in producing Gregorian reflectors has often been attributed to his ingenuity and incessant

13 Tomita, "Investigation of the Gregorian telescopes", 9-41 and his private communication.
14 Tsuko Nakamura, "Telescope making and its Western influence in the modern history of Japan: Kunitomo's reflector telescopes," *Proceedings of the Third International Conference*

invention so far, but this is really one of the unanswered enigmas relating to Kunitomo.

Kunitomo's workshop notebooks tell us that during the course of developing his reflector telescopes, he frequently pointed them to the Sun and the Moon. He repeated such tests in order to examine the completeness of the parabolic surface of the primary mirror by checking the image quality of celestial bodies. However, he made such observations not only for the testing purpose of his products. His documents obviously show that he bore also a strong motive for investigating the true nature of the Sun, the Moon and planets. Such a typical example is his solar observations.[15] His sketches of the solar disk and attached memoranda show that he distinguished the penumbra of the sunspot from the umbra, indicating his carefulness in observations and superiority of his telescopes. His most conspicuous achievements were that he left consecutive sketches of the sunspots (158 days), ranging over 13 months from the beginning of 1835; just nine years after S.H. Schwabe of Germany started continuous monitoring observations of sunspots in an attempt to discover the then hypothesized near-Sun planet Vulcan. Needless to say, Kunitomo did not know the Schwabe's project at all.

Analysis of the Kunitmo's words cited from his book collection suggests that he probably wanted to confirm the possible seasonal variation of the sunspot number, which was written in an introductory book of astronomy he read.

The Moon was another target of Kunitomo's frequent observations. The next image shows Kunitomo's sketches of the Moon drawn in September of 1836 (Figure 3.5).

Explanations of the drawings state that the observations were made on the ninth age of the lunar phase. However, we must call attention to numerous small craters painted far away from the terminator in Figure 3.5, where it is generally difficult to recognize such craters near the half moon because of the uncontrasted visibility. Therefore, it will be reasonable to suppose that both the figures, the right one in particular, were not the sketches for one night but composed from a few nights observations. Nevertheless, detailed features of Figure 3.5 remind us that Kunitomo's sketches are much more objective compared with those by other Japanese like Asada and Iwahashi.

on Oriental Astronomy (2000): 135-142 (Fukuoka: Fukuoka University of Education, Ed. M. Hirai).

15 Issei Yamamoto, "Kunitomo and his astronomical activities in the pre-Meizi era," *Isis*, 26/2 (1937) 330-335.

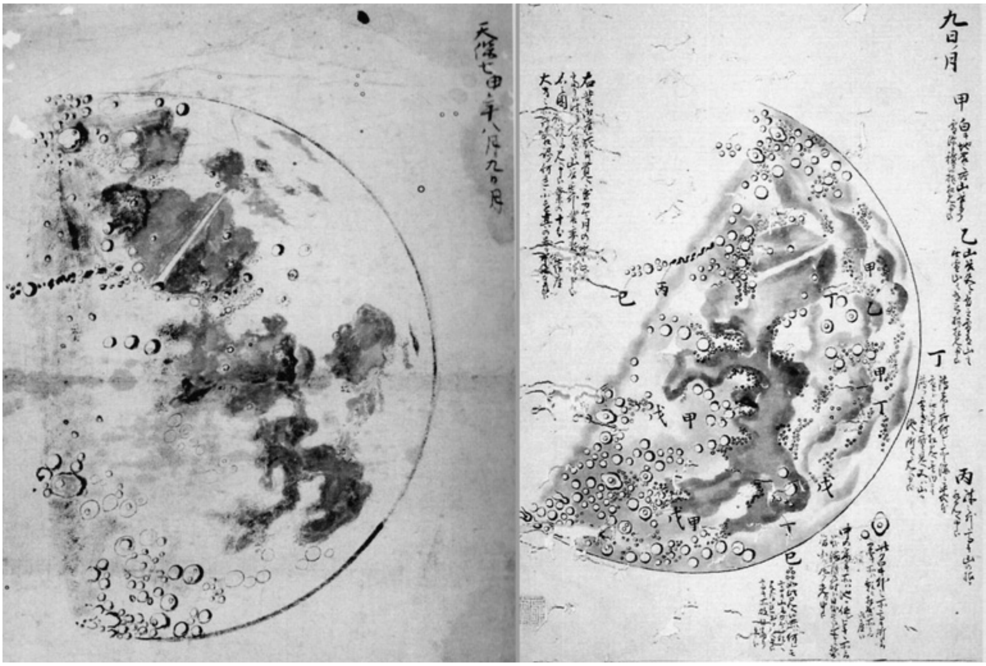

FIGURE 3.5 Kunitomo's sketches of the lunar disk observed in September of 1836, NAGAHAMA-JO CITY MUSEUM

4 Lunar Maps Made by Feudal Samurai Lords

Although in Japan there exist some other records of lunar observations made during the 1790s-1840s, all of them including Kunitomo's are basically no more than sketches made on a single night. On the other hand, what is introduced in this Section is not a sketch of the Moon but a genuine lunar map.[16]

4.1 *The Lunar Map* Taiiin no Zu *Drawn by Masatami Hotta*

Figure 3.6 shows the lunar map now owned by a local collector in Kumamoto, Kyushu. This historical object, entitled "*Taiin no Zu*" (Figure of the Moon) was painted in the traditional style of a hanging screen: an upper part with a figure and a section below containing an explanation in Chinese. The explanation here says that this map was drawn using a telescope in September 1813, proba-

16 Tsuko Nakamura, "A lunar map made in 1813 by a Japanese feudal warlord," in *Mapping the Oriental Sky*: Proceedings of the 7th International Conference on Oriental Astronomy, ed. Tsuko Nakamura et al. (Tokyo: National Astronomical Observatory of Japan, 2011), 82-87.

FIGURE 3.6
The lunar map painted in the Japanese traditional style of a hanging screen. This was observed and composed by Masatami Hotta in September 1813. Below the map is an explanation in Chinese with Masatami's signature, whose sentences were written in 1835; the reason of such a delay is unknown. COURTESY OF S. SHIMADA.

bly in Edo (Tokyo), by Masatami Hotta , a feudal lord who governed a small district close to Kunitomo's village.

The map was made in response to a request from Masazane, who was Masatami's father. In spite of the lengthy sentences, most of them consist of decorative and literary expressions and there is little scientific description. The diameter of the lunar globe measures 38.5cm, and the surface features, the craters, mountain ranges and the high-land and low-land (mare) regions, are very delicately and elaborately drawn in blue, silver, and green, although those colors now look fairly dull as a result of aging.

In Figure 3.7 one can notice the famous crater Plato as a distinct ellipse on the upper right, and very numerous tiny craters in the high-land regions. Very conspicuous are two bright-ray craters, namely Kepler on the lower left and Copernicus on the lower right.

Figure 3.8 represents the lower left part of the lunar disk. Here we can see the famous crater Tycho, with its magnificent ray system extending up to the region of the maria.

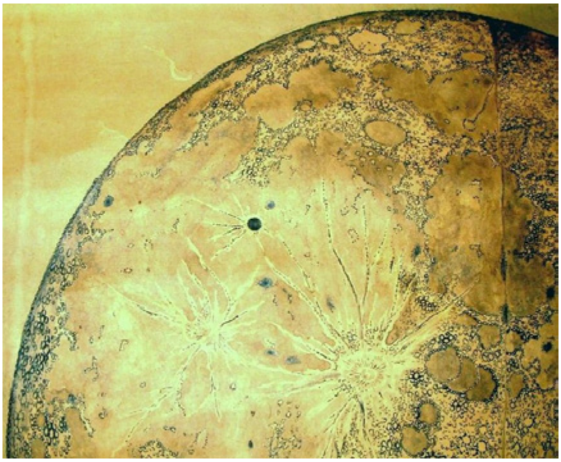

FIGURE 3.7
The upper left quarter of Taiin no Zu.
COURTESY OF S. SHIMADA.

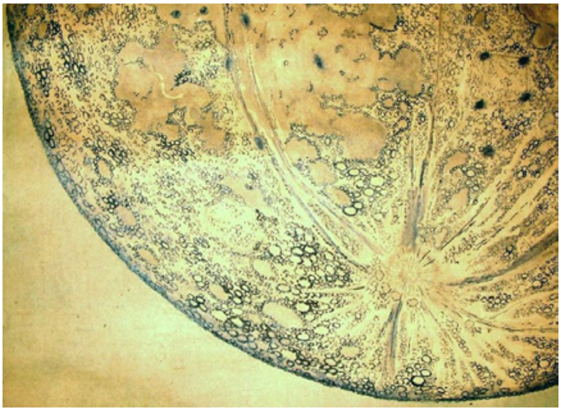

FIGURE 3.8
The lower left quarter of Taiin no Zu.
COURTESY OF S. SHIMADA.

From figures 3.7 and 3.8, it is highly likely that Masatami used an imported telescope with a high magnification and one that gave an erect image. Since it is well known that in the latter half of the eighteenth century the British optician James Short manufactured many portable Gregorian reflecting telescopes[17] similar to the one produced by Kunitomo and some of these were exported worldwide (including to Japan), we speculate that Masatami used such a telescope, or a comparable one made by Dutch artisans.[18]

17 Harriet Wynter and A.J. Turner, *Scientific Instruments* (London: Studio Vista, 1975).
18 Huib J. Zuidervaart, "The reflecting telescope in the Netherlands," *Annals of Science* 61 (2004): 407-452.

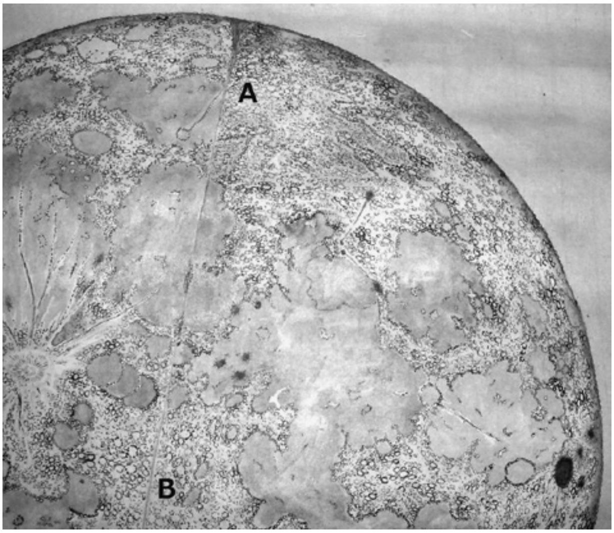

FIGURE 3.9
The upper half quarter of the Moon, showing the line (AB) jointing the two halves of the Moon. COURTESY OF S. SHIMADA.

The Chinese explanation in figure 3.6 contains Masatami's signature and the date 1835, and states that he painted this lunar map during a single night's observation of the full moon in September 1813. However this statement is doubtful. Those who have some experience in telescopic observations of the Moon know that at full moon the lunar surfaces have least contrast, so it would be impossible to detect some of the detailed features painted by Masatami. Therefore, we infer that in reality he assembled this map from sketches made at multiple lunar phases.

Actually there is clear evidence that supports this inference. Upon scrutinizing the *Taiin no Zu*, one can see a line that connects two halves of the Moon (the line AB in Figure 3.9), and on both sides of this line the features drawn seem to be discontinuous.

This strongly suggests that each half-moon was observed at different phases and then the two were later combined into a full disk. In that sense, this diagram is surely not a simple sketch of the Moon but is a lunar map.

In Europe, it was M.F. van Langren, a Dutch astronomer and cartographer, who in 1645 published the earliest lunar map produced from observations at different phases, and the general scheme of feature depiction and nomenclature adopted in his map have basically been retained up to the present day.[19] Lunar map-making after van Langren, represented by astronomers like Jo-

19 Ewan A. Whitaker, "Selenography in the seventeenth century," in *The General History of Astronomy*. Volume. 2: Planetary Astronomy from the Renaissance to the Rise of Astro-

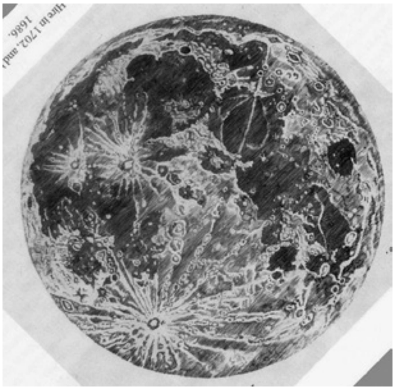

FIGURE 3.10
The lunar map by La Hire (1702). For easy comparison with other lunar maps, the figure shown here is rotated by 135 degrees from the original one.
Note: Whitaker 1989.

hannes Hevelius, Giovanni Battista Riccioli and Giovanni Domenico Cassini, gave birth to a new field of research called 'selenography' in the second half of the seventeenth century.[20] Since Masatami's lunar map was drawn nearly 150 years after these European activities, one may consider this map not so valuable from an historical point of view. However, we should also take into account that Masatami was totally ignorant of the astronomical situation in Europe – because of Japan's seclusion policy at this time – and he painted his lunar map independently and out of pure curiosity.

With this background in mind, we attempt here to compare the *Taiin no Zu* with some typical European lunar maps produced during the period 1650-1720. Figure 3.10 shows an example of a European lunar map with nicely-drawn ray craters.

This was produced by the French astronomer, Philippe de La Hire, and included in his Astronomical Tables, which were published in 1702. Upon comparing this lunar map with the painting by Masatami, it can be seen that the Masatami's lunar figure almost rivals the best of the European lunar maps, from both an artistic and a descriptive viewpoint. At the same time, however, it is worth noting that the bright ray craters were depicted differently by different observers even in Europe; for example, the lunar maps by Riccioli (1651) and Cassini (1679) did not show Tycho's ray system so clearly.[21]

Now we wonder how precisely Masatami's map is drawn from a scientific point of view. At this time in Japan there was a spiritual consensus among

physics. Part A: Tycho Brahe to Newton, ed. René Taton et al. (Cambridge, Cambridge University Press, 1989), 119-143.

20 Whitaker, "Selenography in the seventeenth century," 119-143.

21 e.g. see the photographs in Whitaker 1989.

Japanese intellectuals and scholars who were interested in so-called natural history, that they should describe natural things – like fauna and flora – by drawing them 'true to life'. Although this spirit may be somewhat different from the Western scientific attitude, there is no doubt that Masatami made efforts to record the Moon as realistic as possible.

In order to examine the positional accuracy of Masatami's lunar map, a comparison was made with an image generated by the planetarium software 'Stellar Navigator'[22] for 8 September 1813 (Gregorian calendar), which corresponds to the date of Masatami's alleged observations. Although we have had no chance yet to confirm how accurate the software is, it seemed that this software takes account of the lunar libration because it produces lunar images with different orientations for different dates.

It was found that Masatami's positions of ray craters like Tycho and Copernicus were fairly accurate, but the maria do not fit well. Also, the location of Plato crater was shifted to the left, and its size was exaggerated. However, the enlargement of specific features can also sometimes be seen in European lunar maps from the second half of the seventeenth century, probably because observers tended to be more affected by conspicuous features like Plato. As for the overall positional inaccuracy, it will not be fair for us to blame Masatami, because he was not a scientist. He was a painter after all, and he had no means of accurately measuring positions on the lunar disk.

Another possible cause of the geographical inconsistency in the Masatami's map could be that he actually made his observations not at full moon in September 1813 but on different days and at different phases, before combining them into a lunar map. In any case, the production of lunar maps like the one made by Masatami had never been attempted previously in Asia in pre-modern times, so we believe that *Taiin no Zu* represents an important achievement in the history of selenography.

4.2 *What Motivated Masatami to Draw His Lunar Map?*

It is well known during the latter half of the seventeenth century in Europe selenographical activities were motivated by two points.[23] The first was to accurately pinpoint the positions of minute but conspicuous lunar features, so they could serve as a 'common clock' and be used to determine the longitudes of places on the Earth. The second motivation emerged later, when the Moon was regarded as a habitable or creature-bearing world, so that astronomers needed a geographical map of our nearest celestial neighbor.

22 AstroArts, *Stellar Navigator,* ver. 6.0 (Tokyo: Astro Arts Inc, 1998).

23 Whitaker, "Selenography in the seventeenth century," 119-143.

Then, what motivated Masatami to draw such a detailed lunar map? Although we cannot of course be certain, there exist some clues. The existence of this map was first revealed to the Japanese astronomical community before World War II,[24] when relevant materials and references were unavailable. But our literature survey has revealed that Masatami's father (Masazane) also had made a vassal of a different feudal lord draw another lunar map for him, in 1799[25] – although its current whereabouts is unknown. According to Hukui, who recorded the explanation attached to the 1799 map, Masazane noted with dissatisfaction that he was then using a telescope that gave inverted images. This could be a reason why he made his son draw a new lunar map in 1813, but with an erect orientation. This episode also suggests that it was Masazane, rather than Masatami, who was more enthusiastic about producing lunar maps.

During the period from 1790 to 1840 Japanese interest in European science and arts experienced rapid growth. Some of the Dutch interpreters at Nagasaki (where the Japan branch of the Dutch East India Company was located) and pioneering local scholars imported Dutch books, read them and began writing and publishing books on novel Western things and affairs. Also affected by such developments were people who could not read Dutch but had a strong interest in Western learning. Among them, Shiba Kokan was a typical figure. He was a well-known painter at that time who mastered the technique of Western oil painting, and became famous for his invention of the copper-plate print. He also contributed to popularizing Copernicus' heliocentric system of the Solar System among the Japanese people.[26]

Around 1796 Siba published *Tenkyu Zenzu* (Figure of the Celestial Sphere), a series of colored copperplate engravings, which were widely welcomed by the Japanese of the Edo period. They included a few images of the Sun, the Moon and the celestial sphere, which were modified copies by Shiba, taken from the Western sources.

Among them, there was a plate of the Moon (Figure 3.11, left) entitled '*Getsurin Shinkei Zu*' (*True Moon*), which much impressed the Japanese because they had never before seen such a detailed figure of the Moon. In light of the

24 Kazuyuki Ikeda, "Bunka Nenkan" "*Taiin no Zu*" (The lunar map drawn in 1813, in Japanese), *Tenkai* 123 (1931): 337-340.

25 Kyuzo Hukui. 1937. *Shodaimyo no Bungei to Gakujutsu* (Literature and Scholastic Achievements by Daimyo Warlords, in Japanese) (Tokyo: unknown publisher, 1937): 336-337. Reprinted by Hara Shobo Inc. (1976).

26 Kokan Shiba, *Shiba Kokan Zenshu* (Collected Works of Shiba Kokan, in Japanese, four volumes, reproduced version) (Kyoto: Yasaka Shobo Inc, 1992-1993).

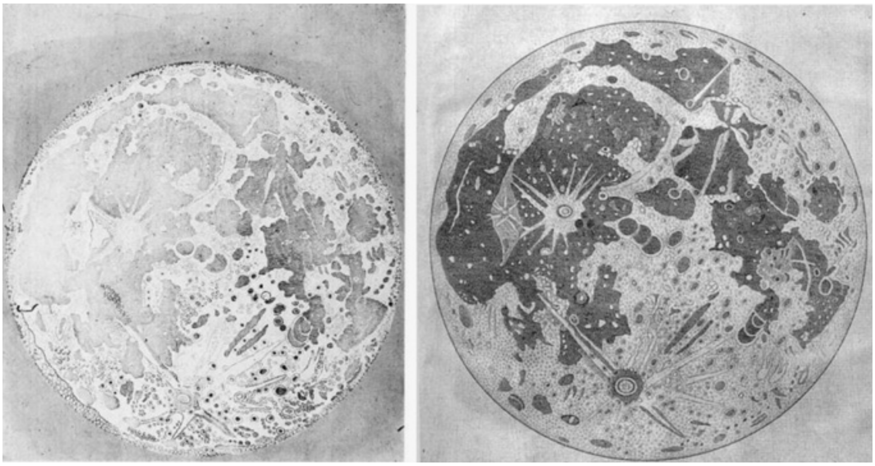

FIGURE 3.11 (left): Copperplate engraving '*Getsurin Shinkei Zu*' (True Moon) by Shiba Kokan (1796), and (right): The figure of the Moon cited in the book 'Underground World' published by Athanacius Kircher in 1664.

historical circumstances of that time, it is likely that Masazane was also influenced by this popular *True Moon*, because Masatami's first lunar map was drawn just three years after Shiba's publication.[27] We suggest that the *True Moon* provided the motivation for Masazane to confirm by himself the reality of the Shiba's print by observing the Moon with his own telescope.

It has recently been revealed[28] that Shiba's True Moon was actually based on an image in the book *Mundus Subterraneus* (Underground World) which was published in 1664 by Athanacius Kircher[29], a German Jesuit scholar and naturalist (see Figure 3.11. right). Also it has been well known that the Kircher's image was based on the lunar map made in 1655 by the eminent Jesuit astronomer Christoph Scheiner.

27 Kokan Shiba, *Tenkyu Zenzu* (Figure of the Celestial Sphere, in Japanese), 12 plates. (Tokyo: Shunparo, c.1796).

28 Kobe City Museum, *Shiba Kokan Hyakka Jiten* (Encyclopedia of Shiba Kokan, in Japanese). (Kobe: Kobe City Museum, 1998).

29 Athanacius Kircher, *Mundus Subterraneus, quo Universae Denique Naturae Divitiae* (Underground World, in Latin) (Amsterdam: Janssonio Waesbergiana, 1664-1678).

5 Early Photographs of the Moon

During the 1860s Japan experienced the civil war, conflicts between the Shogunal government and opposing feudal lords backed up by the Emperor. In 1868 the Shogunate finally surrendered and the political power went to the hands of the Meiji government, which is called the Meiji Restoration. The new government soon abandoned the national seclusion policy that had been maintained by the *Ancien Régime* for about 230 years, and rapidly introduced Western institutions in various fields of the society. As a result, the Western culture, educational system, science and technology flooded into Japan like a tsunami, along with European and American diplomats, teachers, and overseas merchants.

In 1874 a very rare astronomical event took place over the Far East including Japan. It is called the transit of Venus; a phenomenon that planet Venus passes across the solar disk, whose elaborate measurements allow us to determine a very precise solar parallax (a mean distance between the Sun and the Earth). Thus France, US and Mexico dispatched expedition teams to Japan for the observations. Thanks to this unparalleled fortune having received researchers from advanced countries in astronomy, the Japanese (both professional and non-professional) could learn and master three fundamental observation techniques in modern astronomy, namely the exact determination of astronomical latitude and longitude for a place, the time synchronization of two remote sites through the electric cable communication, and astronomical use of photography.[30]

Considering the above mentioned situations, it is likely that by around the end of the 1870s the Japanese had taken photographs of the solar and lunar disks through telescopes. Nevertheless, such materials are not known to exist. A possibility is that, for professional astronomers, simple photographs of the Sun and the Moon were not a target of serious science but no more than an observational testing, so they did not preserve them as astronomical archives. On the other hand, for ordinary photographers, astronomical images might not be a topic of interest after all.

In the case of the Moon, our literature survey found out a low quality lunar photograph shown in figure 3.12. This was included in the book *Seigaku Shokei*

30 e.g., Jules Janssen, "Mission du Japon pour l'observation du passage de Vénus," *l'Annuaire du Bureau des Longitudes de 1876* (1876): 572-588; Kuniji Saito and Shinozawa Shizuyo, "On the observations of the transit of Venus over the Sun with particular emphasis on the December 9, 1847 event observed in Japan: Part I," *Tokyo Astronomical Observatory Report*, 16/1 (1972): 72-162, 73; and Part II, 16/2 (1973): 259-385.

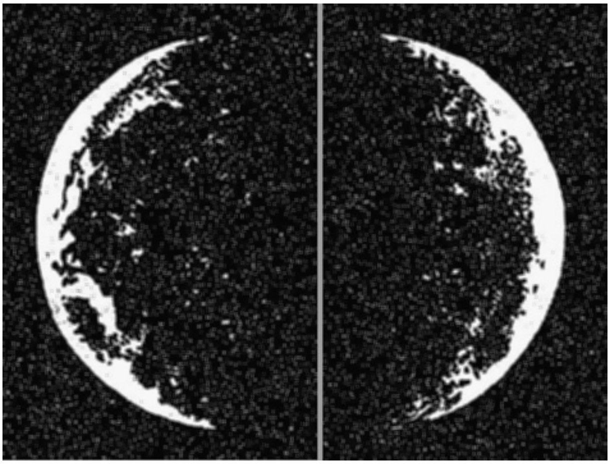

FIGURE 3.12
Early photographs of the Moon taken by the Japanese in or before 1875.

(Introduction to Astronomy) published by the Ministry of Education.[31] The explanation simply mentions that this photograph was taken in Japan, with neither the date and place of observation, nor information of photographic emulsion. Although the resolution of the photograph is fairly low, one can identify the Mare Crisium on the lower left and some other major features. This photograph could be an outcome learned from the experience in the Venus transit expedition of 1874.

6 Concluding Remarks

Finally we would like to add some comments based on a wider perspective than just the history of astronomy. As mentioned in the previous sections, during the period from the 1790s to 1840s in Japan researches in the field of the natural history became very popular among both specialists and dilettantes (amateurs), and at this time intellectual daimyos were also engaged in recording colorful and detailed drawings of plants, animals, insects, etc. Masatami, for instance, left us a beautifully-illustrated encyclopedia of butterflies and moths, '*Seicho hu*', which is now preserved in the National Archives of Japan.

Therefore, the enthusiasm of Masazane and Masatami to make lunar maps at this time can best be understood within this framework, which arose from a strong curiosity towards the wonders of Nature.

31 Naruo Sekidou, *Seigaku Shokei* (Introduction to Astronomy, in Japanese) (Tokyo: Ministry of Education, 1875), 76.