

## Study of the Measured Drawings of the “Shell Mounds of Omori”

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### Introduction

The shell mounds of Omori were found and excavated by Edward Sylvester Morse. The site is one of the most important discoveries in Japanese archaeology, and is internationally recognized. The artifacts excavated from the site have been designated as Important Cultural Property by the Japanese government in 1975. The importance of the remains, however, does not solely lie in its discovery, but also in the way the objects were illustrated in a scientific manner and documented in academic publications. Approximately 300 original drawings of the Omori relics, made 140 years ago, are stored in the Department of Anthropology and Prehistory, The University Museum, The University of Tokyo (UMUT). Makoto Sahara recognized that the drawings had tiny pin holes and gridlines (Sahara 1977). This observation revealed that the drawings were not merely sketches of the relics but were in fact measured drawings.

This report is the first thorough analysis of these drawings. My personal motivation for this research was shaped when I first saw and was intrigued by the scientifically sophisticated illustrations. This seemed important not only for the archaeological realm but also to science history. One problem was that the pin holes and marks were tiny and seemed fragile that can easily be damaged or lost by a single touch by researchers. Because filmed photographs are not sufficiently clear for research observations on the details of these drawings, higher resolution imagery was needed to be prepared for a closer look. The curatorial work done by UMUT includes classifying, researching, and reporting what it stores. The artifacts of the shell mounds of Omori have also been a part of this work (Hatsukano et al. 2009, 2010, 2017), and the original drawings have been documented digitally, which I utilized in my research. The digital imagery of the drawings revealed that Edward S. Morse clearly intended to record what is seen in a scientific fashion in even the smallest fragments, which I will discuss in this paper. It is a great honor to finalize this report at the 140th anniversary of the discovery of the shell mounds.

## CHAPTER 1

### Path to “Omori” Memoir

#### 1.1 THE PLAN OF EDWARD S. MORSE (Figs. 1 to 5)

In June 1877, Edward S. Morse, an American zoologist, came to Japan without financial sponsorship when he heard that the country was rich in brachiopods. On his way from Yokohama to Tokyo by steam train, he found the shell mounds of Omori. In April of the same year, the University of Tokyo was founded and it employed Morse as a professor for the science

department. Morse worked for the university as well as on his own work on the shell mounds. He planned to issue an academic publication by using drawings of scientific character (Morse 1917: Vol 1.p.301) that can provide detailed information of the relics. This is what we today call measured drawings.

The “Shell Mounds of Omori, Memoirs of the Science Department, University of Tokio, Japan” (hereafter “Omori”) was published in 1879 as the first university memoir to be published in Japan. It is written in English, with a lithograph of people digging the remains as its frontispiece, and includes in its contents 18 plates, one lithograph, and 17 copperplate etchings of the relics. The original hand drawn illustrations and related documents of the published plates are stored in the UMUT, including 269 measured drawings, one cover page on traditional Japanese paper, 17 paper holders, and one piece of hand written note by D. G. Wayman, biographer of Morse. The 269 drawings consist of 231 pottery drawings, 11 for tablets, 9 for horn and bone implements, 9 for stone implements, and 9 for mollusc specimens. Morse himself did the mollusc drawings, and a professional Japanese scientific artist named Seizan Kimura did the remaining drawings. Kimura worked for the Educational Museums of Japan, which had opened in the same year as the University of Tokyo. At that time, the university did not have scientific illustrators as staff, and outsourced the work to professional artists just as Morse did with Kimura. Kimura started his job at the museum with the support of Keisuke Ito, professor of biology at the University of Tokyo, who worked at the Koishikawa botanical gardens of the university. Although Morse, Ito, and Kimura were working close by, Ito never mentioned Morse in his diary.

Morse conducted fieldwork at the shell mounds of Omori on three occasions: initially on 16th September 1877, next on 18th or 19th September (Isono 1987: p.116), and thirdly on 9th October which he specifically called “the first excavation” (Morse 1879: p.3). Surprisingly, Morse had developed a detailed plan to publish a scientific report from the very beginning of his fieldwork. Makoto Sahara argued that Morse started to prepare drawings for the 1879 “Omori” memoir in the spring of 1878 (Sahara 1977: p.47) when Morse came back to Japan after his short (November 1877 to April 1878) return to the U.S. D. Wayman agrees with this, that the job was done probably in 1878-79 while Morse was in Tokyo. My opinion, however, is that Morse had started the drawings immediately after he visited the Omori shell mounds in September 1877. This is because the drawing was an important part of the whole study and therefore needed to be done as early as possible. In addition, Morse had to temporarily leave Japan for the U.S. by the 1st November 1877. Therefore, Morse needed to make full use of the month and half before his five-month departure from Japan. It can be said that Morse had forcefully arranged for Kimura to do the work that Kimura was not accustomed to. In fact, Kimura’s mentor, Ito, suggested that Morse pay Kimura better for the work (Fig. 4; Keisuke Document Study Group, ed. 2008: p.78). It is surmised that both Ito and Kimura had felt frustrated by the unexpected work brought by Morse.

## 1.2 THE DRAWINGS OF MORSE AND KIMURA (Figs. 6 to 15)

The drawings by Morse himself, that was done after the September 1877 work at the Omori shell mounds appeared later in the journal “Popular Science Monthly” and in Morse’s book entitled “Japan Day by Day”. The drawings in the two publications have many things in common with those of “Omori” (Fig. 7-1, 2, 3). Morse was apparently preparing for “Omori” during this time (September and October 1877). Composition and views of the pottery changed somewhat from 1 to 3 (of Fig. 7), through which the drawings became scientific illustrations. Many other

tablets, horn and bone implements, stone implements appear in the “Popular Science Monthly” and “Japan day by day”, all of which basically follow the scale and drawing manner of “Omori”. Even in his quick reports and diary, Morse tried to maintain the same consistency of scale of the measured drawings. It seems that Morse intended to use these drawings as sample models while he was away from Japan. In “Omori”, some similar potteries are drawn from different angles, which I believe is the sign that Kimura was struggling during Morse’s absence.

Traditionally, “Omori” was believed to follow the writing style of “Fresh-water Shell Mounds of the St. John’s River, Florida” (Wyman 1875). Yet these drawings were done in a three-dimensional way in contrast to “Omori”. A land snail that Morse drew in the “American Naturalist” (Morse 1868) is both in horizontal and top views (Fig. 9). This is called third-angle orthographic projection (Fig. 10) and what Morse regarded as the fundamental way of drawing. His scientific position was that illustrations of relics should help researchers see objects from a different angle in the same scale, such as in third-angle orthographic projection.

As opposed to Morse, Seizan Kimura had been required to draw objects such as fish and portrait, which need a pictorial expression. The difference in the characteristic of drawing, however, did not hamper Kimura from becoming a dedicated drawer for Morse. Kimura was known for his fine dessin of insects, which was made around the same time of “Omori” (Fig. 14-1). In the drawings, there is a line drawn in the centre that divides the picture bilaterally symmetrically (Fig. 14-2a). There is a needle hole at the end of the line (Fig. 14-2b), and these holes are not found in other works of Kimura. There are also many needle holes in the measured drawings, but the holes in the insect drawings are not for actual measurements. It is rather a reference mark for a balanced layout on a sheet. On “Japan Day by Day” it is stated that Morse gave insect needles to students who love insects (Morse 1917: Vol 1, p. 364). At that time there were no Japanese insect needles, so it is possible that the hole used for “Omori” may be the one given by Morse.

### 1.3 MAKING LITHOGRAPHS AND PUBLISHING THE REPORT

(Figs. 16 to 19, Table 1)

I consider that most of the illustrations that Kimura made were done while Morse was out of Japan (Table 1). Morse required a high standard in such drawings and he, in fact, it seems that Morse made Kimura redo some after his review. Even so, the quality of the drawings met Morse’s expectation and almost everything was printed as it was except for the layout.

The next step was to make the lithograph. Rokuzan Matsuda, who ran a print shop named Gengendo, undertook the lithograph printing (Figs. 16, 17). At the time, lithograph prints were preferred over photographs, because it had better endurance yet looked very similar. Gengendo was highly esteemed, and served the Meiji government in printing monetary notes. Chi-ichi Kamei, a staff of Gengendo, was regarded as the best lithograph artist in terms of capturing a moment, and he made the lithograph for the first page of “Omori” (Fig. 18-1). Photographic cameras at that time needed long exposure times, and Kamei’s sketch prevailed in this regard. (Fig. 18-2).

Morse had to hurry with his “Omori” project under the time constrain, although he made some complaints on the work of lithographers (Morse 1879: PLATE II). As already summarized above, Kimura probably created the original drawings while Morse was away, from November 1877 to April 1878. I would suppose that the drawings were handed over to Gengendo in July 1878 after Morse reviewed them and decide the layout order. It is recorded that Morse visited the

shell mounds of Omori again to check the shells in November 1978. Considering the fact that Gengendo was famous for its quick processing, Morse probably started his writing in December 1978. The writing work was completed by 16th July 1879, just before his term in the university ended that month. Nisshu-sha Printing Office undertook the type-printing and bookbinding. Orizou Taneda, an assistant, helped to clean Morse's poor hand writing before it was submitted. The printing company is known for publishing the first English-Japanese dictionary in Japan, and an every-other-day newspaper which later became one of Japan's leading newspaper the "Yomiuri".

The exact publishing date of "Omori" is unrecorded, but Naohide Isono estimated it should be at the end of August 1879, because The Japan Weekly Mail cited "Omori" in its article of 9th September (Isono 1988: p.484). Despite the incredibly quick processing of proofreading, printing, and bookbinding within a month or so, the whole process was not completed in Morse's contract time with the university. The school decided to extend his contract until the 31st August so that it could exchange Morse's work with those of European universities and museums. Morse left Japan on the 3rd September from Yokohama by a ship named City of Tokyo with a copy of "Omori" in his hand.

#### 1.4 AFTER "OMORI" (Figs. 20 to 25)

Despite his relatively short stay in Japan, Edward S. Morse was truly admired by Japanese locals. This is primarily because he loved Japan and dedicated himself to its development.

Chujiro Sasaki, Morse's student, continued to research shell mounds with his study group. He included drawings of artifacts from the Okadaira shell mounds in his letter to Morse (Fig. 20-1; Sahara 1988a, Miho village E.B 2006), and in the report for the academic journal "Gakugei Shirin" (Sasaki and Iijima 1880). Some large potteries were drawn in third-angle orthographic projection in horizontal view, with scale descriptions such as 1/2 or 1/4, and color codes such as "red" can be found in the corner of these drawings. This apparently follows Morse's style. However, the drawings for "Gakugei Sirin" were rather sketches, not measured drawings (Fig. 20-2). There are no scale descriptions and they are drawn in a three-dimensional way. These features were taken over to the illustrators, as seen in the lithographs published in the "Okadaira Shell Mound at Hitachi" (Fig. 20-3; Iijima and Sasaki 1883). Although Sasaki used the "Omori" style to write "Okadaira", the large potteries were drawn by a combination of horizontal but slight upper diagonal and top views. Kimura did not join this project of "Okadaira" because he changed his workplace to the Koishikawa botanical garden after completing "Omori". He and Ito wanted to stay away from the university job, and alternatively, an artist named Matate Indo joined the team.

Indo was a student at Kobu art school, governmental art institute, whose teacher was Antonio Fontanesi. Fontanesi's artwork is known for its contrast of light and darkness and this clearly appeared in Indo's work in "Okadaira" (Fig. 21-3) when it is compared to the original drawing of Kimura (Fig. 21-1) and its precise copy by Gengendo (Fig. 21-2). Light from the top is emphasized in "Okadaira" and the illustrations appear as if they are pictures. Upper diagonal lighting is also seen in Indo's lithographs (Fig. 21-4). This drawing style depicts both pottery and humans three-dimensionally, and this is what was admired at that time. This, however, is not what Morse preferred, and none of Morse's students became a professional archaeologist. The illustration methods developed by Morse and Kimura was not passed on.

## CHAPTER 2

### Analysis of the Measured Drawings

#### 2.1 DOCUMENTED DATA (Figs. 26 to 29, Table 2)

The original drawings were formerly stored in specifically designed cases (Colour Plate). In the cases, there were 288 documents in total: one paper sheet with “Oomori” written with a brush, 269 measured drawings, 17 paper holders, and 1 piece of note written by Dorothy G. Wayman who came to Japan in August 1939. Before these drawing and documents were digitally recorded, the UMUT catalogued them Morse 1 to Morse 19. The corresponding digital imagery were numbered from #01-01 to #19-10, which adds up to 297 numberings in total (Table 2). The following account refers to these numberings. The original drawings used in “Omori” starts from the #03 series. The #01 series comprise drawings that were not used in “Omori”. The number of digital imagery, 297, is larger than that of documents, 288, because some sheets have drawings on the both sides. Some of the paper holders have something drawn on their surface. Out of 269 object drawings, potteries account for 231 (series #01 to #15), tablets total 11 (#16), horn and born implements 9 (#17), stone implements 9 (#18), and illustrations of mollusc 9 (#19).

Even during time away from Japan, Morse continued to categorize the relics. Potteries, in particular, were what troubled him most because of the sheer number of types and complicated decorations (Fig. 28-1, 2). On the paper holders, there are hand written notations, such as “Shallow pots round bottoms” (#04-01a) and “Deep pots” (#06-01, #07-01) which are the shape categories, and “Ornamental pots” (#03-01) and “Flat vessels” (#05-01) which related to the degree of decoration, and “Constricted necks and dry carving” (#08-01), “Fragments of pottery finger squeezing borders” (#09-01), and “Fragments of pottery inside ornamentation and crenulated edge” (#12-01) which concerns type of decoration. Small projections from the pottery edges were named “Ears” (#13-01) or “Knobs” (#14-01). Although Morse made a number of categories, in the end, he adopted only the categories by material. If one looks at the plate number notations, there are some changes such as PLATE IV is changed to PLATE I (#03-01). There are drawings with plate number notations but without comments or notes (#10-01, #15-01), and drawings with notes but without plate number notations (#11-01, #12-01, #14-01).

#### 2.2 DRAWING SHEET AND MORSE’S NOTES (Figs. 30 to 31)

Morse used three types of paper for measured drawings (Fig. 30-A, B, C). Paper type A, a dessin sheet, is used for 88% of the drawings. Paper type B, Kent paper, is only used presumably when dessin sheet was in short, while type C, although the type of paper is not identified, was used for molluscs and believed to be brought by Morse from the U.S. Kimura used pencils for drawing, which must have been imported as they were not made in Japan at the time.

Morse left his notes on each of Kimura’s drawings, regarding scale, size, colour, fineness or roughness of structure, and pattern features. Overall, these notes correspond to the Figure legends of the “Omori” plates, although there are some notes that provide further insights. Morse also checked the quality of drawing and apparently often gave feedback to Kimura or make him redo the artwork if necessary.

## 2.3 MARKS LEFT ON THE DRAWINGS (Figs. 32 to 34)

What is unique about the measured drawings of “Omori” is the tiny pin holes and thin lines drawn from them. Some are actual holes that penetrate into the paper, while others are rather dents. Since the holes and lines are tiny and thin (Fig. 32-1), in this study, I used the 720 dpi TIFF files of the digital imagery made by the UMUT and examined them in 1200% size in Adobe Illustrator CS3. In the following figures and plates, the pin holes are depicted as • and the trace lines with 0.5 pt. The color pictures were converted to grey scale (Fig. 32-2). The drawings shown in Plate 1 to 166 of this volume are the images edited in this way, while some unedited ones are shown wherever necessary.

### **Holes and lines**

There are many sorts of the mark left on the original drawings, most of which are holes and lines. Brief descriptions are given below.

### **Holes for Central Baseline**

Holes that are made in the top and bottom of the paper to draw a vertical line, especially for potteries (Fig. 33- a, b).

### **Holes for Grid Line**

Holes that are made in the start and crossing of gridline, especially to show the scale for fragments of potteries.

### **Short Line**

Short lines are marked on the extension of lines in many drawings (Fig. 33-g). The purpose is unclear, but this appears mostly in drawings with grid lines (13-31).

### **Holes for Scale**

Holes that are made with a certain interval on the line or its extension line (Fig. 33-e). The interval is usually 5 mm.

### **Remarkable Point**

Not only the outline of potteries and the surface patterns (Fig. 33-f), this is left on the drawings of stone tools, bone and horn tools, and molluscs in original scale. Especially for the decorative pattern of pottery, remarkable points are drawn with a significant concentration in order to capture the detail of specific parts.

### **Compass Line**

Morse attempted to restore the size of potteries from fragments (Fig. 34-h). He also tried to spot the location of protuberances that were already lost, by using ruler and protractor (04-02). Compass was used in the bottom part of potteries and concentric patterns in the body.

### **Depression Line**

This is a type of mark seemingly made by a sharp end of the object, such as a pencil. This line can be seen anywhere from outline to a pattern, whether it is written by hand, ruler, or compass (Fig. 34-i). Drawing lines without using pencil should reflect Kimura’s policy as an artist.

### Holes Around Edge

Holes can also be found around the edge of the paper (Fig 34-j to l). The interval varies from 0.5 to 2.0 cm depending on drawing. This should be used as an alternative to grid paper.

### Holes On Top

All the mollusc illustration by Morse have two pine holes on the top of the paper. The interval varies and this is thought to be used to fix the paper on the table. This seems to be the way Morse preferred because Kimura never left pin hole such as this.

## 2.4 DRAWING OF POTTERY (Figs. 36 to 51)

Concerning scale, approximately 86% of all drawings are 1/2. Out of 231 drawings, 11 are 1/4, 13 are original scale, and 207 are 1/2, although seven of them (01-02 to 05, 09, 11, 14) are unspecified and they are not used in "Omori". This clearly represents Morse's preference of the 1/2 scale and his attempt to record relics in a precise scientific manner.

In this report, I categorize the drawings into three categories, Unmarked-type, I-type, Gridline-type by how the baseline is drawn on the paper. Out of 231 drawings, Unmarked-type and those unclassifiable account for 25 (11%), I-type 122 (53%), and Gridline-type 84 (36%).

Unmarked-type is mostly for "complete pottery" and original scale drawings of fragments, while I-type covers all sorts of drawings and Gridline-type is primarily for the 1/2 scale of fragments. The drawing tends to have a common drawing method for each series, and work proceeded according to Morse's classification. In other words, it seems to begin with Unmarked-type, which presents the entire shape and iconic in the shell mounds, turning to I-type which covers a wider range of drawings and Gridline-type which only deals with fragments.

On the other hand, the 3 types are not always clearly segregated. A number of potteries are drawn by Gridline-type on the front and I-type on the back. Each drawing is treated independently and the whole shape is not captured in third-angle orthographic projection. Morse also saw value in debris as well as complete pottery from an early stage of his academic life. Even the cracked state was depicted in detail. In order to accurately capture features, it is essential to provide squares of regular intervals for both paper and relics. The difference in the three types is merely whether or not the necessary lines are drawn on paper in advance.

#### (1) Unmarked-Type

As is apparent in the "Popular Science Monthly" article and "Japan Day by Day", Morse had clearly identified pottery that well represented the Omori shell mounds from the beginning. These pottery were restored immediately after excavation (Fig. 35-1, 2), and the actual measurement started with such potteries which retained the whole shape. Kimura regarded the measured drawings as a complete artwork, unlike Morse. This is apparent in 03-06. In a self-sustaining state, the bridge-shaped handle is centred and is drawn symmetrically (Fig. 36). Shadows are emphasized by applying light from the centre to the lower right, and the work stands out from the other ones. Since it is 1/2 scale, it should have been easier to draw reference lines on paper, but the draft lines, as well as needle hole, cannot be seen. Such drawings are so artistic that the painter would sign on it and it is presumed that this is what Kimura regarded as a properly measured drawing. By this method, however, drawing becomes highly time-consuming, and Morse should have told Kimura to alter his method. And the character as drafting became more apparent in 03-

02 (Fig. 37). Although the centre line has not yet been drawn, shadows are weaker than 03-06 like a design drawing. The pattern of the mouth part (g) is drawn by measuring notches in millimetres (h). Information on each part from 1a to 1c is added, and they are shown in original scale.

### (2) I-Type

I-type shows vertical lines from the holes on the top to the ones at the bottom of paper drawn with a ruler. More than half of the pottery drawings were made in I-type. The lines are considerably thin that they are not recognized. Some make a hole at the top and bottom of the paper (03-03), while others draw the line only inside the pottery (Fig. 38). This can also be applied to fragments (Fig. 40). The number of lines is limited even when they are required. It seems that Kimura was still not positive about this way before he was finally forced to draw long lines in the centre of the paper. When deciding on an I-type method, papers are stacked and the holes are opened up at one time. This assumption is evidenced by the fact that there are a number of papers with an exactly same interval of holes. I-type is a scheme to draw self-supporting pottery symmetrically. 03-10 marks the scaled hole in units of 1 to 1.5 cm on the centre line (Fig. 41-f to k). This is because the actual relics were measured in units of 1 cm. In addition, by using a compass and the ruler, Morse tried to restore the missing part based on a rational assumption (Fig. 42). There are many pin holes and lines are left on the paper and this must be a sign of struggle during the work (Fig. 43-1 to 3). It is not hard to imagine how difficult it would be to capture the feelings of people of the Jomon era, who were absolutely free.

Even today, it is extremely difficult to accurately estimate the lateral shape of pottery from its fragments. Depending on the degree of inclination of pottery, the shape of the whole differs significantly. Morse attempted to identify subtle inclination by using ruler and needle from the centre line, but he had to make some corrections from time to time (Fig. 44-1 to 4). Fragments were drawn in multiple angles, but the placement is not constant, and the drawing is made for each face.

### (3) Gridline-Type

Gridline-type is a method specific to fragments to be laid flat on paper, not for a complete pottery. There are original, 1/2, 1/4 scale in I-type, but only 1/2 in Gridline-type. Small fragments, which are difficult to be drawn in either Unmarked-type or I-type were finally placed in the record by the Gridline-type method.

Gridline-type is an evolution of I-type. The vertical line is drawn in the centre and pottery is placed so as to straddle the line. Unlike complete pottery, however, there is no way to divide fragment symmetrically and determine remarkable points. This necessitates a new sort of gridline that covers the entire shape of the fragments. Most of the compartments are 2.0 cm or 2.5 cm, but they range widely from a minimum of 1.4 cm to a maximum of 6.1 cm (Fig. 46). It seems that Morse tried to measure the original scale drawings in the unit of 1 cm and 1/2 in 5 mm, but there are some variations by several millimetres. Morse apparently tried to adjust the size of square to fit all sorts of fragments different in size and shape. The squares (usually four) covers most of the shape (Fig. 47), but even the areas that did not fit inside the grid are thought to be measured by grids in order to precisely scale down the fragments as a whole. Same can be said for patterns, where in some part there are dense remarkable points while in another part no such points are seen, yet all these patterns are measured by using the grid.

Even when three faces are illustrated in one drawing, only one side is drawn Gridline-type. The other sides are placed on the centre line and drawn in I-type. Each side is drawn independently. 13-03 draws the top with Gridline-type and the bottom back in I-type (Fig. 48).



However, its contour (b) has small needle holes (e), which coincides with the contour of the front. This may indicate that the shape of back copies that of the front. This example should be considered rare and it is customary to draw each drawing independently.

#### (4) Review and Modification

Even under the limitation of time, Morse did not compromise, and often ordered to redo drawings that did not meet his expectation, or stopped using it. Not only the scale (Fig. 49) but also the expression of the pattern (Fig. 50) and the position (Fig. 51-5) are also checked and remeasured wherever necessary. Instructions were given not only to Kimura but also to lithographers (Fig. 51-6). In this case, the bottom position under 07-03 was moved to the left and draw the broken line (Fig. 51-f) to match the figure above. In addition, in order to rotate the bottom slightly to the right, a continuous needle hole (h) was made. These corrections are reflected in "Omori".

## 2.5 TABLETS, IMPLEMENTS OF HORN AND BONE, AND IMPLEMENTS OF STONE

### (1) Tablets

Compared to 1/2 scale pottery drawings, it is not too difficult to draw simple earth plate or bone and horn implements in the original scale. Therefore, none of such drawings has a centre line, and the remarkable points are hardly seen. Depression line can be found and this indicates that such drawings are regarded as artworks as we discussed before. Both paper types A and B are used for one plate. The patterns on both sides of the plate tend to be similar, and it is difficult to choose which one to use when drawing only one side. In the first place, FRONT was drawn on the paper type A and later BACK was added and paper type B was used alternatively when type A was running out.

### (2) Implements of Horn and Bone

Multiple small objects are drawn on one sheet. Few remarkable points can be confirmed unlike usual original scale drawing, and the contour line tends to be drawn slightly inside the holes. It is thought that the object is fixed at the position of the needle hole and the outer rim was traced.

### (3) Implements of Stone

Similarly to implements of horn and bone, there are few needle holes that can be recognised for stone implements. Some are almost invisible, such as in 18-06. In 18-05 and 09, there are thin lines tracing the edge. In 18-02 it emphasizes the border that broke away like saw tooth (Fig. 52-a). Morse thought that these were caused by use and called it hammers (Morse 1879: PLATE XVII). In 18-04, 05, 08, 09, 10, the fracture surface is extracted. It is Morse's remarkable work in the history of stone tools research to illustrate the specific state of breakage. 18-10 is thick, and there is sign of attempts to pierce the needle many times to trace its shape on paper vert (Fig. 52-b to e).

### (4) Mollusc

In "Omori", Morse took the most pages for the item of "A COMPARISON BETWEEN

THE ANCIENT AND MODERN MOLLUSCAN FAUN OF OMORI" (Morse 1879: pp. 23~36). There are nine drawings of 9 species in original scale, but not all species are drawn. Some species are only stated in explanation or mathematical figures, but not in drawings.

Only shellfishes are drawn by Morse himself, and PLATE XVIII is the only copperplate. Morse drew shellfish with lines and it seems that the copperplate is more suitable than lithograph, which is an expression of shadows with particles. Gengendo could do both.

Eight out of nine items use C paper, while only the one for *Arca inflata* Reeve (19-06) uses large B paper. All the papers have large holes in the upper part (Fig. 53). These holes are not found in Kimura's drawing. It seems that Morse stuck the needle in this position during work, and fixed the paper on the desk.

Morse discovered that the shellfish of same species differed in size and proportions between the ones from Omori shell mounds (the old) and the ones newly collected around Omori area (the new). For Morse, it was a key objective to describe such difference between the new and old. For that reason, each drawing shows both the new and old side by side. The seven bivalve clams shown are all left-hand shells, and two conch snails are right-handed. Bivalve shells from 19-02 to 04 show the old on the left and the new on the right as shown in "Omori" paper.

When they are measured, shellfishes that are close to average size are chosen. Remarkable points made by pencil (b) remain on both the left and right of the shell apex and the outer edge (Fig 54- a). Drafting lines were drawn down only thinly with a pencil inside lines drawn between remarkable points, and then it is inked with a pen. This is because the shape drawn by simply connecting remarkable points become slightly larger than the original shape of the object. 19-05, 07, 08 overlays the outer rim of the new and old and compare them. Dotted lines are for the ones from shell mounds, while solid lines for current species. The reason behind comparing this way is uncertain: the objects might be too big to place side by side, or he might be running out of time.

*Arca inflata* Reeve (19-06) applies a different way of drawing. It arranges the new and old face-to-face and draws them both from the side and the hinge area. Therefore, this B paper is larger than others. The side view on the left draw saw-tooth like the line for ventral line and furrow lines that extend to the hinge with shadow (Fig. 55-a). Furrow lines look to be drawn precisely by using pin holes and divider (c). The hinge view on the right is fairly simplified without shadow in contrast to the side view on the left in order to show the exact number of ribs of the original species (b). Morse also measured the thickness and recorded remarkable features (e, d), marked pin holes in detail (f), and used different symbols for different features (g, h, i). Despite all the efforts, however, the final drawing was as simple as an outline of one side with the mark "5" with a pen.

What is unique about the mollusc drawings is that Morse drew one shell of bivalve (e.g. left shell) first and trace it from the other side of the paper to draw the other shell (e.g. right) such as in 19-02b, 04b, 05b, 07b, 08b. PLATE XVIII in "Omori" indicates that Morse was remarkably sensitive to the method of drawing and its layout. He made sure that his work was presented appropriately to convey his interpretation precisely.

The difference between old and new snails is described that "it may be recognized as a marked variety" (Morse 1879: p.33). Yet the shape is not as simple as bivalves. The difference between the old and new is identified through ten standard lines that enable to match each part of the new and old (19-09, 10). For 19-10 only the sign "recent" and "mound" is written on the left and right respectively. The drawings seem to be wrongly placed in the first place and they are corrected in "Omori" as instructed.

## Conclusion

Edward Sylvester Morse developed high quality measured drawings for the artifacts excavated from the Omori shell mounds of the later Jomon period. The University of Tokyo has cherished and preserved the original illustrations carefully for 140 years. Of the 269 measured drawings, Morse himself drew the molluscs. Yet the others were drawn by a Japanese artist named Seizan Kimura. The entire collection has never been introduced until very recently. My attempt is to analyze the original drawings using the digital imagery created by The University Museum, The University of Tokyo.

Morse primarily drew pottery with a scale of 1/2, and so instructed Kimura. Kimura tried various methods to create a scale map accurately. In the original drawings, there were a number of signs and marks of such trial remains, such as rulers and compass drawn lines and many needle holes. My analysis concludes that there was a striking difference between Morse aiming at scientific actually measured drawings and Kimura sticking to his artistic expressions.

In many of the original drawings, pin holes are left used for drawing reference lines. Depending on the presence or absence of this reference line, I categorized the drawings into three types: Unmarked-type, I-type, and Gridline-type. Morse's work apparently started from the Unmarked-type for complete pottery representative of the Omori shell mounds, then did some trial and error with the I-type for various sorts of earthenware, and finally ended with the Gridline-type exclusively for fragments. However, it also became clear that the needle holes remained at regular intervals on the original drawings of the earthenware even if there is no visible line, proving it was drawn using 1 cm squares. It was a mystery that similar earthenware was drawn in different ways as it cannot be explained from a practical point of view. Although the original drawings are merely a draft for lithographic printing, Kimura regarded them equally as artistic work. So in the first series, he tried not to leave lines on the paper, but gradually began to follow the typical drafting process and it became necessary to prepare the standard lines on paper in advance. The lines are extremely thin and very hard to identify. Making a hole with a needle at remarkable points is also an attempt not to leave a trace of a pencil. The original drawings of Omori shell mounds are a truly collaborative work of Morse, who wanted to make precise scientific records, and Kimura, who kept pride in his work as an artist.

What Morse emphasized in mollusc drawings was the comparison between ones from the shell mound and its current species. In doing so, he was even considering whether to place the new and the old on the left or right and to use left or right shell if it is bivalve. For those with a difference in the number of ribs, Morse changed the way he measured to reflect such differences. Also, the position of the radiating rib is accurately recorded with the needle one by one in the unit of millimeters. Even more surprisingly, he would decide not to choose such a method if he judged it would not help to convey his interpretation.

Unfortunately, despite all the effort and dedication, the methods that Morse and Kimura developed were never inherited. Before the art of drawing was passed down to somebody, Morse's position at the university ended and he went back to the United States. Kimura too ceased the work that was not what he normally did. None of Morse's students majored in archaeology, and photography quickly swept out the measured drawings. This, however, will never diminish the value of their work. Despite his short stay, Morse paid close attention to even the smallest fragments that even today can easily be ignored, and devoted the efforts to convey scientific facts. In addition, at that time in Japan, an excellent level of knowledge and techniques had already been developed, which was essential in completing his aspiration with the "Omori" memoir, and which Morse praised lavishly. Nowadays, such measurement drawings are done through the desktop monitor. Yet the work of Morse and Kimura tells us how the material should be observed and recorded.