

## **Muromachi Period Iron Tsuba & Armor – Similarities in Material, Function and Manufacture**

Early iron tsuba and armor share material as well as functional affinities. Quality of metal, forging techniques, carbon content and presence of impurities are considerations pertinent to both groups. Ultimately, both tsuba and armors were created to endure battle conditions and protect the user from grave injury. In this context, it would follow that one should be able to analyse the product from contemporaneous tsubako and katchushi, and be able to make informed comparisons of technique, material and possibly even age and place of manufacture.

Early iron tsuba evoke an emotional response which later (Edo Period) iron tsuba fail to elicit. The limited decorative features of these tsuba had to capture the desperate yet hopeful mood of turbulent times, therefore, these tsuba tend to have a subtle elegance yet deeply expressive quality. Such early tsuba were utilitarian items, designed for potential use on the battlefield, and thus it is reasonable to assume that their owners placed demands on the tsubako to produce a quality product.

When reviewing Muromachi armors, it is also generally perceived that these early pieces reflect a quality of manufacture not rivaled by Edo period examples. The iron quality, construction techniques, and aesthetic all seem to lose purpose and functionality, to be replaced by emphasis on artistic qualities and consumer appeal during the Edo period.

This article attempts to present some key material and manufacturing elements which are common to Muromachi iron tsuba and armor, as well as provide an explanation of why they contributed to the functionality of the items.

### **Material Considerations in Muromachi Tsuba**

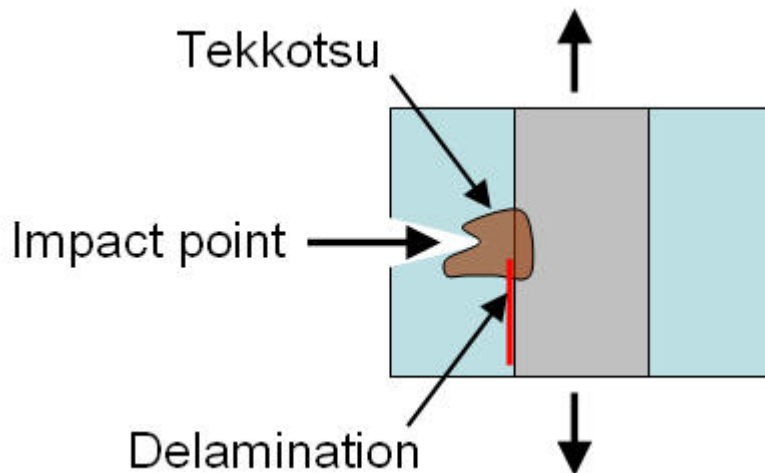
Perhaps the two most important and characteristic, and yet most poorly understood aspects of early tsuba manufacturing techniques are 1) folding of the metal and 2) heterogeneous carbon distribution. As collectors we look for these features respectively manifested as fold or weld lines and various forms of *tekkotsu* (iron bones). We attribute these features to increased age and quality of tsuba, but usually fail to understand why.

From a mechanical perspective, both folding and carbon distribution alter the stress behavior of the iron tsuba in ways which increase resistance to impact. Folding iron greatly increases resistance to ballistic and notch-impacts, by dissipating the impact energy from effectively a point or line source, to a greater surface area provided through successive planes of laminated material that tend to shear or delaminate rather than fracture.



Modern materials testing illustrates the principle of stress dissipation in a laminated compound subjected to high velocity impact. (Wadsworth, J and Lesuer, D.R., 2000)

*Tekkotsu* may be defined as segregated areas of high carbon content, formed as a result of a process of successive episodes of heating, folding and hammering of an iron plate. Generally speaking, increasing the carbon content in iron, results in decreased ductility. Thus, a localized area of high carbon content (*tekkotsu*) effectively forms a localized hard spot. These localized areas of decreased ductility tend to interfere with crack propagation by deflecting or blunting the crack.



Crack propagation is deflected when intersecting an area of reduced ductility such as *tekkotsu*. Often the crack is redirected to form a localized delamination (modified from Wadsworth, J and Lesuer, D.R., 2000).

The combination of the laminated plate of a *tsuba*, with heterogeneous carbon is thus a very effective crack arrestor. Evidence of this is seen in the thinness of the earliest iron *tsuba*. Perhaps the tendency to thicken the rim and/or plate of a *tsuba* toward the end of

the Muromachi period is attributable to attempts to find balance between tsuba integrity and the call for increasing amounts of artistic design elements via sukashi in a tsuba meant for the battle field.

Another consideration in understanding early iron tsuba is material of manufacture – is the tsuba composed of high carbon steel or iron, and what are the implications of this distinction? Kremers (1994) briefly addressed the question of steel vs. iron, pointing out the main problems as being the difficulty in distinguishing between the materials in an old tsuba, and in identifying the possible source of the materials employed in the manufacture.

The high degree of variance among Muromachi tsuba suggests that a potentially large number of independent artists scattered throughout the country were responsible for production. Iron ore extraction in Japan was uncentralized and resource constrained. Old records indicate that a number of ore deposits were exhausted at various times during the Muromachi, and resource replacement was a constant issue, especially during times of civil war when the demand for iron surged. This would suggest that iron qualities varied regionally as well as through time. By extension it is reasonable to assume that iron workers across Japan had to purchase raw materials from common sources, and as Kremers and others have suggested, that they may have been instrumental in avoiding wastage by re-using scrap materials.

The implications are that some tsuba were made as secondary products of early sword manufacturing shops, while others were made as secondary items by some armor manufacturers. As usual, modern nomenclature too easily sways us into potentially erroneous associations. The term kokatchushi tsuba was applied first to early iron tsuba whose sukashi motifs, robust mimi and iron character reminded people of some late Muromachi mempo and hachi. The term kotosho was based on observations by some scholars of metal similarities between certain early iron tsuba and the metal of sword tangs. Both terms are thus based on empirical, somewhat subjective observations, and yet they have been broadly incorporated, and likely over-used.

If, despite their origins, these terms are reflective of manufacture, then kotosho tsuba should be made of highly refined iron or steel that was likely folded, and associated with blade manufacture. Kokatchushi tsuba would then be made from scrap metal used in the production of armor, which may have been folded, but generally more iron-like in feeling and appearance.

I think the safe and most reasonable approach is to recognize the tremendous variety in early iron tsuba, and that many groups or independent producers utilizing a wide range of methods were actively engaged in their production, and often cross-pollinated each other with materials and ideas. This cross-pollination may well have come from groups involved in the production of armor or swords, but the actual physical or documented evidence of such an association is non-existent.

The same mechanical reasons for folding tsuba would apply to folding the plates of armor. Further, we can only assume that the functional advantages given to tsuba by tekkotsu would also have been applicable to armor.



Kotosho tsuba (late Muromachi) showing a distinctive sinuous fold line (see arrows) starting in the upper left corner of the nakago-ana and ending on the upper left edge. This is clearly not a crack, as it meanders smoothly across the plate, then dips around the edge. The metal is very dense and hard – likely steel.

### **Material Considerations in Muromachi Armor**

Today, the best means of analyzing katchushi forging techniques comes from the study of unlacquered kabuto, and more specifically the hachi (helmet bowl), as well as some mempo (face protectors). One of the most striking aspects of Muromachi hachi is the thinness and density of the constituent iron plates. Typically they are less than 2mm thick. Although it is not often readily apparent, the iron in many Muromachi hachi was typically folded. On hachi and occasionally mempo which have had their lacquer removed, we can find areas of visible lamination – typically the edges of the koshimaki (shikoro attachment plate), the mabizashi (visor) and in the suji (ridges) of sujikabuto. The reason we don't often see the folding on the surface of the plates is the tendency of katchushi to file the surface in preparation for the application of lacquer.



This mempo (face armor) dates to the Momoyama period. It was likely made in Western Japan by a Haruta school smith. It is thin, light weight and the steel is very hard with a high carbon content.



Evidence of folding is evident throughout this piece. Lacquer would have covered it originally. Later “art” mempo in the Edo era were made out of softer thicker steel that would have had fewer visible lamination separations, or more likely, no laminations at all.

Tekkotsu if present, were often filed down to facilitate lacquer application. The mabizashi of some Myouchin kabuto do show what appears to be granular tekkotsu. Since tekkotsu appear in the mabizashi, they are likely also present in the hachi plates, and thus could also have added to the energy absorptive qualities of the metal.



Close-up of the mabizashi of a Myochin kabuto dating to ca. 1530. Note the dense, uniform appearance of the metal, as well as the numerous granular tekkotsu.

In this section we attempt to discuss differences between two important Muromachi era armor schools for the purpose of understanding how and why they produced metal and armor in the fashion that they did. Part of the understanding comes from assessing of how their products performed in battle. We have enough examples of early kabuto with serious battle scars, for us to begin to appreciate the quality of the metal and strengthening techniques used in their production, as well as the emphasis likely placed on quality control by the samurai commissioning their manufacture.

We understand that under ideal circumstances a well trained sword expert can cut a kabuto in half with a sword. The authors would like to remind the reader that opportunities as “ideal” as seen in kabuto cutting “exhibitions” would not typically manifest in battle. Therefore the best source for retrieving this data is from kabuto that have actually been scarred in battle and preserved in that condition. Such evidence is true testimony as to the effectiveness of a piece of armor since it has been subjected to, and survived the conditions it was designed to withstand. We use examples from each school that have in fact been in actual battle and received battle scars in the 16<sup>th</sup> century.

How can we be sure that such a scar was actually made in battle? There are several ways that a battle scar can be authenticated. The first and best way is by a technique often employed by archeologists called the “Law of Superposition”. This states that what is on the bottom is the oldest and what is on the top is youngest. We can apply this rule to armor because often armor has been altered over time. Ways in which an armor may be altered may include metal repair, metal alteration, and lacquer application. From looking at a particular kabuto such as the haruta kabuto mentioned below, we can see that when the brown lacquer was applied it was done in such a way to hide the dent made from a sword blow in battle. The kabuto hachi dates to the late Muromachi era, however the brown lacquer and metal alterations date to the Momoyama-Early Edo period. Another point to look for in the authenticity of a battle scar is the consistency of the scar

itself. Is it consistent with an actual blow in battle conditions - could a sword make such a mark? Finally, it is highly unlikely that a previous owner would intentionally damage a kabuto for the purpose of making it look like it has been through a battle. To control a forced blow to achieve such a desired effect is not only foolish but wasteful especially if the blow is easily detectable as being fake.



This particular kabuto dates to the latter 1500s and has undergone multiple reparations which are described below...



Battle Damage. Notice the two sword blows that created straight dents in the hachi from the front to the back. The quality and design of this kabuto, as well as the way it absorbed the blow is indicative of the Haruta school.



Patching to repair battle damage. The patches were applied with rivets. The difference in patina is evident and the texture of the steel appears to be different.



And finally lacquer work to cover the damage. The lacquer was one millimeter thicker on this side to make the kabuto appear proportionate and hide the deformity caused by the damage and repair. Notice the faux plate line in the lacquer.

The two dominant katchushi groups operating in the Muromachi were the Haruta and Myochin. Observation of the metal employed in the manufacture of hachi of these groups show some striking differences. The Haruta are credited with the introduction and propagation of the akoda nari form of hachi beginning from the early to mid Muromachi. One outstanding attribute of Haruta hachi dating to the Muromachi period is that they are composed of very thin dense plates (~1.5mm) that tend to patinate to a uniform grey-brown color with little or no rust, which is usually bright red/orange if it exists.

Battle scars on Haruta hachi tend to be broad dents centered on shallow cut marks (in the case of sword contact), indicating that the metal's tensile qualities acted to distribute energy radially away from the impact point. We can't comment at this point on the character of an arrow impact, as no surviving hachi with this form of damage are known to us. However, based on the current evidence, depending on the point of impact it would be likely that an arrow would either penetrate completely or bounce off leaving a dent similar to that left by a sword. Clear indications of folding are extremely rare in

Haruta kabuto. It is possible that some Haruta kabuto are either not folded, or are folded to such a degree that individual laminations are not apparent. It is clear however that the metal is very dense and hard, suggesting a high-carbon steel. One might even compare the tensile qualities of Haruta hachi to that of stainless steel.

In addition to using steel with a very high tensile strength, Haruta kabuto utilize another variable for added protection in the shape of the akoda nari itself. True Muromachi period Haruta akoda nari kabuto appear bulbous in shape. This shape is not just due to numerous flat pieces of steel joined into a bowl, but rather due to each plate being individually curved to form the desired hachi shape once assembled. This construction demanded that both the strength and quality of steel, as well as the curvature of the plate be sufficient to absorb impact with only formation of a dent. Haruta akoda nari kabuto of the Muromachi period tend to have comparably few plates. If suji were employed, they seem very far apart and few in number compared to the number on a Myochin Kabuto of the same period. Hence, the number of plates in a kabuto of this period does not necessarily reflect quality of construction. A 32 plate Myochin Nobuie made in 1540 may appear to be a lot of work compared to an 8 plate Haruta Mitsusada made in the same year. However, when you take into consideration that the individual plates of the Mitsusada had to be forged into high carbon folded steel, which then needed to be individually shaped to form a proportionately perfect, and difficult bulbous form, it is understandable why the Haruta akoda nari were favored for so long.



This akoda nari hachi is unsigned Haruta school, dating to the first half of the 1500s. It has the typical bulbous shape of a traditional akoda nari. The steel is light weight, high carbon with a grayish brown patina on the inside.

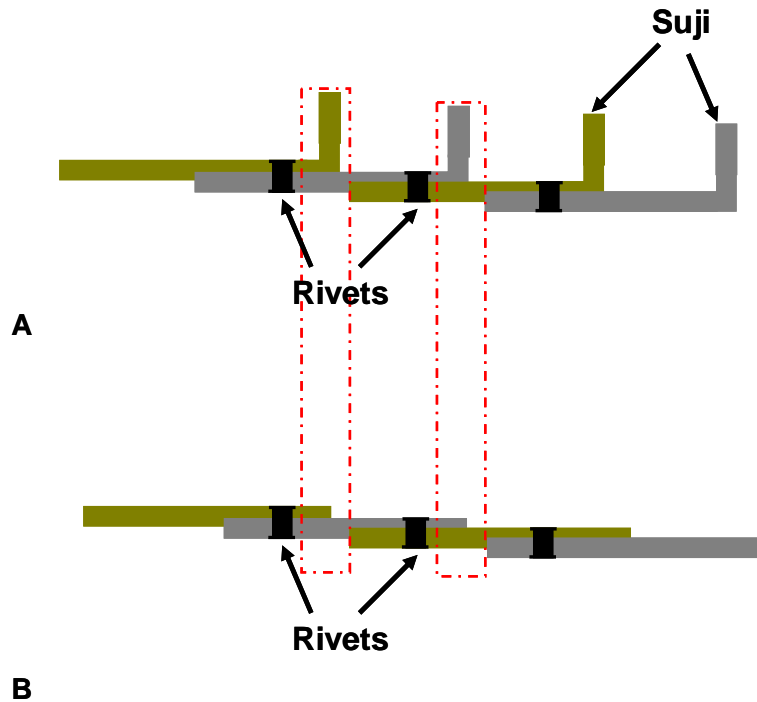


This dent crosses over two plates in this Muromachi era Haruta akoda nari kabuto. The blow was so strong that it knocked out two rivets from the plates. The blow resulted in a significant dent, but the plates were not penetrated. . The metal integrity held, however the shape had to be fixed by building it up with lacquer to make the dent unnoticeable.



From the top, no damage to the kabuto is visible. Lacquer was used to compensate for the dent inflicted by the sword blow.

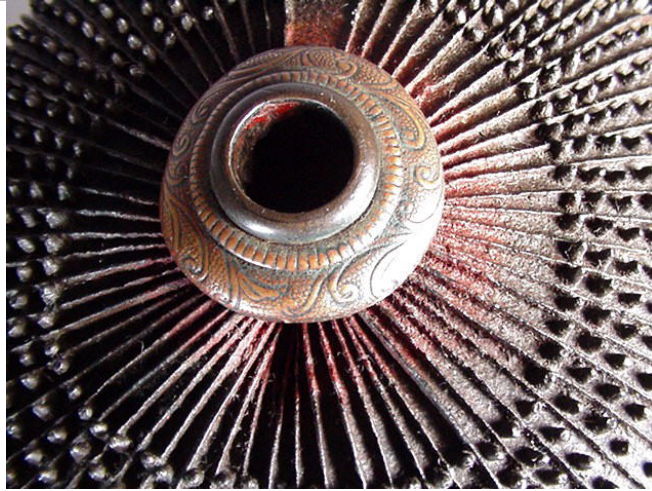
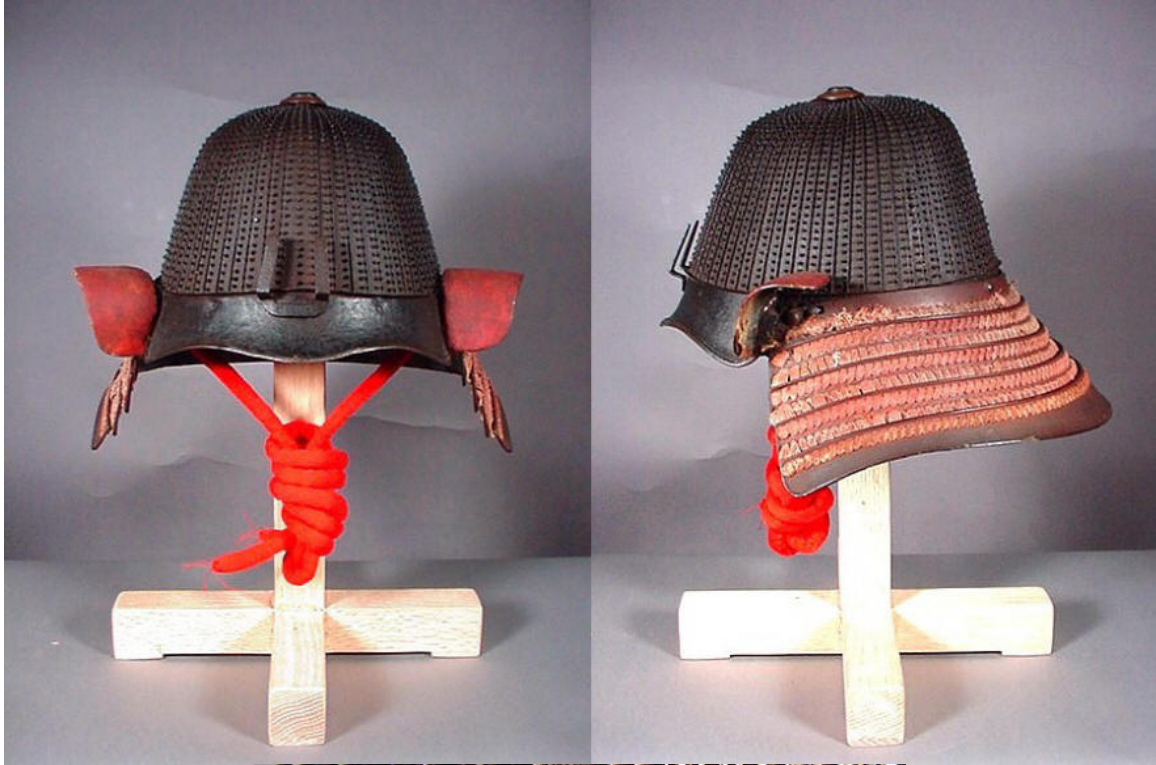
Myochin hachi on the other hand tend to take a softer russet patination, and be composed of slightly thicker plates (~2mm). The Myochin stylistic patriarch was Nobuie (active ca. 1504 – 1560). Nobuie is credited with the refinement of the suji kabuto. *Suji* are standing ridges formed by a 90deg bend in the trailing edge of each plate composing the hachi. Since the suji are located along the back edge of each plate, they occur over the area of intersection formed by adjacent plates of the hachi. Thus this design affords functionally 3 levels of protection at very closely spaced intervals.



Generalized construction of a **A**) Myochin suji-kabuto from the late Muromachi. Note that under each suji is the overlap area of the adjacent plate, thus functionally providing 3 layers of protection against impact, with the suji providing added absorption. Note also that the rivets are slightly off-center in each gap between suji's. This is intended to place the rivet closer to the most shock-absorptive area between plates (dashed red areas), thus further strengthening the area. **B**) Akoda nari of the Haruta group from the mid-Muromachi. Placement of rivets and plate overlaps is essentially the same as Myochin's, but with no suji.

The suji-kabuto became an increasingly popular hachi form, and largely supplanted the akoda-nari of the Haruta by the Momoyama period. In fact many of the later akoda nari "style" kabuto of the Momoyama and Early Edo period employed Myochin techniques of high vertical suji with flat (rather than bulbous) cross sections and increased number of plates – at the expense of steel quality and design. Therefore, the later, more common akoda kabuto maintained a traditional "bean" shape yet was easy to produce, even though they tended to have more plates on the average than their Muromachi predecessors.

Battle scars on Myochin kabuto tend to occur across one or more suji as the plates tend to be closer together. If the suji did not arrest the blow, often a significant cut-mark is seen on the hachi, but rarely with break-through. Laminations are rare, but are more readily visible than on Haruta hachi. It can be surmised that the Myochin hachi were composed of a softer iron rather than steel, and that in compensation for the decreased rigidity, the suji were designed to absorb the energy of a blow. In addition, there tend to be more rivets/unit area than Haruta kabuto. Softer steel required more rivets to keep from being deformed in a blow. Some Myochin armorers specialized in the production of hachi with up to 62 plates and over 2000 rivets. It seems that the incorrect positioning, rather than number of rivets weakened the structural integrity of this type of hachi.



Joshu Myochin suji kabuto ca. 1530's. 62 plates are joined expertly by over 1800 high standing rivets. This type of kabuto was perhaps the technical pinnacle of Muromachi Myochin expertise.



This hachi is signed Nobuie and is dated 1518. This type of hachi is typical shape and style of the Myochin smiths of late Muromachi period. In contrast to the previously mentioned Haruta kabuto, this hachi has 32 flat plates, more rivets, and is made out of a softer steel or iron with a more absorptive quality. It is also much heavier.



Battle scar across a suji (ridge) of the Nobuie Myochin hachi. Depth of the cut is approximately 4mm with some extension onto the horizontal portion of the plate, but with no penetration and the form of the plate remains intact with no deformation or denting – the suji did its job. Note the offset position of the rivets in the inter-plate gap.

In the final analysis, both the late Muromachi Haruta akoda nari and Myochin suji kabuto were effective armors that solved similar problems in very different ways. It is hard to definitively say why the Myochin suji-kabuto became increasingly favored, however, it is likely that both economics and culture played a factor. Lower grade steel or iron could be formed into a kabuto by smiths of lesser experience, likely in higher numbers. Hence during the late Muromachi when we see larger armies and more frequent engagements, economics would have driven manufacturers to lower cost, higher capacity options. The Myochin kabuto could likely be produced in greater numbers, despite generally having more plates than the Haruta akoda nari. Cultural trends likely also had a role in the demise of the akoda nari. Western Japan, where the akoda nari received most favor saw a proliferation of hachi styles in the late Muromachi through Momoyama. Eastern Japan during this period tended to favor the Myochin style suji kabuto. Ultimately the classic Haruta akoda nari was lost to history.

### **Refining the Muromachi Chronology**

Clearly there are similarities in materials, manufacturing techniques and likely even sourcing between Muromachi tsuba and armors. Despite this, these fields of study remain largely separate. Some tantalizing possibilities relating tsuba to armor production begin to surface if the right questions are asked. If tsuba were at least partially byproducts of an armor (or sword) industry, is it possible to show the distinctly

different metals and styles from Haruta and Myochin shops being utilized for tsuba? Is the iron vs. steel variance a key in determining origin of some tsuba, and if so, how about levels of folding and presence of tekkotsu?

A subgroup of kokatchushi tsuba have high perpendicular mimi's. Often the mimi is about 2 mm thick (the same thickness of the plate) and stands off each side of the plate by 4mm. The form of mimi of this subgroup is strikingly similar in shape and height to suji of Muromachi Myochin kabuto. Is this subgroup possibly the product of Myochin related tsubako?



Through the efforts of researchers such as Sasano, Kremers and Torigoye among others, a rough chronology of iron tsuba development through the Muromachi has been drafted. This chronology is rather subjective, and a great deal of interest exists in any information which may augment the existing body of work. The study of armor provides a longer timeline of signed and in some cases dated pieces. It is generally accepted the first armors were signed during the mid-Muromachi – over one century before the earliest tsuba were signed with any regularity.

We think that a scientific study focusing on the comparison of physical qualities of metals from both Muromachi tsuba and armor could yield enough concrete information to revise and link the two disparate chronologies, and help better date and categorize the early iron tsuba that are the subject of so much ongoing controversy.

## **References**

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- Kremers, E (1994). *Sukashi Tsuba in European Collections*. pgs 190.

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