Report on a Special Investigation of the Shosoin Treasures —Ivory, Horn, Antler and Bone Materials

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This Special Investigation of the Shosoin Treasures focused on the analysis of ivory, horn, antler and bone materials used in the treasures. The number of objects examined in this study was 53 items (102 pieces).

The treasures crafted from ivory included such artifacts as *shaku* (a ritual baton held by court nobles), *shaku rulers*, *sugoroku-tō* (dice), tags, combs, hilts and sheaths of penknives, *shakuhachi* flute, and transverse flutes. The cutting layout of ivory differs depending on the artifacts. The Schreger lines distinctive to ivory were utilized as decorative patterns for the "*Tsuten-geshaku*" (a ritual baton made from ivory) and the sugoroku-tō dice. Rhinoceros horn was used for *obi* sash ornaments, penknife hilts, cups, and shaku rulers. Cattle horn was mainly used as a material for penknife sheaths and weapons such as whistles attached to *kaburaya* (whistling arrows) and *Itatsuki* (unpointed arrowheads).

With regard to bone artifacts, it was found that shaku rulers were made from whale bones, and arrowheads were manufactured from Cervidae (deer family) metacarpals or metatarsals. Furthermore, bone arrowheads of similar style with the Shosoin ones have been found at archaeological sites of the Late Kofun to the Heian Era. Deer antlers were used as materials for arrows including arrowheads, Itatsuki arrowheads, and arrow notches, as well as crafting tool.

Fossils were used as medicines and known as "*Goshikiryu-shi*" (literally means multi-hued dragon tooth), "*Ryu-kotsu*" (lit. dragon bone), "*Hakuryu-kotsu*" (lit. white dragon bone), and "*Ryu-kaku*" (lit. dragon horn). Some of the fossils have never been found in the Japanese archipelago, suggesting that they were imported from abroad. In addition, the investigation found that a treasure named "reindeer antler" was actually the antler of *shifuzo* (*Elaphurus davidianus*), while another called as "ivory" was identified as a rib of a large whale. The investigation also looked into the identification of mummified animal named "*Koryu*" (lit. rainbow dragon) and "*Jusoku*" (lit. beast foot).

3D Measurement Conducted as Part of the Special Investigation of the Shosoin Treasures —Ivory, Horn, Antler and Bone Materials

Hiroshi Yamaguchi

As part of the special investigation of the Shosoin Treasures—Ivory, Horn, Antler and Bone Materials, a non-contact 3D measurement using a Structure-from-Motion and Multi-View Stereo photogrammetry was conducted. 27 objects among those objects included in the special investigation were selected for the photogrammetry, and their 3D form was digitally documented. Consequently, detailed 3D models of these objects were successfully created. These 3D models can be observed in the digital space by zooming in and out, and rotating freely. In addition, these 3D models enabled us to obtain a range of measurements and measured drawings such as developed and sectional views. With these results, we were able to accurately record the shape of the treasures, and to comprehensively compare them with those relevant artifacts excavated from other sites. Furthermore, the 3D models as well as other data obtained through this project will contribute to further detailed studies and utilization in the future.

Radiocarbon dating of the *Kōryū* (remains of *Martes melampus*)

Minoru Yoneda

The three tissue fragments that had dropped from the *Kōryū* (remains of *Martes melampus*) over time were measured for their radiocarbon dates. After undergoing acid, alkali and acid treatment as a preparation process, the fragments were analysed using an accelerator mass spectrometer (AMS) at the University of Tokyo. The conventional radiocarbon ages were 940±20 BP, 979±20 BP and 941±27 BP. The three results can be treated statistically as dated values derived from the same material, so the three tissue fragments analyzed in this study originate from the *Kōryū*. These results are considered to be reliable with little influence from contamination or other factors. A calendar year calibration, which corrects for variations in atmospheric radiocarbon concentrations and half-lives, was carried out on the weighted average of the three dates of 956±13 BP, which was estimated more accurately to be between the middle of the 11th century to the middle of the 12th century. This estimated date is consistent with the oldest record relating to the *Kōryū* from the second half of the 14th century to the first half of the 15th century. However, it is thought to be unlikely that the Kōryū dates from the Nara Era, the origin of many of the Shosoin treasures.

Conservation Treatment of *Shō* Bamboo Panpipes: Application of Enzymes to Undo the Restoration from the Meiji Era

Rikiya Nakamura and Daisuke Nagata

Kanchiku-shō (South Section 112) is an ancient bamboo panpipes, preserved in the Shosoin and was originally Emperor Shomu's personal belongings. Due to its aging, the adhesive between the bamboo pipes had degraded and the attached wood bands had been lost. The panpipes was restored in the Meiji era (late 19th century), during which several bamboo pipes and leather straps to bind the pipes were newly prepared, and the new and original materials were adhered together to form a 12-pipe panpipes. Then in 1965, the missing original wood band was found, confirming that the Kanchiku−shō was originally not a 12-pipe panpipes, but an 18-pipe panpipes.

This paper reports about a conservation treatment on the Kanchiku-shō undertaken between 2016 and 2023, aiming to restore the original construction and appearance. Trypsin, a proteolytic enzyme, was used to detach the added pipes during the Meiji era. Incidentally, it was the first time at the Shosoin to use an enzyme in conservation treatment of the treasures. Therefore, we tested and confirmed the safety of the enzymatic reaction by testing on mock-ups of the bamboo pipes. To remove the leather straps from the Meiji era, a mixture of desionized water and acetonitrile (1:3 v/v) was used. All the components from the Meiji era were successfully detatched. Insect holes in the original bamboo pipes were stabilized by using fillers such as *kokuso-urushi* (wood powder mixed with urushi) and polyvinylidene-chloride filler, as well as animal glue. Since the original adhesive has weakened, we decided not to re-adhere the separated bamboo pipes all together. Instead, we prepared a paulownia wood mount carved and indented in the shape of the 18-pipe panpipes, and placed the pipes on it so as to recreate its original appearance.