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## Japanese tissue paper and its uses in osteological conservation



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### Abstract

Various grades, weights and types of traditionally hand-made Japanese tissue have been used in the conservation of paper, manuscripts and books for hundreds of years and have also been used in the repair of ethnographic and taxidermy specimens in museums more recently. However, not much has been published about the use of this material in the conservation of osteological specimens even though it has several applications. For example when used in the repair of breaks in bone with an appropriate conservation adhesive it can help to add greater strength to the join than adhesive alone, especially where bone is thin. It can also be used as a gap-filling medium, for modelling-in areas of missing bone in a break and to provide long term support for fragile but important labels removed from specimens. Adhesives that have been used successfully with Japanese tissue paper in the conservation of natural history specimens include ParaloidB72, polyvinyl alcohol and neutral pH PVA adhesive, all of which are reversible.

**Keywords:** Japanese; Tissue; Paper; Osteology; Conservation; Repair; Gap-filler

### Introduction

Japanese tissue is handmade with traditional techniques using natural fibres found in the bark of the gampi tree (*Diplomorpha sikokiana*), mitsumata shrub (*Edgeworthia chrysantha*, also known as the oriental paper bush) and the kozo plant (*Broussonetia kazinoki*). The latter is a type of mulberry tree and whilst other varieties of mulberry tree yield bark also suitable for making paper, this variety (*kazinoki*) is considered to produce the best results. The bark fibres of these three plants are exceptionally long and strong which gives the thin tissue its characteristic strength. Tissues of varying grades and weights can be made by choosing the appropriate plant fibres and slightly altering the manufacturing process. The handmade papers are very pure, are acid free, do not degrade easily and they reputedly have a strong resistance to insects (McBride, 2009). The history and process of their manufacture is well documented (e.g. Narita 1980; Fukuda 2015; Moore 2007) but there is now a complicating issue of inferior products being made elsewhere such as Thailand and Indonesia but still being sold as 'Japanese Tissue' (Moore, 2007).

The traditional process of turning the bark fibres into large sheets of tissue deliberately aims to make a strong, thin and flexible paper suitable for repairing tears and filling-in gaps when conserving paper, books, manuscripts and paper-based art objects but it is also suitable for aiding in the conservation of leather, parchment and cloth (Fukuda, 2014). As such, Japanese tissue in its various grades, weights and types has been used for conserving objects for hundreds of years. As it is a very versatile material its use has spread to the conservation of ethnographic specimens in museums - principally for backing and facing materials and filling gaps (e.g. Kaminitz & Levinson 1989) - and also for the conservation of taxidermy specimens, giving support and filling gaps during the repair of fur, feather and skin and the repair of entomological collections (Moore, 2007).

However, not much has been published about the use of Japanese tissue in the conservation of osteological specimens even though it has several applications. For example when used in the repair of breaks in bone with an appropriate conservation adhesive it can help to add greater strength to the join than adhesive alone. It can also be used as a gap-filling medium, for modelling-in small areas of missing bone and for backing fragile but important labels removed from specimens to provide long term support.

Traditional adhesives used with the tissue in Japan are derived from plants (such as wheat starch) and seaweeds and wheat starch is still used in paper conservation in the UK. However, the tissues can be used with many modern reversible conservation adhesives including neutral pH PVA adhesive, polyvinyl alcohol and ParaloidB72 (the latter at 10 to 50% in ethanol or acetone solutions). A strip of tissue of an appropriate size for the task in hand is taken from the main sheet by wetting the paper along the line to be torn and then tearing the strip away slowly. This is to ensure the edges are 'feathered' so that the tissue fibres will have a firmer hold on the specimen and will have an almost invisible edge when the adhesive dries.

Heavier weighted tissues make for stronger repairs but need to be well moistened with the adhesive. It is best to apply the adhesive to the tissue, then move the tissue to the specimen, especially when making a gap fill by folding the tissue in on to itself. It can also be pulped with an adhesive and applied with a small spatula. When dry it can be trimmed with a scalpel or lightly filed or sanded.

**Example projects involving the use of Japanese tissue in the conservation of osteological material**  
**Repairing a broken orangutan skull for the Grant Museum of Zoology, University College London**

This orangutan skeleton (*Pongo pygmaeus* [Linnaeus, 1760], Grant Museum specimen num-

ber Z409) required some adjustments to its mount but the main issue was with the skull. The rear of the skull had been badly broken in the past (Figs 1 & 2) and although the bone fragments had been wired together, many pieces were still loose and moved against one another and one large piece was completely detached.

The thin wires used to hold pieces together protruded from the surface (Fig 2) and were unsightly as well as a health and safety issue (they could puncture skin if the skull was picked up incorrectly or poorly handled). A couple of these twisted wires had actually snapped, which is one reason why some of the pieces of bone moved against one another. Also, the skull was attached to the rest of skeleton simply by being placed on the end of the rod that ran through the vertebrae and inserted into the skull through the occipital foramen, from which the skull dangled precariously. This meant that the weight of the skull was taken by the broken pieces of the skull that were loosely wired together, inviting further damage.

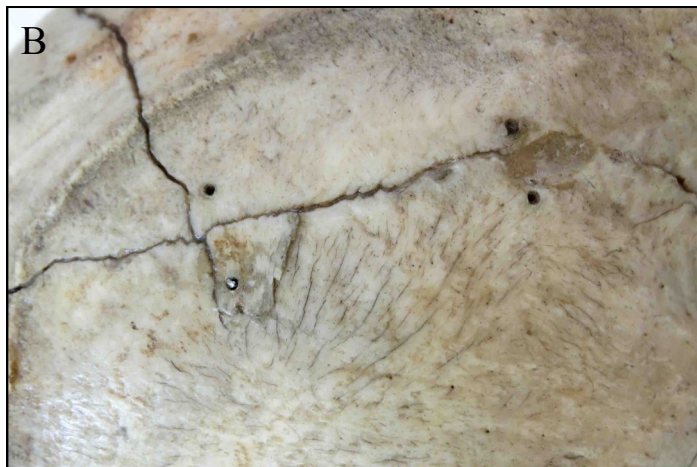
The skull was repaired with Gampi Japanese tissue paper and neutral pH adhesive, applying it within the breaks where there had been some bone loss and also applying it to the inside of the skull across the joins in small sheets while the bone fragments were held in place. Gaps between pieces of skull where fragments were missing were filled with the Japanese tissue and adhesive and when this dried it did not need to be painted out as it was a similar colour to the bone (Fig 3). Significant gaps were filled in this way. This made the skull so robust that the unsightly twisted wires could be removed in the areas that had been repaired (Fig 3), reducing the health and safety issue. The right side of the mandible had also been damaged in the past and some of the old gap filler had disintegrated so where appropriate these gaps were filled with Japanese tissue paper soaked in adhesive, to strengthen the mandible.



**Fig. 1.** The skull of the orangutan from the UCL Grant Museum of Zoology (specimen no. Z409) before conservation commenced, showing the large hole and some sections of bone wired together.



**Fig. 2.** Close up of the same orangutan skull as in Figure 1 showing pieces of bone wired together in two places, with some gaps along the joints surrounded by old adhesive showing where fragments have been lost.



**Fig. 3.** A. The same area as shown in Figure 2 (from a slightly different angle) after the bone fragments have been realigned and glued with Gampi Japanese tissue and adhesive, the gaps filled with Gampi Japanese tissue and adhesive and the wires removed. There were several such areas glued and gap-filled around the skull; B. Detail.

**Gap-filling and modelling to join two pieces of a skull of a heavy-footed moa for Leeds Museums and Galleries.**

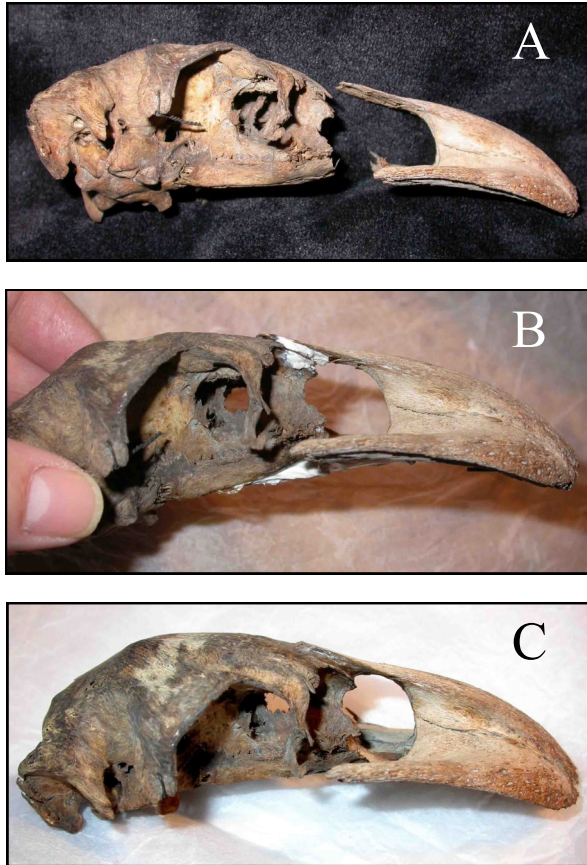
This moa skeleton (*Pachyornis elephantopus* [Owen, 1856], specimen number LEEDM.C.1868.6) required thorough cleaning, remounting and extensive conservation. Japanese tissue was only used in the conservation of the skull which was in two pieces (Fig 4A) without any clear join. After cleaning (with Synperonic A7) the two portions of the skull were attached together using Gampi Japanese tissue with neutral pH PVA and one small short wooden skewer embedded within the tissue for extra support. When the adhesive had set, the missing areas of bone were modelled-in using the same tissue and adhesive (Fig 4B) and a scalpel. When this had set, the tissue was painted with artists acrylic paints to blend in with the dark bones (Fig 4C). The mandible was partially broken at the symphysis and this was repaired with Paraloid B72 and gap-filled with a small amount of the same tissue and Paraloid B72 adhesive to ensure a good bond before the mandible was wired back on to the skull.

**Repairing a tortoise carapace for the Grant Museum of Zoology, University College London**

This tortoise specimen (Fig 5, Grant Museum specimen number X1369) required cleaning (including removing red nail varnish from its claws!), a perma-

nent plinth made to reduce overhandling and whilst some pieces of the 'shell' of the carapace and plastron were missing some remaining pieces were loose and had to be glued down. More significantly, there was a large crack running right through the bone of the carapace on the front right along a suture, adjacent to where a large piece of the edge of the carapace had become detached (Fig 6). This crack needed to be closed and the edges adhered together so that the detached piece of bone could be re-joined.

Unfortunately the crack was quite old and the edges had moved quite far away from one another over the years (maybe responding to changes in RH). Some pressure was applied to the pieces of the carapace to get the gap between them to close, but a long thin gap was still left between the two edges within which an adhesive on its own would do almost nothing. Similarly, any gap filler placed between the two edges would almost certainly have simply fallen out once dry. The best way to repair this crack and to re-adhere the detached piece of bone (which now would not fit back perfectly either) was to glue Japanese tissue paper to the rear



**Fig. 4.** The skull of the heavy-footed moa from Leeds Galleries and Museums (specimen number LEEDM. C.1868.6): A. the two portions of the skull before re-joining; B. after joining the pieces of the skull with Gampi Japanese tissue paper and neutral pH adhesive (the tissue is the white material underneath and on top of the skull, in the middle); C. after the Japanese tissue had been painted out.

(internal) sides of the bones across the joins so that it bridged the gaps and stuck to the bone on either side, holding the bones in place. To do this several small sheets of Gampi tissue were applied across each of the joins with neutral pH adhesive. By having a much larger surface area of bone (i.e. either side of the gaps) employed in keeping the bones in place with adhesive and tissue rather than just adhesive within the cracks, this made for a much more robust repair of this specimen. This is important as the specimen is in a University museum collection and is used for teaching so it moved and handled regularly. Whilst a gap can still be seen between the pieces of bone (Fig 7), the sheets of tissue are transparent and almost invisible, even on the inside (Fig 8).

#### **Rebuilding a large broken *Aepyornis* egg**

This large ancient *Aepyornis* egg, consisting of over 120 fragments from more than one original shell, had undergone collapse and many pieces were separated (Fig 9). It was previously held together with photocopy paper and old brown parcel paper glued to the inside of the shell. These materials were removed and the egg fragments were cleaned (using conservation erasers) and the specimen completely rebuilt (Fig 10). The pieces were backed internally with Gampi Japanese tissue and neutral pH PVA adhesive, adhering the small sheets across the joins. The pieces needed to be stuck back together with reversible conservation materials and techniques not just because this is best practice but because this would enable the egg to be dismantled and put back together again, or at least adjusted, during the painstaking rebuilding process as corrections were required to the three dimensional shape in the later stages. Japanese tissue and neutral pH PVA adhesive can be reversed by softening it with a small amount of warm water. To keep the shape and provide additional structural support thin wooden skewers were glued into position across the width of the shell with the Gampi tissue and adhesive. Some small gaps were filled with the tissue and adhesive but larger gaps were backed using tissue and then filled with plas-



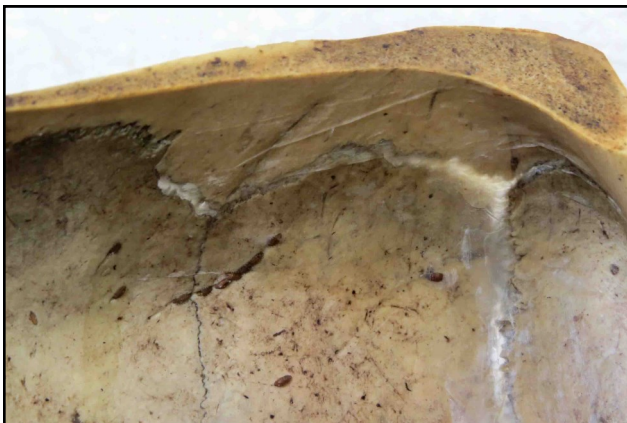
**Fig. 5.** The Grant Museum of Zoology tortoise (no. X1369) after cleaning and conservation, on its new plinth.



**Fig. 6.** The area of the tortoise carapace (no. X1369) requiring repair: The detached piece held roughly in place, with the crack in the carapace just visible in the bottom left, below the thumb.



**Fig. 7.** The joins in the tortoise carapace repaired with Gampi Japanese tissue paper: external view with gaps still evident.



**Fig. 8.** The joins in the tortoise carapace repaired with Gampi Japanese tissue paper: internal view with gaps still evident and the tissue shown adhering to the bone either side of the gaps but quite transparent and almost invisible.

ter of paris. In retrospect, and now with more experience with the tissue, the author should have used the tissue and adhesive for all the gap-filling for a much stronger join and to keep the variety of materials used to a minimum to avoid long-term problems.

#### **Repairing and conserving old labels**

Repairs to old labels can be made using Japanese Kozo tissue (Carter & Walker, 1999) although the author has also used Gampi tissue with Paraloid B72. The tissue can be used as a permanent strengthening backing for fragile old labels, including those removed from the top surfaces of specimens prior to display after a photographic record has been made of the label in situ.

#### **Discussion**

The projects described above show how versatile Japanese tissue can be. By applying the tissue

within small gaps in a break or across the 'back' of a join either side of a break it can make a strong repair where adhesive alone would not have provided an effective enough solution (e.g. if the specimen itself is quite thin, so there is not a large surface area for the adhesive to act on, or when bones do not fully meet). Also, the tissue can be applied as a useful gap filler – even used for modelling-in missing bone - resulting in a surface similar in texture and colour to bone, so that little finishing-off is required to disguise it (if that is desired). Many different 'gap filler' materials have been used over the years in museums but different fillers are suited to different tasks. In regards to the conservation of natural history specimens, some comparative studies have been undertaken for use in conserving geological material and subfossil bone (Howie, 1984; Larkin & Makridou, 1999; Andrew, 2009) but not much has been published that is directly relevant to the repair of modern and historical bone.



**Fig. 9.** The broken *Aepyornis* egg showing how it is partly held together with brown parcel paper on the inside and cellotape on the outside.

Therefore gaps filled with Japanese tissue paper and adhesive should not be relied upon to take a great deal of weight until specific strength or weight-bearing tests have been undertaken. However, anecdotal evidence and the author's own experience suggests that Japanese tissue impregnated with suitable conservation adhesive and then pulped for use as a gap fill or used in sheet form to structurally support gaps including where there is limited or no contact between joins, or indeed both techniques combined, can make a very strong repair in bone.

### Conclusions

Japanese tissue paper is a very versatile medium and has been used in a variety of ways with a range of adhesives in paper conservation for hundreds of years. Its use in the conservation of other materials in museums is increasingly diverse and it is now used regularly in the repair of taxidermy specimens and elsewhere in the conservation of natural history specimens. As long as the adhesives it is used with are reliable, well-known, and reversible conservation products there is no reason not to experiment with it and employ it on suitable specimens.

### Acknowledgements

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**Fig. 10.** The same *Aepyornis* egg as in Figure 5 after being cleaned, repaired and rebuilt using Gampi Japanese tissue paper and neutral pH adhesive with a few wooden skewers providing additional internal structural support. With the author for scale.

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