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The Investigation and Conservation Treatment of a Mounted Juvenile Orangutan

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ABSTRACT:

A taxidermy juvenile orangutan was damaged when removed from display at the Buffalo Museum of Science and submitted for treatment at Buffalo State College. Analyzing the materials that make up the specimen, as well as researching historic mammalian taxidermy, helped identify the condition concerns of the specimen and inform conservation treatment. For example, running ATR-FTIR on skin samples revealed that the torn hands and feet are actually made of rubber that is deteriorating and in need of lining. XRF and x-radiography proved the specimen did not contain heavy metal pesticides and treatment could commence without danger. Once the specimen was stabilized and repaired, it was attached to a new display support mount and visual compensations were made to create a visually uniform specimen. Because of the conservation treatment, the Museum now has the ability to display the orangutan, the only one of the species that they own.

1 INTRODUCTION:

The following research contains the analysis and conservation treatment of a mounted juvenile orangutan owned by the Buffalo Museum of Science (BMS) in Buffalo, NY. The taxidermy specimen represents many of this type of object—specimens that were once prized for their artistic and/or scientific value, but are often neglected today. The collecting and mounting of animals has been in and out of vogue for centuries, in both private collections and museums. The organic materials are prone to deterioration, and when these collections are viewed as outdated, they are over-looked for conservation treatment. The BMS, however, wishes to save their important taxidermy specimens. Founded in 1929, the museum has amassed a collection of over 700,000 objects that explore the natural world and humankind's place within it. The objects on display range from cultural artifacts to natural history specimens. Of those natural history specimens, the mounted orangutan was prioritized for treatment and was given to the Buffalo State College Art Conservation Department in October of 2011 for research and repair. The orangutan is the only one of that species owned by the museum, but it is no longer displayed because of damage that occurred in 2002. This investigation and conservation treatment of the mounted orangutan will provide the museum with information on the object, as well as the option to exhibit the orangutan once again.

Figure 1: Orangutan before treatment.

2 HISTORICAL BACKGROUND

2.1 BRIEF HISTORY OF MAMMALIAN TAXIDERMY

Humankind's fascination with animals has been ever-present, as evident by the animals painted in the ancient caves of France, considered the first examples of art (see Figure 2). It should be no surprise, then, that humans throughout cultures and time periods have attempted to preserve animals after death. Animals were mummified along with humans in ancient Egypt, saved as regalia to respect the animal's spirit in Native

American cultures of North America, and preserved in chemicals for scientific study after the Renaissance in Europe (see Figures 3, 4, & 5).

Figure 2: "The unicorn" from the Great Hall of the Bulls in Lascaux Cave, France.

Figure 3: Mummified cat from Abydox, Upper Egypt. Roman Period, perhaps 1st century A.D.

Figure 4: Shield with wood stork head. Made 1800-1830 by Chief Araposh (Crow/Absaroke).

Figure 5: Bat in formalin from 1760-1793 from the Hunterian Museum at the Royal College of Surgeons in London.

The actual mounting of animals to resemble their living forms arose from the desire to provide a more realistic interaction with the animals. To determine the beginning point of taxidermy and find the oldest extant example, Dr. Pat Morris, a zoologist and taxidermy enthusiast, defined the needed characteristics in his book *A History of Taxidermy*. The word "taxidermy" comes from the Greek words *taxis* (arrangement) and *–dermis* (skin), so a taxidermy specimen must have preserved skin, an internal support, and be posed in a life like form. According to these guidelines, mummified animals, fragments of animals, study skins, and wet-preserved specimens do not count as "taxidermy." The birth of taxidermy can be traced to roughly 400 years ago.

After emerging from the Middle Ages in Europe, people explored and traveled the world, returning with foreign flora and fauna. The oldest extant pieces of taxidermy are reptiles, perhaps because their tough skins could survive the centuries. A crocodile was given to the Church of St. Maria Annuziata at Ponte Nossa in Lombardy in 1534 as a tribute to the Virgin Mary for performing a “miraculous deliverance” during an expedition (see Figure 6) (Morris 2010: 14). Although a priest ordered that the crocodile be discarded, it was found hanging in the church a hundred years later and there it has remained.

Figure 6: Hanging taxidermy crocodile.

The oldest extant mammal, however, is slightly younger and more difficult to trace. Popular belief is that a rhinoceros is the oldest extant taxidermy mammal (Browne 1896), but that has not been recently located (Morris 2010). There are several taxidermy horses in old European collections that date to the early 17th century, and were preserved most likely because of the strong relationship between humans and horses. The oldest that Dr. Morris was able to locate was mounted in 1600 and is displayed in the Museum of the Army in Brussels (see Figure 7) (2010: 23). Although the oldest pieces of taxidermy were relics and tributes to important horses, taxidermy eventually reached a wider audience through public display.

Figure 7: Oldest extant mammalian taxidermy.

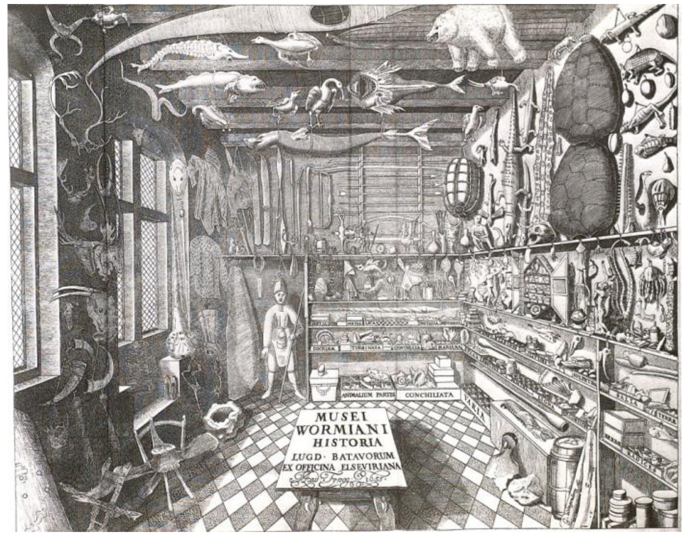


Figure 8: Frontispiece from *Museum Wormianum* showing a cabinet of curiosity.

The European cabinets of curiosity (or *wunderkammer* in German) of the 16th and 17th centuries were amassed by aristocrats who had the wealth to travel and wished to display this natural fortune. The curio cabinets sought to classify nature and were precursors to museums as they are known today. Explorers returned to their homelands with "the curious creatures encountered on their journeys," and exhibiting them showed their dominance over the exotic (Morris 2010: 10). Establishing a curio cabinet "not only contributed to the personal enrichment of the Renaissance man, but also enhanced his reputation" (Aloi 2012: 31). Preserving the specimens as taxidermy and in chemicals allowed them to be showcased, even after death. Illustrations contemporary to the cabinets, like the frontispiece from *Museum Wormianum* (see Figure 8), show preserved animals lining the walls and ceiling of rooms, some as study skins and some as articulated animals. The Dutch were the first on record to stuff animals after they returned from exploring the East Indies in 1517 (Browne 1896). To aid in the preservation, the first taxidermy manual was published in 1555, with additions added in the early 17th century (Morris 2010: 10). Although curio cabinets were popular for a while, taxidermy (the display of dead animals) has fallen in and out of fashion throughout its history.

After the cabinets of curiosity, the next major wave of popularity for taxidermy developed during the Victorian Era of the late 19th and early 20th centuries. This was a time of peace and prosperity in England that coincided with the Gilded Age of prosperity in the United States (late 19th century); a time of the Great Exhibitions and World's Fairs when more humans were able to explore exotic lands and conquer nature through industry. Mounting animals during this time demonstrated both curiosity for and power over nature. Although photography had been invented, it was still a developing field and seeing taxidermy was a thrill for the public. Some of the world's leading natural history museums were established during the Victorian Age, like the Science Museum and Natural History Museum in England, and the American Museum of Natural History and the Field Museum in the United States. These museum exhibits "evolved in response to the public's growing awareness of wildlife and wilderness as finite and fragile ecosystems as well as a resource for human exploitation" (Quinn 2006: 10).

Animals were also exhibited in private homes. As the middle class grew, so did the Victorian parlor—a room with the sole purpose of leisure and entertainment. The middle class began to establish these rooms in their private homes as a space where they could "present their public faces" to entertain and hold rites of passages, proving their respectability and economic standing (Grier 1988: 59). Curious and whimsical display of animals, like those of Walter Potter and Herman Plouquet (see Figure 9), or trophy mounts from hunting excursions kept animals close in these spaces, yet still, silent, and submissive. The audiences of taxidermy during this time viewed a taxidermy specimen as the "tangible proof of the greatness of nature," and it was an "unproblematic object to be admired; the manifestation of the subjugation of nature that man alone is capable of" (Aloi: 2012: 27). Even though Vanderbilt heir George Vanderbilt did not hunt himself, he lined the walls of his giant banquet hall at

Figure 9: "Kittens' Tea Party" by Walter Potter.

Biltmore Estate with examples of large North American game. George Eastman, the founder of the Kodak Company, did support hunting and financed expeditions to African to collect trophy specimens, some of which can see be seen in his historic home today (Morris 2010).

Figure 10: A stuffed chimpanzee.

As taxidermy specimens expanded from the cabinets of curiosity and into museums and homes, the need for better presentation methods arose. Montagu Browne, the author of taxidermy manuals from the late 19th century, revealed that the field of taxidermy desperately needed to move away from leaving everything "to the fancy of the 'stuffer,'" a person without formal training or desire to mount animals as realistically as possible (Browne 1896: 4). Browne found that specimens "are not well done" in museums, since "stuffed birds are so perfect in colors, [yet] are disgraceful in form" (5, 7).

The techniques used in the type of mounting that Browne found so offensive were based on filling the preserved animal skin with loose material (see Figure 10). The animal's cleaned skull was attached to a wooden frame with iron rods to provide internal support, the wet skin was sewn over, and then "the whole [thing] was stuffed with straw or something similar like wood wool and then pummeled with fists or beaten into shape using wooden bats" (Morris 2010: 68). As Carl Akeley observed, "no knowledge of the animal's anatomy" was used for this process (1920: 4). This method produced an uneven, lumpy surface once the skin dried.

Some early mounts, especially those still extant today, were mounted to solid sculpted wooden forms (see Figure 11). While they provided support, the wood was expensive to produce, heavy to transport, and time-consuming to carve (or very unrealistic if not carved) (66). To provide more control over the surface and create the illusion of musculature, a "direct modeling" method was adapted. For this method the wooden and metal rod frames were bound with wood wool, and then the skin attached with glue and/or nails (see Figure 12) (Carter 1999: 20). The surface of the binding could be smoothed by applying a layer of plaster, and then covered with shellac for water-proofing. Finer detail work for faces and for animals with wrinkly skin could be produced by applying modeling clay over the binding. Although binding provided a better alternative to stuffing, the direct modeling taxidermy mounts left room for improvement.

Figure 11: A taxidermy horse with carved wooden internal support.

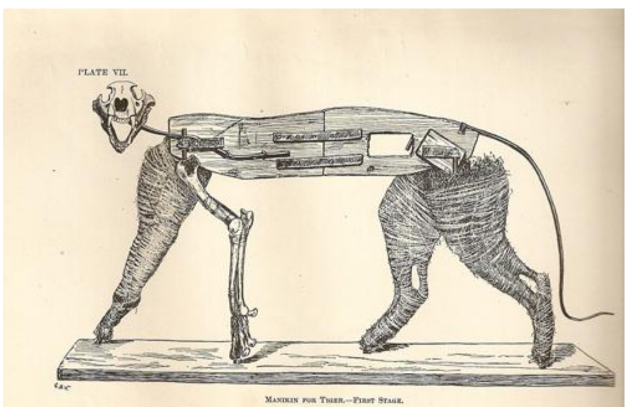


Figure 12: In-progress binding method (three limbs have been bound with wood wool and string).

Browne desired taxidermists who combined "knowledge of anatomy and modeling with taxidermy technique" and found importance in knowing the geographic habitats of the animals (1896: 7). As the general population was more exposed to taxidermy in museums and World Fairs, the accuracy of form and pose increased. Louis Daguerre patented the diorama in 1822 and delighted the public by showing them that 3-dimensional artwork can look as though it is "real" (Quinn 2006: 13). The public responded favorably to life-like mounts, and the era of taxidermy as an artform began with the dermoplastic technique. Taxidermy was a secret profession, with individuals keeping techniques and preservative recipes to themselves for profits. Because of the lack of communication, taxidermy techniques were discovered in isolated events.

Although Carl Akeley was not the very first to use dermoplastic techniques, he is considered the father of modern taxidermy because he perfected it while working for major museums in the United States, including the first natural history diorama that he created in 1889 (Browne 1896; Morris 2010; Quinn 2006). While working at the Milwaukee Public Museum on two orangutans, Akeley realized that "if a man was going to model a realistic manikin for an animal's skin, instead of stuffing the skin with straw, it was evident that he would have to learn to model" (Akeley 1920: 9). Akeley drew from his experiences as a sculptor and began mounts by creating highly detailed and anatomically correct clay models of the animal. Exact measurements taken of the animal during expeditions provided the basis for the models. Akeley himself visited Africa several times to collect specimens and measurements for the American Museum of Natural History (Akeley 1920; Quinn 2006).

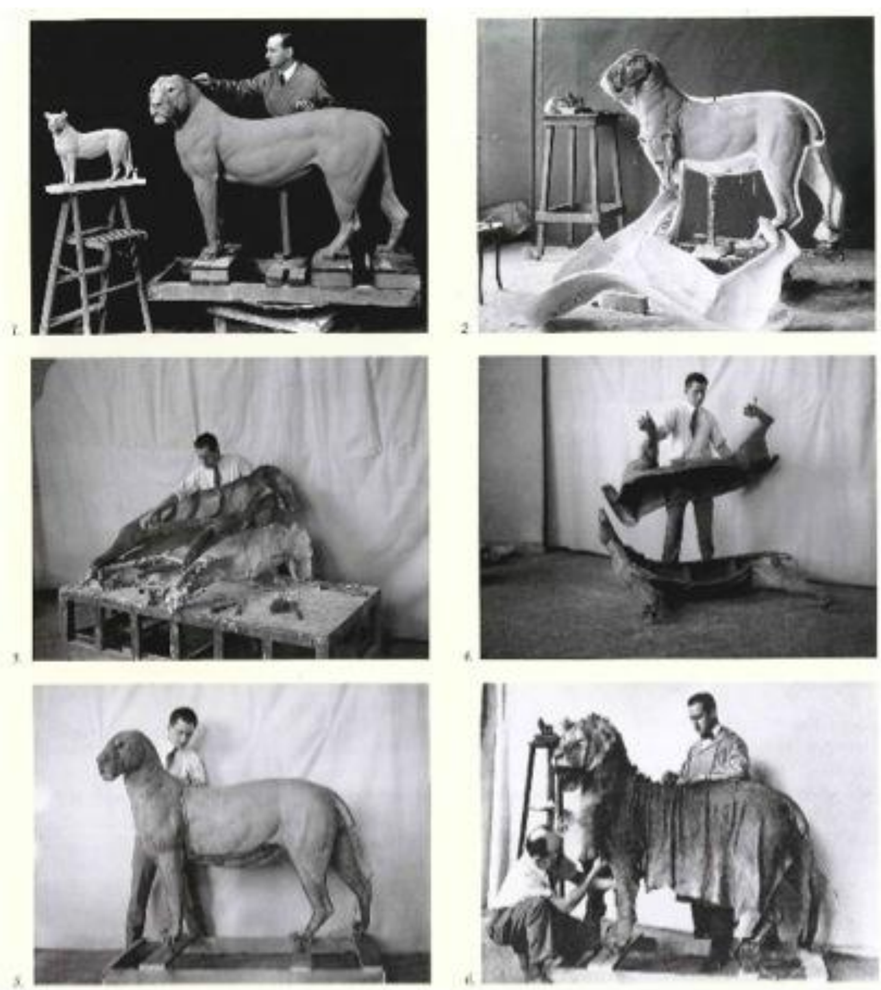


Figure 13: The dermoplastic method from clay models to sewing the preserved hide on *papier-mâché* cast manikin.

The life-sized clay models were covered with plaster to create a mold. Once set, the plaster was lined with glue or shellac to seal them, and then lined with strips of *papier-mâché* that were "reinforced by wire cloth and coated with shellac" (Akeley 1920: 12). The layers of *papier-mâché* created a tough, but lightweight, hollow form of the animal to which the preserved skin could be sewn (see Figures 13 & 14). The practice of applying a skin over a modeled form is more of a mounting of the skin than stuffing it, and thus taxidermy animals constructed in this way are referred to as "mounted" and not "stuffed" (to prevent evoking images of the bad stuffed animals of the past).

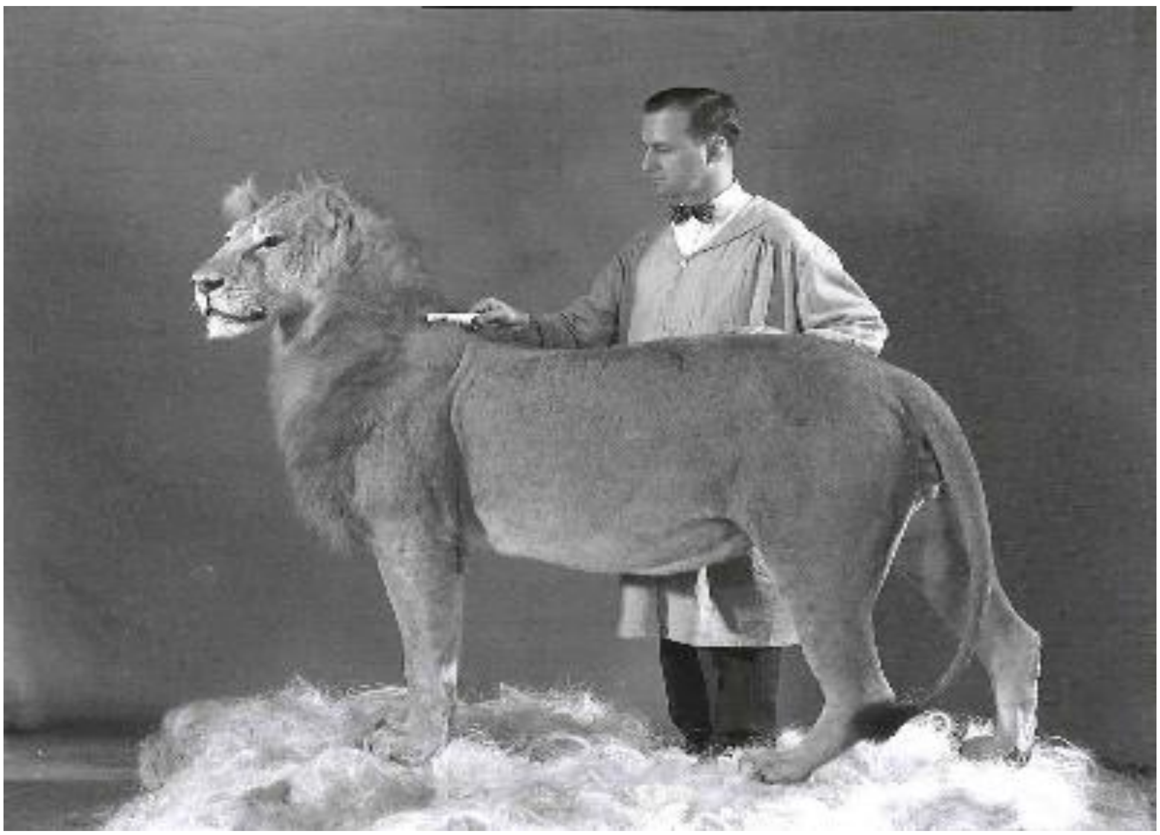


Figure 14: The final taxidermy mount from the demonstration of dermoplastic technique in Figure 13.

Preservative techniques also helped improve the quality of mammalian taxidermy. The organic material of animal skins makes them susceptible to pest infestation, mold, and dimensional changes due to fluctuations in the environment. While environmental and mold damage can be somewhat regulated by displaying the taxidermy in dryer conditions, taxidermists actively attempted to prevent pest infestations that could eat the specimen. Early accounts of taxidermy reveal attempts to ward off pests by using salts, peppers, and aromatics, like tobacco and spices (Morris 2010: 26). A French apothecary named Jean-Baptiste Bécoeur created a recipe for a powered preservative involving arsenic and other chemicals in the 18th century (Browne 1896: 68).

Although not the first to use arsenic, Bécoeur's mixture was the first to be widely published and "it came to be almost universally adopted in taxidermy" (Morris 2006: 26). A taxidermy manual from 1840 published "Bécoeur's Arsenical Soap" as a mix of "5 oz camphor, 2 lbs powdered arsenic, 2 lbs white soap, 12 oz salt of tartar, and 4 lbs lime in powder (or powdered chalk)" that should be brushed and rubbed into the skin (Browne 1896: 68). Successful taxidermists, like William Hornaday, and museum professionals, like Charles Wilson Peale of the U.S. and Louis Dufresne of the Paris Museum, supported the use of arsenic. Arsenic is toxic for humans as well as pests, and despite its long history, many taxidermists did not support its use because of the dangerous affects on humans. Montagu Browne strongly discouraged the use of arsenic, pointing out that even a single particle under a fingernail will aggravate, and he believed that it still did not completely prevent pest infestation (1896: 64). Although taxidermists use other preservatives today, like Borax (sodium tetraborate), some used arsenic into the 1970s.

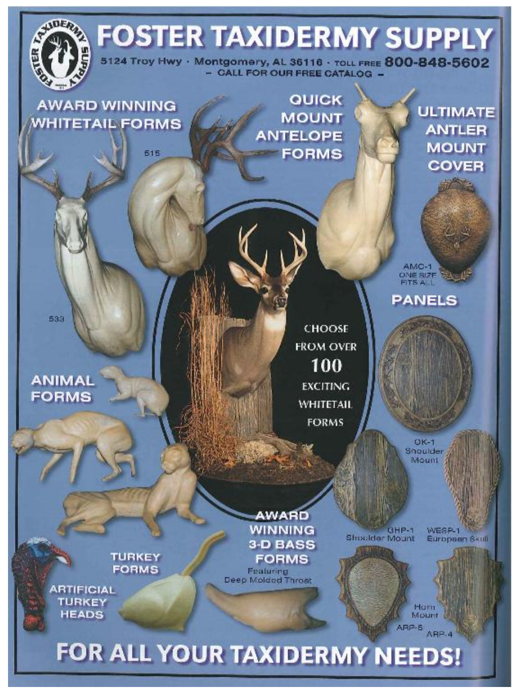


Figure 15: Advertisement for modern polyurethane foam manikins.

The preservation methods may have changed to less toxic approaches, but the dermoplastic technique pioneered by Akeley is still followed today. The mammal hides are carefully removed from carcasses using minimal cuts, then synthetically tanned and sewn onto the forms. Contemporary manikins/animal forms are often made of polyurethane foam. In the United States, taxidermy supply companies offer pre-made foam forms that fit virtually every common animal that the average hunter would encounter (see Figure 15). Specialists who mount large and exotic game animals will still custom create the forms for those uncommon animals. Artificial eyes placed within the manikin were traditionally made from glass, but then replaced with plastic once they became available in the 20th century.

Taxidermy is currently experiencing a resurgence, thanks to taxidermists who strive to produce pieces as striking as those made by Carl Akeley and his contemporaries. Taxidermists today, like Ken Walker, consider themselves to be “wildlife artists.” The mounts look as though the animal has been encountered in real life, that the taxidermy animal is actually in “arrested motion” (see Figure 16) (Quinn 2006: 42). The annual World Taxidermy Championships award wildlife artists for creating the most realistic mounts, and the judges pay critical attention to “anatomical accuracy and artistic merit” (Milgrom 2010: 56). Taxidermy trade magazines like *Breakthrough* and *Taxidermy Today* offer advice and showcase award-winning pieces.

Contemporary artists also have begun to incorporate taxidermy into their shows. One art critic has noted that “this revival [of taxidermy] is not a hollow trend but a highly intriguing and layering revisionist phenomenon” (Aloi 2012: 16). People can now expect to encounter taxidermy in art museums as well as natural history museums, thanks to artists like Petah Coyne, Maurizio Cattelan, and Damien Hirst (see Figure 17). Although taxidermy remains an unregulated field (anyone can mount an animal), the development of high-caliber taxidermy specimens has been made possible by blending the fields of taxidermy, art, and biology.

Figure 16: A taxidermy mount from 2009.

Figure 17: Petah Coyne’s *Untitled #1336*

2.2 Description of Orangutans

Orangutans belong to the order of mammals called Primates, an order that includes monkeys and apes. Among other discerning characteristics, monkeys have tails, while apes do not, and thus orangutans are apes. The apes are distinguishable by size and split into "lesser apes" and "great apes." The great apes all belong to the family of Hominidae that includes humans, chimpanzees, bonobos, gorillas, and orangutans (see Figure 18). Orangutans were the first species to branch from the common great ape ancestor, and are the most distant relative from humans among the great apes (chimpanzees being the closest). Because of this distance, Orangutans belong to the sub-family Pongidae, with two types of orangutans that are distinguishable by their geographic range.

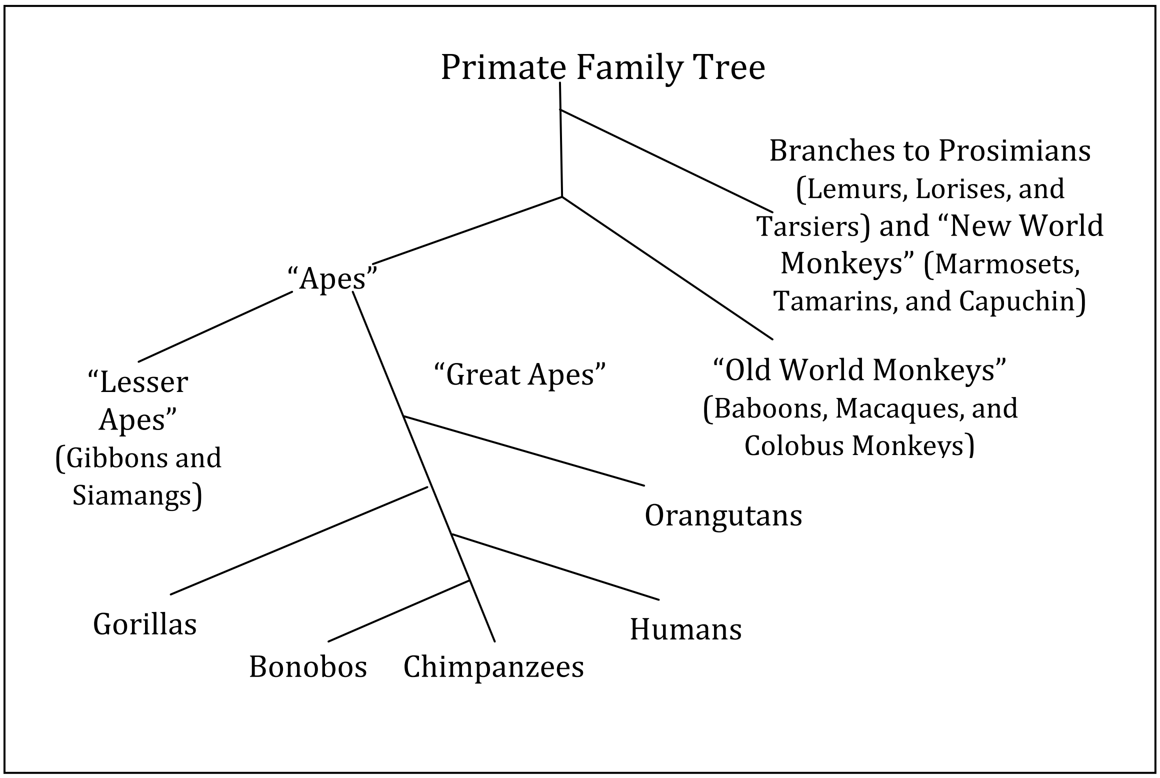


Figure 18: The Primate Family Tree.

Found only in the tropical rainforests of Indonesia in Southeast Asia, *Pongo abeli* is from the island of Sumatra, and the other, *Pongo pygmaeus*, is from the island of Borneo (see Figure 19) (Galdikas 1995; "Great Apes & Other Primates" 2012). Comparing the specimen from the Buffalo Museum of Science to photos of other orangutans, it appears to be from Borneo, although the National Zoo website states that "outside of their native ranges, they can be differentiated only through chromosomal or DNA analysis" ("Great Apes & Other Primates" 2012).

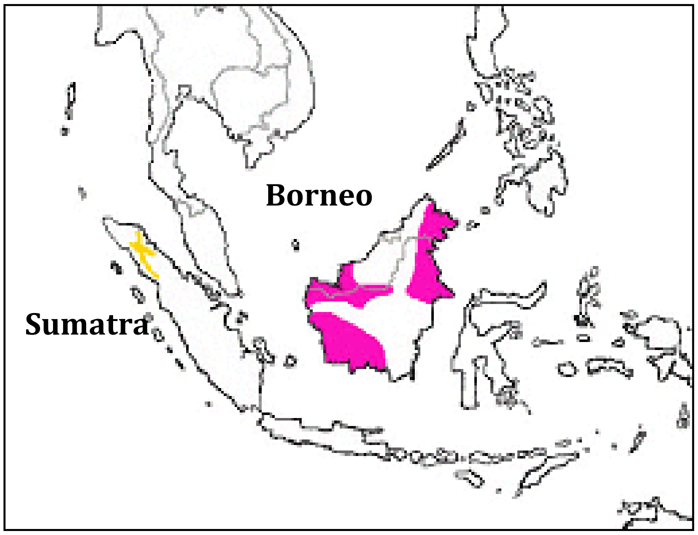


Figure 19: Orangutan habitat range in Southeast Asia- in yellow for the island of Sumatra and in pink for the island of Borneo.

The specimen from the Buffalo Museum of Science has patchy hair that is dark orange-red in color. The hair has not fallen out or changed color, though. Orangutans are known as the "red ape" because their hair "varies in hue from dark brown to light blond" and only sparsely covers their bodies (see Figures 20 & 21) (Galdikas 1995: 25).

Figure 20: Lucy, a female at the National Zoo with red and orange hair.

Figure 21: Batang, a female at the National Zoo with sparse hair.

Males are larger than females and there are two types of males that develop different physical characteristics, a species trait called bimaturism ("Pongo pygmeaus" 2012). The most dominant males grow extended cheeks, or flanges, have throat pouches that produce distinct sounds/calls, and have longer hair. Figure 22 is the dominant male Kiko from the National Zoo. These males are aggressive towards other males. The lesser dominant male is roughly the same size as females and does not grow the "secondary sexual characteristics" ("Pongo pygmeaus" 2012). Figure 23 is the less dominant male Kyle from the National Zoo. Both males are able to reproduce and the less dominant male can transition into dominant and grow the secondary sexual characteristics if the proper social cues arise. The two males at the National Zoo are kept away from one another, although the females are free to move between the living spaces of the two.

Figure 22: Kiko, the dominant male at the National Zoo.

Figure 23: Kyle, the less dominant male at the National Zoo.

The word orangutan is Malaysian for "man of the forest," which is indicative of their livings habits ("Great Apes & Other Primates" 2012). Orangutans are the only great apes to spend a majority of their lives in trees. Their long arm span of up to eight feet and hips that are as flexible as their shoulders allow them to grab branches and swing through trees (Galdikas 1995: 25). Although they typically move slowly through the jungles searching for food, orangutans use a hand-over-hand swinging motion, or brachiation, to cover larger areas. This brachiation may be observed at the National Zoo in Washington, D.C. where the orangutans have a special Orangutan Transport System, or "O-line." The cables of the O-line stretch high overhead of zoo visitors and allow the orangutans to move from one enclosure to another by swinging, and thus imitating life in the wild (see Figure 24). Males that have become too large and old for arboreal living are the only ones who will move to the ground to travel great distances (Bateman 1984:132). Orangutans are solitary animals that travel and live alone, although offspring live with the mother for their first few years before becoming independent. Orangutans spend their days eating a variety of fruit, shoots, and leaves, but have been known to eat small mammals (Bateman 1984:135). At night orangutans collect branches and leaves to build nests for sleeping.

Figure 24: Kiko, a male from the National Zoo brachiating on the O-Line.

Orangutans once lived in a wider geographic distribution in Southeast Asia, but human activity has severly dimished their habitats. According to the International Union for Conservation of Nature (IUCN), the Sumatran orangutan population has had an "estimated decline of over 80% over the last 75 years," while the Bornean population has had an "estimated delcine of well over 50% during the last 60 years" ("Pongo pygmeaus" 2012). These numbers are significant enough to place both the Sumatran and Bornean orangutans on the ICUN Red List of Threatened Species; the Sumatran orangutan is considered critically endangered and the Bornean orangutan is considered endangered. The ICUN attributes habitat loss, fires, illegal logging, habitat fragmentation, hunting, and pet trade to the declining populations. While there are rehabilitation centers in place to save the orangutans, their future is uncertain (Galdikis 1995). The orangutan specimen owned by the Buffalo Museum of Science allows the museum to have an illustrated piece of human evolution through primate relatives, but one day it could also become a rare artifact of an extinct species.

2.3 History of the Museum's Specimen

According to records at the Buffalo Museum of Science (BMS) and the Buffalo Zoo, the orangutan was a gift to the Museum from the Zoo on May 23, 1966. The description in the records, authorized by zoo curator Clayton Freiheit, indicates that the orangutan was a female given "in the flesh – to be mounted." Zoo registrar Jean Miller states that it was not common practice for the museum to mount animals that died (Personal Communication 11/21/2011). Animals are usually incinerated, although there are records that some animals were given to the State University at Buffalo for research.

There is an orangutan on that list from 1966, so this specimen was most likely given first to the University, and then to the Museum. This correlates with the type of taxidermy performed. The specimen is not mounted with the meticulous attention to detail that display taxidermy is given. This specimen is pieced together with obvious seams, and there are areas where the internal structure is exposed because the pieces did not exactly align.

According to Dr. John Grehan, former Director of Science and Research at the BMS, the specimen was on display in a case in one of the public galleries from an unknown date until 2002. Dr. Grehan states that "given the way it was arranged and the surrounding diorama, it would appear that the initial mounting was designed for the case," although there are no records as to the actual taxidermist who performed the mounting (Personal Communication 11/29/2011). In 2002 the specimen was removed from the case, causing the damage on the hands and feet because of the poor support system. The specimen has been in storage since that event.

3 Description and Materials

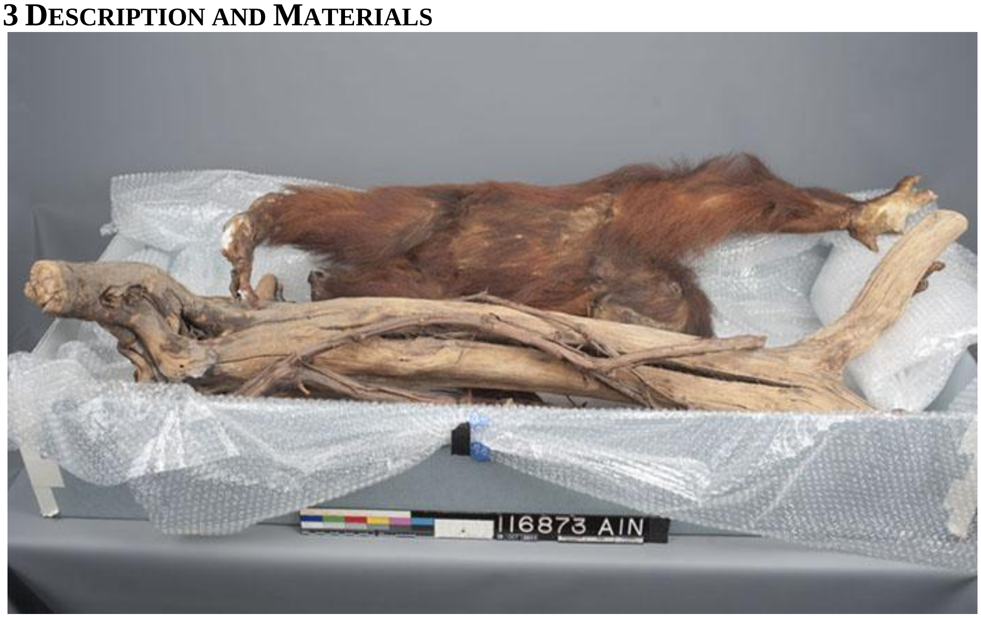


Figure 25: The orangutan as received by the Art Conservation Department. The specimen is still attached to the driftwood display mount.

3.1 Mounted Specimen Description

The object is a taxidermy juvenile female orangutan (CNS116873). The specimen is positioned standing with its proper right arm out-stretched overhead and the proper left arm in a front gripping position. The proper left knee is raised and the proper right leg is straight for support. Originally mounted to a heavy piece of driftwood that caused damage to the specimen (see Figure 25). The wood was removed and discarded at the request of the Buffalo Museum of Science.

3.2 Fabrication

To create the mounted orangutan, the specimen was first skinned to remove the carcass. Skinning usually involves minimal cuts that will be nearly invisible after the mount is complete; however, this specimen was skinned in several obvious pieces. The pieces were preserved, or tanned, most likely using a synthetic tanning agent available in the 1960's. X-radiographs reveal that a wire armature was fabricated to provide the position and support, and then layers of wood wool (fine wood slivers) were modeled around the wire and attached with string to create the shape of the orangutan (see Figure 26 and Section 4.3). Damage to the hands and feet, as well as misaligned pieces of leather, also reveal that a plaster-like material was used to line these areas, perhaps to add more support (see Figure 27). When still wet, the tanned skin was attached to the form using nails, and perhaps glue (Dickinson 2006: 133), and pieces were stitched together using thick thread. The face was pinned into place during drying (as evident by the visible pinholes). Once dry, the face and lips were painted to compensate for the color loss that occurs when hairless skin dries (Morris 2010: 78). The palms of the hands and pads of the feet were replaced with rubber, also to

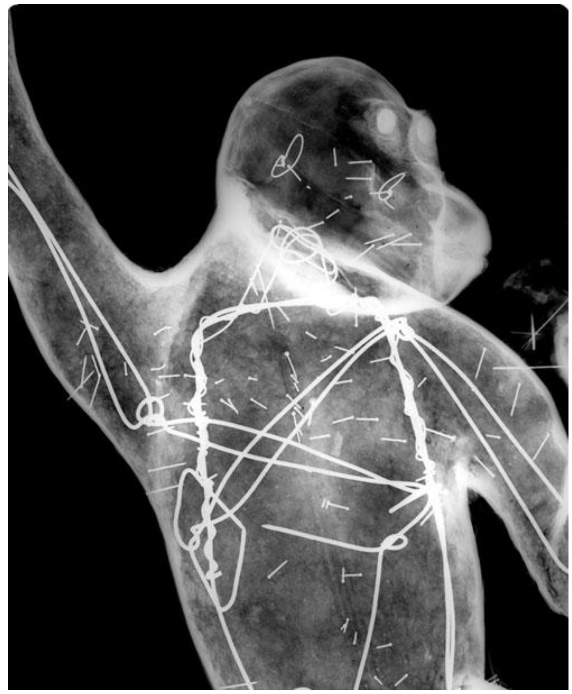


Figure 26: Detail x-radiograph of the torso and head of the specimen.

Figure 27: Detail of proper left hand. Misaligned leather is exposing internal plaster-like material (in circle).

compensate for the drying out of hairless skin. The rubber can be seen peeling away from the real skin under the fingernails because the rubber was attached below the fingertips/toe tips (see Figures 28 & 29). The hands and feet were padded using cotton batting. The specimen's hands and feet were then nailed to the driftwood display support.

Figure 28: Rubber peeling away from the fingertip of the proper right thumb.

Figure 29: Rubber separating from a toe on the proper right foot.

3.3 Condition

The most damaged areas of the specimen are the hands and feet. The specimen was mounted to a piece of driftwood using nails and pins through the fingers and toes. Analyzing a sample of the sticky skin recovered from the mount using Attenuated Total Reflectance-Fourier Transform Infrared (ATR-FTIR) spectroscopy found that the "skin" on the palms of the hands and pads of the feet is actually rubber (see Section 5). The sample did not match at all to a skin reference spectrum, and is a mixture of rubber, kaolin, and a polyvinyl acetate (PVAc) adhesive. The kaolin may have been a coloring or thickening agent, and the PVAc adhesive is most likely wood glue (although a layer of glue is not visually apparent). There are remnants of the wood from the wooden mount on the PR hand, suggesting that the wood glue was used to mount the specimen to the driftwood. The glue was strong enough to cause splinters to rip away from the driftwood and remain on the specimen. The rubber is exhibiting the typical deterioration pattern of latex rubber (Hatchfield 2007; Wolfe & Nagy 2001). In some areas it is supple and in good condition, in other areas it is sticky and glossy, and finally on the bottom of the PR palm it is becoming hard and brittle and is cracking.

Because the rubber of the hands and feet is thin and deteriorating, the weight of the specimen pulled away from the mount during de-installation. This event ripped off half of the proper right hand (two full fingers with palm skin and the thumb) and the thumb and skin fragments of the proper left hand (see Figure 30). The proper right foot pulled out of the nails attaching it, causing it to split open along the ball of the foot (see Figure 31). The weight of the toes flapping open from this split also strained the skin on the top of the foot, which also split over time. The toes of the proper right foot remain attached only by the skin on the sides of the foot. The proper left foot also pulled away from its nails, causing it to split open in the arch and toes. The proper left foot was still stuck to the mount via a small area of sticky rubber on the pinky toe. The foot was easily pried off of the mount using a microspatula during removal of the specimen from the mount. All of the splits and areas of detachment reveal the cotton batting used to stuff the hands and feet. The handling of the orangutan during de-installation, coupled with the improper mounting and deteriorating rubber, is what caused the damage to the hands and feet.

Figure 30: Torn proper left hand.

Figure 31: Torn proper right foot.

The top layer of the skin/leather throughout the specimen is flaking and curling, especially on the torso, proper right underarm, and head. The exposed layers are lighter in color than the surrounding undamaged areas. This damage could have been a result of taxidermy methods and not just environmental conditions. There is also loss on the tip of the proper right ear that is noticeable as a bright cream area. There is a white accretion throughout the PR side of the face and back of the head that is not heavy metal pesticide, as x-ray fluorescence (XRF) proved. Running samples of the accretion with ATR-FTIR microscopy revealed that it is wax (see Section 5). Some taxidermists have infused wax beneath the skin of primate faces to increase realism, although the amateur nature of the rest of the mount suggests that this taxidermist was not experimenting with this technique (Morris 2010: 78). The cause of the blooming wax is unknown.

Figure 32: Detail of proper right side of the face. Paint is flaking, exposing lighter areas in the dark face.

The skin was painted to compensate for the color loss and loss of translucency that occurs when the hairless patches of skin dry out. The paint on the face is flaking, as well as the pink paint on the lips (see Figure 32). There are also several small holes in the face that formed when the specimen was mounted and pins were used to hold the shape while the hide dried. Odd beetle casings were found in the hair on the PR arm and PR ankle. During treatment one odd beetle larva was collected from the top of the hair on the PR hip (see Figure 33). There is overall dust and dirt accumulation, as well as particulates stuck in the hair.

Figure 33: Odd beetle larva crawling on the hair of the proper right hip.

A few individual hairs detached from the specimen during handling and transport, but not an excessive amount that would be indicative of a drying out of the skin. The areas of hair that look sparse are not balding areas, but are representative of how the orangutan looked when alive. The loose hairs have been collected and bagged. Three unknown skin fragments found in the storage box and in the driftwood mount were also bagged and saved.

The internal metal armature is structurally sound; the limbs and head are not loose or drooping. There are no indications of rust surfacing on the exposed cotton on the hands and feet, although there may be rust inside the specimen. The cotton on the hands is yellower than the cotton exposed on the feet, suggesting the damage occurred first on the hands. Examination using x-radiography and XRF showed that the inside of the specimen was not lined with heavy metal pesticides.

4 Imaging Techniques

4.1 Objectives

A variety of photographic and imaging techniques were utilized to document the condition of the orangutan before, during, and after treatment (in addition to the written documentation in Section 3.3). The specimen was photographed under normal visible illumination, and ultraviolet radiation, and was also x-radiographed. Such documentation assists in guiding present and future conservation interventions, and also provides enhanced understanding of the specimen's condition, appearance, and material structure for future research.

4.1 Photographic Documentation

The specimen was documented photographically with a digital single-lens reflex camera (Nikon D700). Initial photographs were taken of the specimen while in the receiving crate to document condition upon arrival as well as attachment of the specimen to its wooden mount. Once the orangutan was removed from the mount and crate, its anterior side was photographed from several angles, as were the portions of the hands that were attached to the mount (see Figure 34). The posterior side could not be safely documented at until the completion of treatment because of the potential of damage to the hands and face (see Figure 35). See Examination Report in Appendix C and Treatment Report in Appendix E for full photographic documentation.

Figure 34: Orangutan before treatment during photographic documentation (anterior side).

Figure 35: Orangutan after treatment during photographic documentation (posterior side).

4.2 Documentation of Ultravolet-induced Visible Fluorescence

The subject was photographed in a darkened room while irradiated by a longwave ultraviolet lamp (blacklight) using a digital single-lens reflex camera (Nikon D700). The ultraviolet radiation (UVA) causes some materials to fluoresce and emit visible light. This fluorescence can be useful for differentiating materials that might look similar in normal light, or for indicating the presence of added materials such as adhesives, that might not otherwise be readily visible. (See Discussion Section 4.4 below.)


Figure 36: Proper right hand fragments (palmside) recovered from the mount under longwave ultraviolet irradiation showing fluorescing rubber.


Figure 37: Sample degraded latex rubber (left) compared to specimen skin/rubber samples (right) under longwave ultraviolet irradiation showing similar fluorescing.

4.3 X-Radiographic Documentation

The subject was penetrated by a beam of x-rays and the extent of x-ray penetration was recorded on a digital imaging (see Figure 38). Areas of the subject that are denser, thicker, and/or composed of materials that contain elements of higher atomic weight (such as the iron in the internal wire support) absorb more x-rays, diminishing penetration. They thus appear lighter in tone in the radiograph. (Radiographic technique: Philips MCN101 tube at 44” film-focus distance; 40kV, 400mAS, no tube filtration, Kodak Industrex Flex HR Digital Imaging Plate 2174, no screens, Kodak/Carestream Health ACR 2000 computed radiography scanner.)

Figure 38: X-radiograph of the specimen before treatment.

Figure 39: Specimen mounted on new display support after treatment. New threaded metal rods are visible in the circled areas.

4.4 Discussion of Results

Beyond providing an archival reference for the condition of the orangutan before, during, and after treatment, the imaging techniques provided information on the materials used in constructing the taxidermy mount. Examination under UVA showed that the palmside of the hands fluoresce, in a similar manner as latex rubber. Comparing specimen palm samples to degraded latex rubber under UVA helped confirm that the palm "skin" is, in fact, rubber (see Figure 37). The x-radiograph clearly revealed a metal armature placed inside the specimen as a means of support, and assortment of tacks and nails to shape and attach the preserved hide. Superimposing the x-radiograph upon a normal lighting photograph gives a greater understanding of how the specimen was mounted upon its internal support (see Figure 40). This imaging informed Section 3.2 on the fabrication of the specimen. The x-radiograph shows no indication of the application of heavy metal pesticides, such as arsenic soap or mercury. The presence of such materials is usually evidenced radiographically by scattered areas of dense white clusters near the surface of the specimen. X-radiography was utilized again after treatment was completed to document the new support mount and the position of the threaded metal rods that were inserted into the specimen (see Figure 39).

Figure 40: X-radiograph superimposed over normal illumination photograph.

5 Material Analyses

5.1 Objectives

Unknown materials on the specimen were tested using various analytical techniques intended to provide identification when compared to known references. Fibers of batting material, the stitching thread, and hair, as well as the paint from the lips were viewed and identified using polarized light microscopy. Readings from X-Ray Fluorescence Spectroscopy (XRF) were taken at five points around the specimen to determine whether toxic heavy metal pesticides are present.[1] Attenuated Total Reflection Fourier Transform Infrared Spectroscopy (ATR-FTIR) was run on skin samples to determine whether or not adhesives were used to attach the specimen to the mount. Transmission FTIR spectroscopy was used to identify the white accretions on the face so that a treatment plan could be developed for its removal. The samples taken were as minimal as possible, or were pieces that had detached from the specimen, like hair found inside the storage box and skin fragments recovered from the mount removal. These investigations were deemed necessary to understand how the specimen was made, which can inform about previous and potential future deterioration, and help to establish a treatment protocol. See Figure 44 for locations of material analysis.

[1] It is important to identify whether or not specimens contain heavy metal pesticides because exposure can be toxic to humans (i.e. museum staff and visitors).

5.2 Polarized Light Microscopy

Small samples of fibers and paint were collected from the specimen and mounted on glass slides using MeltMount™ (refractive index of $n^{25}_{D} = 1.662$). The fibers were examined under plane polarized light on a Nikon Eclipse E400 POL microscope at 100-400 times magnification. The morphology and color were noted. Examinations for the pigment under plane-polarized light included average measurement (based on Feret's diameter technique), color, morphology, and pleochroism, as well as a comparative refractive index (RI) to the known RI of MeltMount™ using the Becke line test. Crossed-polarized light was used to examine each fiber and pigment for isotropic or anisotropic characteristics, angle of extinction, interference colors (order of retardation), birefringence value (based on the Michel Levy Birefringence Chart), and optic sign. These observations were compared to known reference samples to determine the type of fiber (natural or synthetic) and possible pigments used in construction of the mount. Samples of the batting material, thread, and pigment were removed from the specimen (see Figure 44), but the hair was collected from the storage box of the orangutan.

5.3 X-Ray Fluorescence Spectroscopy

X-ray fluorescence (XRF) spectra were collected using a Bruker Tracer III-SD handheld energy dispersive X-ray spectrometer that was mounted on a tripod and set to specific locations on the specimen. The excitation source was a Rhodium (Rh) target X-ray tube, operated at 40 kV and 20 μA current. An aluminum (12mils)/titanium (1mil)/copper (1mil) filter was used to reduce the background radiation and enhance the sensitivity in the energy range of interest (heavy metals to indicate the presence of heavy metal pesticides). The X-ray beam interacts with sample at approximately a 4x5 oval. X-ray signals were detected using Peltier cooled XFlash silicon drift detector (SDD) with a resolution of 146.4eV. Spectral interpretation was performed using the Artax software to determine and label the elements present. Each spectrum was collected over 60 seconds live time. Readings were taken from the cheek, armpit/torso, proper right hand, proper left wrist, and proper right foot (see Figure 44).

5.4 Attenuated Total Reflection (ATR) Fourier Transform Infrared (FTIR) Spectroscopy

Infrared spectra were collected using a Nicolet 6700 FTIR spectrometer (Thermo Scientific) with a Thermo Scientific Smart iTR ATR accessory. Samples were analyzed by pressing them against the Diamond ATR crystal. The spectra are the average of 16 scans at 4 cm^{-1} spectral resolution. An ATR correction routine was applied to compensate for variations in penetration depth with wavenumber. Sample identification was aided by searching a spectral library of common conservation and artists' materials (Infrared and Raman Users Group, http://www.irug.org) using Omnic software (Thermo Scientific). Samples were taken from two locations on the specimen (see Figure 44), and collected from the wooden mount after the orangutan was removed.

5.5 Transmission Fourier Transform Infrared (FTIR) Microscopy

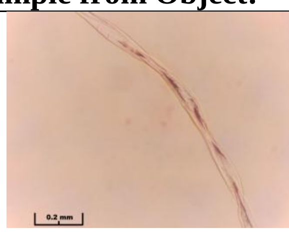
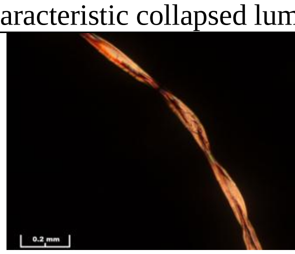
Infrared spectra were collected using a Continuum microscope coupled to a Nicolet 6700 FTIR spectrometer (Thermo Scientific). Samples were prepared by flattening them in a diamond compression cell (Thermo Spectra Tech), removing the top diamond window, and analyzing the thin film in transmission mode on the bottom diamond window (2 mm x 2 mm surface area). An approximately 100 mm x 100 mm square microscope aperture was used to isolate the sample area for analysis. The spectra are the average of 32 scans at 4 cm^{-1} spectral resolution. Correction routines were applied as needed to eliminate interference fringes and sloping baselines. Sample identification was aided by searching a spectral library of common conservation and artists' materials (Infrared and Raman Users Group, http://www.irug.org) using Omnic software (Thermo Scientific). Samples were removed by scraping the white accretions from the cheek using a microchisel (see Figure 44).

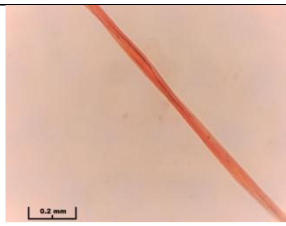
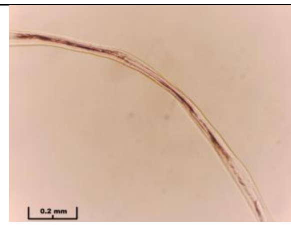
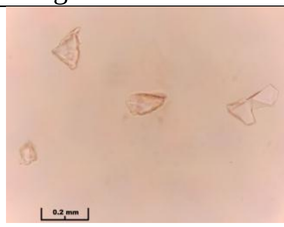
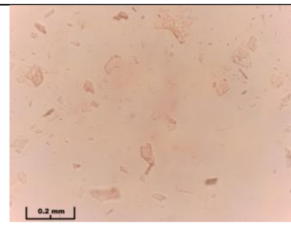
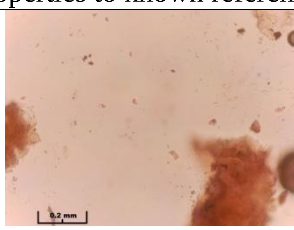
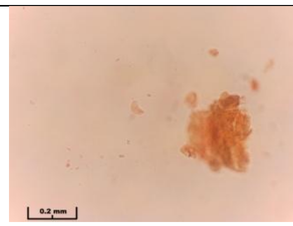
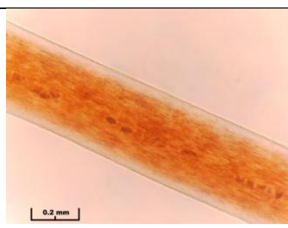
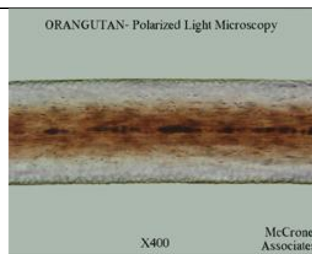
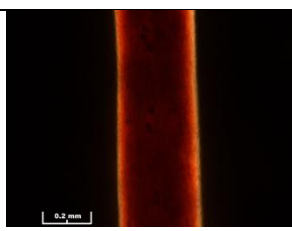
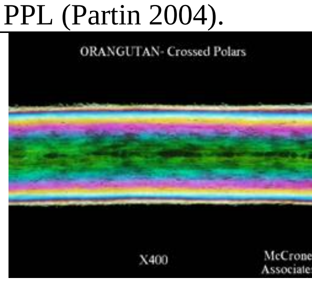
5.6 Discussion of Results

Polarized Light Microscopy: Scientific analysis helped identify several materials on the orangutan. Comparing known reference samples of cotton to the batting fibers from a hand and foot using polarized light microscopy showed the fibers all shared the same characteristics in plane- and cross-polarized light (both morphological and optical properties). These similarities are adequate to conclude that the batting materials are both cotton, despite the difference in color between the yellow-brown batting of the hands and white batting of the feet. The sample of stitching thread also exhibited the same characteristics as the reference cotton fiber. The fact that these materials are organic and not synthetic, points out that they are more susceptible to fluctuations in the environment, pest infestations, and mold growth, and this should be considered when stored and displayed (see Appendix B on Preventive Conservation).

Polarized light microscopy also showed that pigment particles collected from the lips were remnants of paint. Some of the particles matched the reference pigment Gypsum, while others were similar to Rose Madder. The pink paint may be a blend of more pigments, but the confirmation that it is paint is adequate for the treatment. Since the pink paint was most likely applied by the taxidermist, it will not be removed. The orangutan hair was mounted and observed and will be saved for future reference (since no reference orangutan hair was available during treatment).

Figure 41: Table of microscopy results:

Sample from Object:	**Reference Sample:**	**Conclusion:**
 Batting material from proper right foot in plane-polarized light (PPL) showing characteristic collapsed lumen	 Cotton reference fiber in plane-polarized light (PPL)	The batting fiber and cotton reference fiber match. The batting material is made of cotton.
 Batting material from proper right foot in cross-polarized light (CPL)	 Cotton reference fiber in cross-polarized light (CPL)	The batting fiber and cotton reference fiber match. The batting material is made of cotton.
 Batting material from the proper right hand in PPL.	 Cotton reference fiber in PPL	The batting fiber and cotton reference fiber match. The batting material is made of cotton.

 Stitching thread in PPL	 Cotton reference fiber in PPL.	The stitching thread fiber and cotton reference fiber match. The thread is made of cotton. (The thread is red from dye.)
 Individual particles from the pigment on the lips in PPL. Samples display similar morphology and optical properties to known reference.	 Gypsum pigment reference in PPL	The pigment gypsum matches some of the particles found in the paint on the lips. The paint on the lips includes some gypsum.
 Individual particles from the pigment on the lips in PPL	 Rose madder pigment reference slide in PPL	The pigment rose madder matches some of the particles found in the paint on the lips. The paint on the lips includes some rose madder.
 Orangutan hair in PPL	 Orangutan reference slide in PPL (Partin 2004).	Slight color difference expected, since orangutan hair ranges in colors. Medulla and cuticle similar between the two samples.
 Orangutan hair in CPL.	 Orangutan reference slide in CPL (Partin 2004).	Higher birefringence in reference, but both samples are anisotropic.

X-Ray Fluorescence (XRF): Although the x-radiograph revealed that there was no evidence of toxic heavy metal pesticides within the specimen (see Section 4.3 on imaging), readings from the XRF were used to confirm the findings. Arsenic and mercury are two of the heavy metal pesticides that were traditionally used in preparing taxidermy mounts in order to deter insects from eating the proteinaceous material (see Section 2.1 on traditional taxidermy methods; Marte et. al. 2006; Morris 2010; Goldberg 1996). Because arsenic and mercury are heavy, or dense, the x-ray would be able to detect their presence, even when internally applied (Sirois et. al. 2008). Collecting spectra from five locations did now show signs of arsenic or mercury, even in areas that traditionally would be treated with pesticides, like the face and torso (see Figure 42). Elements that were present in the largest quantities are most likely from the organic/proteinaceous material that makes up the specimen (Sr, Ca, Mn, the large Compton peak), or from the metal armature and tacks/nails (Fe, Zn, Cu). A very small lead (Pb) peak is present, but it is most likely from the environmental contamination. The elements Rh, Pd are present from the x-ray tube.

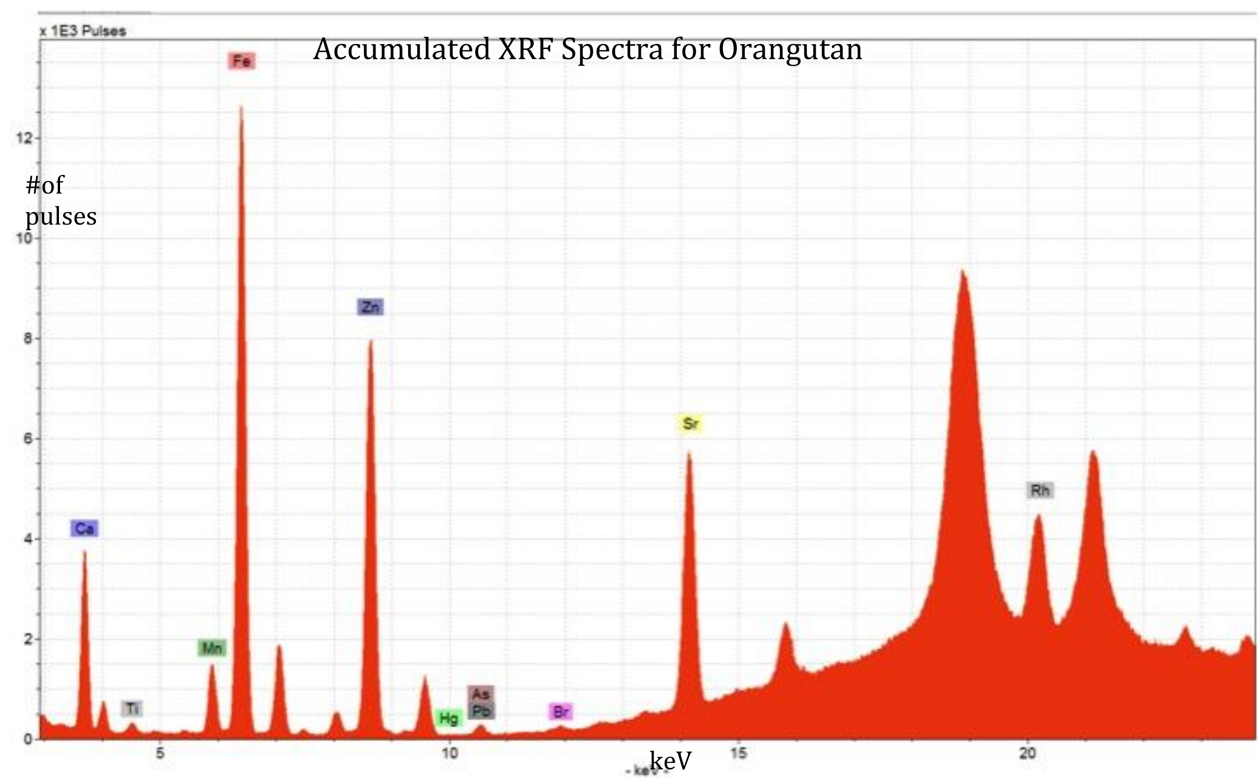


Figure 42: An accumulation of the spectra collected in five different locations on the specimen. Arsenic and mercury are not present, and the peak for lead is so small compared to the other peaks that it is most likely from the environment.

Attenuated Total Reflectance Fourier Transform-Infrared Spectroscopy (ATR-FTIR):

Using ultraviolet radiation to image the orangutan showed that there were some areas in the hands that fluoresced a bright white-yellow in the cracks under the skin. Samples from the hands and feet were tested using ATR-FTIR to discover the element composition of the samples. The spectra collected were compared to known reference spectra provided by the Omnic software reference library to determine whether or not an adhesive was used for attaching the orangutan to the mount. The samples from the proper right hand (recovered from the mount) and the proper right foot produced similar spectra (see Appendix A). The spectra matched reference spectra for natural rubber (like rubber cement), kaolin, and an ethylene/vinylacetate (EVA) adhesive (see Appendix A). A composite of those three materials was produced using the Omnic Spectra software and compared to the proper right hand sample to further confirm the match (see Figure 43). The composite spectrum did not match a reference spectrum for human skin (a close cousin to orangutan) (see Appendix A). Running ATR-FTIR confirmed the visual analysis that the palms and foot pads are made almost entirely of latex rubber.

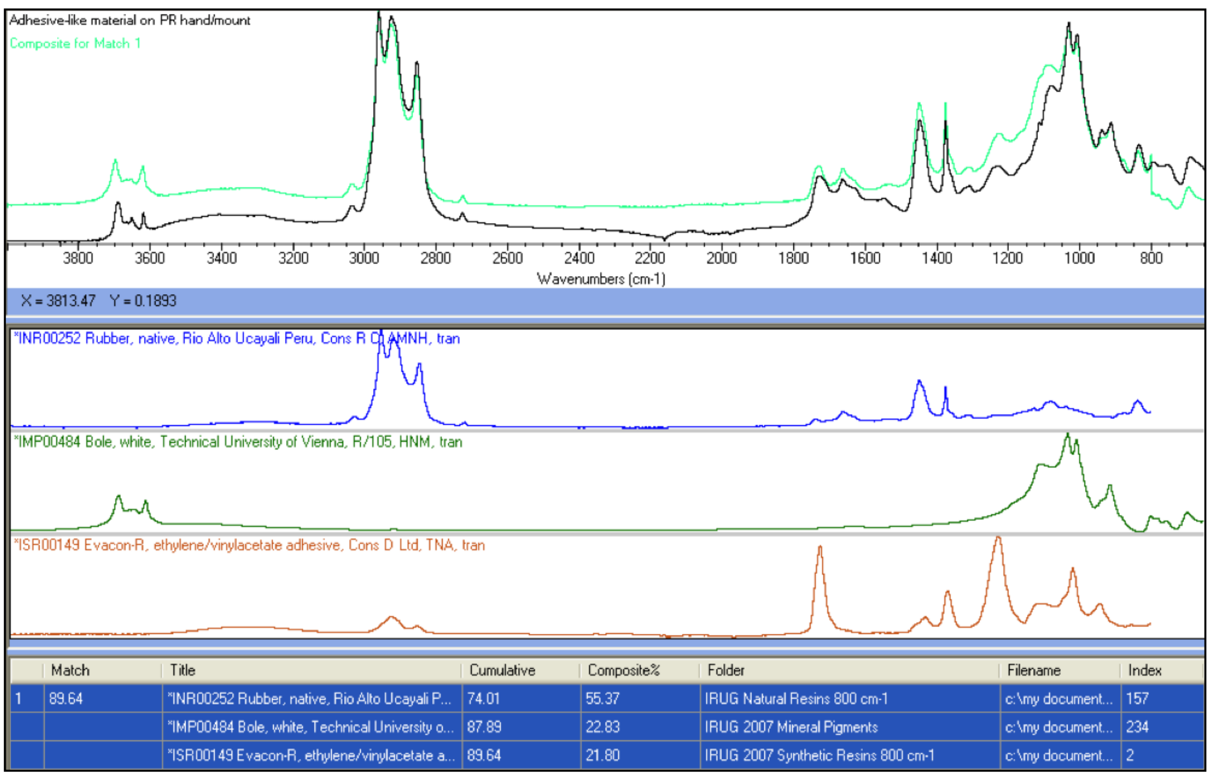


Figure 43: The Omnic Specta reference software produced a composite spectrum using the three materials that were the closest matches to the sampled spectra and are shown individually at the bottom ("native rubber" in blue, bole representing kaolin in green, and Evaon-R representing the EVA adhesive in brown). The composite spectrum is shown in aqua at the top, above the sample spectrum in black. Visually comparing the composite and sample spetra show that they are a very close match and that the three materials are present in the sample.

Transmission Fourier Transform Infrared (FTIR) Microscopy: Comparing the spectrum that was obtained from the transmission microscopy FTIR to the library of reference spectra produced a close match with Japan wax (see Appendix A). Both spectra have sharp peaks in the 2850-2960cm^{-1} regions that represent the C-H stretching (carbon chains), as well as small sharp peaks around 1730cm^{-1} (weak C=O bonds) and 1175cm^{-1} (weak C-0 bonds) that represent ester groups (see Appendix A). The doublet peak around 1470cm^{-1} is a "confirmatory band" for wax (Derrick et. al. 1999: 102).

Figure 44: Material Analysis Locations

Key:
- =XRF data collection points
- =batting material sampling
- =pigment sampling
- =stitching thread sampling
- =skin sampling
- =white accretion sampling
- =sticky rubber sampling

6 CONSERVATION TREATMENT

6.1 TREATMENT GOALS

The Buffalo Museum of Science (BMS) would like the orangutan to be more portable than it was when attached to the previous mount. The future use of the orangutan is unknown at this time, but the museum is interested in utilizing it for display in cases or during lectures. The type of repair and extent of treatment will depend upon how well the specimen can be re-mounted. After conservation treatment, the specimen will be mounted to an appropriate-looking mount that supports it without causing harm during handling and display. The mount will be reminiscent of indigenous habitat for orangutans, but it will not be elaborate. Improving the aesthetic is an important aspect of the treatment, in addition to the structural repairs, since the specimen is used for public display. Therefore, more in-painting will be executed than if the object was valued for scientific purposes only. The overall appearance of the specimen will improve after cleaning, consolidation, and in-painting.

The taxidermy techniques that were used to mount the orangutan are distracting because the seams are large and prominent. The BMS is not concerned with this look, and redoing them would be highly invasive since they are not loose. The seams and misaligned pieces of skin will remain as is; the skin will not be remounted onto the internal form.

Figure 45: Proper right hand fragments nailed to driftwood.

Figure 46: Proper left hand fragments nailed to driftwood.

6.2 PRELIMINARY TREATMENT

The department received the specimen with the heavy wooden driftwood display mount still attached. The specimen was too fragile to remove it from the cardboard receiving box and position for photography, so initial shots were taken while still in the box. The orangutan and driftwood were then carefully removed from the receiving box and separated by prying out the nails in the hands (see Figures 45 & 46). Fragments of three fingers from the proper right hand, and the thumb and a fingertip from the proper left hand, remained nailed onto the driftwood. These fragments were recovered and bagged for future reattachment. The skin on the proper left foot was stuck to the wood and had to be gently scraped off using thumbnails and microspatula. After removing the orangutan, the driftwood was discarded at the request of the Buffalo Museum of Science. The orangutan was photographed and examined (see Sections 3 & 4).

6.3 Stabilization

Although the hair of the orangutan was dusty, the flaking skin layer needed consolidation before any cleaning. Large areas of flaking skin, such as a patch on the proper right side of the torso, were consolidated by injecting a dilute solution of BEVA 371 liquid under the skin (see Figure 47). After the xylenes evaporated, the skin was reattached by tacking with a tacking iron set to 150$^{\circ F}$ (the amount of heat required to set the BEVA). The consolidant needed to be injected because the flaking outer skin layer (epidermis) was pierced by hair secured in the inner skin layer (dermis). The hair could not be moved out of the way when trying to insert BEVA film, which made it difficult to push the flaking skin back into place. Heat-set BEVA was chosen because the pieces could be tacked into place without requiring a clamp. BEVA is a stable mixture of several copolymers and solvents that has a lower T_g than other heat-set adhesives, making it safer to use on organic materials that are damaged by excessive heat. BEVA liquid and BEVA film are popular adhesives with paintings and ethnographic objects conservators because of those properties, as well as its flexibility (Kronthal 2003).

Figure 47: Injecting dilute BEVA liquid under flaking skin on the proper right side of the torso.

Figure 48: White area of skin loss on the proper right armpit. Edges consolidated by wicking dilute B-72.

Smaller patches of flaking skin were also consolidated inadvertently. A barrier layer of acrylic resin Paraloid B-72 (dilute solution) was applied to areas of loss on the skin using a small brush. This barrier layer will allow in-painting to be removed more easily in the future, if need be. During this process, several smaller areas of lifting skin were discovered. The thin B-72 solution was wicked beneath this skin and held with a finger for a minute to clamp until set (see Figure 48). Using the B-72 in small areas was more manageable than injecting BEVA because it could be clamped sufficiently with a finger and wicked in well, whereas injecting would be cumbersome. Any excess B-72 that "leaked" from the flaking skin did not need to be cleaned, as it is the barrier layer. The Paraloid B-72 was chosen as an adhesive because of its known stability, solubility, and good adhesion properties (Down 1996).

Figure 49: Inserting toned Japanese tissue infused with BEVA film as the lining material for the splits in the rubber.

Figure 50: After repairing the splits on the proper right hand fragment.

There were several splits in the rubber of the hands and feet that needed stabilization and repair. Lining the splits with adhesive-infused lining provided more support than adhesive alone. Pieces of Japanese tissue toned with acrylic paint were infused with BEVA film to create the lining. Japanese tissue is a thin, but strong, paper because it is made of laminated fibers and is thus a good repair material for conservation. The toning helped the tissue visually blend in with the rubber and also provided a contrast to the white batting material in the hands and feet. Without a contrast in color, it would be difficult to see if the patch was positioned correctly. BEVA liquid was then brushed onto the thick edges of the split to provide additional adhesion during lining. Although it dried quickly, it was reactivated and set in place during the tacking of the lining, thus preventing the edges from gaping open. Once the tissue was positioned in the desired location, it was attached from the heat of a tacking iron set to 150$^{\circ F}$ (the amount of heat required to set the BEVA). See Figures 49 & 50 for before and after repair.

Some splits were easier to repair than others, based on accessibility of the back inner surface. The splits on the detached finger fragments were easily accessible to line on the inside by temporarily removing the inner batting material. Some splits on the hands and feet also could be accessed internally by temporarily removing the inner batting material. The split on the ring finger of the proper left hand was not accessible from the inside, so the batting material was pushed away from the skin by inserting a microspatula between the layers. The tissue lining was inserted and tacked on one side of the split, and then fine tweezers were used to pull and hold the other side of the split in place during setting. Two splits on the toes of the proper left foot did not realign exactly and the lining material is visible. A hole in the first toe of the proper left foot was difficult to line without access to the back, and the rubber was very flexible and sticky, causing it to slowly pull away. The hole was therefore also lined from the top and in-painted with acrylic paints to match the surrounding rubber. Lining on the top also reduced the amount of sticky rubber, which will prevent it from attracting dust and dirt.

Figure 51: Proper left hand before reattaching pointer and pinky fingers (pointer finger fragment resting in palm).

Figure 52: Proper left hand after reattaching pointer and pinky fingers.

The detached fingers were reattached using the same BEVA infused toned Japanese tissue. The lining was attached to one side first, and then to the other. When possible, a microspatula was inserted into the finger to provide a stiff support to press upon with the tacking iron. The join of the pinky of the proper left hand did not close completely and required a small piece of lining to be applied to the outside. The outer lining was in-painted with acrylic paints to match surrounding areas (see Figures 51 & 51). During this process, holes in the rubber of the fingers and toes that were formed from the nails were diminished. The heat from the tacking iron warmed the rubber enough to massage it back into place and significantly reduce the size of the holes. This was successful in many holes, but not all of them. Those in areas of thicker rubber (i.e. some of the toes) did not respond as readily to heat.

Repairing the torn leather on the top of the feet required thicker lining than Japanese tissue. The tanned skin is not soft like the rubber palmside and has a texture more like stiff old leather (similar to thick *papier-mâché*). To line the split on the top of the proper left foot and to re-attach the broken proper right foot, pieces of spun polyester were flocked with BEVA and used as the lining. To flock the spun polyester, liquid BEVA is sprayed onto the surface at a distance that allows it to lose solvent, making strings of the adhesive. The "strings" land on the surface and create a non-woven pattern that is built up, making an ample amount of adhesive. Besides providing a stiffer support via the non-woven polyester, the flocked BEVA also allows less heat to be used for setting. The heat activates the top of the flocked adhesive, which then melts the bottom of the adhesive without needing to keep the tacking iron on the specimen. Because there is more adhesive in the lining, it worked best when held in place during setting/cooling to prevent repositioning. The pointer finger of the proper left hand also required the use a tougher lining because it was torn from the topside that had thick leather like the top of the feet.

Although the hair on the orangutan is stable overall, some did detach during treatment and required stabilization and reattachment. Clumps of hair on the torso and in the armpit were loose and only held onto the specimen by being tangled with other attached hairs. The clumps were reattached using B-72. Individual hairs that detached were collected and grouped together. The groupings were also reattached using B-72 and added to inconspicuous places, since their original locations were unknown. Smaller hairs and hairs that detached during final photography were bagged for return to the museum. The stabilization of the loose hairs, splits in the rubber, and broken fragments slow the rate of deterioration of the specimen, allowing it to be viewed and studied for many more decades.

6.4 Re-Mounting

The new display support mount for the specimen was made from artificial tree branches that provided stability without excessive weight (unlike the original heavy driftwood mount). An artificial branch of a good shape was purchased from a taxidermy supply company. According to the manufacturer, the branch is made from "polyester resin foam" (polyurethane foam) with a layer of fiberglass and wooden core. The branch arrived uncolored and with rough, noticeable seams from fabrication. The seams were coated with an adhesive that dried slightly tacky (Rhoplex mixture), then covered with lightweight spackle. Once set, the spackle was carved/impressed to match the surrounding texture. The circumference of the branch was too big to fit in the grip of the proper left hand, so an additional branch segment needed to be added. This segment was made by collecting a real branch similar in texture to the artificial branch with the desired circumference (a fragment of Slippery Elm was used), molding it out of silicone rubber, and casting it with araldite epoxy. Araldite epoxy is lightweight, stable, and easily carvable after setting. A second araldite branch was made to accommodate the difference in height between the proper left and proper right feet (because the proper left is stepping up). The branches were colored with a base coat of acrylic airbrush paint that was sprayed on to ensure that all the crevasses in the texture were filled. The polyurethane branch and one araldite branch were attached via screws and nuts to a wooden box base that was made from birch

Figure 53: Polyurethane branch (painted brown) and two araldite branches (light brown) attached to wooden box base (before painting to look realistic).

ply and held together with wood glue. The second araldite branch was attached to the polyurethane branch, secured with a screw. Screw holes were countersunk and filled with lightweight spackle carved to add texture (see Figure 53). The box base was painted with acrylic house paint. Once the specimen was reattached, the branches were sponged with different colored acrylic paints to create a final realistic look.

Threaded metal rods (zinc plated) were inserted into the specimen to provide a strong link between the internal support of the specimen and the new external display support. To prepare the proper right hand, the batting material was removed from the palm and a hole drilled into the plaster of the wrist. A wooden peg coated with araldite was inserted into the hole, and an approximately four-inch long rod fragment was inserted perpendicularly into the peg (held in place with araldite) (see Figure 54). The palm was reconstructed and reinforced by filling with lightweight spackle. The remaining fingers were reattached using the toned Japanese tissue infused with BEVA method previously described (see Figure 55). The proper left hand was prepared by inserting an araldite-covered piece of rod approximately four inches long directly into a drilled hole in the palm. The proper right leg was prepared by inserting an araldite-covered piece of rod approximately ten inches long directly into a hole drilled in the proper right leg (from the heel of the foot).

Figure 54: Palm of proper right hand during insertion of wooden peg and threaded rod.

Figure 55: Palm of proper right hand with reconstruction (using lightweight spackle) and after reattaching the broken fingers.

The specimen was attached to the new support mount by drilling holes into the artificial branches and inserting the new rods from the specimen. Washers and nuts secured the rods into place. Aluminum foil was applied to the ends of the rods on the hands to act as a barrier layer for the fill materials. The hole in the artificial branch for the proper right hand attachment was filled with lightweight spackle. Araldite was applied around the end of the rod from the proper left hand to resemble a branch stump. The "stump" center was filled with lightweight spackle, not araldite, so that it can be removed more easily in the future (see Figure 56). The proper left foot was attached to the araldite branch using Japanese tissue infused with BEVA film. The pieces of tissue were only added to areas where the foot already aligned with the branch, so the rubber was not forced into place.

Figure 56: Attachment of proper left hand (before final painting of mount support). Screw end covered in aluminum foil with araldite surround, and then filled with light weight spackle.

6.5 Visual Compensation

Taxidermy specimens are valued for their aesthetic, so visual compensations were made to create a more complete look of the specimen. To clean the orangutan, surface debris, dust, and dirt were removed by gently brushing with a soft bristle brush into a vacuum cleaner. The vacuum nozzle was covered with nylon mesh to protect from losing valuable loose pieces. A smaller soft bristle brush was used to clean debris from the eyes and ears. The specimen seems to have a coating on the hair because it is stiff and slightly sticky (it feels similar to hairspray). Small clear drops of resin are visible throughout some of the tips of hair. This condition makes it difficult to brush or fluff up the hair, and has resulted in tangling hair and embedded debris. The resin coating also makes it difficult to dust the skin beneath the hair. Smaller pieces of wood (from the mount) and flaking skin were removed using tweezers, being careful not to pull out the individual hairs. The white accretion of wax on the face and neck was removed through several rounds of lightly rubbing slightly dampened cotton swabs of petroleum benzine onto the accretion.

To make the overall appearance of the specimen more uniform, several areas were touched up using fills and in-painting. The broken tip of the proper right ear was repaired using Japanese tissue adhered with wheat starch paste. Wheat starch paste has good adhesion properties with paper and other organic materials, and is easily reversible if the fill needs to be removed in the future. A small amount of paste was left in an open container to evaporate some of the water, making it stickier and introducing less moisture. For the darker area on the ear, the tissue was first painted with acrylic paint and then attached. A more mottled area was filled with unpainted tissue and then in-painted to match surrounding areas using acrylic paints.

The unsightly seams running down the torso, in the proper right armpit, under the chin, and the proper right wrist were also visibly reduced using toned Japanese tissue adhered with wheat starch paste. It was water cut to feather the edges and make them blend in with surrounding areas. The fills were placed on top of thread stitches and nail heads, as well as bridged over gaps in the seams (see Figure 57). The hair of the orangutan was held out place during this process using hair clips and could be worked around, for the most part. In some areas (especially under the chin), the hair was sticking out of the seams. In those areas the toned tissue was stuffed into the seam around the hair, since it could not be bridged over the hair. The Japanese tissue was toned with fiber reactive acid dyes, and colors were chosen to match surrounding areas. The skin is varied in color, making the color matching easier. Only a few of the tissue fills required further in-painting after application to complement surrounding skin. The most visible thread knots were covered with tissue, and the loose knot ends were trimmed and bagged. The knots were consolidated with B-72 to keep from unraveling.

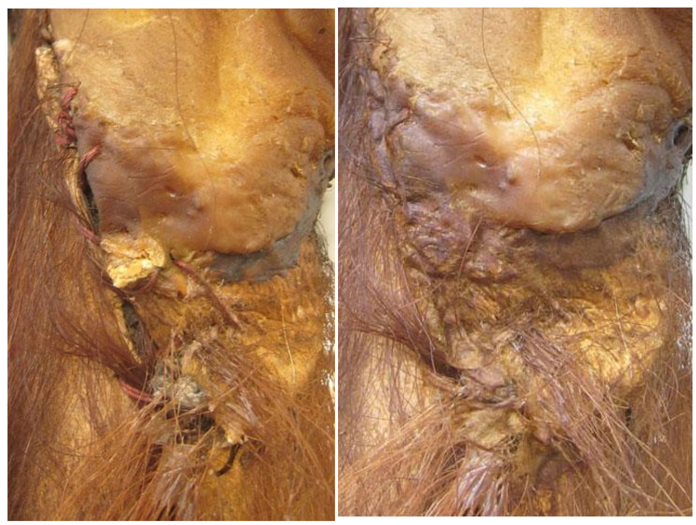


Figure 57: Proper right wrist seam before and after treatment.

The batting material in the palm of the proper left hand matted down after many years of gripping the driftwood during display. The palm was reconstructed/filled by cutting off excess rubber (which was then bagged for archiving), applying lightweight spackle in the void, and in-painting (see Figure 58). The rubber of the pointer finger of the proper left hand pulled away from the leather over time, so that gap was bridged with the spun polyester flocked BEVA and Japanese tissue lining and then in-painted (see Figure 59). The tip of the first toe on the proper right foot was pointing up, so two insect pins were inserted to reposition it into a more downward (natural) position. The pins were covered with the Japanese tissue lining and in-painted. Smalls splits and nail holes on the outside of the proper left hand and on the toes were covered with toned Japanese tissue lining and in-painted. Once the specimen was mounted it became evident that the fingers on proper left hand may separate and slump as time passes. To prevent the movement of the ring finger, a splint of the Japanese tissue lining was added between the ring and pinky fingers. A small piece of lining was added to the base of the pinky finger because it appeared to be separating as well.

Figure 58: The palm of the proper left hand during reconstruction with lightweight spackled (left) and after treatment (right).

Figure 59: Broken pointer finger on proper left hand during addition of spun polyester (flocked with BEVA) lining/bridging (top) and after treatment (bottom).

In addition to in-painting the fills, areas where the top layer of the leather had flaked away were visually compensated. The areas of loss were noticeable because of a color difference (the loss being lighter) and painting the surface with acrylic paints created a more uniform surface. Once the skin was in-painted, the hair appeared thicker and the face of the orangutan more life-life. The main areas that required in-painting were the face, proper right armpit, and torso. Smaller patches throughout the orangutan also required compensation, as well as an area of resin applied by the taxidermist. The resin had a cloudy appearance that was very noticeable because it held together a clump of hair directly under the chin. The cleaning, filling, and in-painting improved the overall appearance of the orangutan, making the specimen appear fresher.

Figure 60: The specimen after treatment (anterior view).

7 Conclusion

Exploring the history of mammalian taxidermy and utilizing scientific analyses helped inform the investigation of the fabrication of the taxidermy orangutan from the Buffalo Museum of Science. After determining the materials and condition of the specimen, a treatment plan was outlined and carried out, resulting in the stabilization and visual compensation of the orangutan. Although this conservation treatment was successful in stabilizing the specimen for now, it does not prevent future deterioration, especially for materials with inherent preservation problems, like the rubber. See Appendix B for recommendations on preventive conservation that will help preserve the specimen for years to come.

ACKNOWLEDGMENTS

This project could not have been successfully completed without the support of the faculty and staff of Buffalo State College Art Conservation Program, the Buffalo Museum of Science, and the Buffalo Zoo. The treatment would not have been possible without the guidance and knowledge of Object Professor Jonathan Thornton at Buffalo State College. Dr. Aaron Shugar and Dr. Cory Rogge, Conservation Scientists at Buffalo State College, each provided direction for analytical techniques. Examination and Documentation Professor at Buffalo State College, Dan Kushel, aided in the imaging documentation, especially x-radiography. Kathy Leacock, Curator of Collections at Buffalo Museum of Science, graciously allowed that the orangutan be submitted for treatment. Dr. John Grehan, former Director of Science and Research at Buffalo Museum of Science, was instrumental in identifying the orangutan's need for treatment. Jean Miller, Registrar for the Buffalo Zoo, provided information on the history of the orangutan.

REFERENCES

Akeley, Carl. 1920. In Brightest Africa. Garden City, NY: Doubleday, Page & Co.

Aloi, Giovanni. 2012. Art & Animals. New York: I.B. Tauris & Co. Ltd.

Asma, Stephen T. 2001. Stuffed Animals & Pickled Heads: the culture and evolution of natural history museums. New York: Oxford University Press.

Browne, Montagu. 1884. Practical Taxidermy: a manual of instruction to the amateur in collecting, preserving, and setting up natural history specimens of all kinds. To which is added a chapter upon the pictorial arrangement of museums. London: L. Upcott Gill, London and County Printing Works. (Available on-line http://www.gutenberg.org/files/26014/26014-h/26014-h.htm#Toc178253673)

Browne, Montagu. 1896. Artistic and Scientific Taxidermy and Modeling: a manual of instruction in the methods of preserving and reproducing the correct form of all natural objects, including a chapter on the modeling of foliage. London: Adam and Charles Black.

Carter, David, and Annette K. Walker. 1999. Care and Conservation of Natural History Collections. Oxford: Butterworth-Heinemann.

Derrick, Michele R., Dusan Stulik, and James M. Landry. 1999. Infrared Spectroscopy in Conservation Science. Los Angeles: The Getty Conservation Institute.

Dignard, C. 1989. "Tear Repair of Skins with Minimal Access to Their Backs: The Treatment of a Kayak." In *Leather Conservation News*. Vol. 7, no. 2. Pp. 1-8.

Down, Jane L, Maureen A. MacDonald, Jean Tetreault, et. al. 1996. "Adhesive Testing at the Canadian Conservation Institute: An Evaluation of Selected Poly(vinyl Acetate) and Acrylic Adhesives." In *Studies in Conservation*, Vol. 41, No. 1. Pp. 19-44.

Duckworth, W. Donald, Hugh H. Genoways, and Carolyn L. Rose. 1993. Preserving Natural Science Collections: Chronicle of Our Environmental Heritage. Washington, D.C.: National Institute for the Conservation of Cultural Property.

Entwistle, Robert, Georgina Kemp, Julie Marsden, et. al., Eds. 1992. "Life after Death: the Practical Conservation of Natural History Collections." London: United Kingdom Institute for Conservation.

Found, Christine and Kate Helwig. 1995. "The Reliability of Spot Tests for the Detection of Arsenic and Mercury in Natural History Collections: A Case Study." In *Collection Forum* by SPNHC. Spring. Vol. 11, No. 1. Pp. 6-15. (http://www.spnhc.org/media/assets/cofo_1995_V11N1.pdf)

Fountain, Henry. 21 October 2011. "Behind the Glass, Primping Up Some Old Friends." In The New York Times. <http://www.nytimes.com/2011/10/23/arts/artsspecial/diorama-restoration-at-the-american-museum-of-natural-history.html?_r=2> Accessed 1 March 2012.

Galdikas, Birute M.F. 1995. Reflections of Eden: My Years with the Orangutans of Borneo. Canada: Little, Brown & Company.

Goldberg, Lisa. 1996. "A History of Pest Control Measures in the Anthropology Collections, National Museum of Natural History, Smithsonian Institution." In *Journal of the American Institute for Conservation*. Vol. 35, No. 1. Pp. 23-43.

Golden Pigments. <http://www.goldenpaints.com//products/color/infopg.php?K=0007350> Accessed 1 March 2012.

"Great Apes & Other Primates." Smithsonian National Zoological Park. <http://nationalzoo.si.edu/Animals/Primates/Facts/default.cfm> Accessed March 2012.

Grehan, John. Nov. 29, 2011. Director of Science & Research, Buffalo Museum of Science. Personal Communication via electronic mail. (jgrehan@sciencebuff.org)

Grier, Katherine C. 1988. Culture and Comfort: People, Parlors, and Upholstery, 1850-1930. Rochester, NY: University of Massachusetts Press.

Hatchfield, Pamela B. 2007. Pollutants in the Museum Environment. London: Archetype.

Hawks, Catharine. 2001. "Historical Survey of the Sources of Contamination of Ethnographic Materials in Museum Collections." In *Collection Forum* by SPNHC. Vol. 16, No. 1-2. Pp. 2-11.

Henning, Michelle. 2007. "Anthropomorphic Taxidermy and the Death of Nature: The Curious Art of Hermann Ploucquet, Walter Potter, and Charles Waterton." In *Victorian Literature and Culture*. Vol 35. Pp 663-678.

Horie, C.V. 1990. "Fading of Feathers by Light." In ICOM Committee for Conservation 9th Triennial Meeting Preprints. Los Angeles: ICOM Committee for Conservation.

Kamanitz, M. and J. Levinson. 1988. "The Conservation of Ethnographic Skin Objects at the American Museum of Natural History." In *Leather Conservation News*. Vol. 5 (fall). Pp. 1-7.

Kite, Marion, and Roy Thomson, Eds. 2006 Conservation of Leather and Related Materials. Oxford: Butterworth-Heinmann.

Kronthal, Lisa. Spring 2001. "Conservation of Chinese Shadow Figures: Investigations into their Manufacture, Storage, and Treatment." In *Journal of the American Institute for Conservation*, Vol. 40, No. 1. Pp. 1-14.

Kronthal, Lisa, Judith Levinson, Carole Dignard, et. al. 2003. "BEVA 371 and its Use as an Adhesive for Skin and Leather Repairs: Background and a Review of Treatments." In *Journal of the American Institute for Conservation*, Vol. 42, No. 2, Article 9. Pp. 341-362.

Mack, Abigail. 1993. "Evaluation of Backing Adhesives for Degraded Native Tanned Leather." Senior Research Project, Buffalo State College.

Marte, Fernando, Amandine Pequignot, and David W. Von Endt. 2006. "Arsenic in Taxidermy Collections: History, Detection, and Management." In *Collection Forum* by SPNHC. Vol. 21, No. 1-2. Pp. 143-150. http://www.crcc.cnrs.fr/IMG/pdf/Arsenic_in_taxidermy_collections-2.pdf

Milgrom, Melissa. 2010. Still Life: Adventures in Taxidermy. New York: Houghton Mifflin Harcourt.

Miller, Jean. Registrar, The Buffalo Zoo. Personal Communication. November 21, 2011. (716) 995-6149.

Morris, P.A. 2010. A History of Taxidermy: art, science, and bad taste. London: MPM Publishing.

Nieuwenhuizen, Linda. 1998. "Synthetic Fill Materials for Skin, Leather, and Furs." In *Journal of the American Institute for Conservation*, Vol. 37. Pp. 135-145.

Nudds, J.R., and C. W. Pettitt, Eds. 1997. The Value and Valuation of Natural Science Collections: Proceedings of the International Conference, Manchester, 1995. London: the Geological Society.

Partin, Kristen D. 2004 "A Microscopical Study of Exotic Animal Hair: Part 1." On-line. < http://www.modernmicroscopy.com/main.asp?article=24&page=3> Accessed April 23, 2012.

Pearlstein, Ellen, and Lionel Keene. 2010 "Evaluating color and fading of Red-Shafted Flicker (*Colaptes auratus cafer*) feathers: technical and cultural considerations." In Studies in Conservation. Vol. 55, no. 2. Pp. 81-94.

"Pongo pygmeaus." IUCN Red List of Threatened Species. <http://www.iucnredlist.org/apps/redlist/details/17975/0> Accessed 3/2012.

Quinn, Stephen C. 2006. Windows on Nature: The Great Habitat Dioramas of the American Museum of Natural History. New York: AMNH/Harry N. Abrams.

Rogge, Dr. Cory. Class notes. "Technical Aspects of Preventive Conservation." Spring 2012. Buffalo State College.

Rose, Carolyn L., and Amparo R. de Torres, Eds. 1995. Storage of Natural History Collections: Ideas and Practical Solutions, Vol. II. Washington, D.C.: Society for the Preservation of Natural History Collections.

Sirois, P. Jane, Jessica S. Johnson, Aaron Shugar, et. al. 2008. "Pesticide Contamination: Working Together to Find a Common Solution." In *Preserving Aboriginal Heritage: Technical and Traditional Approaches, Proceedings of Symposium 2007*. Ottawa: Canadian Conservation Institute.

"Take the O-Line." From "Beast in a Populous City" on-line blog. July 12, 2010 entry. <http://beastsinapopulouscity.blogspot.com/2010/07/take-o-line.html> Accessed March 2012.

Thornton, Jonathan. Fall 2010. "Leather Conservation." Class notes from CNS 642: Objects II, Buffalo State College.

"What does it mean to be human?" Smithsonian National Museum of Natural History. <http://humanorigins.si.edu/evidence/behavior/primate> Accessed March 2012.

Waddington, Janet, and David M. Rudkin, Eds. 1986. Proceedings of the 1985 Workshop on Care and Maintenance of Natural History Collections. Toronto, Canada: Royal Ontario Museum.

Williams, Don, and Louisa Jaggar. 2005. Saving Stuff. New York: Fireside.

Wolfe, Julie, and Eleonora Nagy. 2001. "Considerations for the Structural Stabilization of Deteriorated Industrial Rubber." In American Institute for Conservation of Historic and Artistic Works. Objects Specialty Group Postprints. Vol 8. Pp. 77-96.

MATERIAL SOURCES

Acrylic House Paint: Behr Premium Plue Ultra Interior & Exterior Latex House Paint ("Breakfast Blend" color). Behr Process Corporation; Santa Ana, CA 92704.

Acrylic Paint: GOLDEN ACRYLIC PAINT (raw umber, burnt umber, yellow ochre, raw sienna, burnt sienna, titanium white, carbon black, graphite grey) Golden Artist Colors, Inc., 188 Bell Road, New Berlin, NY 13411-9527; 607-847-6154

Araldite Epoxy: Araldite AV1253 Huntsman Advanced Materials Americas Inc.; 5121 San Fernando Road West; Los Angeles, CA 90039

Airbrush Acrylic Paint: GOLDEN ACRYLIC AIRBRUSH PAINT (raw sienna hue, raw umber hue, carbon black, titanium white) Golden Artist Colors, Inc., 188 Bell Road, New Berlin, NY 13411-9527; 607-847-6154

Artificial (polyurethane) Branch: Taylor's Habitat Replicas. (Limb-1; 45 ½ x 16 x 7 ½" off the wall with 2 ½" largest diameter) 336-674-8891. mike@Taylorshabitatreplicas.com http://www.taylorshabitatreplicas.com/prod03.htm

BEVA 371: (an ethylene vinyl acetate based adhesive) Conservator's Products Co. (CPC), P.O. Box 601, Flanders, NJ 07836. (201) 927-4855.
Film Form or
Dilute Solution: 4:5 solution of BEVA:xylenes

Japanese Tissue: SHIN TENGUJO (machine made roll) imported by Aiko's Art Materials Import, Inc., 3347 N. Clark, Chicago, Il 60657 [101cm wide x 200 m long; made by Morita Japanese Paper Co., Ltd. Kyoto, Japan]
Toned with Acrylic Paint or
Fibre Reactive Acid Dyes

Lightweight Spackle: Red Devil's Onetime Lightweight Spackling (soda lime, borosilicate glass, acrylic polymer emulsion, water, ethylene glycol, and mineral oil defoamer) 1-800-423-3845

Metal Rods: Zinc plated threaded metal rods, #8 and #10. Crown Bolt, Alibo Viego, CA 92656. (Purchased from Home Depot).

Paraloid B-72: B-72 (a copolymer of ethylmethacrylate and methyl acrylate) Rohm & Haas, Philadelphia, PA.
Dilute Solution: 5% solution of B-72 in acetone
Repair Solution: 25% solution of B-72 in a 50:50 mixture of acetone:ethanol

Rhoplex Mixture: A 1:1 mixture of two types of Rhoplex: B60A and N580. The B60A dries tacky and can provide the qualities of a pressure-sensitive tape. A mixture was used to ensure that any areas not covered by spackle would be able to dry more than B60A alone. RHOPLEX ([butyl acrylate homopolymer] emulsion) Rohm & Haas, Philadelphia, PA. Available from Conservator's Emporium, division of Museum Services Corporation, 385 Bridgepoint Drive, South St. Paul, MN 55075; 651-554-8954
OR Talas 330 Morgan Ave Brooklyn, NY 11211; 212-219-0770

Spun Polyester (before BEVA flocking): CEREX (spun bonded nylon, 0.4 oz./sq. yd.) Talas 330 Morgan Ave Brooklyn, NY 11211; 212-219-0770

Wheat Starch Paste: AYTEX-P, precipitated wheat starch, General Mills, dist. by TALAS, New York, NY

Wood Glue: Titebond II Premium Wood Glue. Franklin International; 2020 Bruck Street; Columbus, OH 43207.

LIST OF FIGURES

(Unattributed photos are property of Buffalo State College)

AUTOBIOGRAPHICAL STATEMENT

Fran Ritchie graduated from the University of Delaware in Newark, DE in 2006 with a double major in Art Conservation and Anthropology. After working as a Conservation Technician for the Objects Conservation Lab at Biltmore Estate in Asheville, NC for two years, she earned her Master's degree in Museum Anthropology from Columbia University in New York, NY. While in New York, Fran worked for a year and a half in the Natural Science Conservation lab at the American Museum of Natural History. Fran also completed conservation internships in the Archaeological Metals Conservation Lab at the Patronato Panama Viejo in Panama City, Panama, and in the Paintings Conservation Lab at Winterthur Estate and Gardens in Wilmington, DE. After a third year internship at the Peabody Museum of Archaeology and Ethnology at Harvard University in Boston, MA, Fran graduated in 2013 from the Program in Art Conservation at Buffalo State College, earning her M.A. C.A.S. in Art Conservation.

APPENDIX A: ADDITIONAL ATR-FTIR SPECTRA

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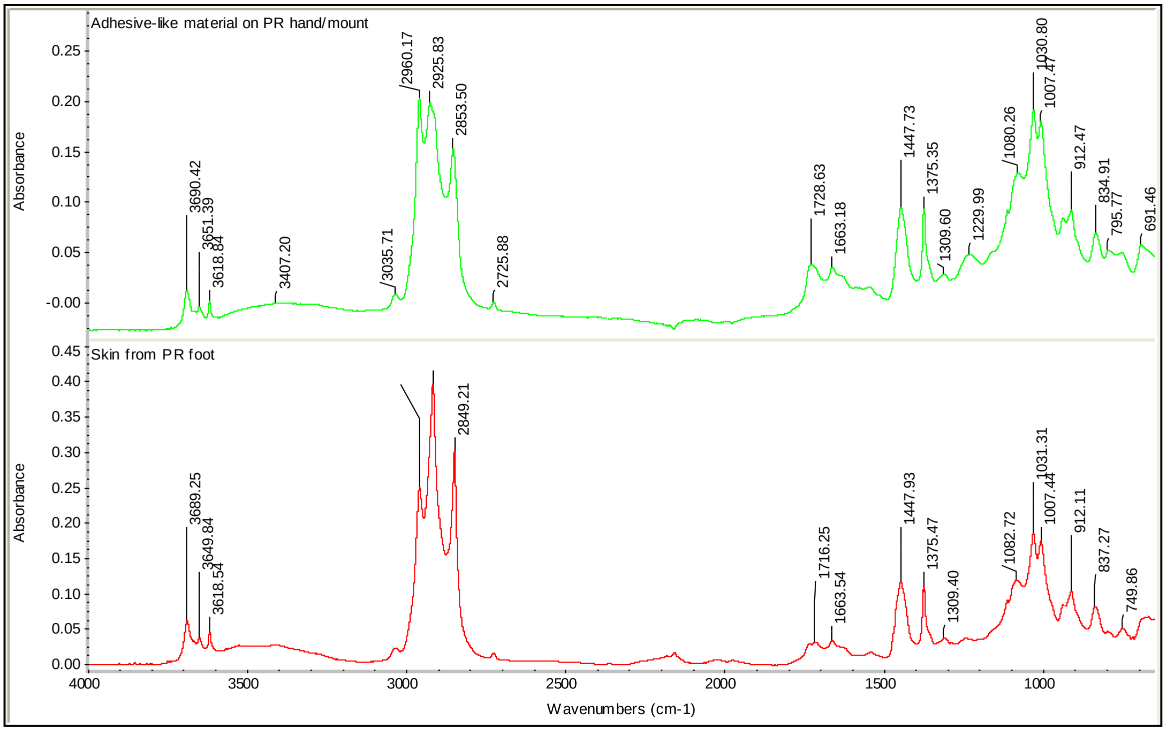

Figure A1: Spectrum for the adhesive-like material (later determined to be degrade latex rubber) sampled from the proper right hand (recovered from the mount) on top, compared to the spectrum for the sample of skin from the proper right foot on bottom.

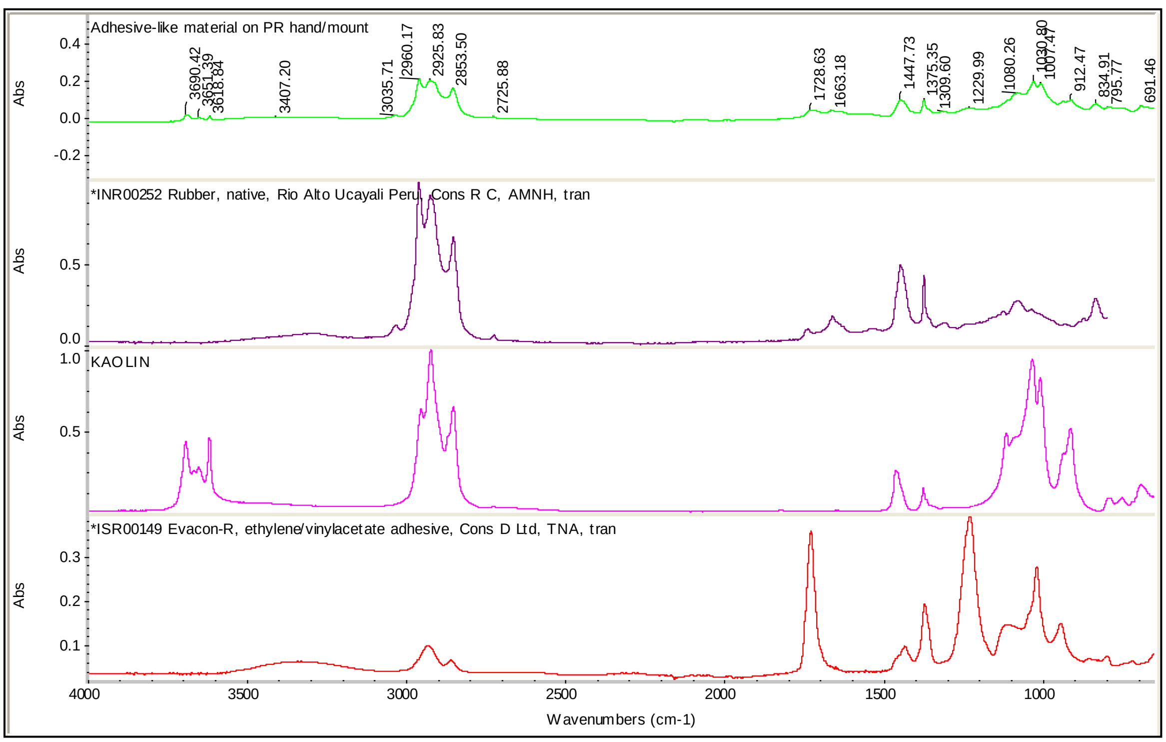

Figure A2: The spectrum from the adhesive-like material (degraded latex rubber) sampled from the proper right hand (recovered from the mount) on the top, compared to the spectra for natural rubber, kaolin, and an ethylene/vinylacetate adhesive (ex: woodglue).

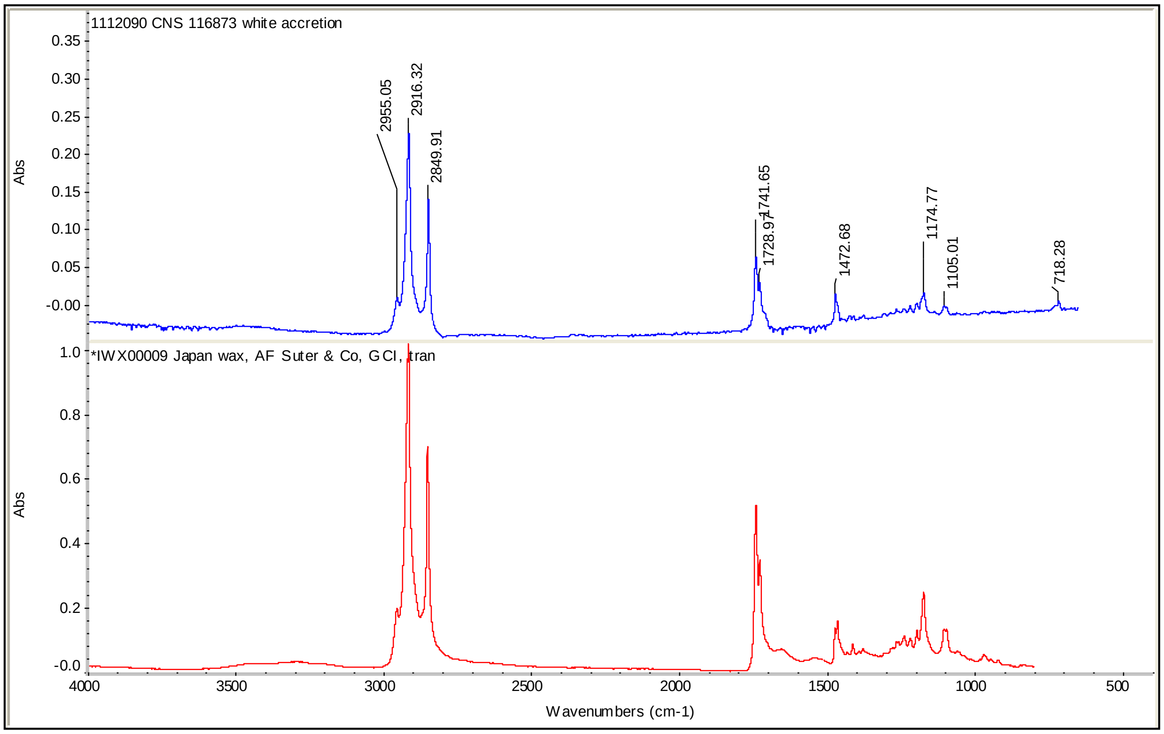

Figure A3: The top spectrum is the white accretion sample from the cheek of the orangutan, while the bottom is a reference spectrum of Japan wax that was obtained from the Omnic software.

APPENDIX B: PREVENTIVE CONSERVATION RECOMMENDATIONS

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Museum objects can be harmed due to factors beyond handling and the inherent vice of their material composition. There are several environmental concerns that museums (and private collectors) should be aware of when preserving artifacts. Exposure to the environment is unavoidable, but does not have to cause the demise of the specimen if the correct protocols are observed. The following sections outline different threats that environmental conditions pose to taxidermy specimens, like the museum's orangutan.

Pests:

Taxidermy objects are notorious for developing pest infestations because of the proteinaceous make-up of the animals (skin, fur, feathers, etc.), as well as the often organic mounting materials that are inviting to many insects. Taxidermy specimens are so inviting that toxic pesticides were commonly used as a pest deterrent until the latter half of the 20th century. The mounted orangutan has been tested for heavy metal pesticides using x-ray fluorescence and x-radiography, but none appear to have been used. An infestation would be expected because of the lack of pesticides; however, only one live odd beetle larva and several casings were discovered on the specimen. The casings were located toward the roots of the hair on the proper right arm, and the proper right ankle. The live larva was located on the proper right hip. The odd beetles were identified by comparing them to reference specimens of other protein-loving pests. To monitor for new infestations, the storage or display areas should be kept clean so new frass, debris, and loose casings will be detected. Periodically pick through the hair to spot casings and/or insects feeding close to the leather body. Freezing and anoxic chambers are two possible methods of pest eradication. An anoxic chamber is recommended for the treated specimen so that the freezing does not interfere with the adhesives.

Protein-Loving Pests:	Wood-Loving Pests:
-clothes moths (*Tineata bisselliella* and *Tinea pellionella*) -dermestids (aka lard beetles, hide beetles) -carpet beetles -odd beetles	-powderpost beetle -furniture beetle -deathwatch beetle

The leather and other organic components of the specimen (the internal cotton batting) are reactive to fluctuations in the environment. The orangutan does not have evidence of biological or bacterial growth, although it is susceptible to mold, fungi, and bacteria if conditions allow (i.e. high relative humidity, stagnant air). A white accretion did develop on the proper right cheek and neck, but analysis using Transmission Microscopy Fourier Transform Infrared Spectroscopy (FTIR) found that it was wax, not mold. To help prevent biological and bacterial growth, the orangutan should be kept in a cool, dry storeroom, or where the environment will be the most constant. Implementing a program of periodical visual analysis of specimens will help detect biological and bacterial growth (as well as insect infestation). Storing an older photograph of the specimen in the storeroom will allow for easy comparisons if a new area of growth is suspected.

Taxidermy animals that are mounted, not study skins, may also have organic mounting material that is susceptible to pest and biological infestation. The original wooden mount for the orangutan was removed upon arrival, but no flight holes (small circular holes) or frass were present, indicating no wood-boring pests. The mounts should be monitored for pests and unwanted growth by looking for flight holes and frass/debris on and below the mount, and visually studying them periodically.

Light:

Organic materials in natural history collections, like the orangutan, are not only susceptible to pest damage and biological growth but also suffer from light fading. As conservator C.V. Horie points out in his article on feather light fading, "it is known from common observation that natural history materials fade and change colour on exposure to light and air" (1990: 431). The American Museum of Natural History (AMNH) knows of this fading first-hand. The taxidermy specimens in the Hall of the North American Mammals have faded since installation in 1942. Stephen C. Quinn, the head of the museum's Exhibition Department, describes the specimens' furs as "dull," because the incandescent and fluorescent bulbs used to illuminate the dioramas have washed out the subtle tones over time (Fountain 2011). Despite this evidence of light fading of taxidermy, there is not a wealth of research specifically derived from testing furs for light-fastness and appropriate lighting guidelines. The chapters on fur and taxidermy conservation in the Butterworth-Heinemann book on *Conservation of Leather*, as well as *Care and Conservation of Natural History Collections* do not offer guidelines for lighting exposure or light levels (Kite 2006, Carter 1999). Microfading the fur and hair of taxidermy specimens is a research gap that needs filling in the field of conservation.

The orangutan does not exhibit signs of light damage-- no brittleness or color fading. The variation of color in the hair (from reddish brown to light orange) is consistent with hair of orangutans in the wild. Orangutans are known as the "red ape" because their hair "varies in hue from dark brown to light blond" and only sparsely covers their bodies (Galdikas 1995: 25). As the AMNH specimens show, the fading continues throughout the lifetime of the taxidermy specimen. Light damage is cumulative. To help stall fading, museum employees should follow recommendations for other light-sensitive materials. Ultraviolet (UV) filters should be placed on light bulbs to reduce the higher-energy UV emissions. Lights should be turned off when visitors are not present. Organic materials that are suspected to be fugitive should be kept around 50 lux (Horie 1990: 341, Williams 2005: 6), with an annual dose of 10000 lux hours (Pearlstein 2010: 82). These numbers are typically used as guidelines for natural history collections, although conservators are beginning to perform more thorough research into whether some materials can actually sustain higher lux values for longer duration (Pearlstein 2010).

Conservators are also concerned with the stability of the materials used in conservation treatments. Adhesives that are sensitive to light can yellow and become brittle, and paints for in-painting may fade. The acrylic resin Paraloid B-72 was used to provide a barrier layer for the original leather surface and the acrylic paint added to diminish the visual disruption of flaking skin. Although the adhesive is covered with a layer of paint, some small areas may be exposed and should be as stable as possible to prevent introducing further deterioration to the specimen. B-72 was tested by conservation scientist Jane Down and found to be stable with minimal light aging (Down 1996). The acrylic paints used for in-painting are Golden brand, a respected brand for artist paints that list a light-fastness value on each tube of paint. According to the Golden paints website, their light-fastness values are based on the standards for acrylic paints set by the American Society for Testing and Materials (ASTM) ("Golden Pigments"). The paints used in conservation treatment all have a lightfast value of "I," the highest ranking meaning excellent. Materials used in future steps of the treatment will be researched for light aging testing, in order to prevent material failure.

Relative Humidity:

Although natural history collections, specifically taxidermy mammals, experience fading from light damage, the effects of relative humidity (RH) are more detrimental to structural soundness. The organic make-up of taxidermy specimens that makes them vulnerable to pest infestations and mold growth (as mentioned previously), also makes them especially responsive to changes in the environment. A relative humidity of 40-50% is ideal, although not always attainable. A high RH (60-65% or above) may encourage mold growth, invite pests, and introduce moisture into the leather and hair; while a low RH (30% or below) can crack and split leather, ivory, wooden components, etc. Materials can acclimate to a low or high RH over time, and collections in tropic and dry locales can be relatively stable as the environment remains steady. Because they are so responsive to changes, it is fluctuation in RH that can be the most problematic for taxidermy specimens. If leather/skin is constantly expanding and contracting, it changes dimensionally and will split or sag from its mount. Taxidermy specimens are also composite pieces. The different materials may all respond at different rates to fluctuations in RH, causing damage.

Despite the threat posed by fluctuations relative humidity, the orangutan specimen has been displayed within a controlled museum environment and does not exhibit extreme deterioration from relative humidity. There are no splits or cracks in the leather of the body of the orangutan and the skin is still firmly attached to the internal mount. However, the hair does appear to have split at the ends, just as human hair splits over time from exposure to fluctuations in RH and temperature.

Pollution:

While light fading, pest infestations, mold growth, etc. can be detectable, damage caused by pollution may not be as obvious. Off-gasing from surrounding objects could have a harmful affect on taxidermy specimens. For example, nitrous oxides present in the air as a by-product of fuel burning can form nitric acid that will cause hydrolysis and weaken the organic materials in taxidermy. Sulfur, another by-product of fuel burning, as well as geological minerals and natural rubber, can also produce sulfuric acid within the collection and react with museum objects. Organic acids, such as acetic and formic acids, develop as certain types of wood (like oak) off-gas and can also cause hydrolysis of surrounding materials. Although the orangutan does not appear to have damage as a result of pollutants, it would be wise for the museum to examine the materials that are located in storage and display areas near the specimen. Building materials, paint, and storage cases should be allowed to off-gas before objects are placed within the spaces. The museum should keep windows closed and control the air flow within the building in an attempt to prevent contamination from outside pollutants. The new mounting materials (artificial branch and base) of the orangutan have been tested and produced negative results for nitrogen and sulfur, but have been given time to off-gas before adding the specimen.

Microclimates:

Despite all of the factors that can negatively affect the museum's specimen, the use of an enclosed microclimate may help reduce the possibility of deterioration from the environment. To help block dust and other pollutants from the settling on or interacting with the orangutan, it should be placed in a protective glass enclosure that is sealed to minimize air flow as much as possible. The addition of silica gel can help maintain the relative humidity in the case. Adding scavengers to remove oxygen, or designing a case that uses a nitrogen or argon atmosphere can help reduce the oxidation (and subsequent degradation) of the rubber. If the rubber does degrade, it will off-gas sulfur oxides into the enclosure. To scavenge the sulfur dioxide, oxidizers like potassium permanganate should be placed within the case as well. Replacing oxygen will also help eliminate pests living on the specimen. Lights around the enclosure should be turned off when the exhibit hall is not in use. If the specimen is not on display, a microclimate would still help slow deterioration in storage. If a microclimate is not available, covering the specimen with an archival material, like tyvek, will help protect against dust accumulation and light damage.

Although these factors seem insurmountable, taxidermy specimens have survived since the 16th century, even in unfavorable environmental conditions. Common preventive conservation practices can go a long way in protecting vulnerable organic materials, like the taxidermy orangutan.

Appendix References:

Carter, David, and Annette K. Walker. 1999. Care and Conservation of Natural History Collections. Oxford: Butterworth-Heinemann.

Down, Jane L, Maureen A. MacDonald, Jean Tetreault, et. al. 1996. "Adhesive Testing at the Canadian Conservation Institute: An Evaluation of Selected Poly(vinyl Acetate) and Acrylic Adhesives." In *Studies in Conservation*, Vol. 41, No. 1. Pp. 19-44.

Fountain, Henry. 21 October 2011. "Behind the Glass, Primping Up Some Old Friends." In The New York Times. <http://www.nytimes.com/2011/10/23/arts/artsspecial/diorama-restoration-at-the-american-museum-of-natural-history.html?_r=2> Accessed 1 March 2012.

Galdikas, Birute M.F. 1995. Reflections of Eden: My Years with the Orangutans of Borneo. Canada: Reed Business Information, Inc.

Golden Pigments. <http://www.goldenpaints.com//products/color/infopg.php?K=0007350> Accessed 1 March 2012.

Hatchfield, P.B. 2002. Pollutants in the Museum Environment. London: Archetype.

Horie, C.V. 1990. "Fading of Feathers by Light." In ICOM Committee for Conservation 9th Triennial Meeting Preprints. Los Angeles: ICOM Committee for Conservation.

Kite, Marion, and Roy Thomson, Eds. 2006 Conservation of Leather and Related Materials. Oxford: Butterworth-Heinmann.

Pearlstein, Ellen, and Lionel Keene. 2010 "Evaluating color and fading of Red-Shafted Flicker (*Colaptes auratus cafer*) feathers: technical and cultural considerations." In Studies in Conservation. Vol. 55, no. 2. Pp. 81-94.

Rogge, Dr. Cory. Class notes. "Technical Aspects of Preventive Conservation." Spring 2012. Buffalo State College.

Williams, Don, and Louisa Jaggar. 2005. Saving Stuff. New York: Fireside.