Reflections on **Research**

The Deterioration of the Chinchorro Mummies of Arica, Chile

By Christian de Brer

The mummies of the Chinchorro culture are of utmost importance to our world heritage. The Chinchorro people lived along the coast of present day northern Chile and southern Peru. They are believed to have been sedentary fishermen and gatherers that thrived on the abundant marine life. Significantly, the Chinchorro practiced elaborate mummification techniques that created the oldest artificially mummified humans known, reaching as far back as 5050 B.C. Equally impressive is the fact that these mummification practices lasted over 3,300 years with some minor variations in technique.

Many of the most remarkable Chinchorro mummies have been discovered in and around the town of Arica in Chile, where they are housed in the excellent Museo Arqueológico San Miguel de Azapa. Recently, the human remains have been exhibiting deterioration products in the form of an opaque dark substance that is very disfiguring. This summer, I had the opportunity to spend three weeks at the museum examining the substance, the mummies, and the surrounding storage environment. The analysis of this material and the prevention of further damage became the focus of my Master's thesis.

Conservation of the mummies requires a holistic approach that involves investigation of both internal and external agents of deterioration. Initial examination showed that the dark substance is found exclusively on the skin of the mummies and is intensified by multiple layers or thicker layers of skin and soft tissue. The skin exudate appears to have once been a liquid, but is presently hard and glass-like. Research on parchment (sheep and/or goat skin) from the Dead Sea Scrolls and soft tissue from the royal Egyptian mummies reveals a breakdown in the skin from collagen to gelatin, which is soluble in water. Also, the substance does not appear to originate from any other material used in the mummification process as it is also found on a naturally mummified Chinchorro mummy (unless there an ointment or other preparation of the dead was used). FTIR analysis at the Getty Conservation Institute (GCI) and GC/MS analysis at the Pasarow Mass Spectrometry Laboratory at UCLA are currently being utilized for comparing the exudate with the original skin, identifying the possible existence of gelatin, and determining the presence or absence of embalming materials or other substances used as part of a funerary ritual.

Microscopically, salt crystals can be seen efflorescing throughout areas of the skin that were probably impregnated from the soil during burial. Forthcoming ion chromatography analysis at the GCI will be used to compare salts within the skin with salts from soil collected from Chinchorro sites.

External agents can have a profound effect on not only the skin, but also on the many other organic materials that comprise the mummies. Contributing factors of deterioration of human remains include high and fluctuating relative humidity (RH) and temperature, improper lighting, pollutants, insect infestation and poor housing. Research suggests that the exudate could be a product of the putrification process of the skin from exposure to oxygen and water vapor in the surrounding environment. Soluble salts will also attract water vapor and can cause physical damage to the skin substrate. Tests in the storage facility of the museum revealed very high levels of relative humidity and generally poor control of the fluctuating outdoor environment. In July 2007 I installed data loggers in various areas of the museum to record RH and temperature periodically in order to understand the full extent of the problem. I also trained the staff at the museum in the use of the equipment, which is essential to creating a monitoring



program. At the GCI, samples are currently housed in chambers with fixed humidities to determine optimal parameters of RH for the Chinchorro mummies. High relative humidity can also lead to the growth of fungi and mold, which is currently being studied by microbiologists from the Universidad de Tarapacá de Arica. Other external factors of concern include the high level of particulates, such as dust, accumulating on the surface of the skin, which also attracts water vapor, and the improper housing, which has prevented mechanical damage to the human remains, but does nothing to mitigate the environmental causes of deterioration. It might be determined that adequate housing requires oxygen-free cases to prevent the breakdown of collagen.

A new hall of the museum is currently being constructed for the display and storage of all the Chinchorro mummies in the collection. It is the goal of my research to be able to better

Photo Captions: Left : A complete Chinchorro mummy in the storeroom of the Museo Arqueológico San Miguel de Azapa.

Top Right: The storeroom containing the best examples of the Chinchorro mummies. **Bottom Right:** Investigating Chinchorro artifacts found by a local near a Chichorro site.

understand the deterioration of the artificially mummified Chinchorro remains and to develop recommendations for housing and a museum environment that can be applied to all areas of the museum.

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