

## MICROBIOLOGICAL IMAGE

# Fungi and bacteria in the biodeterioration of archeological fibers. Analysis using different microscopic techniques

Hongos y bacterias en el biodeterioro de fibras arqueológicas.  
Análisis con diferentes técnicas microscópicas

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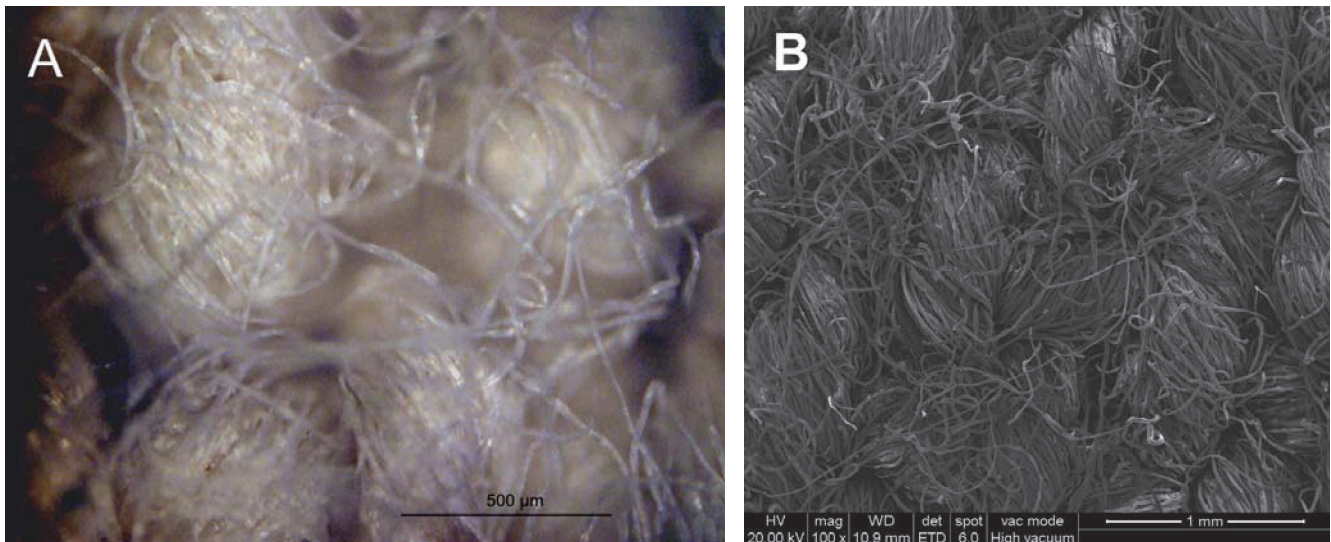
Pre and post-Columbian archeological textiles from the Southern Andean area, sheltered in Deposit 25 at La Plata Museum (Fig. 1), were analyzed by Olympus BX51 optical microscopy (OM) (Fig. 2A and 3A), FEI Quanta 200 scanning electron microscopy (SEM) (Figs. 2B and 3C) and Leica SP5 confocal laser scanning microscopy (CLSM) (Fig. 3B) with the aim of studying their biodeterioration<sup>3</sup>. For over 120 years, these textiles have provided information to archeologists around the world, and it was through the study of many pieces that we now know in detail the characteristics of the material culture of the various groups that inhabited the territory during the national Holocene period. Textiles containing natural fibers, and cotton fabrics can present problems when exposed to unfavorable external conditions. High humidity and temperature and insufficient air circulation result in enhanced growth of microorganisms, especially fungi<sup>2</sup>. Uncontrolled fungi growth leads to the complete deterioration of archeological fibers. Microorganisms such as fungi and bacteria (ie. *Cladosporium* sp. and *Pseudomonas* sp.) (Fig. 3) cause the biodeterioration of cellulose, which



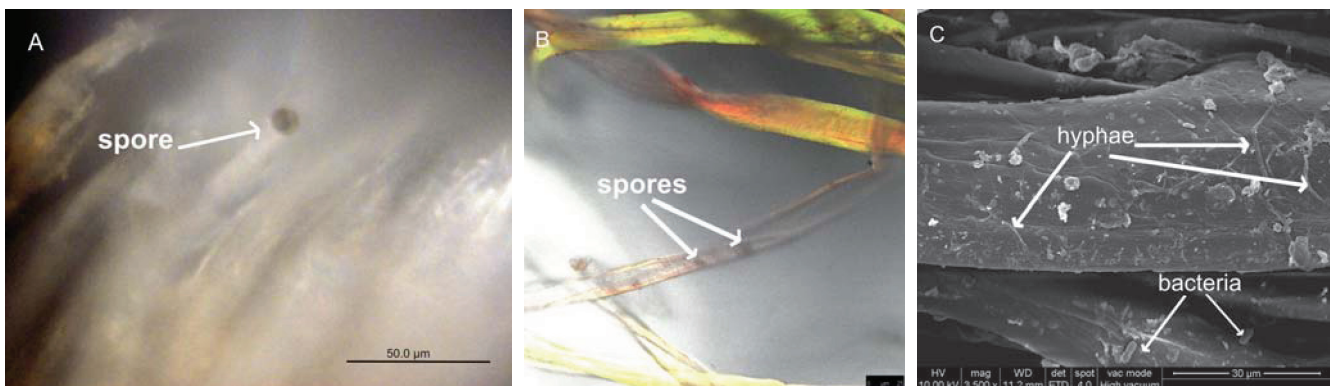
Figure 1 General view of textile No. 60177 at La Plata Museum where foxing spots are observed.

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**Figure 2** Details of textile structure. A. Image from optical microscopy (X10, Bar= 500 µm) and B. image from SEM (X100, Bar= 1 mm).



**Figure 3** Biological structures related to the development of hyphae of cellulolytic fungi (*Cladosporium* sp.) and bacteria (*Pseudomonas* sp.) are observed. A. Image from optical microscopy (X100, Bar= 50 µm), B. image from Confocal Laser Microscopy C (Bar= 25 µm) and C. image from SEM (X3500, Bar= 30 µm).

is the main component of natural fibers such as flax and cotton<sup>4</sup>. This leads to loss of strength of the natural fibers, causing odor emission, esthetic damage, the presence of staining, discoloration (foxing) and finally loss of fiber structure<sup>5</sup>, and giving rise to significant losses at economic and cultural levels. Proper storage of textiles susceptible to biodeterioration in special containers under conditions of temperature and relative humidity suitable are effective preventive measures to avoid undesirable results. Essential oils and silver nanoparticles<sup>1</sup>, among others, can be used as disinfectants for the surface of archeological fibers, historical objects and archival documents. It is essential that all tasks and strategies used in the preservation of the material be written and documented photographically, so as to keep a record for regularly assessing changes of microorganism activity leading to textile damage.

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