Mycology Meets the Chessmen

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Increasingly recognized as agents of attacks on various types of specimens stored in museums around the world, fungi now seem likely to have been responsible for the degradation of some extraordinary medieval sculptures in Scotland. These are the Lewis Chessmen, made mostly from walrus ivory and some from whales’ teeth. They are generally thought to have been discovered in Uig, on the west coast of the Isle of Lewis in 1831 (although an inland site on the island has also been claimed). Studies by James Tate at the National Museums Scotland, Edinburgh, together with researchers at the University of Dundee and the Istituto Centrale per il Restauro e la Conservazione del Patrimonio Archivistico e Librario in Rome, Italy, now point to fungi as causes of the strange but very characteristic damage seen on the chess pieces.

Not the least implication of the work on the Lewis Chessmen is that it highlights the shortage of appropriate microbiological expertise that is limiting progress in understanding the deterioration of many other museum artefacts around the world. “An important reason why fungi are a great problem for the conservation of cultural heritage is a lack of information and training for restorers, curators and other museum personnel,” wrote Katja Sterflinger of the University of Natural Resources and Applied Life Sciences in Vienna, Austria, in Fungal Biology Reviews (24: 47, 2010). “Although mycologists’ knowledge would be of tremendous value for museums, very few collections offer consulting in this field. To my knowledge only one collection of those recognized by the World Federation of Culture Collections, namely the Austrian Center of Biological Resources and Applied Mycology, offers a special service for museums and other institutions working on the care of monuments and cultural heritage.”

Historians are interested in the Lewis Chessmen because they are the largest surviving group of objects, made for purely recreational purposes, that date from the end of the 11th century when chess was popular among the aristocracy throughout Europe. The 78 pieces, 67 of them now in the British Museum, London, and the remainder in the Edinburgh museum, apparently came from a sand dune, where they were probably in a small drystone chamber. The fact that they were from four different sets supports the theory that they belonged originally to a merchant travelling from Norway to Ireland.

Although the elaborately carved pieces, of kings and queens, bishops and warders, along with pawns shaped as obelisks, are mostly in excellent condition, networks of channels, mostly about 0.5 mm wide and deep, criss-cross their surfaces. Over the past two decades, investigators have attributed these markings to “etching by acids secreted by rootlets or alternatively by grazing organisms,” to “the burrowing of tiny termites such as are common in sand,” or to “the burrowing action of insects that live in the sand.”

This was the problem which James Tate and his collaborators decided to investigate. Aware that fungi which can dissolve minerals (especially phosphate) are ubiquitous in the environment, they published a paper two years ago (Archeosciences, 25:249, 2011) speculating that such organisms might have been responsible for the marks on the Lewis Chessmen. Perhaps saprophytic and/or ectomycorrhizal fungi had etched the surface channels while the chess pieces were buried in soil?

Their latest research (Environmental Microbiology, 15: 1050, 2013) suggests that their hypothesis may well be correct. Their approach was to inoculate two microbial species known to have geoactive capacities, Aspergillus niger and Serpula himantoides, onto samples from a tusk of a walrus (Odobenus sp.L.) and a tusk of a boar (Sus scrofa,
L). Tate and his coworkers then used a combination of light microscopy and scanning electron microscopy (SEM), alongside other techniques, to characterize fungal interactions with the ivory. These included alterations in the composition of the ivory, dissolution and tunnelling, and the formation of new biominerals.

The report on the SEM work confirms that it revealed fungal hyphae penetrating within cracks in the walrus tusk. The hyphae also tunnelled widely throughout the material. In areas etched by mycelial colonization, “fungal footprints” could be observed. Studies on boar tusk showed similar phenomena, while additional evidence indicated that the formation of various metabolites could lead to complete dissolution of the material. Thirdly, colonization of the ivory, and/or exposure to fungal activity, led to extensive secondary formation of a biomineral. The researchers identified this as calcium oxalate (principally the monohydrate, whewellite).

“We hypothesise a contribution of both fungi and plant roots to the formation of the damage on the Chessmen,” the authors write. Citing previous evidence of the role of ectomycorrhizal organisms in the dissolution of calcium- and phosphate-containing rocks, they say it is now increasingly apparent that free-living and mycorrhizal fungi can be significant agents of mineral weathering.

“It should also be noted that many fungi can form hyphal aggregates ranging from simple strands and cords to macroscopic rhizomorphs, that can be of sizes ranging up to and exceeding the dimensions of the tracks on the Chessmen,” the authors write. “A role for mycorrhizal fungi in the biodeterioration would be consistent with the dimensions of the tunnelling present in the Lewis Chessmen. In the in vitro experiments the tracks produced by fungi were associated with a dense pattern of crystals corresponding to the monohydrate form of calcium oxalate.”

James Tate and his colleagues feel that future work on the Scottish chess pieces should take these findings into account, with additional efforts to search for the presence of oxalates that could be markers of soil/terrestrial burial or simply of the involvement of fungi in causing the observed damage. For the moment, direct examination in a SEM (even in controlled pressure mode) has been ruled out because the Chessmen are thought to be too fragile. If Tate and coworkers are allowed to do so, they might use a micro Raman system to learn more about uncleaned grooves in the pieces.

Work on the extraordinary medieval sculptures from the Isle of Lewis is the latest manifestation of growing recognition of the activities of fungi in ravaging our cultural heritage. Last year, writing in *Environmental Microbiology* (14: 559, 2012), Katja Sterflinger in Vienna and one of Tate’s coauthors, Flavia Pinzari in Rome, highlighted hyphomycetous fungi as “the most important agents of biodeterioration in museums, museum storage rooms, libraries, collections and restoration studios.” There are several reasons for their potency. They can live at low water activities and are perfectly adapted to indoor environments. They thrive in microclimatic niches created by condensation, lack of ventilation or water retention by hygroscopic materials.

Writing in *Microbe* (December 2008, p. 565), Nick Konkol of Harvard School of Engineering and Applied Sciences, together with coauthors from other centers, observed that microorganisms are a major cause of deterioration in stone structures, which are among the most important cultural objects in the Western Hemisphere, in Mayan archaeological sites in Southern Mexico. “Together with bacteria, algae and lichens, they not only alter the appearance of the artefacts but seriously damage them. “Once established, fungal hyphae can penetrate deep into stone,” they say. “Subsequent shrinking and swelling of the hyphae severely degrade the surrounding material, providing entry sites for water and leading to further deterioration.”

There is one piece of good news for Lewis islanders who have been arguing for the return of “their” Chessman. After being exhibited at venues abroad recently, including The Cloisters in New York last year, six of the pieces are to go on permanent exhibition in a Museum of the Western Isles, now being constructed on Lewis. I do hope the planners get the temperature and humidity right.