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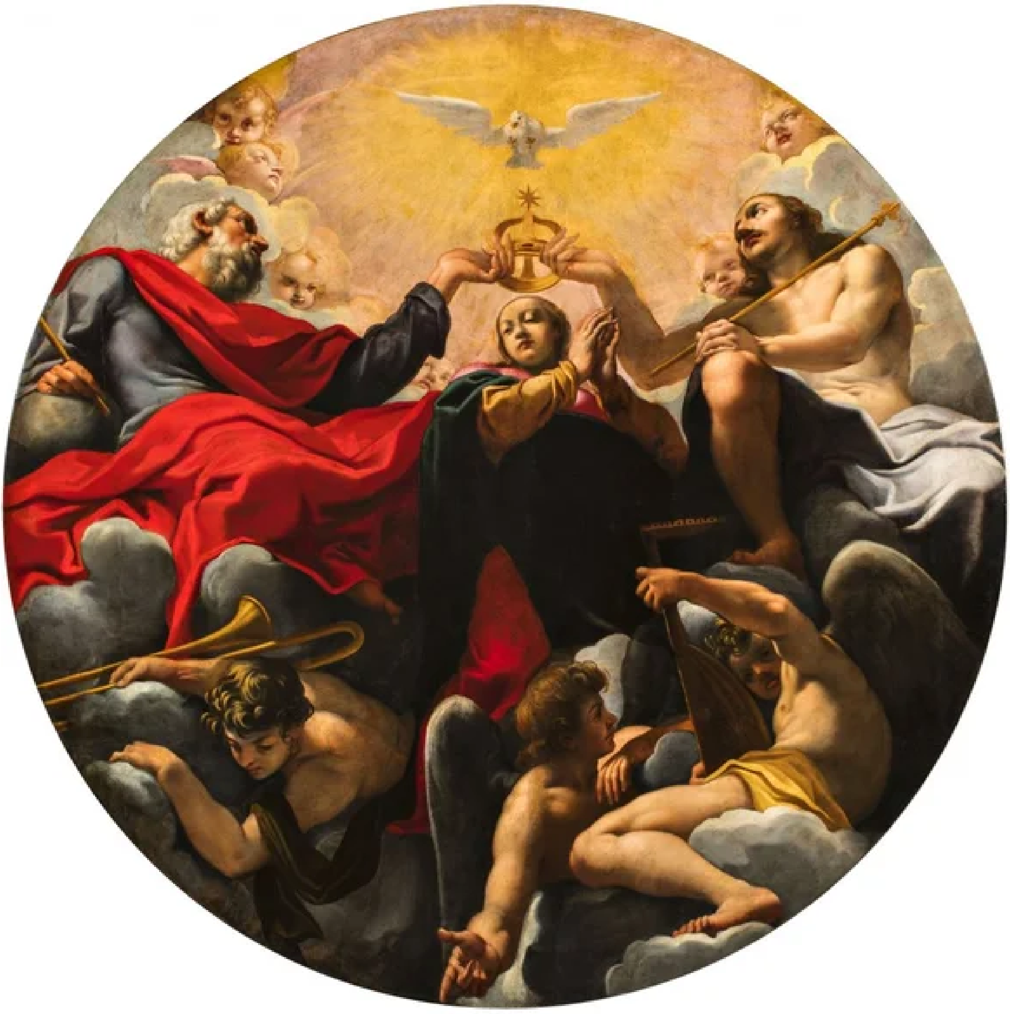
BIOLOGY

Germs of Genius—a Masterpiece's "Microbiome" Can Spell Its Demise

But microbes living on canvases may also help preserve irreplaceable works of art

By Richard Conniff on December 6, 2018



Coronation of the *Virgin Mary* (1616–20) by early Baroque artist Carlo Bononi, was found to be occupied by thriving colonies of bacteria. Credit: CC BY license, with permission from *MuseoinVita* biannual journal, original copyright 2018

People have worried about the effects of fungi and other microorganisms on cultural objects almost as long as there have been cultural objects to worry about.

In fact, the entire science of microbiology began with a fungus damaging a cultural object. In his 1665 book *Micrographia* the British polymath Robert Hooke included his sketch of what looked like a flower garden on spindly stalks. It was the first known depiction of a microbe, showing the reproductive structures of a fungus from "a small spot of a hairy mould" found on the leather cover of a book.

And yet modern microbiology has played surprisingly little role in efforts to conserve some of humanity's most precious cultural objects: the easel paintings, typically oil on canvas, that adorn the walls of great museums everywhere. A new study published Wednesday in *PLOS ONE* aims to change that—and proposes using microbes themselves to prevent microbial damage.

A team from the University of Ferrara in Italy examined a 500-year-old painting called *Coronation of the Virgin Mary*, by the early Baroque artist Carlo Bononi. This circular work, nine feet in diameter, had been painted on canvas and then applied directly to the ceiling of the Basilica of Santa Maria in Ferrara's Vado neighborhood. It was Bononi's masterpiece, and earned him praise for having "mixed his colors with a liquid heart." But a 2012 earthquake tore the painting down the middle and necessitated its removal, which revealed further damage from infestation of the dome ceiling by insects, mice and pigeons.

The restoration proceeded on conventional lines. But along the way, clinical microbiologist Elisabetta Caselli and her co-authors took microbial samples by gently rubbing both the front and back of the painting with sterile swabs, then culturing them in sterile tubes and petri dishes. They found thriving bacterial communities of *Staphylococcus* and *Bacillus* genera colonizing the painting, along with *Aspergillus, Penicillium* and other filamentous fungi. Knowing what they were dealing with helped guide conservator and co-author Fabio Bevilacqua as he chose chemical biocides to remove these microbes during the restoration.

Such biocides are problematic, however, because they can be toxic for the people who work with them. Microbial communities also tend to be highly diverse, and a chemical that kills one kind of microbe can inadvertently open up habitat for a neighboring species that is more resistant—and potentially more destructive. In 2001, for instance, conservators began intense treatments using chemical biocides to control a white fungal growth on the spectacular paintings in the Lascaux Caves in southwestern France, estimated to be up to 20,000 years old. The unexpected result was that a previously unknown fungal species called *Ochroconis lascauxensis* suddenly flourished, staining painted surfaces with black mold.

For the new study, Caselli and her co-authors wondered if—instead of inadvertently opening up new habitats—it might be possible to use beneficial microbes to occupy habitats instead, thereby crowding out harmful microbes. They placed microbial samples from the painting in a petri dish with a growth medium, then added a natural compound that had previously been used mainly to prevent bacterial and fungal growth in hospitals. Its active ingredients are three *Bacillus* species "that are able to counteract the growth of bacteria and fungi by competitive antagonism and simultaneous production of antimicrobial compounds," Caselli says. "The advantage of using live *Bacillus* instead of biocide compounds is that they colonize the treated surface," she notes, explaining that these microbes displace and gradually eliminate contaminants, reconfigure the painting's microbiome and prevent recolonization. The test produced "encouraging preliminary results," she adds. But it will take further testing on a variety of artistic materials and painting fragments to verify that the technique does not "induce any damage to the painted surface."

Use of microbial and other bio-based methods is further along in other areas of art conservation that are less complex than easel paintings. Restoration companies currently use certain bacteria types, for instance, to remove animal glue from documents or encrusted pollution from buildings and statues. At Catholic University of Portugal, microbiologist Patrícia Moreira is currently experimenting with an antimicrobial nanofilm derived from the exoskeletons of shrimp, with the aim of applying it to protect public sculptures in the city of Porto late next year.

But easel paintings, especially on canvas, are far more challenging. "The problem with canvas paintings is that in one little area it's possible to have 10 different materials—organic and inorganic together," says Fatima Morales Marín of the University of Murcia in Spain, who co-authored a 2017 study on biodeterioration in canvas paintings. A painting may support a different assortment of microbes depending on whether: the canvas backing is made of linen, hemp or cotton; it is covered with a thin coat of animal glues or linseed oils; and the pigments in the painting itself include natural materials like red lac (made from insects or plants) or red and yellow earths.

Kristin deGhetaldi, a Delaware-based conservator specializing in hurricane-damaged paintings, who was not involved in the new study, thinks this is an argument for caution.

Caselli may have “found that there is potential to inhibit growth of harmful microbes—but it means you now have to apply an additional material to the painting,” deGhetaldi says. “And we have learned from our past that we really have to be careful when spraying new varnishes on paintings or feeding new compounds into cracks. Who knows what complications there could be? Or what interactions with pigments or materials?”

Fernando Poyatos, a professor of painting at the University of Seville who also did not participate in the current work, likewise urges extensive further studies on a variety of artistic materials. He also contends the new study should have employed genetic methods to characterize the microbial community more thoroughly. (Caselli replies that she avoided genetic analysis in this case because it “does not distinguish live or dead microbial cells whereas the aim of our study was isolating all live, cultivable microbes to test their susceptibility” to the *Bacillus* compound.) Poyatos adds, “the best biocide method is prevention, to keep the paint in good environmental conditions, with proper humidity control.”

Bononi’s restored *Coronation of the Virgin Mary* is, however, now back in the Basilica of Santa Maria where it belongs. For paintings in such circumstances, Caselli’s study suggests protection may someday come in the form of a better microbiome.

ABOUT THE AUTHOR(S)

Richard Conniff

Richard Conniff is an award-winning science writer for magazines and a contributing opinion writer for the *New York Times*. His books include *House of Lost Worlds* (Yale University Press, 2016) and *The Species Seekers* (W. W. Norton, 2010).

Credit: Nick Higgins