



Extracting Stories from DNA preserved by 19th century Americana

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Microorganism diversity is a source of information on location, time, human identity and human activity. In unmanaged environments, such as an art studio, the concentration of airborne microorganisms is as much as 10^5 per cubic meter. Artists (and humans in general) exhale 10^5 - 10^6 non-human microbes from their lungs every hour and shed millions more. In contemporary biological studies of air, measurement of $>10,000$ different species from an hour-long sample collection is the norm. Importantly, statistical assessments of environmental microbiome have shown that variations can be used to distinguish between specific cities in a country, the passage of time within a single city, rooms within a building, and even the identity of former occupants of a room.

Oil-based paints do not “dry” primarily by evaporation of a volatile component. Rather, chemical bonds form between individual molecules of oil. As this process progresses, vast 3-dimensional networks are formed halting any appearance of fluid-like flow and immobilizing pigment particles. Drying can take days to months. The formation of these paint films may therefore be viewed as method for environmental sampling capable of adsorbing and then preserving microorganisms settling from the air. The identity and relative abundance of all embedded and preserved species defines the “microbiome” of the finished artwork.

Our work with oil-paint entrapped microbiome has led to a novel workflow that allows 100 microgram paint samples to yield unambiguous information about artist process and materials. Central to this are chemical approaches that break the paint’s chemical bonds without damaging the DNA. A two-step DNA-extraction procedure is followed to distinguish DNA embedded within the paint matrix versus entrapped between dried layers or on the surface of the sample. A significant and surprising result is the identification of macro as well as micro-organisms relevant to an object’s handling after it has been made. We can, for example, report and account for the identification of species indigenous to South America present on the surface of a 100 year old painting of a bucolic scene from New England. Only later did we learn that the artist spent time in South America serving on a mission for the Church of Jesus Christ of Latter-day Saints. The painting appears to have recorded its own travel to the southern hemisphere.

The inadvertent capture of environment by oil paint has led to an expansion of our efforts to include items of historical relevance. Our team has recently expanded to include the New-York Historical Society whose collections include numerous opportunities. Examples we will report on include soldier’s garments and paraphernalia dating from the US Civil war. We will report, for example, on the utility of even simple non destructive swabbing to identify organisms relevant to diet, medicine and provenance on objects from this era.