Extended Abstract—Noninvasive Assessments of Cleaning Tests on an Unvarnished Oil Painting on Canvas by Edvard Munch

Tine Frøysaker, Mirjam Liu, and Costanza Miliani

INTRODUCTION

Varnish is rare on the great majority of the paintings by Norwegian artist Edvard Munch (1863–1944). Empirical experience has shown that many of his oil colors are notably vulnerable to dirt removal, especially the lean blues, greens, yellows, reds, and whites (B. Topolova-Casadiego, The Munch Museum, personal communication, 5 March 2009). The removal of firmly attached dirt and dust (or any other impurities, e.g., tide lines from water stains or bird droppings) is and will continue to be utterly challenging for Munch's unvarnished paintings. This is particularly evident in paintings that are not protected by airtight, glassed frames, as is the case of *Chemistry*, one of the artist's 11 large-scale canvas paintings for the Aula of Oslo University (1914–1916).

For over 30 years, the surface of *Chemistry* (about 444 × 220 cm^2) had been exposed to vast amounts of airborne pollutants, severely soiling it (Figure 1). In 2008, various aqueous and mechanical cleaning tests were performed. In order to evaluate the efficacy and harmfulness of each cleaning method with respect to the different colored areas of the painting, a noninvasive methodology based on in situ spectroscopic measurements, as well as visual examination, was carried out (Frøysaker et al., 2011).

MATERIALS AND METHODS

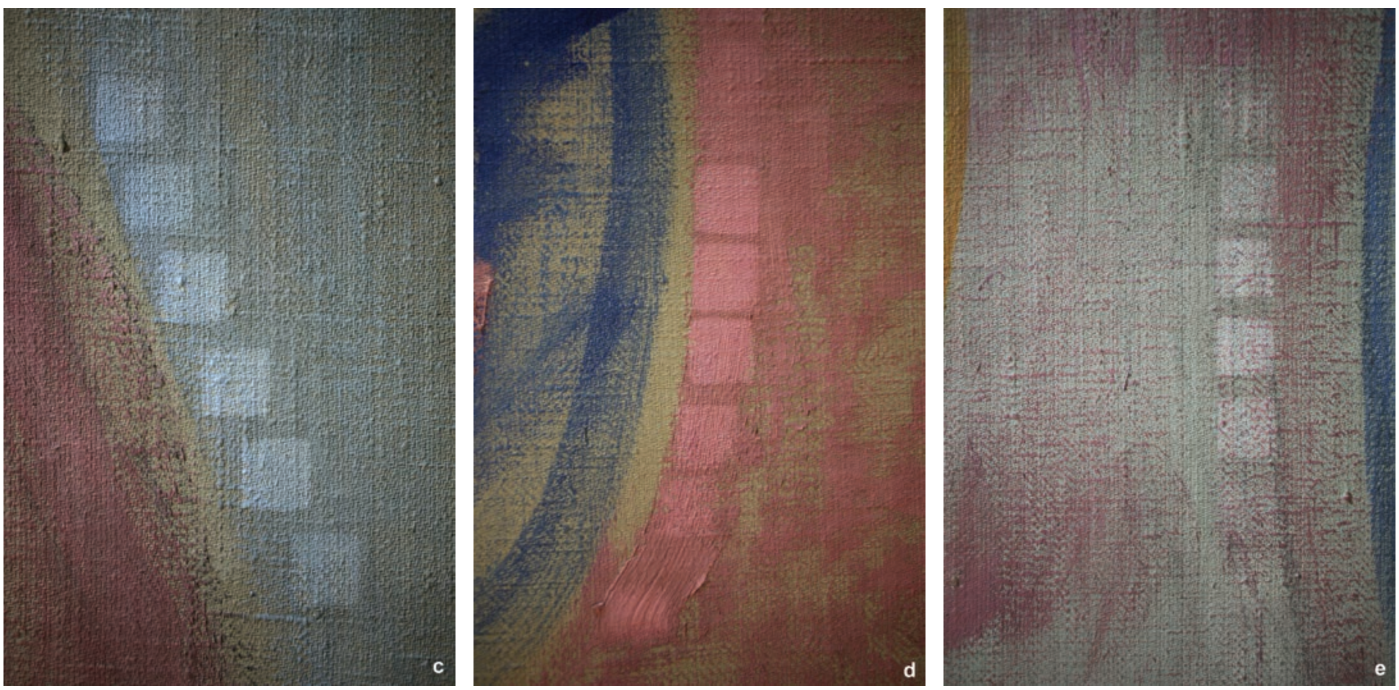
Eight colors (dark blue, blue mixed with white, dark green, green mixed with white, dark red, red mixed with white, semisolid paint on underdrawings of carbon black, and bare white ground) were selected for eight individual tests (about 2 × 2 cm in size). The locations were chosen on both exposed surface areas and on surfaces below the picture frame that have always been protected from light exposure and pollutants. The eight cleaning agents were (1) natural saliva, (2) Marlipal 1618/25, (3) Brij 700 gel (pH 6), (4) Triton X-100 gel (pH 8), (5) triammonium citrate (TAC) applied by cotton swab, (6) TAC applied by sponge, (7) vulcanized natural gum sponge, and (8) bread dough (Figure 2).

The surface examination was conducted by visual evaluation and optical microscopy (63×) and under UV lamp irradiation on the cleaned areas, on their surrounding colors, and on the cotton swabs used for application and cleansing. Then noninvasive measurements were carried out by mobile facilities for in-situ non-invasive measurements

Tine Frøysaker *and* ***Mirjam Liu****, Conservation Studies, Department of Archaeology, Conservation and History, University of Oslo, Frederiksgate 3, 0164 Oslo, Norway.* ***Costanza Miliani****, Consiglio Nazionaled delle Ricercha, Istituto di Scienze e Tecnologie Molecolari, Dipartimento di Chimica, Università di Perugia, Via Elce di Sotto, 8, 06123 Perugia, Italy. Correspondence: Tine Frøysaker, tine.froysaker@iakh.uio.no; Mirjam Liu, mirjam.liu@gmail.no; Costanza Miliani, miliani@thch.unipg.it.* *Manuscript received 19 November 2010; accepted 24 August 2012.*

FIGURE 1. *Chemistry*. Unvarnished oil colors on white ground on canvas (1914–1916). About 440 × 220 cm^2. Photograph © Svein Andersen and Sissel de Jong, The Munch-museum/The Munch-Ellingsen-Group/BONO 2010.

FIGURE 2. Cleaning tests on (a) bare ground, (b) dark red, (c) blue mixed with white (only the first six methods are shown), (d) red mixed with white, and (e) semisolid paint on underdrawing. Photographs © Karen Mengshoel 2009.



(MOLAB)'s mid-infrared Fourier transform infrared (FTIR) spectroscopy, resulting in some 130 spectra of the painting surface.

RESULTS AND DISCUSSION

The cleaning agents can be arranged according to the altered appearances of the test areas and the cotton swabs: natural gum could be used for all the colors tested, bread dough for six, Triton X-100 gel for five, TAC (applied by cotton swab) and Marlipal 1618/25 for four, natural saliva for three, and, finally, TAC (applied by sponge) and Brij 700 gel for two. Table 1 rates the first sets of 64 cleaning test on *Chemistry* by their visual appearance, microscopic examination (magnification 63×), and appearance under UV light.

The fiber-optic FTIR spectroscopy revealed various types of surface contaminants in uncleaned areas, such as sulfates, silicates, metal soaps (Pb and Zn), and zinc oxalates (Figure 3). The

TABLE 1. Results of the first sets of 64 cleaning tests on *Chemistry* as evaluated by visual inspection, by microcopic examination (magnification 63×), and under UV irradiation. For the evaluation numbers, a negative value indicates pigment loss: −6, uneven minimal cleaning; −5, even minimal cleaning; −4, uneven average cleaning; −3, even average cleaning; −2, uneven good cleaning; −1, even good cleaning. A positive value indicates no pigment loss: 1, uneven minimal cleaning; 2, even minimal cleaning; 3, uneven average cleaning; 4, even average cleaning; 5, uneven good cleaning; 6, even good cleaning.

	Color							
Test details	**Dark blue, diluted**	**Blue mixed with white**	**Dark green, diluted**	**Green mixed with white**	**Dark red, diluted**	**Red mixed with white**	**Semisolid paint on under-drawing**	**Bare ground**
Application area	laboratory flask below boy	back-ground behind girl	laboratory flask below girl	back-ground behind boy	test tube	cloud behind boy	girl's ankle	omnipresent
Pigments	ultra-marine, Prussian blue, cobalt blue	cobalt blue, emerald green plus white	emerald green, chrome green	emerald green, chrome green plus white	vermilion	vermilion plus white	vermilion plus white on carbon black	zinc white, lead white, chalk
Test 1, natural saliva	2	6	2	5	−4	3	1	1
Test 2, Marlipal 1618/25	−5	6	6	5	−3	6	4	3
Test 3, Brij 700 gel	−1	6	6	3	−1	3	−1	3
Test 4, Triton X-100 gel	−1	6	6	6	−1	6	−1	6
Test 5, triammonium citrate (cotton swab)	−5	6	6	6	−3	3	−1	6
Test 6, triammonium citrate (sponge)	−5	3	4	3	−3	6	1	1
Test 7, vulcanized natural gum sponge	2	2	2	2	2	2	2	2
Test 8, bread dough	2	2	6	3	4	2	2	3

first two were identified on the exposed areas and are responsible for the gray dust layer. The latter two are still invisible to the naked eye. The metal soaps were identified on both exposed and unexposed areas, but the zinc oxalates were only identified on the exposed surface and not below the frame.

When metal soaps become visible, they are seen as white surface deposits, and they are generally regarded as rather common in oil paintings from the 1600s to the early 1900s (van Loon, 2008). They form through the saponification of unsaturated fatty acids in either the binding medium and/or the ground layers. Their development is promoted by various factors, including high temperature and relative humidity (van Loon, 2008). They are removable by mechanical means or can be disguised by increasing their saturation with varnish. Saturation is, however, no option for the Munch Aula paintings since any kind of surface saturation will reveal the darkened canvas in all the areas of bare ground.

When visible, copper and calcium oxalates have been reported as either grayish brown surface crusts on easel paintings (Higgit and White, 2005) or as semiopaque film on murals (Nevin et al., 2008). They are highly insoluble and thus very difficult to remove by traditional methods. There is no known literature on the appearances of zinc oxalate salts or on their removal. If, or when, the zinc salts become visible on the Aula paintings (or any other paintings by Munch), they might cause radical changes to the appearances of the paintings and the artist's intent. Further research must be employed to delay the growth of possible visible and untreatable intrusions of the zinc oxalates on the paintings in question.

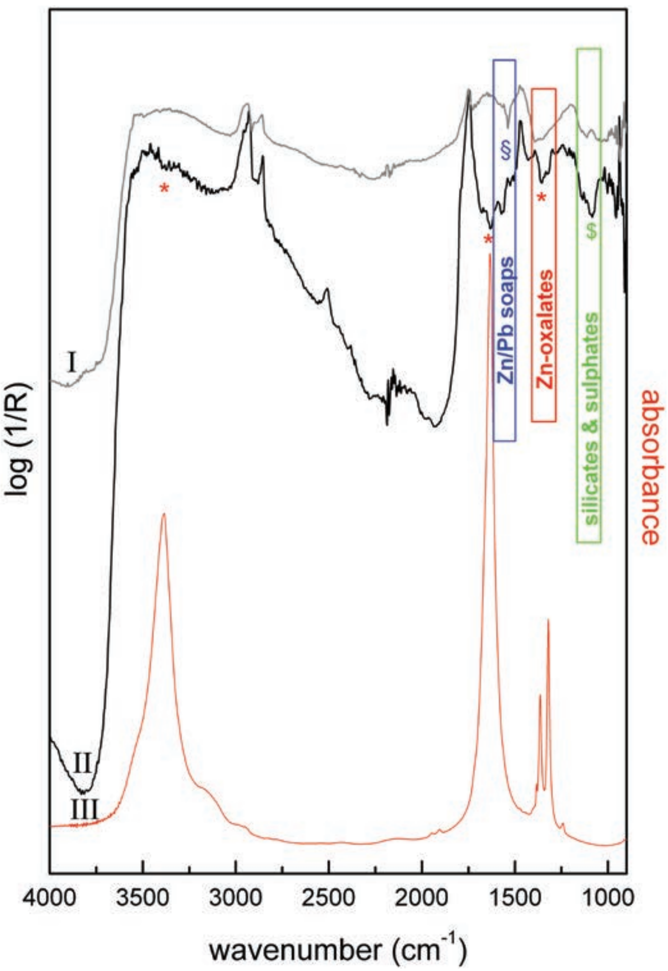


FIGURE 3. Noninvasive reflectance mid-infrared FTIR measurements: comparison of a spectrum collected on an uncleaned area (II, black line) with a spectrum of an area below the frame (I, gray line). The spectral region used for the identification of the different compounds is labeled: asterisk (*), diagnostic bands for Zn oxalates; section sign (§), diagnostic bands for Zn and Pb soaps, i.e., carboxylates; and dollar sign ($), diagnostic bands for silicates and sulfates. The transmittance of hydrated zinc oxalate is also shown (III, red line).

Acknowledgment

Access to the MOLAB was obtained thanks to the 6th Framework Programme (contract Eu-ARTECH, RII3-CT-2004-506171).

REFERENCES

Frøysaker, T., C. Miliani, and M. Liu. 2011. Non-invasive Evaluation of Cleaning Tests Performed on Chemistry (1909–1916). A Large and Unvarnished Oil Painting on Canvas by Edvard Munch. *Restauro*, 4:53–63.

Higgit C., and R. White. 2005. Analyses of Paint Media: New Studies on Italian Paintings of the Fifteenth and Sixteenth Centuries. *National Gallery Technical Bulletin*, 26:88–104.

Nevin, A., J. L. Melia, I. Osticioli, G. Gautier, and M. P. Colombini. 2008. The Identification of Copper Oxalates in a 16th Century Cypriot Exterior Wall Painting Using Micro FTIR, Micro Raman Spectroscopy and Gas Chromatography-Mass Spectrometry. *Journal of Cultural Heritage,* 9(2):154–161. http://dx.doi.org/10.1016/j.culher.2007.10.002.

van Loon, A. 2008. *Color Changes and Chemical Reactivity in Seventeenth-Century Oil Paintings*. MOLART Reports 14. Amsterdam: Netherlands Organization for Scientific Research.