Non-invasive assessments of cleaning tests on an unvarnished oil-painting on canvas by Edvard Munch

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Introduction

Varnish is still rare on a great majority of the paintings by Norwegian artist Edvard Munch (1863-1944). Empirical experiences have shown that many of his oil colors are notably vulnerable to dirt removal, especially the lean blues, greens, yellows, reds and whites (Topolova-Casadiego, 2009). The removal of firmly attached dirt and dust (or any other impurities, for instance, 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 which are not protected by air-tight, glassed frames, as is the case of *Chemistry*, one of the artist's eleven large scale canvas paintings for the Aula of Oslo University (1909-1916).

For over thirty years, the surface of *Chemistry* (about 444 x 220 cm^2) [Fig. 1] had been exposed to vast amounts of air-borne pollutants severely soiling it. In 2008, various aqueous and mechanical cleaning tests were performed. In order to evaluate the efficiency and harmfulness of each cleaning method with respect to the different coloured areas of the painting, a non-invasive methodology based on in situ spectroscopic measurements, as well as visual examination, were carried out (Frøysaker et al., 2010).

Fig. 1. *Chemistry* (about 440 x 220 cm). © Svein Andersen and Sissel de Jong, The Munch-museum/The Munch-Ellingsen-Group / BONO 2010

Fig. 2a

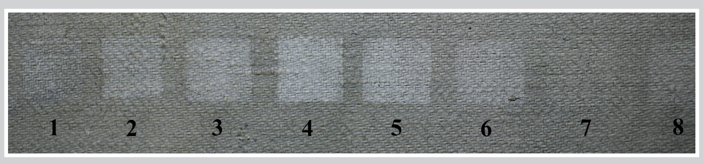

Fig. 2b

Fig. 2c

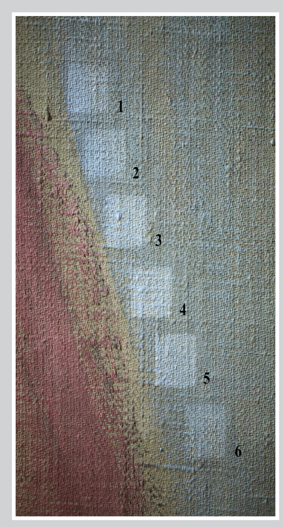

Fig. 2d

Fig. 2e

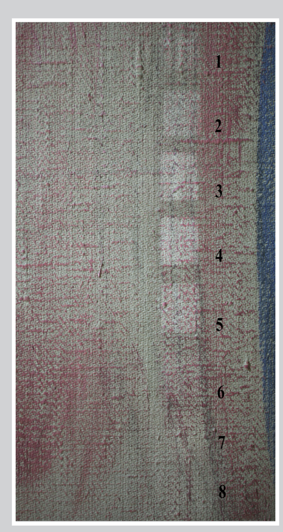

Fig. 2a. Cleaning tests on bare ground.
2b. Cleaning test on dark red.
2c. Cleaning test on blue mixed with white. Only the first six of eight cleaning tests are included in the photograph.
2d. Cleaning test on red mixed with white.
2e. Cleaning test on semi-solid paint on under drawing.

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Materials and methods

Eight colours (dark blue, blue mixed with white, dark green, green mixed with white, dark red, red mixed with white, semi-solid paint on underdrawings of carbon black and finally, bare, white ground) were selected for eight individual tests (about 2 x 2 cm^2 large) [Fig. 2]. The locations were chosen on both exposed surface areas and on surfaces below the picture frame that always have 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) Tri-ammonium citrate (TAC) applied by cotton swab; 6) TAC applied by sponge; 7) vulcanized natural gum sponge; and, 8) bread dough.

The visual surface examination was conducted by visual evaluation, optical microscopy (63 x) and a UV lamp on the cleaned areas, on their surrounding colours and on the cotton swabs used for application and cleansing. Then non-invasive measurements were carried out by MOLAB's mid-FTIR spectroscopy resulting in some 130 spectra of the painting surface.

Fig 3.
Table 1 shows how the cleaning tests were evaluated.

Pigment loss						No pigment loss					
Minimal cleaning but pigment loss		Average cleaning but pigment loss		Good cleaning but pigment loss		Minimal cleaning		Average cleaning		Good cleaning	
Uneven	Even	Uneven	Even	Uneven	Even	Uneven	Even	Uneven	Even	Uneven	Even
-6	-5	-4	-3	-2	-1	1	2	3	4	5	6

Table 2 shows the first sets of 64 cleaning test on *Chemistry* and their visual appearances judged with the naked eye, microscope (magnification 63 ×) and UV lamp.

Colours	Dark blue, diluted	Blue mixed with white	Dark green, diluted	Green mixed with white	Dark red, diluted	Red mixed with white	Semi-solid paint on under-drawings on girl's ankle	Bare ground
Application area	Laboratory flask below boy	Background behind girl	Laboratory flask below girl	Background behind boy	Test tube	Cloud behind boy		Omni-present
Pigments	Ultramarine Prussian blue Cobalt blue	Cobalt blue Emerald green + white	Emerald green Chrome green	Emerald green Chrome green + white	Vermilion	Vermilion + white	Vermilion+ 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 Tri-ammonium citrate (cotton swab)	-5	6	6	6	-3	3	-1	6
Test 6 Tri-ammonium 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

Results and discussion

The cleaning agents can be arranged according to the changed appearances of the test areas and the cotton swabs: natural gum could be used for all the colours tested, bread dough for six, Triton-X-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 [Fig. 3].

The fiber optic FTIR spectroscopy revealed various types of surface contaminants in un-cleaned areas such as sulphates, silicates, **metal soaps (Pb/ Zn)** and **zinc oxalates** [Fig. 4]. The first two were identified on the exposed areas and are responsible for the grey dust layer. The latter two are still invisible to the naked eye. **The metal soaps were identified on both exposed and un-exposed 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. 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, the copper and calcium oxalates have been reported as either greyish brown surface crusts on easel paintings (Higgit and White, 2005) or as semi-opaque 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 will become visible at the Aula paintings (or any other paintings by Munch) they might perform 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.**

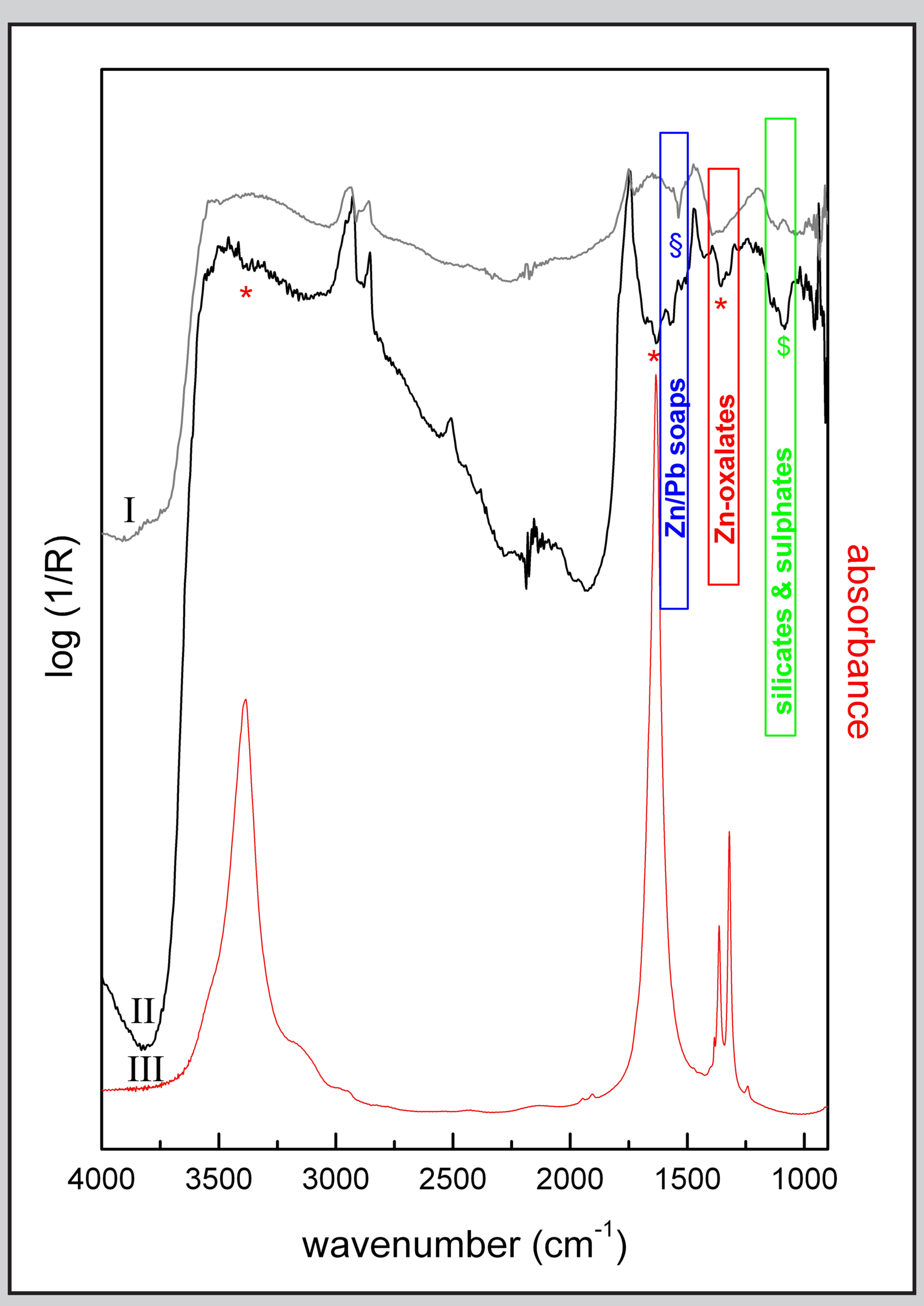

Fig. 4.
Non invasive reflectance mid-FTIR measurements: comparison of a spectrum collected on a un-cleaned area with a spectrum of an area below the frame, the spectral region used for the identification of the different compounds are evidenced and a transmittance of hydrated zinc oxalate is reported. * indicates diagnostic bands for Zn-oxalates, § for carboxylates, $ for silicates and sulphates.

Acknowledgements

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

References

Topolova-Casadiego, B., 2009. The Munch-Museum. Personal communication 5 March.

Frøysaker, T., C., Miliani, and M. Liu. 2010/11. "Non-invasive Evaluation of Cleaning Tests Performed on *Chemistry* (1909-1916), a Large and Unvarnished Oil Painting on Canvas by Edvard Munch (1863-1944) for the Aula of Oslo University." (Submitted to Studies in Conservation 23 February 2010).

Higgit C. and R. White. 2005. "Analyses of Paint Media: New Studies on Italian Paintings of the Fifteenth and Sixteenth Centuries." In *National Gallery Technical Bulletin*, Vol. 26, National Gallery Company Limited, London, pp. 88-104, esp. pp. 93-94.

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." In *Journal of Cultural Heritage* 9 (2), pp. 154-161.

Van Loon, A., 2008. Color Changes and Chemical Reactivity in *Seventeenth-Century Oil Paintings*, MOLArt Reports 14, Amsterdam