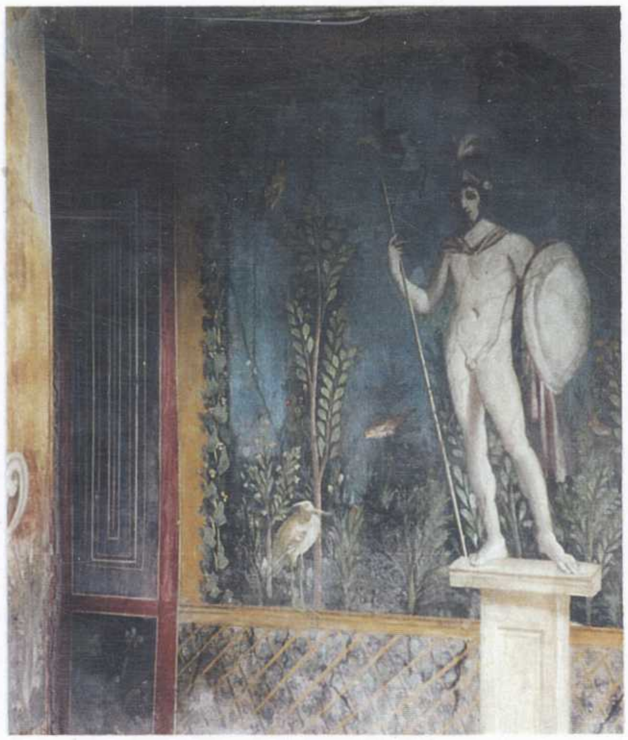
ROMAN PAINTING

WALL PAINTINGS, FAYUM PORTRAITS AND POLYCHROME STATUARY

Conservation, Materials and Context

AGNETA FRECCERO



GÖTEBORG UNIVERSITY
DEPARTMENT OF ENVIRONMENTAL SCIENCE and CONSERVATION
Institute of Conservation

2000:24

ROMAN PAINTING

Wall Painting, Fayum Portraits and Polychrome Statuary

Conservation, Materials and Context

Agneta Freccero

Akademisk Avhandling
som med vederbörligt tillstånd av
Humanistiska fakultetsnämnden vid Göteborgs Universitet
för avläggande av filosofie doktorsexamen i kulturvård
framlägges till offentlig granskning
fredagen den 2 mars 2001, kl.9.00
Aulan, Institutionen för Kulturvård
Bastionsplatsen 2, Göteborg

Opponent: Professor Umberto Baldini, Florens

Betygsnämnd: Professor Carl Nylander, Lund
Docent Solveig Schultz, Göteborg
Docent Jonny Bjurman, Göteborg

Ordförande: Jan Rosvall, Göteborg

Göteborg University
Institute of Conservation
Box 130
SE 40530 Göteborg, Sweden

Tel: +46 31 773 47 00
Fax: +46 31 773 47 03
Email: conservation @icug.gu.

Program in Postgraduate and Doctoral Studies in the Discipline of Conservation

Dissertation for the Ph.D. Degree

Author: Agneta Freccero
Mentor: Dr. Jan Rosvall, Professor

ROMAN PAINTING

Wall Painting, Fayum Portraits and Polychrome Statuary
Conservation, Materials and Context

Abstract

Ethics in conservation and the relation between theoretical guidelines and their application in real life is the comprehensive subject of this study. Choices of materials in conservation, whether traditional or modern products are, or should be preferred, and issues regarding the basis on which such choices are, or should be made, are problems relating to the level of applicability of theoretical programmes in real life.

Some ancient techniques, encaustic painting and ganosis, are at focus in this dissertation, and the materials used have been studied. The principal material, connecting these techniques is beeswax, used in its natural, or raw, state as a paint, or transformed into saponified wax, or Punic wax, either as a paint or as a surface coating. The techniques are related to Fayum portraits, i.e. painting on wooden panels, to Roman wall painting, and to Hellenistic and Roman polychrome statuary as a coating. The materials beeswax and natron, ingredients in such paints and coatings are studied and described, as well as the relation between paints and preparations. Some pigments used during Antiquity, relevant in this study, are shortly described, being part of ancient paints. Ancient and modern interpretations of the terms *encausto* and *ganosis* have been studied. Issues concerning whether or not these materials and techniques might be accepted in professional conservation and modern building construction are discussed. Experiments have been made with the intention of reconstructing these ancient materials and techniques, and testing their applicability in modern environments. Finally, theories have been exposed to situations in real life, and the results are presented in six case studies.

Language of text: English.
xii + 338 pages, 60 illustrations.
This edition is published in a restricted number for the defence of the public examination for a PhD. The intention is to publish the edition in *Göteborg Studies in Conservation* in 2001.

Keywords: Encaustic painting, beeswax, Punic wax, mummy portraits, Fayum portraits, ganosis, polychrome statues, Pompeian painting, Roman painting, conservation.

Cover picture: Garden painting. From the Casa di Venere in Conchiglia, Pompeii.

ISRN GU/KUV - 00/24-SE
ISSN 1101-3303

ROMAN PAINTING

Wall Paintings, Fayum Portraits and Polychrome Statuary

Conservation, Materials and Context

Dissertation for the Doctoral Degree

Agneta Freccero

Mentor:
PhD Jan Rosvall

ISSN 1101-3303
ISRN GU/KUV-00/24-SE

Göteborg University
Institute of Conservation
P.O. 130
SE 40530 Göteborg, Sweden

Tel: +46 31 773 47 00
Fax: +46 31 773 47 03
Email: conservation @icug.gu.

Program in Postgraduate and Doctoral Studies in the Discipline of Conservation
Dissertation for the Ph.D. Degree

Author: Agneta Freccero
Mentor: Dr. Jan Rosvall, Professor

ROMAN PAINTING
Wall Painting, Fayum Portraits and Polychrome Statuary
Conservation, Materials and Context

Abstract

Ethics in conservation and the relation between theoretical guidelines and their application in real life is the comprehensive subject of this study. Choices of materials in conservation, whether traditional or modern products are, or should be preferred, and issues regarding the basis on which such choices are, or should be made, are problems relating to the level of applicability of theoretical programmes in real life.

Some ancient techniques, encaustic painting and ganosis, are at focus in this dissertation, and the materials used have been studied. The principal material, connecting these techniques is beeswax, used in its natural, or raw, state as a paint, or transformed into saponified wax, or Punic wax, either as a paint or as a surface coating. The techniques are related to Fayum portraits, i.e. painting on wooden panels, to Roman wall painting, and to Hellenistic and Roman polychrome statuary as a coating. The materials beeswax and natron, ingredients in such paints and coatings are studied and described, as well as the relation between paints and preparations. Some pigments used during Antiquity, relevant in this study, are shortly described, being part of ancient paints. Ancient and modern interpretations of the terms *encausto* and *ganosis* have been studied. Issues concerning whether or not these materials and techniques might be accepted in professional conservation and modern building construction are discussed. Experiments have been made with the intention of reconstructing these ancient materials and techniques, and testing their applicability in modern environments. Finally, theories have been exposed to situations in real life, and the results are presented in six case studies.

Language of text: English.
xii + 338 pages, 60 illustrations.
This edition is published in a restricted number for the defence of the public examination for a PhD. The intention is to publish the edition in *Göteborg Studies in Conservation* in 2001.

Keywords: Encaustic painting, beeswax, Punic wax, mummy portraits, Fayum portraits, ganosis, polychrome statues, Pompeian painting, Roman painting, conservation.

Cover picture: Garden painting. From the Casa di Venere in Conchiglia, Pompeii.

ISRN GU/KUV - 00/24-SE
ISSN 1101-3303

PREFACE

This dissertation is a result of experiences made as an artist and a conservator, within the field of conservation. Being earlier professionally educated at the University Academy of Arts, Crafts and Design in Stockholm, the first three years studying sculpture, and the last two painting, I had a rather "normal" life of an artist for the next twenty years, when I decided to invest in a second profession. My first contact with conservation ethics, methods and materials, was at the Istituto per l´arte e il restauro, Palazzo Spinelli in Florence, where I studied the conservation of stone, in periods between 1989 and 1994. Beside traditional materials, modern conservation materials were used, including toxic or cancerogeneous substances. The use of such materials seemed rather shocking to me and especially alarming was the fact that young people were more or less in constant contact with these dangerous products, which might be harmful for their health. When working with conservation projects in Sweden after finished training, this experience was confirmed; great quantities of unhealthy conservation materials were constantly used, and no adequate protective measures were taken to avoid negative effects caused by the various substances. During this period of professional preparation I was involved in a six month long project on cleaning ancient tombstones at the parish church of Solna, close to Stockholm. Most of the cleaning was made by using a natural soap (Sw. såpa), and the result was quite satisfactory. The substance, made of derivates from pine, has a pleasant smell, is harmless to the skin and does not kill the surrounding grass and flowers. Not all undesirable signs of ageing could be cleaned off the stones, and that neither was the purpose. In a few cases, a more efficient cleaning agent had to be used, e.g. on black crusts, but at least 90% of the cleaning was made with "såpa". Two years later these stones still were clean, but it has to be stated that a maintenance plan needs to be established in order to keep the objects in a continuing good state of preservation. This example also illustrates the issue of *how* to conserve, considering the aesthetic factor.

Artists often claim "stop conservation of art". The reason for such an attitude is that conservation often means that all signs of ageing are lost on ancient works of art. Not only that, but the material itself looks different after modern conservation interventions. To a certain extent I agree. Cleaning and conservation is often so thoroughly made, that returning to a much appreciated work of art, now conserved, is often a complete delusion – the marble is too white and has a strange dull lustre, the wall painting seems pale and soulless.

My experiences of conservation methods, in Sweden as well as in Italy, have made me suspect, that the pressure from scientific reports and from the chemical industry is very hard to neglect for the conservator, and that such modern products many times are used unquestioned. It is not my intention to suggest a complete return to ancient technology, but rather to point out that there are serious problems with some modern methods. Therefore we ought to consider, and reconsider, ethics in conservation, in order to accept, in each single case, only the methods causing less harm to objects and/or nature. Ancient methods deserve not to be forgotten. Some are useful the way they are still adapted, while other methods may be improved to suit modern needs.

The combination of personal experiences, as related above, connected with the assumption that ancient and traditional materials were less harmful, taken a whole, led to my decision to study some ancient materials and techniques. Among the vast number of ancient materials, possible to investigate, I have primarily concentrated on beeswax – *how* and *when* it was used, and *if*, *how* and *when* it can be used today.

Beeswax as a traditional material for conservation was introduced to the students at the Palazzo Spinelli. Except for objects of marble, lime- and sandstone, ceramics, gypsum etc., also some three-dimensional objects of wax, such as figures, flowers and anatomical studies, were restored. The malleability of beeswax at various temperatures was studied in order to restore miss-shaped parts. Pigmentation of the beeswax was made for producing colours, necessary for reconstructions. Beeswax was also used on wood, when conserving and restoring old furniture, gilded frames, altar-screens etc. In these cases the beeswax was diluted with white spirit, and the mixture used as a surface protective for ancient, or old works of art and handicraft, at terminated conservation.

Since I found wax interesting and challenging to work with, the teacher in charge of conservation of wax objects at Palazzo Spinelli suggested me to write about *encausto* in my diploma thesis. Although the term as well as the concept, at that time were unknown to me, it seemed to be a good idea for a study, as I imagined there would be many interesting facts about wax to discover.

At that time, in 1994, it was not an easy task to find information regarding encaustic painting. Since then, and in particular during the last two or three years, several important publications on the subject have appeared, which has been of great advantage for my studies. My diploma thesis, presented at the institute, did not explain the specific nature of encaustic painting, but could rather be regarded as an initial study, the outlining of a theme. This initial study was very limited and the problems merely stated. Therefore, it was essential to continue to study and look deeper into the complex problems.

During two following years, when I had been accepted as a member of the Doctoral program in Conservation at Göteborg University (ICUG), my studies were principally concentrated on terminology, techniques and historical background, but also by experimenting, in order to try to make Punic wax. In May 1997 the results were presented, and approved of, as a licentiate thesis at ICUG. Since then the historical and art historical background has been further and more precisely investigated, materials and techniques as well. Some new experiments have been made, now in connection with an investigation of the mummy portraits in the Nationalmuseum in Stockholm, which I was commissioned to undertake. Analyses of the materials used for some portraits have been carried out by the academic staff at the scientific laboratory of Opificio delle Pietre Dure in Firenze. The results of this investigation are fully presented in a publication at ICUG.[1] The investigation is briefly related as a case study in this doctoral dissertation, presenting the process of planning and performing the study. Finally the investigation has been published by Nationalmuseum with the title *Mumieporträtt*.

Materials and techniques of Roman mural paintings and the possible use of Punic wax for mural painting, or as a protective surface coating for some mural paintings, were next to be studied in depth. Literary evidences and research results available have been consulted, and mural paintings *in situ*, or fragments of mural paintings, have been examined by various methods. The results from these studies are presented in the case studies nos. 3 and 4. The chemical-technical investigations presented in case study no. 4, have been performed by the same scientists at the Opificio in Florence as mentioned above. The results of these studies are planned to lead to suggestions concerning materials, adaptable for conservation in this field, and possibly also for methods of application in contemporary building constructions, if proved to be suitable for modern building standards.

1. *Fayum Portraits. Documentation and scientific analyses of portraits belonging to Nationalmuseum in Stockholm.* Göteborg 2000.

I want to thank my mentor, Professor Jan Rosvall, for his patience through these years, his constructive criticism and professional interaction, which made this study possible carrying through. I am also grateful to Professor Sture Samuelsson, KTH (i.e. Royal Institute of Technology) in Stockholm, Professor Carl Nylander Director emeritus of the Swedish Academy of Classical Studies in Rome, and Dr Lars Karlsson, research fellow at the same institute, who encouraged me when I took my first, unsteady steps in this field, and later.

The structure of this dissertation automatically made necessary the collaboration with other professionals. Therefore, I have received fundamental help and support from several individuals, teams, or institutions, and to all these I am grateful. My most sincere thanks to Soprintendente Professor Giorgio Bonsanti at Opificio delle Pietre Dure di Firenze for accepting to support the long-term research regarding materials from Fayum portraits and fragments of wall paintings from Prima Porta, and to Dr. Mauro Matteini, Dr. Archangelo Moles, Dr. Giancarlo Lanterna and Dr. Carlo Lalli, at the Scientific Laboratory at the Opificio, who performed the scientific analyses, and contributed with the facts which constitute the scientific basis in these projects.

I want to thank Dr. Görel Cavalli Björkman, Head of Research, and Conservator John Rothlind, Chief Conservator at Nationalmuseum, for giving me the opportunity of studying the Fayum portraits, which became my first real case study. I also want to mention Astrid von Hofsten, remembering the pleasant and instructive team-work while selecting and preparing for the scientific analyses. In addition my sincere thanks to Dr. Nasser Iskander and his staff at the conservation department at the Egyptian Museum in Cairo, for professional help, and to Dr. Sandro Massa at CNR (Consilio Nazionale delle Ricerche) in Rome, who instructed me and opened my eyes to the microscopical realities of the natron salt. Finally I want to thank Dr. Susan Walker and Dr. Morris Bierbrier at the British Museum in London, who read and commented the case study concerning Fayum portraits.

The investigations of Roman wall paintings could not have been done without the opportunity of working with real material. Such opportunities were given to me by the archaeologists Dr. Olof Brandt and Dr. Peter Liljenstolpe, both leading excavations for the Swedish Institute in Rome. Dr. Brandt had the courage of giving me the responsability for the mural fragments excavated at San Lorenzo in Lucina, and following the progress of work with great confidence and enthusiasm. Dr. Liljenstolpe offered the possibility of studying mural fragments at the Villa of Livia at Prima Porta, which led to the beginning of a long-time research project, concerning the wall painting materials at Prima Porta, coinvolving the Soprintendenza Archeologica di Roma, XX Circoscrizione, represented by Soprintendente Dr. Gaetano Messineo and archaeologist Dr. Matilde Carrara. To Professor Anne-Marie Leander Touati, Director at the Swedish Institute in Rome, particular thank for giving professional support in contact with representatives from external institutions, connected to the projects mentioned above. I am deeply grateful to all who made these studies possible, and I am happy for all the inspiration it brought.

My deepest gratitude to *Birgit och Gad Rausings Stiftelse för humanistisk forskning*, Lund, *Fondazione Famiglia Rausing*, Rome, *Fondazione "C.M. Lerici"*, Italienska Kulturinstitutet, Stockholm, *Adlerbertska forskningsfonden*, Göteborg and *Elna Bengtssons fond*, Stockholm, without whose economic contribution this project, including the many journeys to Rome and Florence and to Egypt, would not have been possible.

Stockholm, December 2000

CONTENTS

INTRODUCTION

Choice of Topic

The principal argument in this dissertation is, that we have a common cultural heritage to preserve. As a consequence, questions such as *what* and *how* to preserve it, become of vital importance. Alternatives such as making no efforts in conservation at all, or preserving anything made by mankind, in this context are considered not relevant, and will not be considered as realistic choices. The first alternative would mean a tragic waste of symbols and values while the other would lead to an overcrowded world of things, since continuos producing is imbedded in the human nature. Preservation consequently, by necessity is selective. In the field between *nothing* and *everything* there are immense possibilities of acting, and an almost infinite choice of materials and methods to use, ancient and modern. This leads to the vital problem in this context, *how* to preserve cultural heritage.

My first contact with traditional and modern conservation materials was at the Palazzo Spinelli, where conservation of stone was my principal subject. In addition, I had the opportunity to participate at the professional training of gilding and conservation conservation program of gilded objects. The teachers, instructing on traditional methods, were excellent craftsmen. Working with traditional materials such as various kinds of gypsum and chalk, waxes and clays, was pleasant, while some modern chemical products, such as mastics or *polyfilla*, substituting natural materials often were uncomfortable to work with due to their consistence or intense smell. Liquids and substances such as white spirit and animal glues, had odours which were easier to put up with than those of *Diluente nitro* or modern stone mastics.

The fact that many modern materials used in conservation are toxic or even cancerogeneous, was worrying, and made me avoid working with certain materials, and later to consider alternatives, such as materials which had been used before the invention of modern chemical products. Beeswax and mixtures of beeswax, make part of the vast group of traditional materials.

My diploma theses *La pittura ad encausto* in 1992 at the Palazzo Spinelli, can be considered as my first attempt of understanding ancient methods of using beeswax as a paint and for surface coating. In 1995, through a thesis for the Licentiate degree *Wax Painting, Encausto and Ganosis*, some problems regarding encaustic painting and *ganosis* were presented. In particular, issues concerning ancient sources and terminological problems were studied, as was also the scholarly debate on the encaustic methods, roughly during the last two centuries. Some of these aspects, substantially revised, are presented in this dissertation.

The issues presented above, connected to conservation principles and practice, and to the choice of materials in conservation, lead to the role and the responsibilities of the conservator as a professional individual.

Problems

Problems linked to modern conservation programs of relevance in this context, are at focus in this dissertation. One main objective is to clarify if there is a correlation between internationally agreed, theoretical guidelines, and the conservation work actually taking place in the "real world".[1] In this case "the real world" is visually exemplified at sites and by works of art, principally from the Roman culture. Our perception of Roman art is closely linked to the archaeological circumstances in which the objects were discovered. Therefore, the ethics valid in any period, dictate how excavation might be carried out and how objects are handled.[2] With object is intended, in this context, archaeological remains, wall paintings, mosaics, statues and all kinds of minor art and handicraft, i.e. anything excavated at a particular site. Current ethics and cultural valuations are manifest in the excavation program, i.e. the way the project is carried through and how the site and the objects are handled, during and after the excavation period. Studying the material aspects of Roman art, consequently means considering the archaeological context and measures taken or not, to preserve archaeological finds.

Another set of problems concern *if* and *how* traditional materials are adaptable and/or acceptable, in modern conservation. *If* traditional materials are adapted in conservation, the next questions are *when*, and finally *how* they should be used. By asking *when*, the answer might be "at any occasion", since the chemical similarity between the original and traditional conservation materials often are compatible, or such materials are reversible and therefore not bringing long-term changes to the object conserved. The answer might also be, "just in some particular cases", when, for some reason, similarity between materials is requested. *How* traditional materials ought to be used is the final, and important, question, since material and structural resemblance make possible the performance of indistinguishable reconstructions. This issue also ends up in the general question, what kind of conservation interventions are acceptable, i.e. *how* to preserve. The last, but not the least, problem, concerns the possible effectiveness of such traditional materials in modern building constructions. These problems are presented in depth under separate headings in the following part of this chapter.

Conservation theory and practice

Studies in the history of conservation reveal, that ever since the first written documents on this subject were expressed, and more elaborated treatises on conservation were launched, there has been a considerable gap between theory and practice.[3] Theoretical guidelines in earlier periods as well as today, suggest

[1] Van Gigch, 1991; van Gigch & Rosvall, 1991; Rosvall & Lagerqvist 1992.

[2] Pagano, 1991, 1994.

[3] Coles, 1995; Marconi, 1984; Wolters, 1988; Zander 1993.

that "as little as possible" should be done.[4] Conservation practice on the other hand, often has resulted in massive treatments. This discrepancy has been studied with the objective of pointing out some possible reasons, and hopefully, to determine a possible weak point in the theoretical guidelines set up. In earlier periods, suggestions of care-taking were made by individuals, mainly concerned with the preservation of artistic values. During the last few decades, general guidelines in conservation have been formed on an international level by e.g. CC,[5] IIC,[6] ICCROM,[7] ICOM,[8] and ICOMOS.[9] On the national level, conservators organisations have been developed, e.g. NKF. [10] Codes of ethics and other principal guidelines have been formulated, as e.g. the AIC Code of ethics 1999.[11]

Issues of conservation principles, evidently lead to a set of serious questions concerning reconstruction, restoration and conservation, and ultimately to ethics in relation with conservation interventions. The problems are accentuated only as a set of issues within a few major themes such as:

a) the selection of objects to conserve,
b) the kind of conservation desired,
c) the choice of means within conservation,
d) the different kinds of ethical considerations connected to conservation interventions, such as when an object ceases to be authentic and becomes transformed into something else, followed by the question if to accept such transformation, and
e) how to handle the conserved objects after terminated treatment.

Some specific questions to consider and answer were the following:

a) what shall be conserved and why?
b) should objects be conserved at any cost? Should conservation be considered as more interesting and important than maintenance? Is it, or is it not, possible to accept that there is a limited lifetime for each object? Would it not be accepted as preferable to make repeated conservation treatments with simple methods, if these do not alter the material constitution of the object, rather than to make massive treatments which may have a longer persistence, but which alter the chemical and pictorial composition of the matter treated?
c) should conservators or producers of conservation materials be the persons responsible for the choice of methods used? Why should substances which are harmful/toxic/cancerogenous be used, instead of less dangerous compounds?

---

[4] Blomé, 1997; Brandi, 1977; Fielden, 1993; Marconi, 1984; Price, 1996.

[5] The International Committee for Conservation, within ICOM, founded in 1967.

[6] The International Institute for Conservation of Historic and Artistic Works, founded in 1952.

[7] The International Centre for the Study of the Preservation and Restoration of Cultural Property, founded in 1959.

[8] The International Council of Museums.

[9] The International Council on Monuments and Sites, founded in 1965.

[10] Nordiska Konservatorsförbundet (The Nordic association of conservators) of which NKF-S is the Swedish section.

[11] The Code of Ethics of the American Institute for Conservation of Historic and Artistic Works.

Why neglect the negative effects upon health? May conservation of art, in relation with conservators′ technical interventions, be considered as more important than human health?

d) is it possible, or even desirable, to conserve anything "for ever" with application of various chemicals? It seems obvious that application of penetrating chemicals on works of art is causing a change in their material structure, and consequently the material saved is not the same as the original, and therefore no longer "authentic". Is it preferable to conserve an object, such as a mural painting or a statue, impregnated with material compounds which obviously have the double effect of partly preserving the shape, partly chemically altering the object, or would it not be better to make a surface application of a not so much penetrating substance, creating a "sacrificial coating", which is anticipated to eventually disappear and leave the material composition of the object principally unaltered?

e) when the object has become conserved and treated, the next issue to decide is, whether it is supposed to remain under the conditions that originally caused the decay, or if some new preventive arrangements should be made in order to avoid a repetition of the deterioration process. There are several issues on this subject to consider, such as removing delicate original objects, placed in open-air environment, and replacing them with carefully produced copies, or to create adequate measures for delimitation of exposure to wind, air pollution and other main causes of decay, in order to protect them. The question raised is, therefore, what are the possibilities of acting for professionals with responsibilities for cultural heritage.

Materials

As indicated above, there is nowadays a possibility of choice between traditional materials and such provided by the chemical industry. Among them is beeswax, used in Antiquity as a paint and for surface coating. It was used as a paint in the encaustic techniques. Encaustic paintings, according to tradition, generally were made on a support of prepared wood, but wax-paint could also be used on marble and various other materials.[12] Used as a coating, it could be applied on marble statues, on architectural details and on wall paintings. Since beeswax in Antiquity was used in some, nowadays practically unknown techniques, the intention was to study various objects, possibly painted or coated with beeswax in any form, with the objective of determine the visual aspect and the composition of the materials used.

Encaustic paintings on panels have been carefully studied in a collection of Fayum portraits. The scientific report regarding this project, has been separately published within the Acta series at Göteborg University.[13] It also has been published, in a revised form, by Nationalmuseum in Stockholm, as the yearbook

---

[12] Lucian *Eikones*; Plinius *Naturalis Historia*; Plutarch *Vite parallelle*; Vitruvius *De architectura*.

[13] Fayum Portraits. Documentation and Scientific Analyses of Portraits Belonging to Nationalmuseum, Stockholm. Göteborg 2000.

2000.[14] Beeswax used as a coating, or as a paint on plastered walls has been given greatest attention, and investigations are still being performed, while polychromy on statuary just has been outlined. The technical aspects between applications on plastered walls and on statuary are, however, very similar.

The materials investigated primarily are natural beeswax, and Punic wax, i.e. a transformed beeswax. The issues of Punic wax and its ingredients, e.g. the natron salt, has been given much attention, in order to understand and, possibly, to be able to reconstruct the substance. The technical aspects connected to the encaustic techniques, also included studying the supporting materials and the preparations, being considered as parts of the same unity. Therefore, the plastering techniques, and the compositions of stucco, plaster, binders were studied and also the pigments, being part of the paint.

Terminology

Some unclarities are connected to the terms *encausto, kausis* and *ganosis*, important in this context. These are latinized Greek terms referring to ancient painting techniques and methods for surface coating on art and architectural details. The basic material is beeswax, and a common factor is the use of heat. Heat is needed to melt the beeswax, whether this is used as a paint in its natural state and with the addition of pigments, or boiled with chemicals in water, to create *Punic wax*. Heat is also used to enable wax to partially penetrate into the surface of stone or plaster, in the *ganosis* procedure. Much of scholarly-professional debate over the ages concerning this subject, has been connected to different interpretations of the previously mentioned terms and the question of the use, and value, of heat.[15]

According to Pliny there were two methods established for encaustic painting when a third was invented.[16] Pliny stated that the encaustic techniques were known long before the Classical Greek period, and it had been discovered in Egypt. The first known method consisted in melting the natural beeswax and adding some pigments into it. The second of the early methods was an engraving technique, used on ivory. A pointed metal tool, *cestrum*, was used as an engraving instrument. This method was principally used for small decorations, and according to Homer, it was invented in Asia Minor and brought to Greece.[17] The third method was invented in Greece, and the new discovery was to make possible the use of a brush for spreading the colour on to the surface. This method was initially used to paint ships of war, and Pliny wrote that "...this kind of painting applied to ships is not injured by sun, wind or salt water...".[18]

---

[14] Freccero, 2000, Mumieporträtt, Stockholm 2000.

[15] Berger, 1904; Büll, 1963; Hoppe 1991.

[16] Plinius, NH XXXV, 149.

[17] Büll, 1963, p. 336.

[18] Plinius, NH XXXV, 149.

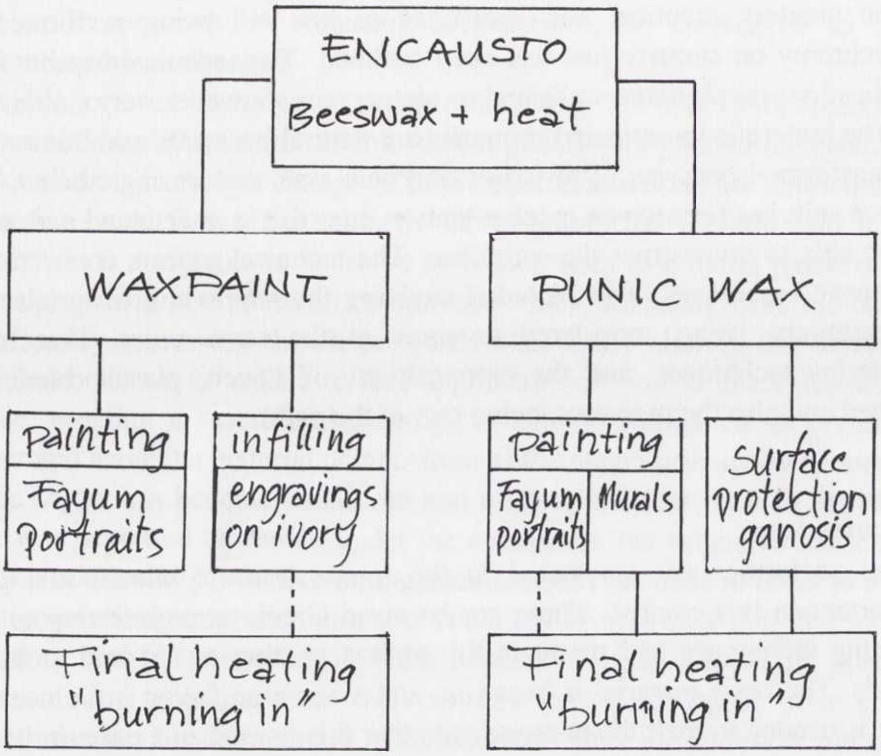


Fig. 1. The relations between *encausto*, *beeswax*, *Punic wax*, *ganosis* and *heat*. *Beeswax* is the natural material used as production basis for all these techniques. *Heat* is initially used to melt the beeswax either to make waxpaint, or to saponify it, which implies to make an wax emulsion, i.e. *Punic wax*. *Wax-paint* could be used for painting, e.g. pictures like the Fayum portraits, or for infills i.e. engravings on ivory. *Punic wax* either was used for painting, e.g. Fayum portraits and murals, or for surface protection, *ganosis*. *Final heating* may have been used for the engravings on ivory and for some paintings made with Punic wax. Heating was used for murals and for surface protection, i.e. *ganosis*.

Encaustic technique	Tools required
I. Melted and pigmented beeswax, used for painting.	A *cauterium*, a spoonlike tool made of metal.
II. Melted and pigmented beeswax, used for filling the lines of engravings on ivory.	A *cestrum*, a pointed needle.
III. Emulsified (and pigmented) beeswax, i.e. Punic wax.	A brush.

Fig. 2. The three encaustic methods, according to Pliny. *Ganosis* consisted in the application of Punic wax with the addition of some oil, which was heated after drying.

Beeswax in form of Punic wax was also used on plastered walls, as a coating for some pigments, among them *indigo*, *orpiment* and *white lead*, pigments which tend to alter in contact with the oxygen in the air..[19] The wax applied to the colours formed a protective shield and prevented a direct contact with the air. Consequently the pigments remained unaltered. Pliny states in a chapter describing *vermilion*, that the exposure to "sun and moon" is harmful for this pigment.[20] In order to avoid alteration of the pigment, hot Punic wax mixed with oil, could be spread on to the wall. Then the wall had to be heated in order to make the paint "sweat", and finally the wall should be rubbed with a linen cloth. Vitruvius describes the same process, and states that " ...this process is called ganosis by the Greeks".[21] *Ganosis* was commonly used on marble statues as well as on architectural elements.[22] It has been suggested that un-pigmented Punic wax was spread upon the nude parts of statues, just to preserve the stone surface intact and at the same time give a slightly warm hue to its whiteness.[23] Punic wax was used also on painted parts on statues in order to protect the painted decoration in exposed positions from a rapid disappearance.

All terms referred to above have been used over the years according to different authors' individual interpretations, which makes it impossible to take the meaning of any of these terms for granted.[24] Generally *ganosis* is used as a definition for any kind of protective surface treatment, while *encausto* mostly refers to painting techniques. *Kausis* on the other hand is not commonly used. Sometimes the term *encausto* is used to describe the *ganosis* process. In my opinion, some early misinterpretations connected to the translations from Greek into Latin, may have caused this lack of clarity already in Antiquity. These issues are presented in the chapter "Terminology".

The Roman context

The discovery of Herculaneum and Pompeii in 1738 and 1748 respectively, shed new light upon Roman art and architecture. These sites and numerous Roman villas, covered with volcanic material since the eruption of Vesuvius in AD 79, are by far the richest classified archaeological sites in the world. Immense amounts of arts and crafts have been discovered, documented, studied, and interpreted.[25] The so called "Pompeian wall paintings" have been given particular interest. Scholars and scientists from different disciplines have tried to understand and explain how these paintings, with brilliant colours and shiny surface, were made.[26] Speculations regarding the technique started immediately after

---

[19] Plinius, NH XXXV, 49.

[20] Plinius, NH XXXIII, 40.

[21] Vitruvius, VII, 9, 3.

[22] Platon, *De rep.* IV 420 c; Plinius, XXXV, 133; Plutarchos, *Quaest. Rom*, 287 b-c; Vitruvius IV, 2, 2.

[23] Ashmole, 1972; Manzelli, 1994; Moorman, 1988; Reutersward, 1966; Richter, 1928;

[24] Mora, 1967, p. 81.

[25] Curtius, 1929; Ling, 1991, 1997; Maiuri, 1931; Mau, 1908; Moormann, 1988; Schefold, 1962; Strocka, 1980; Wallace Hadrill, 1994; Zanker, 1998.

[26] Early publications: Diderot: *L'istoire et le secret de la peinture en cire*, 1753; De Caylus: *Mémoire sur la peinture à*

excavations, and interest was particularly concentrated on the characteristic surfaces, which appeared very smooth and shiny when the paintings were excavated. The lustre of the surfaces, however, tended to fade away after some time, and in order to maintain them shiny, various wax mixtures, and other substances were spread upon them.[27] Such applications were made already at the time of excavation, but also subsequently, as maintenance. Such mixtures of wax were probably chosen for surface coatings due to the passages by Pliny and Vitruvius, relating that *ganosis*, was used as coating on painted walls. Applications of various coatings, made after excavations, has made it difficult for later scholars to define the original chemical composition of the paintings, since it is not always possible to determine the time when a specific application was made. Neither is it known for certain that wax was applied at the time when the paintings were made, but the possibility can not be excluded.

Whether the *ganosis* treatment was used to protect polychromy on statues and architectural elements, or if it was just applied un-pigmented on un-coloured parts to give a slightly warmer hue at the white marble, has been suggested but not finally established.[28] Early documentation of identified objects, does not include scientific analyses of the materials used for painting and coatings. The lack of reliable information from earlier excavations is one of the reasons why there are difficulties in understanding the *ganosis* tradition.

It is a known fact that accurate documentation of the objects were not given much attention at earlier excavations. On the contrary, much enthusiasm and inventiveness was directed to collecting beautiful works of art, offering them to international collectors or in museums for future exhibition.[29] As an obvious consequence, it was important to clean the objects thoroughly, before presenting them. By this approach, much of the excavated material has suffered great damage. Nowadays, excavation methods have radically changed, and the existence of excellent equipment for analyses are available, therefore unsolved questions might be answered.

Wax is not chemically altering with time, and ancient beeswax is of the same composition as recent wax.[30] Therefore, analyses of beeswax found on the surface of an ancient object, does not reveal the age of the wax. Saponified, or Punic wax, neither is altering with time, but remains in principle of the same chemical composition.[31] On the other hand, wax which has been spread as a protective, by chemical reaction with the oxygen in air, tends to become harder, and its melting-

---

l'encaustique, 1755 ; V. Requeno: *Saggi sul ristabilimento dell'antica arte dei greci e romani pittori*, 1784; Astori: *Della pittura colla cera all'encausto*, 1786; Winckelmann wrote a report on his impressions from the excavations of Herculaneum, published in 1762, and published *Geschichte der Kunst des Altertums*, in 1764. Between 1814 and 1830 several works on the subject were published, among them Quatremère de Quincy: *Le Jupiter Olympien* , 1814;
J.J. Hittorf: *Restitution du temple d'Empédocle à Selinonte* ... , 1851; G. Semper: *Vorläufige Bemerkungen über bemalte Architectur* ..., 1834.

27 Pagano, 1994, p. 369; Jokilehto, 1986, p. 88.

28 Moorman, 1988; Reutersward, 1961; Richter, 1928.

29 Berry, 1998, p. 7; Ciarallo and De Carolis, 1998, p. 7; d'Ambrosio, 1998, p. 21.

30 Mills, 1994, pp. 53, 173, 190.

31 Hillyer, 1984, p. 2.

point rises.[32] Since wax does not disappear and is generally not altering, it is possible to determine the presence of wax - including ancient Punic wax - by scientific analyses, for example by gas chromatography and FTIR.[33] It may also be possible to determine if the application was made at the same time as the painting, by studying sections of samples. Other materials, such as lime and glue, may be added into the Punic wax. Different ways of conserving and restoring Pompeian wall paintings were tested by Augusti, among these, Punic wax.[34] According to Augusti, this kind of wax carbonates when applied on lime-plaster. As a result, a wall painting coated with Punic wax visually seems to be a fresco-painting, but in fact, pigments are encapsulated and protected by wax. This prevents some pigments from altering, the way they normally would, when used for fresco-painting. Beeswax is, according to Augusti, not possible to identify in cases when it chemically has been transformed, as described above. Recently performed chemical analyses have been made on some pieces of excavated Pompeian wall paintings, not previously exposed to any modern conservation treatments. Examinations of certain samples have revealed remains of an organic matter underneath the strata of red paint, an observation which was noted with surprise by the research team.[35] The fact that beeswax was found below the surface layer, may signify that it had been used as a binder, i.e. as a paint.

Beeswax is associated also to another type of Roman painting, the so called "Fayum portraits".[36] At the end of the 19th century and the beginning of the 20th, excavations were made at sites in the Nile Valley, principally by Graf and Flinders Petrie.[37] Large amounts of portrait mummies were found, during early excavations. Many of these had portraits painted with encaustic on wooden panels. The discovery of the mummy portraits resulted in a new wave of interest among scholars for the Roman painting techniques, and new hypotheses and opinions on the characteristics of encaustic painting were published.[38]

Case studies

In order to examine the problems presented above, some case studies have been made. The principal problem investigated, has been the relation between theoretical guidelines in conservation and the situation in "real life". The contexts investigated, primarily have been connected to Roman culture. The case studies, aims, objectives and methods of research, are separately presented under the following heading, *Case studies*.

---

32 von Tell, p. 29.

33 Hillyer, 1984, p. 2; Mills, 1994, p. 50.

34 Augusti, 1950, pp. 159-162.

35 Dr. M. Pagano, Soprintendenza di Napoli, Scavi di Ercolano, personal communication, October 1994.

36 The portraits are named after the Fayum district, situated in the Nile Valley, south of Cairo in Egypt.

37 Theodor Graf (1840-1903), Viennese dealer, and Sir W.M. Flinders Petrie (1853-1942), English archaeologist.

38 Donner von Richter, *Ueber Technisches in Malerei der Alten* .. , 1885; E. Berger, *Maltechnik des Altertums*, 1904; A.P. Laurie, *Greek and Roman methods of painting*, 1910 .

AIMS AND OBJECTIVES

The aims of this investigation are

a) to study the connection between conservation theory and practice,
b) to study the actual possibilities of choice in conservation, especially between respectively traditional and modern materials and techniques,
c) to investigate the applicability of some traditional materials within the field of conservation, as well as to
d) explain the historical and cultural context in which the encaustic techniques were developed, further
e) to try to reconstruct these techniques, and
f) to study their usefulness in modern building construction.

The objectives are

1) to indicate the necessity of being professionally conscious and having a critical attitude towards general guidelines in conservation, and in particular those connected to economic and political interests,
2) to indicate the necessity of searching alternative methods in conservation, whether these consist in a return to traditional and sane materials, or in modern approaches, safe for mankind, cultural heritage and environment,
3) to indicate the necessity of working in teams composed of groups of relevant professions, thereby gaining multiple and creative perspectives on problems to resolve; to provide continuing education and better understanding of the complexities in the field of conservation, and the capacity of making correct decisions to achieving optimum results.

Conservation theory and practice

The objectives are to establish the development in the field of conservation concerned and to describe the attitudes towards conservation interventions of the past, the present and the indications for the future. The aim is to contribute to formulate a relevant approach to application-oriented conservation which considers environmental, human and cultural factors.

The history of conservation may be described as a linear development, starting with *repairs* of buildings and artefacts in Antiquity, followed by *repairs and reconstructions*, which were the guidelines for centuries, later to be expanded by the concepts *reconstructions or restorations*, developing into the comprehensive discourse based on the holistic concept of *conservation* which has become the term of honour in the present period. These terms and concepts are described in this dissertation, and comparisons between these concepts and their application in "the real world" have been made. I have also considered it important to indicate possible inconsistencies between a theoretical system and its application in real life, or a possible discrepancy between laboratory tests of materials, and the application of established theories and laboratory test results, in real life situations.

Possibilities of applications in modern building constructions

A set of series of experiments have been performed as "real life" tests *in situ*, which consequently are not repeatable and observable the same way as are tests performed in a laboratory *in vitro*. The reasons of the choice of starting with "real life" experiments were at least two, and fundamentally that the "real life" situations provide all kinds of details which, taken together reflect the situation in environment during particular periods. This kind of "real world" is assumed to be similar to that in which the materials are anticipated to be inserted, unlike the man-controlled laboratory situation.

The "real life" process is a slow one, compared to e.g. the rapid artificial ageing in a laboratory, and therefore, better to start with, since the results must be waited for. Laboratory test series may be performed in the future, when there is a need of studying specific materials or combinations of materials in specifically determined environments, and each detail needs to be studied separately. This was not the case at this occasion, when instead the general aspects of the paints, preparations and environment were observed, but also the applicability of these paints, and their aesthetic appearance. The objective has been to study the possible usefulness of these materials in conservation, and as potential techniques for modern wall painting and surface coatings.

Historical materials and material technology

The principal objective of studying traditional materials and techniques, is to establish the possible correspondence between the materials and techniques actually used, and those of the ancient descriptions. If it is a definite correspondence between the ancient objects studied and the materials used, and available information in ancient sources, then the issues raised above might be fully or partially explained. If, on the other hand no such correspondence is evident, there are new questions to be made. One of the main objectives is to establish the existence and use of some debated ancient techniques, e.g. encaustic painting and *ganosis*.

A second objective is to investigate how the use of traditional materials correspond with modern conservation principles and practice. The aim is in this respect to understand the positive and negative aspects of the introduction of such materials in modern conservation. A third objective is to study the possibility to find a suitable method for conservation and restoration of Roman wall paintings, and finally to develop a method to be used in construction, which is environmentally safe and suitable for modern building standards.

The aim is to test, if the techniques described are technically practicable in real life, and to establish a connection between ancient descriptions, terms, concepts, and available preserved examples.

Historical and cultural context

According to ancient writers, the encaustic techniques were known and used during Antiquity. Evidences of the techniques have been found, e.g. the Fayum portraits. There are, however, many disagreements and unclarities concerning these techniques. In order to gain a clear view on the materials and the corresponding techniques, as well as their status during Antiquity, the cultural context in which these techniques evolved, has been studied. The specific term *encausto* has been investigated under the heading *Terminology*.

Studying the cultural conditions has been important in order to understand and explain encaustic, here intended as a descriptive term for a paint or an emulsion based on beeswax, within its historical context. Due to the fact that these techniques, already during Antiquity, were used for *painting* (on wooden panels, ivory and marble) and as a *surface coating* (on polychrome statues and architectural elements), these two aspects have been regarded as equally important to study. The period investigated is principally between the Roman Republic and the end of the Roman Empire, and with particular regard to the well known Greek influence on Roman culture. The historical objects investigated, in publications and/or *in situ*, are primarily Roman murals, Fayum portraits and polychrome Hellenistic-Roman statues.

The aim is to understand if these techniques were commonly accepted and used in Antiquity, or if they were considered as marginal techniques, hardly ever used. By obtaining an overview of these issues, the usefulness of the materials used, their advantages and disadvantages, would be possible to comprehend. It would also be possible to understand if encaustic was generally used, if it was used in specific occasions or if it was hardly used, or known to be used, at all. These results might be compared to those presented in publications, as well as by confrontation with surviving evidences of the ancient culture. It has been important to describe the encaustic techniques as some of the techniques available during Antiquity with the double purpose of clarifying their usefulness compared to other available techniques, and possibly to understand their comparative advantages.

Terminology, definitions and ancient and later sources

The objectives of this part of the study are to describe and understand the terminology involved with the subject, and to define the concepts and terms connected to *encausto*, *kausis*, *ganosis*, *punic wax*, and various forms of *politio*, as well as to study to what extent these terms and concepts are correctly used in publications on the subject. The aim is to create a reliable and intelligible terminology, and further to establish a clear connection between terms and related concepts. In case the term *encausto* is used only to signify a wax-painting, which has had the surface heated in order to "burn in" the wax-colours, and existing descriptions of *encausto* as well as technical evidence confirm, that wax-paint used as described above, are distinctive for the encaustic technique, then there is no discrepancy between the term and the concept. If, on the other hand *encausto* is used to represent wax-paintings which have been heated, paintings made with Punic wax, and paintings, or three-dimensional objects which have been given a final application of wax, heated or not, then there is an inconsistency between the term and the concept. In the first case there is no problem, in the second an agreement has to be made about when to use the term *encausto*, in order to avoid misunderstandings.

The terms *encausto*, *kausis*, *ganosis* and *Punic wax* are used in all literature concerning classical Western painting methods and surface protections containing beeswax. As stated above, European terminology is not clear and easily understood. In order to clarify this complex of problems a comparative study has been made. Ancient Greek words have been compared with Latin translations or counterparts, of the same words. The changes in interpretation of these terms as well as of the conceptions of the methods that have altered by time, have been studied. The changes in terminology have been studied with the intention to understand the reasons for existing unclarities and ambiguities connected to the matter. If such discrepancies as mentioned above are found, the intention is to establish a correct, relevant and consistent terminology on the subject. Some of the lack of clarity might be explained by confusion of terms and discourses, and such confusions might depend on problems such as incorrect translations, transcriptions or plain misunderstandings. A suggestion of how to use some terms is presented.

Case Studies

Case study 1: Palazzo Calabresi in Viterbo

The present case study relates to a process connected to an architectural environment. The decision to conserve and restore the building for future use had already been made when the Swedish partner was invited, but it was not decided *how to do it* or *for what purpose*. When entering the project, issues immediately were raised concerning important aspects of the building complex. Interior and exterior observations of the building were made, including documentation and measurements of the façade. Since the project co-involved persons from different professions, it was necessary to cross the borders between professions and, as far as the conservators were concerned, to regard historic and art historic as well as environmental and material factors, to be able to formulate suggestions for conservation and future use of the building. This case study refers to the process described above, which, however was not the end of the project, since sampling and material analyses were performed, and a documentary report with all information was made and presented.[39] The participation of the Swedish group ended at that point, and any conservation action is therefore according to decisions made by the Italian co-ordinator.

[39] *Restoration Project of the Graffito Decorated Façade of Palazzo Calabresi. A Rafael Project 1998*. Report presented at the ICUG 1999.

What is described in the report on this case study is the intellectual process of forming guidelines in an architectural conservation project including mural graffiti, and since the conservation interventions started and were completed before this dissertation was presented, some remark will be made concerning the discrepancy between the theoretic frames set and the actions taken in practice.

Case study 2: Fayum Portraits in Nationalmuseum in Stockholm

This case study includes the presentation of the initiation and development of a project concerning some museum objects, which may lead to future conservation interventions. The project started with the definition of a set of questions which were in need to be answered, connected to their material and to their origin, both issues however not very clear at that time. The process described concerns the *investigation of ancient materials*. Also referred to are issues such as *definition of problems* and the successive *investigation and documentation methods*. The survey contained many more issues investigated, such as historic and art historic factors, the cultural and religious context and the methods of early excavations and conservation, all factors that not are presented in this context, but available in a conservation report, and also as a separate publication. [40]

Described in the present case study is the intellectual and practical process leading to decisions on methods of investigation and documentation, followed by sampling and analysis of the ancient materials used for these Fayum portraits.

Case study 3: San Lorenzo in Lucina in Rome

The present case study refers to the process connected to caretaking and conservation of some Roman mural fragments. In this case, the fragments had been excavated within the period of a few years, and successively were kept in separate boxes.[41] It had to be decided *if*, *how* and *for what purpose* to conserve the fragments, followed by considerations on *how* and *for what purpose* to expose them.

In this study the different questions immediately set, and those arising during the working process are described, as well as the methods tested and used in conservation. Also in this case the necessity of historic and art historic explanation and understanding has been confirmed, as of course the need of documentation and chemical-technical investigations of materials. It was decided to make an exhibition of the material in connection with the excavation site. Due to the characteristics of the fragments, they are intended to be used for an exhibition with didactic intentions, such as to explain how Roman murals were made and what kinds of materials that were used.

---

[40] *Fayum Portraits. Documentation and scientific analyses of the portraits belonging to Nationalmuseum in Stockholm. A case study prepared as part of a doctoral dissertation in the discipline Conservation*. Published by ICUG 2000. *Mumieporträtt*. Published by Nationalmuseum, Stockholm 2000.

[41] Report planned to be published in a project publication by Swedish Institute of Classical studies in Rome.

Described in this case study is the intellectual and practical process leading to conservation, publication and exhibition of the project. Alternative methods in preservation, cleaning, consolidation, preventive measures, maintenance and presentation of the fragments have been discussed and are described.

Case study 4: Prima Porta Outside Rome

This case study refers to an investigation comprising analyses of materials used during the Roman period at Prima Porta situated at a short distance north of Rome.[42] The fragments investigated derive from different find contexts located at, or close to the Imperial Villa. The material analyses are made according to the same principles, but it seemed better to separate the contexts studied into three sub-projects, a, b, and c, within case study 4, since each context contains fragments either from one particular period (case studies 4a and 4b), or contains materials from the various building periods observed within the Villa of Livia (i.e. case study 4c). The technical, material and artistic development of mural painting at the Torre di Prima Porta and at the Villa of Livia are in focus, since the sites form a specific Roman context, where mural paintings from at least three centuries are preserved.

Case study 4a: Torre di Prima Porta, First Style decorations

This study refers to the *process of examination*, *conservation*, *sampling* and *material analysis* of the fragments excavated in 1985 at the Torre di Prima Porta at close distance to the Villa of Livia. The main issues, at this initial stage of a larger investigation, have been *testing measuring* as a tool for identification of technical quality and for dating, as well as *testing materials for cleaning* and *testing saponified beeswax* as a surface protective. Samples for chemical-technical analysis of pigments and binders as well as of the composition of stucco and plaster layers have been removed and are investigated at the Opificio in Florence. Stucco and plaster have been observed under binocular microscope. In this study is presented a documentation and conservation process which is intended to provide a base for future investigations.

Case study 4b: Villa of Livia at Prima Porta, Third Style decoration

The present study has been made according to the same principles as described above. In this study one loose fragment from the atrium wall and another still *in situ* are investigated. The decoration is dated to the Augustan period.

Case study 4c: Villa of Livia at Prima Porta, with Second style decorations and decorations from the Antonine as well as the Late Roman periods

In this case study mural fragments from various periods in Roman culture have been investigated, starting with some fragments dated to the Augustan period and

---

42 The results are planned to be presented in the excavation report.

ending with those from the Late Roman period. The fragments have been investigated according to the same principles as described above.

Case study 5: Villa San Michele at Capri.

The conservation of marble, travertine and peperino objects from the Roman period and later is the content of the present case study. In this didactic as well as research oriented project, issues connected to the choice of conservation materials have been at focus. The project started in 1998, followed by a campaign in 1999, and a third campaign is planned for 2001. The results are presented in the conservation reports *Stenkonservering i Villa San Michele, Anacapri Loggia di Hermes, 15 maj – 15 juni 1998, first report*, and *Stenkonservering i Villa San Michele, Anacapri 17 maj – 12 juni 1999, rapport 2* (Stone conservation at Villa San Michele, Anacapri).

Case study 6: Experiments

As part of the project, experiments have been made with the objective to reconstruct ancient wax paint and the ancient wax emulsion, *Punic wax*. The set of problems investigated were related to the usefulness of beeswax as a paint, i.e. its malleability, durability and aesthetic appearance. Punic wax as described by Pliny, and as interpreted by later authors, have been studied with the aim of rediscovering the ancient material, and observing its possible adaptability as a paint and a surface protective. After initial testing, a substance defined as Punic wax by this author, was used for painting on various materials, and as surface protection on marble. This product was chosen as the *Punic wax* after a long series of tests, which had been made according to ancient and later descriptions. The experiments were published in a report in 1997.[43]

THEORETICAL PERSPECTIVES

Conservation Principles

Important theoretical perspectives providing the frame for this dissertation concern issues of understanding conservation in its broadest respect, as being a recently established profession and a young academic discipline, but also a traditional craftsmanship. Between the two extremes lie the conflicts in conservation, e.g. in choices of conservation methods and materials, but also the unique possibilities of combining theoretical and scientific issues with practical skill. Furthermore, the conservator, being naturally involved, theoretically and practically, in issues coinciding with other disciplines, easily becomes professionally co-involved in truly interdisciplinary projects. Consequently, the

43 Enkaustik. Experiment med Puniskt vax. Rapport 4.96. Forskningsstiftelsen för Samhällsplanering, Byggnadsplanering och Projektering. (Encaustic. Experiments with Punic wax).

professional education of conservators is of greatest importance, and training programs set up on an international level ought to be established in order to have a commonly recognised professional training. Such training, in combination with a clear professional vocabulary would facilitate communication outside the national sphere. The prevailing cultural value systems and their impact on ways of choosing conservation methods are of vital importance in conservation, since such values form the base for attitudes towards the issues connected to the conservation field as a whole. The cultural value system is reflected in the general attitudes and approach taken in selection and performance, e.g. in the choices made in conservation. Within the cultural value system is decided e.g. *if*, *when* and *how* to preserve an object (building, site etc.), explanations to *why* it should be preserved, and *by whom*, *to what cost*, and so on.

In the beginning of this century Riegl tried to define common values which were given to any kind of objects, such as artistic and historic value.[44] Feilden has divided values into three groups, emotional, cultural and use values.[45] Important emotional values are those of identity and continuity, while use values are, e.g. functional, economic or political. Among the cultural values are the historic and aesthetic, while artistic values are not specifically mentioned by Feilden. van Gigch et al (1983) recognised four types of values, based on an earlier model by Feilden, as illustrated in fig. 3.

Types of values:	Criteria:
Knowledge values	Values which provide the base in need and reality for anything which has to do with cultural heritage understood as a necessary component of any civilization; i.e. as observed in a longitudial perspective, normally under relatively stable conditions.
Emotional values	Values which allow us to affix desires to certain things, i.e. as apprehended on individual level, concerning intangible existential dimensions, often of collective concern.
Economic values	Values which relate to local or general norms established by society, by asking "How much does Society (or at least one individual) value these things?"
Use values	Values which focus on the degree to which individuals and society at large accept an object and the use of it, or not, i.e. as understood on an operative level within a "market" exchange system, i.e. defined on society level.

Fig. 3. The system of principal values prevailing in conservation. After Rosvall et al. 1995, p. 14.

44 Alois Riegl, Austrian scholar. Author of e.g. *Altorientalische teppiche* (1892), *Stilfragen* (1893), *Der moderne Denkmalkultus* (1903)

45 Feilden, 1988, pp. 56-57.

When considering historic and artistic, or aesthetic values, it seems obvious that the same conservation methods can not always be used for objects representing different values. If the value is mainly historic, maybe in the form of an inscription or as a symbol for a historic event, the historic value is maintained as long as the inscription is legible or the meaning of the monument is remembered, and therefore these aspects of identification should primarily be conserved. It is, however, difficult to define the values of an object of art, since those values may be artistic, historic, symbolic and economic. A model for explaining value systems, has been designed by Beckman, (fig. 4), where experiences and domains are referred to by two crossing axes.

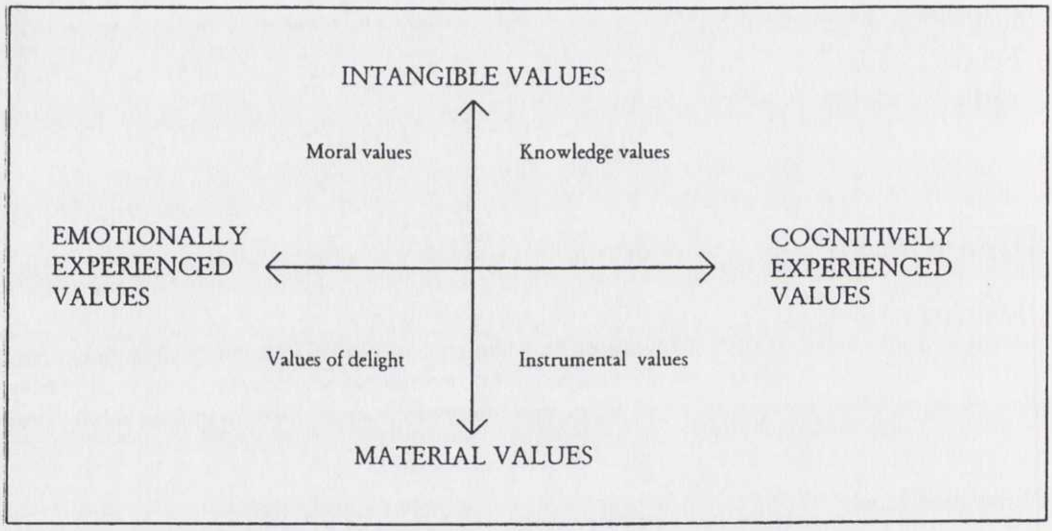


Fig. 4. Value system as explained by Beckman. After Lagerqvist, 1996, p. 24.

There is an initial value attached to any object, which may be a use value, an economic value, an emotional value or a knowledge value.[46] By deterioration any value decreases. Architectural restoration, aiming at restoring any given object to a state defined at a certain historic period, so called "stylistic" restoration, should be avoided, since such interventions lead to the modification of the authenticity of the building.[47] When modifications of ancient buildings have been performed, those should not be removed, but remain as historical evidence. As Zander puts it, "...nobody would certainly dream of abolishing the noble signs from the 16th,

[46] Rosvall and Lagerqvist, 1992, pp. 4-5.

[47] Rosvall 1988, p. 30; Zander, 1993, p. 43.

17th and 18th centuries in Santa Maria Maggiore in Rome, in order to restore it to its 5th century appearance...".[48] Historic evidence must not be destroyed, falsified or removed.[49]

Other important questions are connected to the actual conservation intervention, and include the materials used (traditional or modern) and on which authority is suggesting what materials to use (e.g. the chemical industry, chemists or conservators) and why they are chosen (for reasons of superior quality or because they are easy to apply). A further set of questions refer to valuation of originals and copies, authentic or non-authentic etc, and the impact of such values on choice of materials and methods in conservation. Finally, the tendency not to question experts' opinions and recommendations has to be considered, even though sometimes necessary.

Conservation Theory and Practice

"Conservation shall consist of the minimum effective conservation"
"Prevention is the highest form of conservation" [50]

These concepts have been repeated in, more or less, the same terms by various scholars during the last centuries. In 1772 Goethe stated that it was difficult to do too little, since the damage is caused by doing too much.[51] Victor Hugo suggested, in 1832, a legislation for the maintenance of buildings, since, according to his experience, restorations might be as harmful as decay.[52]

Marconi expressed in 1984 that interventions have to be careful in the restoration of buildings, and not let restoration be entrusted solely to technicians who are exclusively interested in the consolidation of the materials and structures, rather than in maintenance of the objects in order to avoid restoration.[53] Four years later Wolters declared that the abyss between theory and practice in conservation can be noted every day, since the reality at the workshops is totally different to that of the reality presented at conventions.[54]

Zander makes a similar reflection in 1993.[55] Torracca made, in 1989, the following characterisation about the present attitude towards the antique or ancient elements in our environment, in short terms summing up the present situation and its complex problems:

---

48 Zander, 1993, p. 43. (...È chiaro che nella romana basilica di S. Maria Maggiore nessuno oggi sognerebbe di abolire i nobili segni dai secoli XIV, XVII, XVIII per ricostruire il pur limido aspetto del secolo V).

49 Feilden, 1988, p. 72.

50 Feilden, 1993, pp. 11, 41.

51 Kåring, 1995, p. 244.

52 Kåring, 1995, p. 133.

53 Marconi, 1984, p. IX.

54 Wolters, 1988, p. 123.

55 Zander, 1993, pp. 13-14.

"Nowadays the antique is much appreciated in our towns, but just on the condition that it occurs as a noble ageing; one thing is the wrinkles and another is the skin diseases, above all if those are the result of a blameworthy negligence. Our eye today is trained in distinguishing between the patina of time, the slow chemical oxidation or the patient development of colonies of microscopic organisms, and the obscure concretions under which acids are working, or the rugged erosions caused by the rains, scratching the stones like rasps." [56]

A first international document, presenting guidelines in conservation was formulated in Athens in 1931, followed by the Venice charter (Carta del restauro di Venezia 1964) as a result of the agreements at the second international congress in Venice 1964. The necessity of systematic maintenance was one of the guidelines expressed.[57] Although the ideal of minimum intervention has been expressed and continuously repeated, practice has often proved to be the opposite.

One obvious problem seems to be defining and agreeing upon what is intended with the expression minimum intervention. Another issue is withdrawing from transgressing the limits agreed upon. Nowadays, reconstruction of missing parts on objects of art are generally not accepted, but interventions which change the chemical composition of entire monuments are. As long as there is no clear and generally accepted definition of minimum, there will be a gap between ideal and practice. Theoretical principles and practice in real life are two sides of conservation which seem difficult to bring together. Before entering a discussion of if, when, what and how to conserve, some concepts in conservation terminology will be examined. Concepts such as *authenticity* and *originality* will be explained and changes in attitudes towards originals and falsifications will be described. The need of correct and reliable documentation in conservation will be stressed.

Terminology and Concepts

Standing before an object (building, monument etc.) with obvious signs of decay it has to be decided if and how to restore or conserve it. Those questions have to be part of a general policy of what to conserve and for what purpose. Such policy ought not be stated once and for all and followed uncritically. It should rather be an open discourse from time to time, since opinions and taste differ from one period to another, which in fact has been pointed out quite recently by Jokilehto,

---

[56] Torraca, 1989, p. 33. *(Nelle città la vecchiaia è oggi molto apprezzata, a condizione però che si tratti di un nobile invecchiamento; una cosa sono le rughe ed un'altra le malattie della pelle, soprattutto se esse sono il risultato di una colpevole sciatteria. Il nostro occhio oggi è esercitato a distinguere tra la patina del tempo, lente ossidazioni chimiche o paziente sviluppo di colonie di organismi microscopici, e le condizioni fumose sotto le quali gli acidi lavorano, o le ruvide erosioni causate da piogge che raschiano le pietre come raspe.*

[57] Blomé, 1977, p. 206.

referring to changing attitudes towards restorations made by Viollet-le-Duc.[58] Obviously it is not possible to conserve everything, and a conscious decision of whether or not to conserve, ought to be the basis for following decisions, such as how to proceed, i.e. what techniques and materials to use.

The mission of conservation may be easily resolved if the object (building, monument etc.) is private property and if it is not considered to be an important cultural heritage. If, e.g. a private building is partly destroyed, the owner may repair it, more or less the way that suits him/her better, taking economical and esthetical aspects into consideration. A problem arises if the object is regarded as public cultural heritage, whether it is a church or a palace, or if it is a monumental arch, a statue or a painting. In such cases some ulterior decisions have to be made before work is initiated. In case the object is a building, the first question arising is whether to restore it or not. If the decision is made not to restore the building, its destiny is to become a ruin. And what is a ruin?

One aspect of a ruin is that it is the remains of a work of art or any kind of structure made by human hands, which cannot be restored to its potential unity. Another aspect may be described as the remains of a work of art, an artefact, architecture etc., which in connection to other works of art, may gain or yield a spatial qualification without regaining its potential unity, or it may be dignified in itself, as being part of a landscape.[59] Ruins are all things that testify to human activities, but which have received, by decay, a completely different aspect from what they were initially given. A ruin is historical evidence, which has lost its practical usefulness, often also its legibility as an original structure or object. Being a ruin it represents the remains of an object from the past, and as such it may inspire our fantasy and let us interpret it as individuals. Any conservation intervention on the ruin is related to the personal interpretation of the conservator regarding the original aspect of the object. By massive conservation interventions on an archaeological site there is a risk that the spirit of the place or object, its authenticity, which attracts us and is the ground for our fascination, will be lost.[60]

Zander makes a distinction between dead and living monuments.[61] According to his distinction a ruin is a dead monument, since it has lost its original function. Instead it may gain value properties such as being precious due to emotional or aesthetic reasons. Dead monuments are principally archaeological areas, ancient necropoles, excavated towns such as Pompeii, or ruins of abandoned castles, while living monuments are historical centres and ancient towns, palaces and ancient buildings such as e.g. churches, which are still used. Consequently, conservation of a ruin may be a process only aiming at maintaining the status quo.[62] The reconstruction of a ruin is, according to Jokilehto, the opposite to

---

[58] Jokilehto, 1997, pp. 54-55.

[59] Brandi, 1953, p. 4.

[60] Jokilehto, 1997, p. 49.

[61] Zander, 1993, p. 44.

[62] Brandi, 1952, pp. 115-116.

conservation, since reconstruction leads to the creation of a non-finished object while conservation preserves the remains.[63]

If it is decided to restore a building, the next question is how, followed by for what purpose it shall be repaired, restored or conserved. Linked to this is also the question of future maintenance, an issue which must be integrated in the decision process. This is the crucial point in dealing with problems in conservation. Today there are numerous methods available for documentation and scientific analyses. Materials and techniques to use in conservation have increased in number, and have been developed and refined. These achievements must be used critically and consciously, or the general idea of our present tradition may be uncritically followed, which of course, in a longer perspective, would give rise to reactions.

Conservation

Conservation was defined as follows, by Sir Bernard Feilden at the symposium "Air Pollution and Conservation" in Rome 1986.[64]

> *Conservation may be defined as the dynamic management of change in order to reduce the rate of decay. The cultural, scientific, technical and natural heritage and resources must be considered as authentic documents and valuable components. Interventions should be limited to actions strictly necessary to insure the continuing conservation of this heritage, but the techniques and materials used should not impede future treatment or examination. Conservation requires comprehensive socio-economic, legal and cultural planning, integrated at all levels.*

The natural process of decay is ever on-going, and has to be calculated with, but it may be slowed down or practically eliminated, if the causes are recognised and adequate measures are taken. The causes of decay have been usefully illustrated by Plenderleith & Werner in 1979, see fig 5.

The term conservation indicates that an object, site etc., shall be preserved (for the future). Conservation, therefore, does not imply any particular method, technique or ethic consideration. It can be used to substitute a number of terms, which may be related to interventions of a more precise nature. The term can be used to imply "the action taken to prevent decay and to prolong life".[65] Conservation may also be described as "the dynamic management of change in order to reduce decay".[66] It may be described as a way of "managing the long-term survival of cultural environments and artefacts, which are "imbedded" within each other in a system of hierarchically organised sub-systems".[67]

---

63 Jokilehto, 1997, p. 51.

64 Air Pollution and Conservation, p. 23.

65 Feilden and Jokilehto, 1993, p. 61.

66 Rosvall and Lagerqvist, 1992, p. 6.

67 Lagerqvist, 1996, p.14.

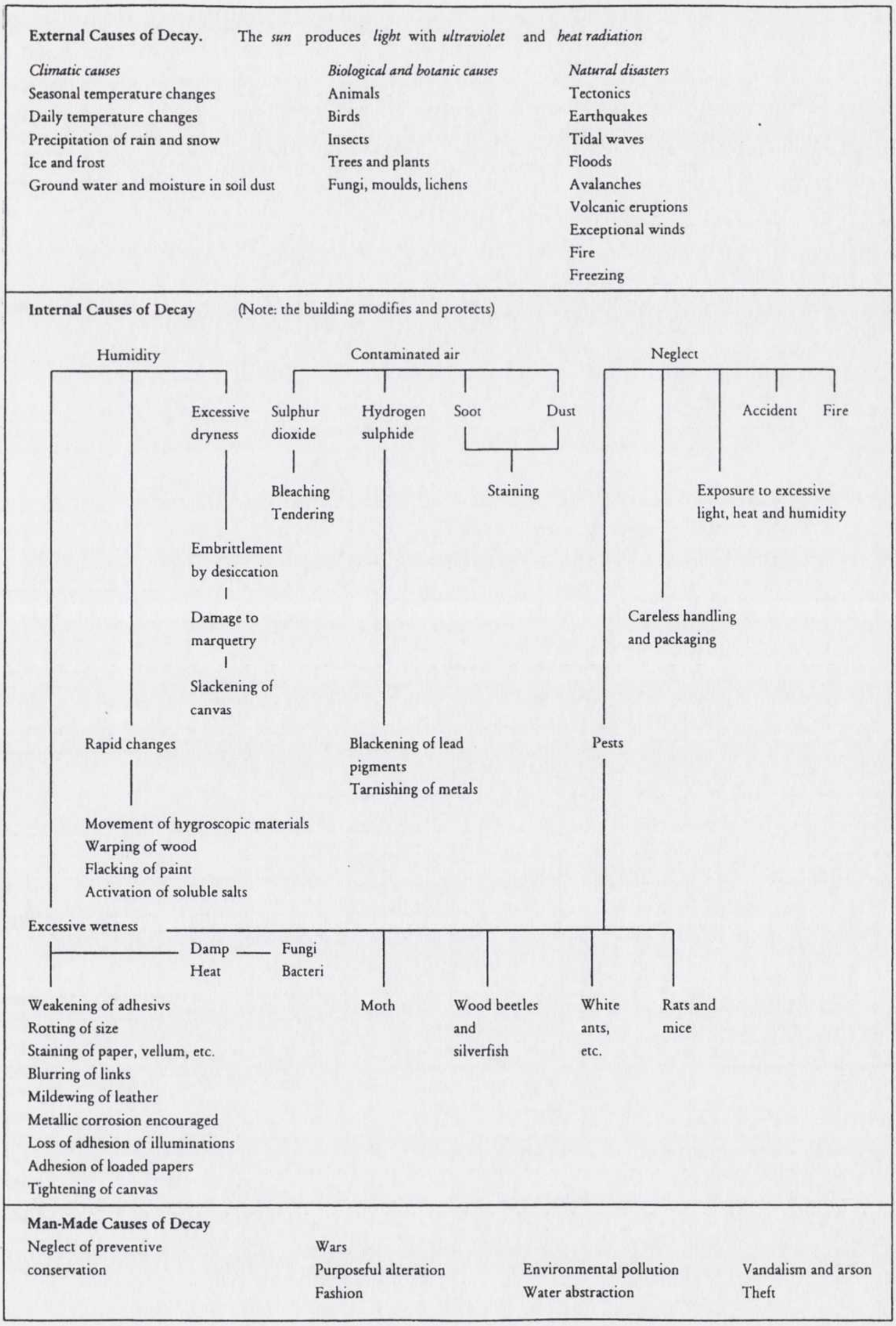


Fig. 5. Matrix illustrating the causes of decay and damage to cultural resources. After Lagerqvist, 1996, p. 12.

Conservation may be defined as one scholarly discourse, based on a set of hypotheses, on how to react to destruction. Conservation is on the one hand a number of guidelines, based on, e.g. ethical, cultural and chemical-technical considerations and on the other a set of possible choices for the conservator when actually performing any kind of conservation intervention.

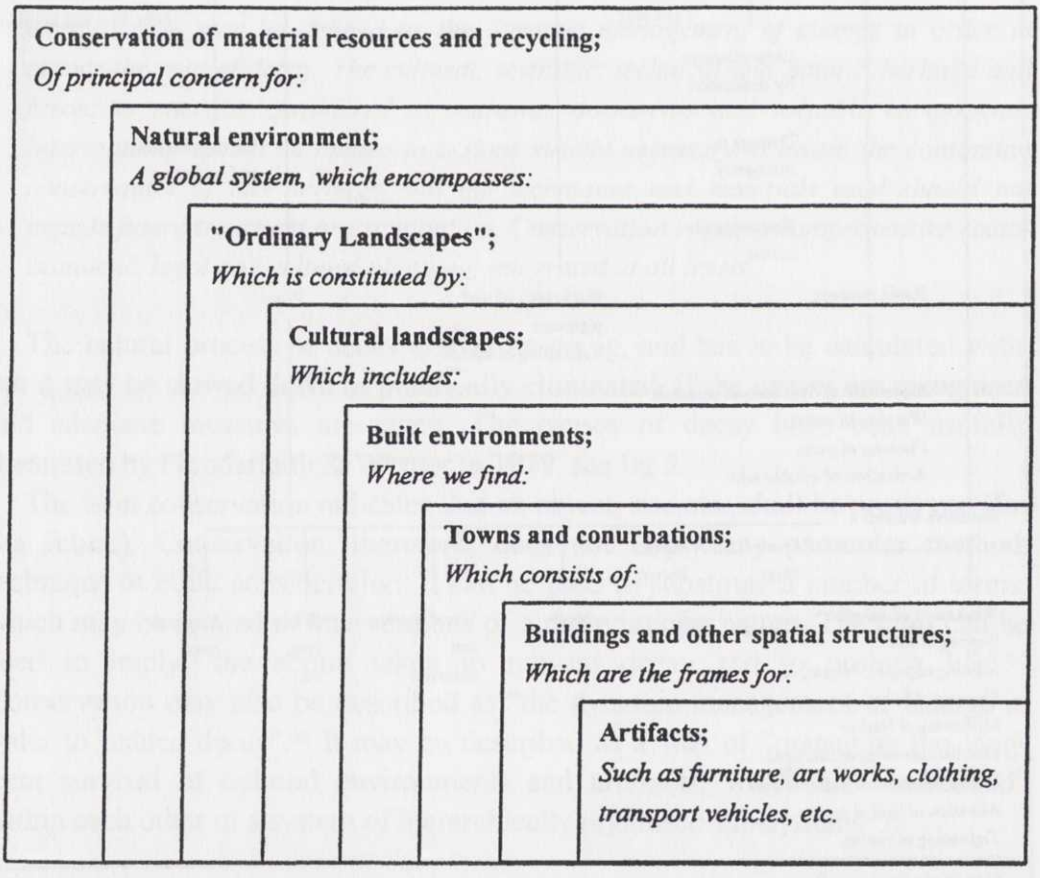


Fig. 6. Conservation hierarchic levels and their relations, as defined by Rosvall et al. 1995, p. 3.

Integrated conservation

Integrated conservation is another term which needs to be explained. According to the definition made by Feilden it indicates that scholarly and scientific methods have been combined with a planning strategy, aimed at solving the physical, environmental, social and economic problems of conservation.[68] By Rosvall et al. integrated conservation has been defined as

> *"... a scientific-professional platform for pragmatic decision-making in city councils and other bodies. Integrated conservation means a holistic approach to the issue of preservcation, which includes the preconditions and techniques for involving the aid of any scientific or humanistic discipline, together with all available methods needed to ensure the practical implementation and execution of the resources required."*[69]

Preventive conservation, maintenance and regular inspections

Preventive conservation is, according to Brandi, the action taken to prevent the object from the involuntary necessity of future conservation interventions.[70] The growing awareness of minimum intervention has led to the acceptance of the fact that, as stated by Price, "prevention is better than cure".[71] Maintenance includes actions aimed at reducing the negative factors causing decay, such as, e.g. protection from the capillary rise of ground water, protection against rain and moisture condensation, protection against biological factors of decay and of dirt.[72] In order to satisfactorily carry out such care-taking, regular inspections of the objects concerned, have to be performed and considered as an integral part of the maintenance plan. Ferroni recognises the necessity of creating microclimates suitable for restored works of art, and calls for scientists from various fields to work together for solving existing problems.[73]

Repair

Repair may be considered as the earliest and simplest method of conservation. Something gets broken, and it becomes mended or repaired, according to trivial decisions in a more or less normal process. Such repairs can be made by a master as well as by anyone. In the first case the results of repair may hardly be seen, while in the second it most certainly is visible and probably clumsy. Repair is simply the way of returning the object into a state where it can be in use again, a way of reassuring its material stability for functional demands. Repair, as described above, aiming at the restoration of the material stability, is what Brandi defines as restoration of manufactured goods or industrially produced objects, a

---

68 Feilden, 1988, p. 71.

69 Rosvall et al., 1995.

70 Brandi, 1977, p. 56.

71 Price, 1987, p. 13.

72 Rosvall, 1988, p. 52.

73 Ferroni, 1999, p. 101.

kind of restoration different to that demanded for works of art.[74] Melucco Vaccaro uses the term cultural heritage to substitute the terms manufactured goods, and in this terminology is also included works of art.[75] Cultural heritage has been defined as "all the signs that document the activities and achievements of human beings over time".[76]

The cultural heritage includes movable as well as immovable objects. Immovable objects are, e.g. archaeological sites and architecture, but mural paintings also belong to this category, since they are part of the walls, sometimes even chemically. In practice, however, murals are often detached from the walls and transferred to museums or private collections. Taken out of their original context, they loose authentic characteristics.

Reconstruction and reintegration

Reconstruction is a term referring to more complex projects, either "virtual" or actually executed, i.e. referring to a presupposed material loss which has to be re-made and inserted into the object, thereby reconstructing part of the object. Reconstruction may consist only of the simple insertion (infill) of a missing piece or in the remaking of large areas. Infill, as defined by the UNESCO Guidelines aims to "re-integrate the lacunae in the urban fabric by contemporary constructions and designs, but taking also into consideration the design of their historic context".[77] In this context no value judgement is given to the term reconstruction, as such. Reconstruction may also indicate the recreation of a building, usually to its original appearance.[78] Virtual reconstruction occasionally may be preferred to actual reconstruction. Such reconstruction do not cause any material changes to objects or sites, but provide the possibility of testing various solutions.

Closely related to the concept of reconstruction is that of reintegration, both measures taken are aiming at the filling of the material loss of a lacuna. Reconstruction indicates that the original shape and appearance of the object is known and restored to a destined previous state. Reintegration should be interpreted as integrating the infill of the lacuna with the general appearance of the original object, an act which, however, must also be considered as an individual interpretation of the original status.[79]

The methods of reconstructing missing areas have changed. In earlier periods reconstructions mostly consisted of naturalistic reintegrations, not intended to be distinguishable from the original. Such reconstructions, in addition, often tended to mirror the personal taste of the conservator, who occasionally even extended conservation to further "embellishment" of the original. Respecting the original and making reconstructions possible to distinguish is nowadays of absolute

---

74 Blomé, 1977, p. 36.

75 Melucco Vaccari, 1989, p. 201.

76 Feilden and Jokilehto, 1993 p. 11.

77 Feilden and Jokilehto, 1993, p. 92.

78 Edman, 1994, p. 7.

79 Jokilehto, 1997, p. 47.

importance. Therefore, some reconstruction methods have been developed. Monochrome areas painted in a neutral colour seemed to be a possible solution, since the method did not mirror the taste or capacity of the conservator, nor did it permit any personal additions to the original form. The method was soon abandoned, since the "neutral areas" in practice were not neutral but became interpreted as monochrome pictures within the painting or the sculpture. Chromatic selection and abstraction, was invented in order to solve the problems with the "neutral areas" without returning to naturalistic interpretations of form and colour.[80] By choosing, selecting, a few unmixed colours and applying them in thin and short lines in concordance with the surrounding areas, the integration does not disturb the interpretation of the object when seen at a distance. When looked at closely, the reconstruction becomes obvious. *Tratteggio* or *rigatino*, as explained by Brandi and further defined by Melucco Vaccaro, may be regarded as a variation on the same theme.[81] On reconstructed areas, some millimetre below the original surface, fine lines are painted with a thin brush, aiming at integration of the restored part with the entity of the object, without falsifying it. This method, theoretically, solves the problems of reconstructions and reintegrations, when used by a competent conservator with a critical mind. If, on the other hand, the technique is used in a too rigid manner, it tends to become a "picture" in itself, just as the, so called, neutral areas are.

Mural paintings should be regarded as part of architecture, and lacuna in wall paintings should consequently be considered as lacunae in an architectural context. The main issue should therefore be to integrate the infilling of such lacunae with the surrounding environment.[82] Such conservation intervention should be carried out critically and with respect for the original context. It has proved to be of vital importance to use pigments and binders with characteristics compatible to those of the original, to avoid some unexpected effects caused by metamerism, which may occur when the appearance of materials changes in exposure to different kinds of light. This phenomenon is caused by differences in reflection and wavelengths between ancient pigments and modern substitutes.[83] The restored or reintegrated area of a painting may look perfectly integrated in one kind of light, e.g. daylight, but when observed in electric light the difference between the original and the integrated area may appear strikingly different. Such surprises have been noted when least expected, such as on photographs made with a flash.

There is a problem connected to the reintegration of modern materials into ancient works of art, this being the question of how to diversify the modern integration from the original object, in order not to produce a falsification. Korres relates to the problem and describes different attitudes to reintegration techniques throughout various periods, beginning with the Roman restoration of

---

80 Casazza, 1981.

81 Melucco Vaccaro, 1989, p. 207.

82 Jokilehto, 1997, p. 53.

83 Staniforth, 1985, p. 101.

Greek temples.[84] According to him it is not advisable to diversify integrations too much, since these integrations disturb the perception of the work of art. Furthermore, he states that Roman integrations of columns in the Erechteion in Athens, are clearly visible at close inspection but not at a distance, and consequently made according to the later concept of Brandi. Those columns were carefully made in order to look like the Classical columns, but nevertheless clearly recognised as Roman copies. Korres therefore suggests that it is not necessary to make extreme differentiations, since it is impossible to perform reconstructions of ancient objects in an identical manner, since the differences are "built in", so to say, due to changes in thinking and mentality, as well as in material aspects and in the technical skill of craftsmen.

Related to reconstruction is also *anastylosis*, defined in the UNESCO Guidelines as an action which

> *"Aims to make the spatial character of a ruined structure more comprehensible by reinstating its lost original form, using the original material which is located at the site and in satisfactory condition. Anastylosis as an intervention refers in general to structures consisting of clearly identifiable components."* [85]

Issues of ethics that arise in such cases are connected with the kind of reconstruction made, and of defining the reasons why that method was chosen. If a reconstruction actually is performed it has to be due to a valid argument, which must be followed by an equally valid decision on how the reconstruction should be made. This problem does not occur with the reconstructions of ancient manuscripts, since the general policy is to reconstruct missing parts, not on the original manuscript, but in comments beside the ancient text.[86]

Restoration

Restoration is a complex term, which implies giving back to the object something which is lost. Objects restored today are often buildings which are in a bad state of decay, and the concept, restoration, is nowadays normally not used for professional conservation of works of art. In certain cases it is an adequate term for the work to reproduce the former shape and look of the building. If the structure of the house and its material and substantial details are known, restoration of the building to its previous state by repairing it and partially reconstructing it may be done. Restoration in this case implies giving life back to the building by repairing it, and reconstructing its details. At restoration interventions not only the structure may be restored, but also its value, i.e. the manifest or symbolic value of the building. The value is not necessarily manifest

---

[84] Korres, 1997, pp. 199, 203-204.

[85] Feilden & Jokilehto, 1993, p. 63.

[86] Jokilehto, 1997, p. 47.

within the building structure itself, but it may just be related to the period in which the building was erected.[87]

Restoration of a work of art is definitely much more complicated, if not - which is often the case - impossible. The choice of methods must be directly linked to the object, according to Brandi.[88] If the object is industrially made or if it is considered as a work of art, the demands for restoration treatments must differ, since the artistic value is not the same. If the object is a work of art, it must be understood that only the material becomes restored, "si restaura solo la materia dell'opera d'arte".[89] According to Cagiano de Azevedo, the term restore does not refer to simple repairs, but consists in "the critical action of repairing the offences made to works of art by the influence of time and of human beings, but also in the interpretation of the work of art as such".[90] In Brandi's terminology, we may solely restore the material of a work of art, not art itself.[91] Restoration should only consist in a minimum of modifications, leading to an improvement in material and an increased legibility.

Methods in Conservation

Conservation of form has been much debated, and a general tendency nowadays is not to reconstruct missing details in a work of art. Infills or stuccoing of lacunae are usually made, and the colour and surface structure of the infills are mostly made to be seen close up but not at a longer distance. Missing parts of a statue in open-air conditions are often filled with various kinds of pigmented stucco, depending on tradition and climate. Such interventions have probably become less extensive due to the increasing awareness of the need to respect the authenticity of works of art. Chemical treatments, on the other hand, often are massive. In modern terminology conservation interventions include various chemical treatments which are intended to preserve or restore the material structure of the object. Chemicals are widely used for cleaning, consolidation and surface coating. The techniques used for cleaning today are, according to Melucco Vaccaro, much more destructive than those which were used during the last century (..."siamo infatti consapevoli che le attuali techniche di pulitura cioè quelle che attengono alle superfici, sono oggi assai più distruttive di quelle ottocentesche"...).[92]

---

87 Edman, 1994, p. 6.

88 Blomé, 1977, p. 36.

89 Ibid.

90 Cagiano de Azevedo, 1949, p. 145.

91 Brandi, 1977 p. 7.

92 Melucco Vaccaro, 1989, p. 202.

Cleaning

Cleaning is the basic, and complex issue in conservation. Cleaning has to be an act of concious intervention, since what has been removed will be removed for ever. Any form of cleaning consequently has to be made after careful considerations of possible methodological choices. Methods which are appropriate for objects placed in protected environments probably have no effect at all on objects in outdoor environment. On the contrary, methods used outdoors probably are more efficient than necessary on indoor objects.

Black crusts is one of the main problems as far as open-air objects are concerned. They appear on surfaces on all kinds of material which are not regularly washed by rain, or cleaned by regular maintenance. The black crusts are mainly composed of atmospheric gases and acids, such as carbonic, sulphuric and nitric acid and of various particles in the air.[93] The combination of these chemicals results in the formation of a dark film upon the surface, which remains on the surface and constantly grows if the object is not cleaned at regular intervals. The aesthetic aspect of these crusts is often tragic, but the development underneath the crust is not less so. It is known that marble transforms into gypsum and consequently pulverises during the continuous process of crust formations, a degradation which finally results in partial losses of the surface. Ammonium carbonate in paper pulp or mixed with clay is regularly used in open-air environments to remove crusts, incrustations and other hard surface deposits. Since the method is effective, in contrast to cleaning with weaker chemicals such as neutral soaps, it is often used before testing a less aggressive substance. Ammonium carbonate is effective even on black crusts, and it is often applied for between 2 and 24 hours. A negative effect is that it bleaches the surface, which is quite notable on white marble, which sometimes becomes extremely white. The bleaching effect is reduced if the surface is carefully washed with clean water.

Works of art placed in gardens or other milieus with extensive growth seldom develop any black crusts, but are mainly attached by lichens and other forms of microbiological growth, often combined with the presence of various insects. Such growth is not as harmless as it may seem. Some white "crustaceous" lichens extend their growth several millimetres inside the material and decomposes it to some extent, by means of the production of organic acids.[94] Biocides have the double effect of cleaning and destroying biological growth such as algae and lichens, and are frequently used on stone objects exposed in open-air environments. They have proved to be very effective, without damaging the stone. Negative side-effects may be that the surrounding growth becomes exterminated as well, if the biocides are not handled with care.

Objects in public halls or museum buildings present other kinds of decay, specific for their context. Problems which frequently occur are the presence of various surface deposits, often fat. The kind of cleaning requested has to be decided from case to case, considering the objects´ material and the composition

---

93 Torracca, 1997, pp. 34-35.

94 Torracca, 1988, p. 51.

of the surface deposits. Natural soaps such as the Swedish "såpa", is a very efficient and mild cleaning agent on "dirty" surfaces, i.e. surfaces where the decay does not consist of crusts or lichens which have penetrated the surface. Mild soaps may be used for maintenance purposes, to avoid more complex conservation interventions.

Pre-consolidation

Before cleaning begins, a pre-consolidation of the object is often necessary. If it is a painting the treatment may merely be the injection of glue in order to stabilise a flaking paint layer. If it is a mural painting, which tends to detach from the mortar layer, a mixture of lime and hydraulic lime or pozzolana can be injected between the layers. If the layer lifts at the edges so that filling may be done with a mixture of higher density, this open space could be filled with a stucco, such as mentioned above, with the inclusion of crushed bricks and a small quantity of acrylic resin.[95] In case the object is of stone with a sugaring surface, pre-consolidation is generally made with applications of ethyl silicates, which penetrates and hardens the surface, in order to make cleaning possible.

Consolidation

After cleaning, a consolidation of the object is often made, with the intent of taking precautions to avoid any rapid future decay. In the past, applications of protective surface films were made with natural materials, such as drying oils, waxes and animal fats.[96] Consolidation today is generally made with chemical components, applied for stabilising the surface, and to some degree the interior matter. In stone conservation, consolidation is generally made with ethyl silicates, which penetrate the surface and link the crystals artificially. A total impregnation of the object is generally intended, aiming at filling its pores until saturation, allowing the substance to form crystals inside the stone. This treatment demands great quantities of solution for a porous stone. Impregnation of marble or lime stone with an Ethel silicate not only brings chemical changes to the material, but are visible also on the surface, even though the substances may be transparent and "invisible". Whether it is possible to define the stone as original or not after such impregnation is another question. Alternative methods, compatible with the stone material, have been studied in Florence for many years. Artificial calcium oxalates have proved to be useful for consolidation and surface protection of stone as well as of mural paintings.[97] Calcium oxalate is a good protective agent, being a low water-soluble compound with good optical properties. Such coating, in addition, remains practically colourless, unlike natural calcium oxalates, which becomes reddish, yellowish or black with the passage of time.

---

95 Forcellino, 1988, p. 130.

96 Torraca, 1988, p. 93.

97 Matteini, 1999, pp. 31, 33.

Another consolidation method for mural paintings, tested in Florence, is based on the use of calcium hydroxide.[98] Also in this case, the approach has been that conservation materials should have a full compatibility with the substrate, and that the materials, in principle, should be of the same chemical nature as those used by the artist.

Surface coatings

After cleaning the surface becomes "nude", especially if the object was cleaned with any efficient substance, removing the natural "patina". Therefore the surface should be protected, by coating it with some suitable substance. If this is not done, the surface easily becomes exposed to a rapid deterioration process. Surface coatings are often applied as the final treatment, on mural paintings as well as in stone conservation. Today such treatments are usually made with available chemical products. No perfect coatings are known today, and therefore coatings are often avoided.

Surface protectives are known since antiquity, and have probably been used in all cultures. Traces of ancient surface protectives have been found on monuments from the Roman Imperial period. These layers are referred to as *patine ad ossalati* or oxalate coats, and were probably made of lime with a proteic binder, such as glue or casein.[99] Analyses of samples from, e.g. the Colonna Traiana or Arco di Tito revealed distinctive layers, mainly consisting of calcium oxalate, calcium phosphate, amorphous silica compounds and gypsum. There were no traces of oil or other fats.[100] A reddish layer was found at investigations on the Colonna Antonina in Rome, and proved to contain calcium and sulphates, sodium and abundant quantities of Si, S, K, Fe, P and Ba, which all together indicate that this layer is the remains of one application or more of a surface protective.[101]

In Sweden oil paint was commonly applied on limestone and some sandstones for centuries, and this custom continued until it became fashion to expose the stone surface. There are, however, remains of paint on architectural elements, e.g. in the historic centre of Stockholm, the Old Town. Also in Göteborg the habit of using oil paint on stone has been documented.[102]

In other northern European countries, such as Germany, casein seems to have been used as a protective on stone since centuries.[103] In Italy surface coatings seem mainly to have been made on a lime basis. Such lime based applications, often containing marble dust, pozzolana dust or peperino dust, are commonly called *scialbatura*. The choice of stone dust, mixed into the lime, was a choice dependent on the stone surface to be protected. As a binder to the mixture several alternatives are possible, such as a glue, casein or Punic wax. These are all superficial applications, i.e. sacrificial coatings, and since they are not liquid

---

98 Baglioni & Giorgi, 1999.

99 Melucco Vaccaro, 1967, p. 40.

100 Guidobaldi et.al., 1984, p. 127.

101 Laurenzi Tabasso and Marabelli, 1989, p.123.

102 Lindqvist et al., 1989, p. 287.

103 Reinhard Meyer Graft, conservator in the German Pompeii project. Personal communication, December 1998.

enough to penetrate deep into the stone, they are unable to change the interior characteristics of matter.

Sacrificial coatings may protect stone surfaces for some years, and since such coatings gradually disappear the applications have to be repeated at regular intervals. Similar applications were commonly used and are known to have existed on ancient stone surfaces.[104] Based on knowledge of the existence of traditional protectives, mentioned in ancient literature and confirmed by recent analyses, it may seem logical to try to rediscover these methods in order to be able to avoid, if possible, modern methods, which are often more harmful to persons and nature, and sometimes even toxic.

Additives into the lime-wash or scialbatura, such as those mentioned above, may have a darkening long-term effect on the surface and colour. In order to know for certain, tests have to be made by chemists and conservators. The materials, or mixtures mentioned, normally do not alter in a surprising way, they rather wash off as time passes. On the other hand, the chemical products nowadays available in commerce are transparent, and they are made to penetrate the surface and impregnate the stone. They will normally not be washed off, and they alter the chemical composition of the stone to some degree, but it is not known exactly how they alter, if in a longer perspective. The only certain factor is that nothing can be conserved unaltered for an indefinite period of time.[105]

Documentation and Conservation

"The condition of the building before any intervention and all methods and materials used, must be fully documented." [106]

Documentation as a research process and the necessity of documentation in conservation has been stressed by Lagerquist.[107] As soon as any action in archaeology and conservation is taken, it has to be carefully documented, in order not to loose important information.[108] A set of questions has to be formed in order to register important and valid information. By identification of problems in conservation operations and by composing an operative-oriented model for documentation, it would be possible to exclude invalid information.[109] It is not the quantity of information which is important, but its quality.

---

[104] Urbani, 1984, p. 17.

[105] Massa, 1982, p. 11; Urbano, 1982, p. 10.

[106] Feilden, 1988, p. 55.

[107] Lagerqvist, 1996.

[108] Lagerqvist, 1996, pp. 96-97, 110, 119.

[109] Lagerqvist, 1996, p. 28.

Documentation in conservation should consist of verbal descriptions, photographs, drawings and measures. In complex cases, even other methods, such as photogrammetry, CAD-CAM and 3D-animations can be comprised in the documentation programme. The absolute need of adequate documentation has been pointed out also by Coles, whose general guidelines, concerning documentation and recording of actions on archaeological sites, also include the necessity of making an interpretation of the finds in their context, and to publish the results.[110]

As stated above, any conservation intervention will lead to a change in the material, either as visible evidence or as a transformation of the material structure. In order to remember the state of preservation before any action is taken, and to provide material for comparisons before and after, relevant documentation has to be made. The inevitable destruction of evidence starts at an excavation site as soon as work begins, and consequently any action must be carefully recorded on site records, written reports, photographs and drawings.[111]

In architectural restoration or conservation there is the same need to document the interventions, since the building will obviously undergo some changes due to the necessary interventions. According to Zander any conservation programme should be prepared by a group of professionals, led by the conservation architect and should include an art historian, an archaeologist and a conscious artist.[112] This team is recommended to form a site vocabulary in which important terms and concepts are defined in order to avoid misapprehensions and to establish a correct diary, which will provide correct and commonly understood information for the final documentation.

Photographic documentation to accorded scale and in absolute frontal view should thereafter be made, and constitute the ground for drawings in, e.g. scale 1:5. Based on these drawings the architect and the designer continue to work, with the final object in order to construct a correct and easily understandable graphic documentation. Upon this drawing transparent sheets may be applied for indication of further important information, such as existing lacunae, the colours of the painting etc.

Documentation, made by artists during the 18th and the 19th centuries at the excavation sites, provides valuable information, in spite of the personal interpretations and the obvious signs of fashions in painting, which often reveal the taste of the period in which the painter was active. In many cases these coloured drawings are all that remain of the once so impressive mural paintings. Present documentation of studies, based on the drawing and painting techniques mentioned above, often occur in contemporary studies and conservation reports, and are often compared to such older documentary material.[113]

---

110 Coles, 1995, pp. 59-61.

111 Ibid, pp. 60, 66.

112 Zander, 1993, p. 37.

113 Martorelli, Bragantini, 1980; de Vos,1980; Paris, 1998; Scagliarini Corlàita, 1998; Parise Bodoni; Ling, 1991.

Although no standardisation in recording exists at present, it is commonly agreed that documentation should be carefully made, independently on the site or with the object concerned. As stated above, any conservation action will change the authenticity of the object, and the process must therefore be recorded and documented before, during and after intervention. The work at an archaeological site, e.g. at Pompeii, nowadays consists of a combination of documentation of previously excavated areas and new excavations. Traditional methods and modern equipment are used parallel. Documentation can, in addition, be made as exhibitions of the site, the working progress and the results achieved.[114]

Authenticity and Originality

Authenticity is, in Western countries, a concept based on the idea that a work of art is understood to be unique, i.e. singular and not repetitive.[115] The authenticity of a building is the history, readable as changes, rebuilding and decay.[116] A copy of such a work of art is generally considered to be a fake, just as is an object restored "too much". It is, however, difficult and subjective to define a precise distinction between restoration and fake.

Originality, in this context, is not understood the same way as in Eastern tradition, where there is obviously no barrier between "original" and "substitute", at least as far as buildings and museal arts are concerned. Chinese and Japanese temples, for example, survive culturally due to the successive change of the deteriorated materials of the buildings, where it is understood that "authenticity" is embedded in the body of the building, but not in its singular elements of wood, even if those might be carved and painted decorative elements. Singular pieces, consequently, may be re-made to substitute missing parts of the total structure, thus securing the identity and authenticity. The totality, according to Brandi, indicates that the work of art is composed of parts.[117]

The attitude towards substituting missing parts has been normal for Europeans, e.g. the Italian conservation of mosaics, where small pieces of disassembled mosaics successively have become replaced with new ones, in order to maintain the identity of an object.[118] Even though such possible replacements of details seem natural regarding the conservation of buildings and artefacts, such as mosaics, and for repetitive motifs in stucco, stone, brick or wood etc, the problem is not the same concerning paintings and statues, at least with respect to their critical parts, such as human faces, individually important components etc. The originality of a building is, according to Edman, its personal character, linked to

[114] Rosvall, 1988, p. 11.

[115] Marconi, 1984, p. 55.

[116] Edman, 1994, p. 7.

[117] Brandi, 1977, p. 13.

[118] Marconi, 1984, pp. 54-55.

the building at a particular time. Through any conservation treatment the identity of the building is exposed to some kind of change in its identity.[119]

A painting is made as one entity of materials. It may be made with millions of brushstrokes and mixtures of colours or with just a few brushstrokes and colours. Those are the personal fingerprints of the artist, which, per definition cannot be remade, the way a single missing piece of a mosaic seemingly can be reinserted. It does not matter if the painting is a mural painting with the different *giornate* visible, or if the painting has been made by many hands, such as the artist and the painters working in his studio. The painting must still be seen as one complete object, existing entirely within its own delimited area. In Brandi´s terminology, the work of art is a unity present as an entirety and not a unity which is achieved by a totality...).[120]

A missing area of a mosaic "painting" or a sculpture presents the same problems as any other painting, since a new interpretation of the missing area has to be made, if it is decided to be reconstructed or restored. Therefore, when confronting a missing area of an object, a decision has to be made on how to intervene without disturbing the legibility of the object, and without falsifying it, or reducing its authenticity.

There is a considerable difference between a building and, e.g. a statue or a painted portrait, and it is therefore necessary to discuss these objects in different ways. A building is not only the exterior, with surface proportions of the façade, since it mainly consists of its structural form, its skeleton, which defines its size and its space. Hence the building material must be regarded as well as the decorative elements, its coatings and its surface structural system. Connected to the building is the environment in which the building constitutes a part, and its history. Such kinds of aspects have to be considered when performing conservation interventions with and on the surface or in the structure of the building, beginning with documentation of its history and by making analysis of the building materials and pigments used. Other kinds of analyses, e.g. of the structural system, iconography and historical development must also be executed.[121]

The colours of a building offer an instructive document of the changes in taste and fashion during different periods. Rome in 2000 is a striking example. The previously warm ochre coloured central part of the city, now appears in pale pastel hues, resembling the colours of Italian ice-cream – peach, pistachio, strawberry and vanilla. It may be difficult to decide which phase in a building´s history that should be chosen to be represented by means of conservation measures. This work should be carried out by a multi-disciplinary group of skilled experts, representing different and adequate fields.[122] The issue concerning

---

[119] Edman, 1994, p. 7.

[120] Brandi, 1977, p. 13. *("... il carattere di unità all'opera d'arte, e precisamente l'unità che spetta all'intero, e non l'unità che si raggiunge nel totale. Se infatti l'opera d'arte non dovesse concepirsi come un intero, dovrebbe considerarsi come un totale, e in conseguenza risultare composta di parti...)*

[121] Gatto, 1988, p. 103.

[122] Marconi, 1988, p. 105.

materials in ancient buildings is still not thoroughly investigated. Such studies must be made, since the outcome of a conservation intervention very much depends on the selection of materials, with special reference to their different chromatic and visual characteristics.[123]

A painting or a statue may also be regarded as decorative elements within an architectural scheme, just as architecture preferably must be analysed and interpreted within its environmental setting. The environmental setting, architecture and decorative elements are interacting parts, together contributing to a whole, and none should be given a value superior to the others.

Originals, copies, replicas and fakes

The conception of copies and originals during Antiquity was different compared to that of the 18th century and to modern times. Original Greek works of art were much appreciated by the Romans, esteemed as superior to traditional Roman art. This gave rise to complaints from some contemporary writers, such as by Pliny and Cicero.[124] Copies and replicas of appreciated works of art were common during the Roman Imperial time, and restoration and reconstruction of statues were part of maintenance. While Greek artists made singular statues, Roman artists had an industrial production of copies of Greek art.[125] The difference between a copy and a replica is, in brief, that the copy was a reproduction of an existing statue, maybe made with the use of a pointing machine, while the replica reproduced a type of statue, and was consequently a more or less free interpretation of an original. Definitions of the terms and concepts behind words such as copy, original, replica, model and prototype have been thoroughly made by Leander.[126]

It is known that the Emperor Hadrian, for example, collected originals as well as copies of Greek and Hellenistic originals, located in Villa Adriana at Tivoli, and that the copies were of an excellent quality.[127] Since Hadrian was a wealthy man, economic reasons may be excluded as the cause for collecting copies. It seems as if, by Roman standards, a good copy or replica, was given the same value as a good original.

Winckelmann, who exerted a massive impact on issues of art and antiques during the 18th century, presented an essay on the conservation of works of art, delineating the problems of integration in sculpture. He had observed that statues had been transformed through restoration, thereby gaining another character.[128] Statues that had been "repaired", often presented a large number of new pieces, and in some cases it occurred that fragments from one original were used to

[123] Forcellino, 1988, p. 126.

[124] Salvetti, 1998, p. 85.

[125] Bartman1994; Hamberg, 1945; Leander Touati, 1998; Moorman, 1988; Poulsen, 1949; Richter, 1928.

[126] Leander Touati, 1998, pp. 82-86.

[127] Melucco Vaccaro, 1989, pp. 33-34.

[128] Jokilehto, 1986, p. 91.

produce two statues.[129] According to Winckelmann, there had to be rules established to make possible the distinction between restored parts and the original object, pointing out some problems that often occurred. He suggested that integrations should be shown or indicated at least in publications, in order to avoid confusion or misapprehensions about what was antique and what were later additions. These general recommendations or guidelines were, at least in principle, followed by the friend of Winckelmann, Bartolomeo Cavaceppi, who was one of the most active restorers of sculpture in Rome during this period.[130] On the other hand, Cavaceppi had expressed the opinion that if reconstructed parts did not exceed one third of the object, the entire statue should be considered as antique.[131] During this period, trade in antiquities was intense in Rome, and it seems as if collectors of that period did not normally ask if a piece of art was restored or reconstructed.

Maybe as a reaction to over-restoration and economical profits and the production of "antiques" during the 18th century attitudes regarding these issues have changed. For later generations much value has been given to the original, while the copies have been regarded as second rate art or even as fakes. As Brandi puts it, "...the copy is a historic falsification and an aesthetic falsification, and may only have a purely didactic justification..."

Today it may be necessary to re-value copies, due to the environmental problems we are still incapable of solving, making originals exhibited in open-air environments deteriorate, dilapidate and disappear. Under circumstances such as those mentioned above, the copy becomes a substitute, rather than a fake.[132]

THEORETICAL FRAMES

The UNESCO Guidelines in conservation, as presented by Feilden and Jokilehto (1993), have been accepted as the basis for any action in the field of conservation. These consequently must be regarded as the frames within which conservation issues are discussed and interventions are performed. Other such important guidelines and principles of ethics, have been formulated by Feilden (1998), by van Gigch and Rosvall 1991, and fundamental codes of ethics have been formulated on the national level, the Code of Ethics of AIC (1999).

Publications relating theoretical systems and theories concerning conservation, such as Brandi (1977), Baldini (1988, 1989), Casazza (1989), Melucco Vaccaro (1989), Lazzarini and Laurenzi Tabasso (1986), have been important for my studies. These publications constitute the basis for conservation

[129] Caira Lumetti, 1998, p. 6.

[130] Jokilehto, 1986, p. 91.

[131] Antonsson, 1958, p. 25.

[132] Melucco Vaccaro, 1989, p. 215. *("...La copia è un falso storico e un falso estetico e pertanto puo avere una giustificazione puramente didattica...").*

theory during the last thirty years, and are consequently of great importance, whether the reader approves of the ideas presented, or not. In my own case, many issues have been important, either because I have approved, or disapproved on the ideas or solutions presented.

For example: The *selezione cromatica* (chromatic selection) and *astrazione cromatica* (chromatic abstraction), as presented by Casazza (1981), have been very important, considered as scientific methods, respecting the object restored, by not falsifying its originality. Consequently, conservation students have been instructed in the painting method of chromatic abstraction. Mainly my disagreement is against the belief that any singular method might be the better method at all occasions. Second, even a "scientific method", is an interference with the original structure, and is therefore, adding something to the original object. Thirdly, independently on the method used, the competence of the conservator is of major importance for the result. In my opinion, there is no method, perfect in conservation at all occasions. Any kind of intervention becomes an "addition". One of the problems which was intended to be resolved by using the methods mentioned above, was to be able to eliminate the "figure" which tended to appear, on larger reconstructed areas, were a "neutral colour" had been applied. Chromatic selection and *rigatino* are useful methods and in many cases the reconstructions have been successful. The major problem, however, is that the conservation result does not automatically become better than is possible to achieve by other methods, since the result depends on the skill of the conservator. In my opinion, openness in mind and interactions between disciplines therefore are more fruitful than dogmatic programs.

Very inspiring and fruitful for my own studies, have been some comparatively short publications on theoretical issues, e.g. Coles (1995), Ferroni (1999), Giannini (ed. 1992), Lippi (ed., 1993), Mora (1996, 1967), Urbani (1982,1984), Wolters (1988), Zanardi (1982) and Zander (1993). Further there are a great number of research reports describing conservation methods which have been of great importance for the investigation, and in fact all reports mentioned in the bibliography have contributed to the theoretical framework of this study, as far as material investigations are concerned, and it is therefor impossible to mention some as more important than the others. The main thing, which all reports have in common, is the systematic procedure of each problem investigated, the clear definition of the methods used, and the documentation of the process from start to conclusion.

RESEARCH METHODS

Due to the design of the study, a set of research methods have been used. There is no common method available to apply for all issues represented, since those consist of matters related to the fields of architecture and fine arts, humanities at large, natural sciences and technology. Relevant written documents ranging from

Antiquity to recent professional research publications on the issues investigated have, however, been generally applied, like comparative studies between those written arguments and real life evidence. The methods chosen, and the theoretical framework on which these have been based, were, as follows.

Material investigations

The methods used for the material investigations comprise observations and analyses made on ancient materials. Before these practical investigations started, materials and material technology were studied in the disciplines chemistry and material science, as well as history and technology of pigments. Such studies, of course, had to be included within the theoretical frames throughout this research, and consisting, later on, primarily of surveying research reports in the fields of conservation and material analyses. The materials relevant for this study, mainly were natural beeswax, Punic wax, and the prepared supports upon which these products were used. When Roman wall paintings were studied, the preparation, i.e. the stucco was studied as well as the supporting material, i.e. the plaster, as being part of the same body. The hypothesis is that by being aware of the construction and composition of the preparations for painting, some indications may be observed regarding the period of construction, about context, and about the social standard of the commissioner. In cases when the supporting material was wood, this has been noted but not studied, being a completely different kind of material, and not immediately important in the study.

Ancient pigments have been studied as being part of the painting materials used during the period investigated, and their chemical composition has been studied, for identification purposes. By knowing the characteristics of these pigments it becomes possible to make some preliminary assumptions about the social standard and cultural outlook of the commissioner of a particular decoration investigated, since some pigments were very costly and others not. By taking into account which were the pigments used in ancient times, it further becomes possible to make conclusions regarding the period when a particular painting was made, since some pigments were not known during Antiquity, and such pigments can therefore not appear in ancient painting. Some other materials have been regarded, e.g. tempera, included in the study for comparative reasons, as being one of the principle paints during Antiquity.

An assumption is that the choice of materials, used for the decoration, show whether the decoration was made for a place of great importance, or not. The technical and artistic skill of the craftsmen and of the painters are, of course, equally important, and therefore, in this study, e.g. a mural painting investigated, is studied as a material, technical and artistic unity, and not only as a piece of art, by describing the image with its pictorial motif and composition and the decoration on its painted surface.

In order to combine theoretical studies with investigations of materials actually existing, a set of case studies were performed. The methods adapted for material investigations concerning Fayum portraits and Roman wall paintings, were partly performed by the staff at the scientific laboratory at the Opificio delle Pietre Dure in Florence. The materials mentioned above, i.e. preparations, binders, pigments and possible surface coatings, have been studied at two extensive material investigations, which are presented as case studies in the present dissertation. The aim has been to study the chemical composition of the preparation and of the paint respectively, with focus set on the possible presence of beeswax. Preliminary investigations were made before the samples were brought to Florence.

The Fayum portraits were initially studied and documented by various methods, such as visual inspection of material and material decay, photography in natural light and in raking light, and in UV-light. Observations and photography in optical microscopy in diffusion light were made when the samples were removed for chemical-technical investigation. The chemical-technical investigations made at the Opificio delle Pietre Dure consisted of the stratigraphic analyses of sections in optic microscopy in diffusion light and under UV radiation for the examination of the fluorescence caused by the materials. The samples selected were enclosed in polyester resin and the surfaces were perpendicularly ground. An optical microscope, Zeiss Axioplan equipped with objectives from 5x to 20x and with a UV lamp of mercurium vapour, was used. Each cross-section was documented with the various techniques mentioned above. The very same sections were utilised also for a SEM investigation, using an electronic scanning microscope Leica Cambridge, and examined by elementary microanalysis EDS, using a system Link-Gem from Oxford. Other samples, in powder form, were selected and their compositions analysed in a spectrophotometer FTIR, using an equipment Perkin Elmer 1725X, adopting the technique of making micropellets (Ø 1,5 mm) in Kbr.

The investigation of Roman mural painting further included documentation of the mural fragments, made as drawings in full scale, and photographs. The construction of the fragments, i.e. the numbers of mortar, plaster and stucco layers possible to distinguish with the naked eye, or under a magnifying glass, was documented and noted on forms made for the occasion. The average grain sizes and the general impression of the layers were noted. The paint layers were studied before and during the cleaning of the fragments, and the observations made were noted. After this initial documentary phase, all information concerning each fragment, accompanied the samples to the Opificio. The chemical-technical analyses at the Opificio were made by using the same equipment and methods as described above.

In a third case study, concerning fragments of Roman wall paintings from San Lorenzo in Lucina, the chemical-technical analyses were very limited, and consisted mainly in the determination of one particular pigment, interpreted as cinnabar, and microscopical studies of some samples, with the aim to have answers to a set of specific questions. The investigation methods were the same as those mentioned above.

The main aim of the case study concerning Palazzo Calabresi, is to study if there was a firm correlation between theory and actions taken in practice. The method of establishing such possible relation was by strictly following existing guidelines when documenting the object and planning for the conservation interventions, and finally evaluating the measures taken in practice.

The methods used for the experiments were following ancient descriptions for making mixtures of wax, and testing their application on traditional and more recent kinds of supports. At this first step, the usefulness of the substances were tried, and in a next step their durability during different circumstances. All the methods used are fully described in the case studies.

Contemporaneously with the investigations of materials, relevant issues concerning the cultural context were studied. The objective was to establish *if* the materials investigated were well known and used during Antiquity, as well as establishing *how* and *when* they were used. It therefore was necessary to understand the cultures within which these materials and techniques were developed, but also defining the materials within their context, either as being the only materials available, or as being some of those possible to choose. If there were possibilities of choice, it was regarded to be important to understand the circumstances during which the materials investigated were chosen, if it was for their specific qualities or due to a local tradition.

Studies concerning the cultural context

Studies in history of art have been an essential method used in this investigation, but also the Roman context has been considered, i.e. the Roman way of using art, in public or private spaces. The history of archaeological excavation of Roman contexts also was studied, since the situation during excavations may have had an influence on the materials studied. Traditional historic and art historic points of view, such as observations of the stylistic changes, have been considered. Various scholarly interpretations of those symbolic values manifested in Roman art, i.e. studies of pictures as carriers of intangible qualities have been taken into account. These aspects have not been of immediate importance in this study, since the material aspect of art has been in focus. Art as a communicative sign, has been given attention, since this aspect explains the kinds of messages sent from the commissioner of art to the beholder –consciously or not-, and requires a direct link to the substances carrying the art messages.

The interpretation of Roman art has changed during the last centuries, and the Roman way of using art may not be fully understood nowadays, since persons within any specific period tend to make interpretations according to the value systems of their own period. During the last decades some investigations dealing with the Roman characteristics in art, based upon analyses of the themes and contexts, have been published, to some extent aiming at excluding that personal opinions and taste is built into the research method, but rather being presented just as what they are, personal preferences.

The method used by Wallace Hadrill (1994) for his systematic investigation of the decorations in Pompeian houses, and the corresponding social status of their owners, has in this sense, been of great importance for my own work, just as the publications by Iacopi (1997, 1999), in which she takes into account the entire cultural context as expressed in the decorations described. The thorough investigation of painted statues, performed by Moorman (1988), has been an inspiring example of how to proceed, just as the publications by Zanker (1988) concerning the power of images in the age of Augustus and, (1998) on aspects of public and private life at Pompeii. Likewise important has been the study of portraits of Livia by Bartman (1999) and those by Marvin (1993) and Kleiner (1993), which, like these mentioned before, are characterised by a combination of strictness in the research method, with that of an open mind and personal intuition. The same is valid for Leander Touati (1998), who has set an example with the thorough investigation and determination of the conceptual framework behind copy, replica, fake and other related terms. Such investigations as mentioned above, consist of the collection and interpretation of facts, and the methods used are clearly described. These methods, as well as the results achieved, may consequently be approved of or questioned by other scholars. The attitudes towards investigations and of research such as mentioned above, have been a guideline to me, rather than the traditional art historian method of describing and interpreting the stylistic modalities and the subjects represented, often, mythological, while paying comparatively little attention to the total ambience. Even though the art historic tradition, and the scholars representing this, indisputably have contributed with important knowledge about ancient art, these research methods, however, have not been applicable in this dissertation.

Terminology

As far as terminology is concerned, a set of terms, and their conceptional dimensions, have been studied with the objective to clarify their linguistic connotations, and to propose an intelligible vocabulary, possible to be generally agreed upon. Languages change, and it is therefore important to be aware of the meanings of important terms, such as they were used during the period which is studied in this context, in order to avoid misapprehensions caused by changes in conceptions. It therefore is an objective to determine some conceptions associated with wax painting and wax as a surface protective, in order to understand the original meaning of the terms. Based upon these studies it might be possible to judge if some existing unclarities linked e.g. to a painting technique, are due to unsatisfactory knowledge about these terms, conceptions and materials. It is a generally accepted approach, that by defining the initial meaning of a specific term, combined with the understanding of the technique and its materials, existing unclarities may be indicated, and consequently, avoided to be repeated. In case that there is a discrepancy between ancient and modern terminology, and if such a discrepancy has led to ambiguities, this would lead to another issue to consider, i.e. whether modern terminology should, or should not, be changed. In cases of unclarities, these have to be clarified, as well as the possible reasons of their occurrence. Based on such knowledge, there is a possibility to establish a vocabulary which may be commonly accepted. The methods used for studying variations in terminology, have been by confronting a carefully considered choice of translations of ancient scripts, and by studying the differences, small or great, between documents. The discrepancies observed during this study, lacking philological explanation, were presented to experts in Latin and Greek, Classical as well as modern, and this collected information was used as a base for further studies.

The reliability of those ancient sources which are important in this context, was also tested. This was done by comparing some translations, with the objective to see if there were, or not, discrepancies between translations, and if such existed, these may have been related to initial unclarities, or to later variations in transcriptions of the original texts. In addition, one of the Plinian passages frequently quoted, was examined word by word, with the intention of comprehending what he actually had written. Some regard consequently has been given to the descriptive literary "style" of Plinius, compared to that of Vitruvius.

Theoretical and practical aspects on conservation

The development of conservation methods and ethics in conservation have been studied, to create a basis for the present understanding of the discourse of the concept conservation. The materials used in conservation, traditionally as well as recently, have been given attention, with the objective to understand if modern chemicals are more suited for conservation treatments than were – and are - the ancient materials and methods. Since this is an enormous field of study, and obviously the topic for more than one dissertation, just some details have been studied more in depth in the ”real world”, e.g. some cleaning methods. The issues discussed in this dissertation are primarily ethical, connected to choices of materials in conservation, how and when to conserve an object, and they are of a more general theoretical character, focusing on the necessity of documentation in conservation. Conservation principles discussed have been presented under the heading *Theoretical perspectives*.

RECENT RESEARCH OF RELEVANCE

In 1939 Istituto Centrale per il Restauro (ICR) was founded in Rome, and its first director, Cesare Brandi, also was the great theoretical scholar of Italian conservation.[133] His discourse, expressed in "Teoria del Restauro", still is the paradigm which forms the application oriented principles base of ICR, and consequently nationally for Italy.[134] Since the middle of last century, new attitudes, and a scholarly-scientific approach to conservation problems

---

133 Istituto Centrale per il Restauro, which is the *National Agency for Conservation*.

134 The first edition of *Teoria del restauro* was published in 1963.

successively has been introduced, not only in Italy but gradually also elsewhere. Research and testing, for a long period have been directed towards industrially produced chemicals, but recently a revived interest in traditional methods has arisen. In the 1950s research and debate on encaustic techniques was intense during a period, as a result of the vast areas and frequent periods of excavations of Pompeii and other important sites in the Vesuvian area, and new results were published.[135] In the 1960s, Rome became the natural centre for development of new ideas, mainly as an effect of modern conservation theories which by then were spread and accepted outside the ICR through the scholarly-scientific reports which were published by conservators and scholars at the ICR.[136]

Gradually a development of new ideas and hypotheses has taken place in connection to the excavations in the area of Naples, mirroring the achievements and new intentions in the approach to archaeology. Considerations on conservation methods and treatments, as well as chemical and technical analyses have become increasingly important, compared to the normal proceedings in earlier periods.[137] As an example of this scientific approach can be mentioned, that traces of some not identified organic substances of a yellow-brownish colour have been found on samples that were recently excavated and not previously examined nor treated. Such details would probably not have been registered in earlier periods, but rather cleaned off for esthetical reasons, since remains of ancient materials were not subject to any particular interest. Research concerning ancient coatings for stone, has since some years, been established in Rome and Florence, where interest has been focused on the *oxalate coats* that are still visible in areas of the carved stone where cleaning projects in the past did not remove it.[138] The coats have been defined as lime-water with addition of some, not identified, organic material.[139] Oxalate coats show a characteristic yellow-brownish colour.

Quite recently, in the late 1990s, a new program on international level was initiated at Pompeii, mainly directed towards alternative and non-destructive methods of conservation, e.g. strictly performed methods of documentation, but also including new excavations, measurements, chemical-technical analyses and conservation treatments of the sites and the objects. Some results of this work has been published, e.g. within the vast German Pompeii project "Häuser in Pompeji" under the direction of Strocka. A conservator has, since the beginning of the project, been part of the excavation team. He has developed a method of making

---

[135] E. Aletti, *La tecnica della pittura greca e romana*, 1951; S. Augusti, *La tecnica dell'antica pittura parietale Pompeiana*; C. de Azevedo, *Encausto ed encausticatura nella pittura murale romana*, 1952.

[136] C. Brandi, *Teoria del restauro*, 1963; M. Cagiano de Azevedo, *Il restauro degli affreschi della Casa di Livia*, 1949, and a large numberr of other articles; A. Melucco Vaccaro, *La policromia nell'architettura e nella plastica antica*, 1988; P. Mora, *Proposte sulla tecnica della pittura murale romana*, 1967; von Graeve, *Zur Technik griechischer Malerei auf Marmor*, 1981.

[137] M. Pagano, *Metodologia dei restauri borbonici a Pompei ed Ercolano*, 1992; *Una legge ritrovata: Il progetto di legge per il riordinamento...*, 1994.

[138] Bralia et al, Del Monte and Sabbioni, Gratziu and Melucco Vaccaro, Matteini and Moles, Seaward and Giacobini, Torraca etc.

[139] Melucco Vaccaro, *Le patine ad ossalati sulle superfici monumentali: alcune acquisizioni*, pp. 3-4, 7. Some organic material mentioned are casein, animal glues, oil and egg,

analyses of the composition of stucchi and plasters, which has become essential for the successive scientific, photographic and graphic work.

There are still questions about the Roman wall painting technique that have not been explicitly or reliably resolved. The only certain fact is, that the murals are not true fresco-paintings, even though the basic monochrome paint layer generally was made *al fresco*. The final, and superior layer of fine marble-plaster could be either white or coloured, often red or black, thus forming a monochrome basis for the ultimate decorative painting. A recent conservation and research project has given important information about the materials and techniques used in early Christian catacombs, mainly in Rome. The project was presented at a conference in Rome in March 2000, and a series of reduced conservation reports were offered to the public.[140] A similar research project, concerning materials and techniques in the Roman catacombs, was presented as a doctoral dissertation in the beginning of 2000.[141] Consequently, late Roman wall paintings have been given a lot of qualified interest during the last period. At the same time, some results from recent excavations in Pompeii, begin to be available to the public. Documentation is a common and important issue in later publications on this subject, and so is the growing interest for the materials used. As mentioned above, the German Pompeii project has been published in a series of publications. In 1997 the first volume, presenting the British Institute project at Pompeii was published.[142]

There are no disagreements between scholars concerning the mural technique, i.e. of how the *intonaco* or how the preparation of the first paint layer *al fresco* were made. Disagreements concern the decorations painted upon the monochrome layer. Some murals are true *frescoes*, but generally the decorations of Roman murals were built up in several paint layers, upon the basic fresco-layer. These additional paint layers are not made *al fresco*, but painted in other techniques. The binders used for painting on a drying or a dry preparation still have not been fully determined, even though it is known that colours made on lime-basis were used, at least preparations which were not completely dry. Other possible binder(s) might be any glue or gum. In some cases, it has been stated that several kinds of binders were used, but in no case there is a general answer available to the question.[143] The paintings are still mainly referred to as *frescoes*, even in quite recent publications.[144] Since refined analytical methods are available today, it would be possible to determine the binders, i.e. the painting techniques. Therefore, an investigation of the compositions of the binders used in Roman mural painting and surface protection, is made as part of this dissertation, with the objective to identify the assumed existence of beeswax, in its natural form or as Punic wax, present in Roman murals.

140 The conference was held by Pontifica Commissione di Archeologia Sacra Città del Vaticano.

141 Bordignon, 2000.

142 Ling, 1997.

143 Ling, 1991, p. 204.

144 E.g. catalogues such as *Alla ricerca di Iside*.

MATERIAL TECHNOLOGY AND MATERIALS

Waxes, Natron, Pigments and Binders, Painting Preparations, Roman Wall Painting, Encaustic Painting and Ganosis,

Beeswax and natron are the principal materials studied in this dissertation. They constitute, together with some ancient pigments, the components of the paints used in encaustic painting and in the coatings, pigmented or not, which were used on marble statues and wall paintings. Special attention has been given to the properties of beeswax, and how it has been used for artistic purposes. Various analytical methods are presented, since they are commonly used for identification of waxes and/or pigments. Wax as a material to create sculptural objects, or as a material for bronze casting are not, within the limits of this dissertation. Ancient pigments and some binders used during Antiquity, are briefly described and also materials used for preparation as well as early painting techniques is described.

The intention is to present a general view of ancient materials and of the techniques in which they were, and still are used, with the objective of providing an idea of the possibilities available during Antiquity for the choice of materials in painting and for coating surfaces of works of art. By knowing the characteristics of materials and techniques it becomes easier to understand how materials react when used in various combinations and environments, as well as comprehending what is possible and what is impossible to do with them.

Waxes

Natural beeswax has been used by man for various purposes ever since Antiquity. It has, until present times, been used as a paint, and as a material for shaping different objects, such as models for bronze casting, votive figures, writing tablets, and for making decorative and functional objects. It is an ideal modelling material, permitting corrections or additions at any stage, as it is does not dry or change during work.

Beeswax was used during Antiquity as a material for decorative objects. In the Roman era, fruit and flowers made of wax were popular.[1] Pigments were added into the fluid wax and the variously coloured and shaped wax pieces were connected to each other to form more or less complex objects. These traditions were still in existence during the 17th, 18th and 19th centuries, when impressive flower and fruit decorations of coloured wax were high fashion. Anatomical objects were created in the same technique and used for medical studies. Such studies still remain in European museums, e.g. at the wax model department at "La Specola" in Florence, which contains all kinds of anatomical studies. Votive figures of wax were popular donations to Italian churches, and in the church Santissima Annunciata in Florence there were about 600 votive wax figures in natural size at the end of the 17th century, some of them donated as early as during the 13th century. Except for the man-sized examples there were a great number of smaller figures as well.[2]

The Ancient Egyptians used beeswax for various purposes, e.g. as a modelling material for small religious figures, as an adhesive and as a surface coating material.[3] They also used it in shipbuilding. Beeswax has been identified as one of the components in an ancient Egyptian wig.[4] Greeks and Romans used beeswax as a paint and as a surface coating, applied on marble statues and on painted walls, but also on various materials such as leather, metal and wood.

Beeswax was, as indicated above, a common material for making objects and protecting them. Sometimes, some other kind of wax was added to adjust the malleability and the melting point. Among waxes which have been used for such purposes are carnauba wax, spermaceti wax, lac wax, wool wax, and paraffin wax. Various other materials, such as resins, fats, oils, and pigments were occasionally added to achieve specific effects.[5] To obtain a higher adhesive strength in beeswax it is sometimes necessary to add a terpene resin that has much more pronounced polarity.[6]

Beeswax has been used as a surface coating, not only on statues and mural paintings but also on tempera and oil paintings, since the protective properties are very good. Waxes have the greatest degree of impermeability to atmospheric

---

[1] Büll, 1963, p. 438.

[2] Ibid, p. 438.

[3] Murrell, 1971, p. 95.

[4] Mills, 1994, p. 54.

[5] Harley, 1993, p. 63.

[6] Ibid, p. 29.

moisture of any of the commonly used protective materials. After wax comes resins, then oils. Resistance to mechanical forces is, however, less than that of resins and oils.[7] Modern technical analysis has revealed that wax impregnation of stone may prevent further need of treatment.[8] A surface with a layer of wax is repelling most solvents.[9] Most complete coverage is ensured by multiple layers of thin coats.[10] A recent study shows that beeswax is an efficient moisture barrier for several kinds of wood panels, such as mahogany, oak, lime-tree and poplar.[11] Natural beeswax is virtually insoluble in water, but becomes soluble in water if saponified. It is known that the adhesive strength of beeswax contributes to its usefulness, and that it is better than that of paraffin waxes, which depends on the different chemical structures. There are many mixtures of waxes available, and these can be dissolved either in water or in various organic solvents. Most waxes become harder when the solvent has evaporated.

The chemical composition of beeswax

Natural beeswax has a low melting point, generally between 40° and 90° C, beeswax at about 64° C. Oxidation with the atmospherical oxygen may increase the hardness and raise the melting point to about 120°.[12] It is translucent and solid. It consists mainly of esters of long-chain hydrocarbons, alcohols, carboxylic acids and esters formed by the two latter groups.[13] The esters are divided into several different groups (table 4.1).[14] The hydro-carbons range from 25 to 35 in carbon number, the major number being 27.

Table 4.2 Composition of free and total acids of beeswax (after Tulloch[3])

Chain length	*Whole wax*	*Free acids*
16	59.8	–
18	2.6	–
18:1	4.1	–
20	1.5	–
22	1.3	3.3
24	11.9	46.8
26	4.2	12.3
28	4.3	12.1
30	3.8	8.4
32	3.2	7.8
34	3.1	8.3
36	0.2	1.0

18:1 signifies a chain length of eighteen carbons with one double bond (oleic acid).

Table 1.1 Straight chain paraffin hydrocarbons

Name	*Formula*	*M.W.*	*m.p.* (°C)	*b.p.* (°C)
Methane	CH_4	16	−182	−161
Ethane	C_2H_6	30	−183	−88
Propane	C_3H_8	44	−190	−44
Butane	C_4H_{10}	58	−138	−0.5
Pentane	C_5H_{12}	72	−13	36
Hexane	C_6H_{14}	86	−95	69
Heptane	C_7H_{16}	100	−91	98
Octane	C_8H_{18}	114	−56	125
Nonane	C_9H_{20}	128	−51	151
Decane	$C_{10}H_{22}$	142	−30	174
Pentadecane	$C_{15}H_{32}$	212	10	270
Eicosane	$C_{20}H_{42}$	282	37	343

Fig. 7. *To the left*: Table 4.2. After Mills, 1987, p. 50.
Fig. 8. *To the right*: Table 1.1. After Mills, 1987, p. 6.

7 Mayer, 1981, p. 418.

8 Horie, 1987, p. 81.

9 Ibid, p. 73.

10 Horie, 1987, p.78.

11 Masschelein-Kleiner, 1995, p. 43.

12 von Tell, p. 29.

13 Frinta, 1963, p. 148.

14 Mills, 1994, p. 50.

Waxes are lipids, and lipids are esters, i.e. combined with alcohol. The main components of waxes are the cerides, containing long chains of fatty acid combined with normal, i.e. not branched, alcohols of high molecular weight, such as e.g. myrilic alcohol, CH_3-$(CH_2)_{28}$-CH_2OH or cerilic alcohol, CH_3-$(CH_2)_{24}$-CH_2OH.[15] Wax esters crystallise in sheet structures, most with their hydrocarbon chains in tilted form, some with vertical chains while others give X-ray diffraction data for both forms.[16] (The vertical phase seems to have about the same stability as the tilted form.) Infra-red spectra show no obvious differences between different forms. The acids largely contain palmitic acid. After saponification, beeswax yields, in addition to the original hydro-carbons and free acids, further free acids, monoalcohols, hydroxy-acids, and diols (table 4.2).[17] Saturated hydrocarbons are chemically inactive compounds. Both carbon-carbon bonds and carbon-hydrogen bonds are strong and non-polar and not easily broken. For splitting these bonds, energy, such as high temperature is needed.

The hydrocarbons in waxes are heavy, i.e. they can be found in the lower part of the table of carbon atoms (table 1,1). Hydrocarbons with low numbers are gases, those in the middle are liquids and those with higher numbers are solids.

Methods for identification of waxes

Several methods are available for the identification of waxes, e.g. *gas chromatography*, *mass spectrometry* and *infra-red spectrometry*. Lately. FTIR (Fourier transform infra-red microscopy) and SEM/EDS (Scanning Electron Microscopy/Elementary Diffraction Spectroscopy) are frequently used in well equipped laboratories. Modern equipment often is possible to combine with additional instruments, and vast possibilities consequently are available. Cross-section and thin section samples can be examined in a number of ways, including observations in diffuse light or ultra-violet fluorescence light.[18] In addition there are traditional methods such as *optical microscopy*, *micro-chemical analyses* and, if a larger sample can be removed, the *determination of the melting point*.[19] When examining paintings and other objects, only milligram or microgram samples can be removed, and in such cases the modern methods are indispensable.

Gas chromatography was often, and still is, used for identification of waxes. The method makes it possible to identify the composition of different mixtures, for example of one wax mixed into another, or the addition of resins or oils into the wax.[20] The composition of the wax sample can be observed on the gas

[15] Masschelein-Kleiner, 1995, p. 34.
[16] Aleby, 1971, p. 421.
[17] Mills, 1994, p. 50.
[18] Lalli, 1999, p 214.
[19] Kühn, 1960, p. 73.
[20] Mills, 1994, p. 54

chromatogram, although a considerable proportion of the original components consist of compounds of molecular weight too high to pass through the column even at high temperatures.[21]

Paint samples containing saponified wax appear differently than natural beeswax on the gas chromatogram, and therefore, saponified wax can be identified by gas chromatography.[22] The wax esters are in such cases converted into methyl esters. Saponified beeswax, or Punic wax, has been identified in paintings. In a few cases some oil had been added into the mixture.[23] In other cases there had been an addition of lime as an emulsifying agent.[24] Analyses of samples have revealed the addition of non-drying fats and resins into the saponified wax.[25]

Mass spectrometry can be used for the analysis of organic materials, especially when combined with gas chromatography. Analysis of crystal growth on a Victorian fruit decoration of wax revealed that the crystals consisted almost entirely of free palmitic and stearic acids, while the wax areas on which they grew contained no such acids. [26] The migration of fatty acids probably is caused by continuos changes in the surrounding temperature. Changes in temperature is the cause of a second problem, namely cracks on the surface or in the structure of wax objects. The fatty acids function as plasticizers of the wax, and when they are lost, due to the migration, the wax looses its plasticity and this eventually leads to cracking. The formation of surface bloom may be due to polymorph transformations of fats and waxes.[27] On some parts of the fruit decoration, a red pigment had been applied, and on those parts no crystals had formed. The general impression was that the pigment had prevented crystallisation of the wax. Crystal growth on the surface of objects of wax are frequently documented.

A head of a girl, made with the mixture of beeswax, paraffin wax and pine resin, presented similar formations of crystals on the surface.[28] It seems that in most cases when this problem occurs, there has been an addition of stearic wax into the beeswax, and that the objects have been exposed to great variations in the surrounding temperature, which favours the forming of crystals.[29]

Infra-red spectrometry is a useful method for the analysis and identification of waxes, and has, in recent years, been frequently adopted as an analytical method in conservation. As the infra-red spectrum of beeswax is a rather reliable and constant characteristic, the method is convenient for unmixed samples of sufficient size. Infra-red spectrometry served to identify materials of appliqué brocade materials in some wooden sculptures, being made either in pure

---

[21] Ibid, p. 50.
[22] Hillyer, 1984, p. 2.
[23] Mills, 1994, p. 173.
[24] Kühn, 1960, p. 78.
[25] Mills, 1994, p. 173.
[26] Harley, 1993, pp. 63-66.
[27] Ibid, p. 66.
[28] Ibid, p. 65.
[29] Ibid, p. 64.

beeswax or in a beeswax/resin mixture.[30] Quite unexpectedly, some samples of both types contained small quantities of sand, sometimes with the addition of a drying oil or lead white. The meaning of the sand and the oil or pigment was not clear.[31] Infra-red spectrometry was successfully used for the identification of pure beeswax in wax sculptures from the 17th, 18th and 19th centuries. Kühn used infrared for analysis of the paint medium of three mummy portraits, all painted on wooden panels. Two of the portraits, painted in encaustic, had a spectrum similar to that of recent beeswax, and also to the spectrum of a wax seal dated to 1218, which clearly shows that wax does not undergo much change in the course of time.[32] Emission spectroscopy showed that sodium was present in all three portraits. In mummy portraits belonging to the Louvre, beeswax was also detected.[33] The convenience and good results obtained by using infrared spectrometry, sometimes in combination with gas chromatography, has been described in many conservation reports, as e.g. for the material analysis of a portrait made in polychrome wax, signed by S. Percy and dated to 1788.[34]

Infra-red spectrometry has also proved to be adaptable for analysis of samples from mural paintings.[35] In one case a rather large sample of a Pompeian wall painting was extracted with chloroform. The infra-red spectrum indicated beeswax, but in such small quantities (only 0,01%) that it would not have been sufficient as a binding medium. It is therefore possible that a mixture of lime and wax was used as binder.[36] Kühn indicates the possibility of a *ganosis* procedure on the mural, in which case the heat might have had a reducing influence on the wax.[37]

FTIR can be used for identification of pigments, binders, varnishes and other materials contained in pictorial preparations.[38] Samples of just microscopic size are needed, and the method may therefore be characterised a micro-destructive technique, in comparison with non-destructive methods operating by radiation and with no need of samples. The results of FTIR analyses appear as spectres, where the peaks indicate the materials included it the sample. Organic matters often are not visible since they usually are a low percentage of paint mixtures.[39]

SEM/EDS analyses reveal the constituent elements of the samples. The great power of SEM/EDS reduces the necessary size of sample, and it is therefore competitive with not invasive diagnostic analyses.[40] The EDS analyses allow us to obtain a higher magnification as well as an element by element analysis.[41]

---

30 Frinta, 1963, p. 138

31 Ibid, p. 144.

32 Kühn, 1960, p. 78.

33 Ibid.

34 A portrait of Dr. Joseph Priestley, belonging to the Science Museum in London.

35 Frinta, 1963, p. 138; Kühn, 1960, pp. 71-79.

36 Kühn, 1960, p. 78.

37 Büll, 1963, p. 359.

38 Matteini and Nepoti, 1999, pp. 217-218.

39 Matteini and Nepoti, p. 223.

40 Lanterna, 1999, pp. 40-41.

41 Lalli, 1999, p. 215.

Recently a chemical-technical investigation of samples from some mummy portraits in Nationalmuseum in Stockholm was performed, and a set of methods, including FTIR, and SEM/EDS, were used for determination of preparations, binders and pigments.[42] These methods are presented in a separate case study, "Fayum portraits in Nationalmuseum".

Determination of the melting point of paint samples is another method of identification of waxes. The melting point of natural beeswax is rather constant, and does not change with ageing of the material. Wax has proved to melt at about 64° C, normally within the range of 63.4-65° C.[43] In early days the analysis of the melting point was frequently used, and it is a rather reliable method in art and conservation, if large samples are available.

Ageing properties of beeswax

Beeswax changes only slightly through oxidation or ageing. The chemical composition is more or less the same for beeswax in different countries, or different periods of time and does not seem to vary in chemical composition due to which period of the year it is produced. Samples from various sources look much the same, a fact which has been noted by analysis of such different samples as an Egyptian sarcophagus, a Roman candle and a Medieval wax seal.[44] A fresh, natural beeswax is of a fairly similar composition as old beeswax. Changes in wax have, however, been noted by infra-red spectrometry in cases where wax had been exposed to ground water. Material analyses from a 17th century ship burial showed reduced ester-group absorption relative to that of free acids.[45]

Saponified beeswax also remains of the same chemical composition whether it is fresh or old. The chemical difference between natural beeswax and saponified beeswax does not alter in the course of time and each material shows its specific pattern in gas chromatograms.[46]

Consequently it might be difficult to determine the exact age of wax, at least with the methods described above. Age may sometimes be determined by C^{14} analysis of the material supporting the wax application. The analytical programme of a mummy portrait was made by a group of conservators at the Getty Conservation Institute, is a good example, illustrating this statement.[47] Since there were some doubts about the age of the portrait, and FTIR of the paint does not reveal the age of wax, a C^{14} test was made. The test revealed that the age of the wood was roughly 250 years old, a result which excluded the possibility that the portrait was an original Fayum portrait.[48]

---

[42] The investigation was made at the scientific laboratory at Opificio delle Pietre Dure in Florence.

[43] Mills, 1994, p. 50.

[44] Mills, 1994, p. 53.

[45] Ibid, p. 53.

[46] Ibid, pp. 173, 190.

[47] Corzo, et al., 1997, p. 82.

[48] Corzo et al.., 1997, p. 82.

Additions of other materials into the wax

Remaining ancient descriptions, made more than two thousand years ago, give some information on how beeswax was used, as a singular material and as component in mixtures. The practical knowledge regarding the characteristics of organic materials obviously were discovered in Antiquity, but the possibilities of making exact chemical analyses have not been offered until recent times. The advanced technical equipment nowadays makes it possible to do exact and reliable analytical determinations. Analytical methods have made possible, not only to determine material compositions, but also to understand the interactions between different materials in mixtures. One such compound is *Punic wax*. Ancient Greek and Roman craftsmen used Punic wax as a protective coating on marble statues in the process called *ganosis*.

Experiments have revealed that beeswax can be useful if mixed into modern materials. Such an example is the addition of bleached beeswax into an artificial resin, a polycyclohexanones, AW2. The resin hardened rather rapidly and became almost as insoluble as dammar and mastics. The addition of bleached beeswax improved the resolubility of the resin, and the result was considered to be very successful.[49] This mixture, in fact, resembles an ancient Roman glue used for marble coating, which principally consisted of a mixture of colophon and beeswax.[50]

Natron

Nitrum, nitro, natron are terms referring to a double salt which may be collected in natural circumstances in salt lakes in desert regions. *Nitro*, a term used by Pliny, is a form of the Latin word *nitrum*. The corresponding Greek word is *natron*, and in the English chemical terminology it is called *Trona*.[51]

Natron exists in a natural form in Egypt, where the salt can be found on the surface of the shores along some salt lakes. One important such lake is situated in the Wadi Natrun, a partially cultivated valley in the Western Delta of the River Nile, in the Libyan desert north-west of Cairo. In the middle of the valley, a chain of salt lakes are extended, which collectively are called Wadi Natrun. The name indicates the finds of *natron*, which has been collected in the area since ancient Egyptian time.[52] During the Pharaonic era this *Wadi* was considered as one of the seven oases in the Libyan desert, and was called either "The salt field" (*Sechet Hemat*) or "The Lake of Heaven" (*Schet-Pet*), the latter referring to the importance of *natron* for incense, which was used in the daily temple ceremonies. The *Wadi* continued to be an important place during the Graeco-Ptolemaic era, when it formed a district of its own, the "Nitriotes", under

---

49 Raft, 1985, p. 143.

50 Alessandro Danesi, personal communication, 1999.

51 The double salt Natriumsesqvicarbonate, $Na_3\ (HCO_3)\ (CO_3) \cdot 2H_2O$.

52 Bonniers kulturguide, Egypten, pp. 390-391; Laurie, 1910, p. 40.

the protection of the god Serapis. Another large salt lake was the Birket Quarun in the Fayum district. The salt from this lake *may* be of the same composition as that from Wadi Natrun, but there are, to my knowledge, no existing reports on this matter. There may also exist other North African desert lakes containing *natron* salt, but this, to my knowledge, has not either been established. According to Dr Nasser Iskander, *natron* for the purposes mentioned above was exclusively taken from Wadi Natrun.[53] Due to these facts, in this context, *natron* will be understood as *a natural impure salt collected at Wadi Natrun.*

Natron salt was used for different purposes, e.g. for mummification, where it was a drying agent in the desiccation process, since the salt absorbs liquids and is antiseptic. *Natron* was, in addition, used in the fabrication of glass, and for cleaning purposes. It was also one of the components for making the glaze *blue frit*, which could be used as a pigment in a powdered form.[54]

During winter the level of the water becomes more elevated than in summer, and when the water retires and evaporates from the wet ground, the salt crystallises on the ground. It remains as a white layer on the surface and is easily collected at any time of the year. It may be easier to collect great quantities in periods when the layer is thick. Due to the sand on which the salt crystallises it is almost impossible to avoid collecting sand at the same time. The impurities in *natron*, therefore, are mostly sand, and as sand is not soluble in water it is easily distinguished in analysis, and will have no importance for the determination of the composition of the salt.[55]

Natron may, according to Dr. Iskander, be substituted with pure sodium carbonate, sodium bicarbonate plus a small addition of sodium chloride and sodium sulphate for experimental purposes.[56] The *nitrum*, mentioned by Pliny as an important ingredient for making Punic wax, was most probably this *natron* salt. This may explain the name *Punic wax* - suggesting either that the wax or the ingredient salt was derived from Northern Africa.

In November 1998 I made a visit to Wadi Natrun in order to obtain a general view of the area and to collect some samples of salt. The journey to reach the salt lakes went along the desert road between Cairo and Alexandria, and about halfway, at Sadat City, continued on a local road to the Coptic monasteries, Deir el-Surian and Deir el-Baramous. From there a minor road, constructed of compacted sand, lead to the salt lakes. The most remarkable and immediate impressions of this isolated place was the taste of salt in the air and the extreme quietness of the place. No sounds could be heard and salt, sand and water were exposed under the sun and the clear blue sky. The place seemed untouched by man, and the surroundings gave the impression of sterility and desolation. Salt had crystallised in various systems in the different areas along the shore where the samples were collected.

---

[53] Dr. N. Iskander, Director General of conservation, Egyptian Museum, Cairo. Personal communication, December 1997.

[54] Forbes, 1965, p. 224.

[55] Dr. N. Iskander. Personal communication, December 1997.

[56] Ibid.

Distant to water it appeared in a rather powdery form, easy to collect, just as newly fallen snow when the temperature is very low. Closer to the water it became heavier and in some areas it formed irregular flakes of smaller or larger size. At the edge of the water the salt was rather wet and formed hard flakes.

Six samples of the salt were taken from the surface, at various distances from the water, for study purposes. The salt was collected in sterilised glass bottles and closed with plastic taps. When examined in FTIR at the Opificio, sodium sulphate was identified, an indication of air pollution. This means that even in an isolated desert region there are signs of air pollution, and the salt collected today is therefore not identical to ancient *natron*.

Two of the samples, no. 5 and no. 3, were examined by microscopy at CNR in Rome.[57] The samples presented the same characteristics. The lower side, which had been exposed against the sand, was darker than the upper side, and containing sand. There were distinct formations of crystals, and the structure seemed rather compact and hard. Most remarkable was the transparency and glassy appearance of the material. Some crystals had specific optical properties, transmitting spectral light through prismatic crystal formations. There were stains of red colour, indicating residues of a ferrous material, some undefined black, some burgundy coloured, and some yellow grains. The lower side seemed more fragile, presenting empty spaces and a more complex structure, consisting of formations of stars, serpents and forms similar to painted skies from the Baroque period. The serpent formations, or vein structures, may have been natural tubes for the disposal of air.[58]

Finally samples nos. 2 and 3 were brought to the National Heritage Board in Stockholm, where some grains were examined by Dr. Runo Löfvendahl. The grains were viewed and photographed in an optical microscope, and the same kinds of observations were made, confirming that the natron salt contains various crystals, e.g. quartz and other mineral grains. Some red particles were identified as iron oxide. (see appendix 1. The documentation from the observations on natron salt).

[57] CNR - Consiglio Nazionale delle Ricerche. Centro di studio sulle cause di deperimento e sui metodi di conservazione delle opere d'arte, Roma. Dr. Sandro Massa kindly instructed and supported the microscopical analysis.

[58] Dr. S. Massa, personal communication, 1998.

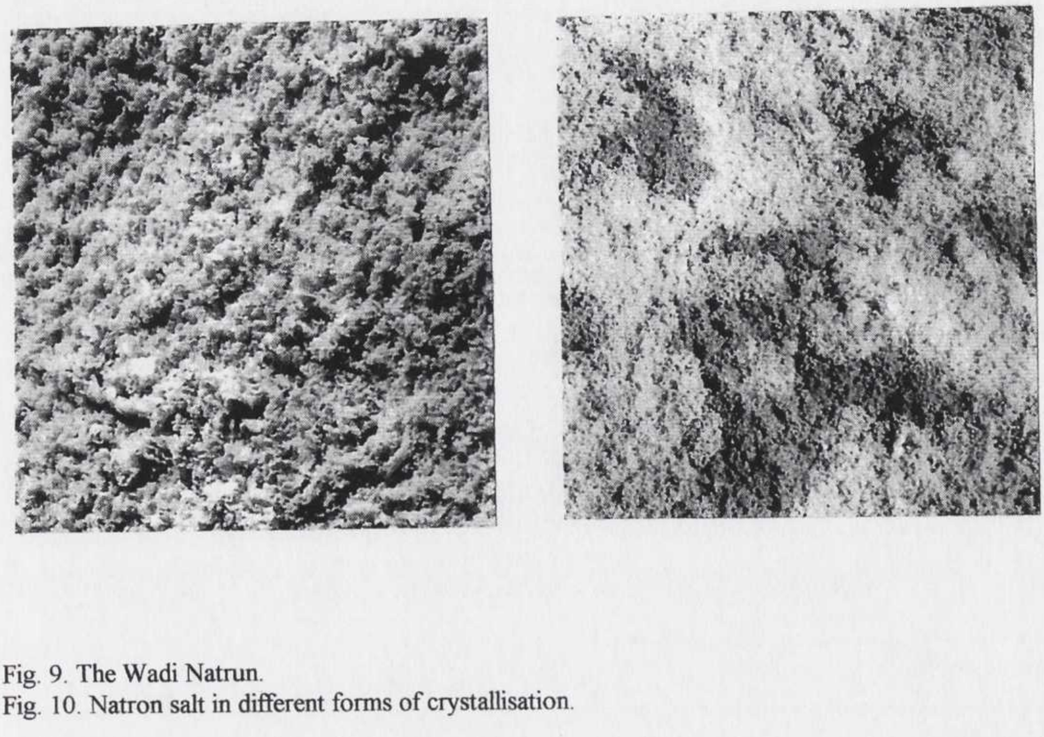


Fig. 9. The Wadi Natrun.
Fig. 10. Natron salt in different forms of crystallisation.

Pigments and Binders

To a great extent our ancient source based knowledge of ancient art refers to Pliny, who wrote about many subjects, and among them, the origin and development of painting. According to Pliny, the Egyptians claimed to have invented the method of painting 6000 years before it reached Greece, and he also notes that painting initiated with the outlining of a man's shadow while more elaborate methods were invented later.[59] Obviously, Pliny had no precise conception of ages at that time, since today it is known that painting started already during the Aurignacien period.[60]

Imprints of hands appear in prehistoric caves, and are preserved in e.g. the French caves Pech-Merle in the province of Lot, at Gargas in the Pyrenean and in the Altamira cave in the province of Santander in Spain. On those sites simple imprints as well as well-performed paintings of animals and figures remain. At a later stage brushes were adapted.[61] The old cave painting techniques and materials have survived in the traditional Aborigine art. Recent analysis of Aboriginal rock art show, that natural earth colours have been continuously used for the paintings, and that no binders were used. This is consistent with traditional cave painting techniques, which include brushing of a water-based dispersion and spraying from the mouth.[62]

Colour had a profoundly important meaning for pre-historic man, and decorating the skin with red, yellow and blue patterns seems to have been practised at a very early date. The earliest pigments that were used for painting were red, yellow black, and white.[63] Yellow, red and brown ochres are earth pigments which have altered very little over the ages. White was obtained by white clays or lime, and black was soot or charcoal. Red ochre was used in grave rites from the Cro Magnon period and onwards, either as layers of pigments encasing the dead body, or placed close to the head of the skeleton, maybe as a symbol for a life-giving substance because of its resemblance to blood.[64] The archaeological finds in "Grotta delle Felci" on Capri is an example of such a tradition. The cave was found at the end of the 18th century, and it contained grinding stones covered with red ochre, together with remains of human skeletons.[65]

Water or grease were suitable binders on walls that were not directly exposed to water, wind or sun, but did not make a resistant paint. In order to achieve a

---

59 Plinius, NH XXXV, 15. "The origins of painting is obscure, and hardly falls within the scope of this work. The claim of the Egyptians to have discovered the art six thousand years before it reached Greece is obviously an idle boast, while among the Greeks some say that it was first discovered at Sikyon, others at Corinth. All, however, agree that painting began with the outlining of a mans shadow; this was the first stage, in the second a single colour was employed, and after the discovery of more elaborate methods this style, which is still in vogue, received the name of monochrome."

60 The Aurignacien culture took place during the Upper Palaeolithic period, that is, about 40.000-10.000 years ago.

61 Forbes, 1965, p. 211.

62 Ford et al., 1994, p. 59.

63 Forbes, 1965, pp. 210-213.

64 Ibid, pp. 210, 211.

65 Andrén, 1975, p. 14.

paint that was waterproof, a more withstanding substance had to be mixed with the pigments, and that might have been either blood, milk, urine, egg or wax. Binders such as those can be diluted with water.

Not only earth pigments were known in Ancient Egypt, but also some manufactured pigment. "Egyptian blue", was achieved by grinding copper-calcium-tetrasilicate, which produces an ultramarine shade of blue. The "blue frit", was ground to a fine powder, often tending to a green.[66] Green was made from copper salts, or by mixing blue with ochre or orpiment.[67] Black pigment was usually made from soot. Lime-white was used in Ancient Egypt, alone or mixed with other colours to lighten them up or to make them more opaque.[68] Early wall-paintings at Hieraconpolis, a site in the Nile Valley, show that not only earth pigments but also manufactured green and blue pigments were known before 3000 BC.[69]

Pliny described the pigments known and used during the Roman period; where to buy them, how to handle them and even what to pay. He gave his opinion about the difference between the old traditions and the methods used by contemporary painters during his own life-time. "When we contemplate the number and the variety of colours known, we are overcome by admiration for the early masters. The greatest artists Apelles, Aetion, Melanthius and Nichomachus used four colours only for those immortal masterpieces - melinum as a white pigment, Attic sil among the yellows, Pontic sinopis as a red and the black atramentum - and yet towns lavished their whole resources on a single picture. Today when purple has made its appearance on our walls and India contributes the slime of her rivers, the blood of dragons and elephants, no noble paintings are produced."[70] That pigments fell into some rank of order is apparent in the comments of Vitruvius and Pliny. Pigments were valued in proportion to their availability and expense. Most esteemed and most costly were the richest pigments such as cinnabar, which could be excluded from the decorators´ contract and charged directly to the customer.[71]

In the Roman tradition the variations in colour were also used for establishing hierarchies of space. Plain white walls were most economical and consequently most common in secondary rooms in the houses of wealthy, and in simple houses used as the overall colour of the walls. Yellow and red ochres represented the norm for the better rooms of houses, while blue pigments were something of a rarity. Black was normally used in rooms of special scale and grandeur.[72] The pigments used in ancient Egypt have been subject to various analyses during the last decades, and the results confirm the information given in ancient sources, e.g. by Pliny.

---

66 Aldred, 1994, p. 29.

67 Ibid, p. 28.

68 Ibid.

69 Forbes, 1965, p. 241; Woldering, 1962, p. 22; Lloyd, p. 34.

70 Plinius. NH XXXV, 50. The artists mentioned were well known Greek painters at the time.

71 Wallace Hadrill, 1994, p. 31.

72 Ibid.

Most commonly appear various red and yellow ochres, Egyptian blue, green frit, carbon black, usually applied to a white ground of gypsum, sometimes with the addition of orpiment and/or malachite.[73] The pigments were mainly minerals with a proteinacious binder.[74] Similar results were achieved in the determination of pigments on painted mummy cloths from Roman Egypt.[75]

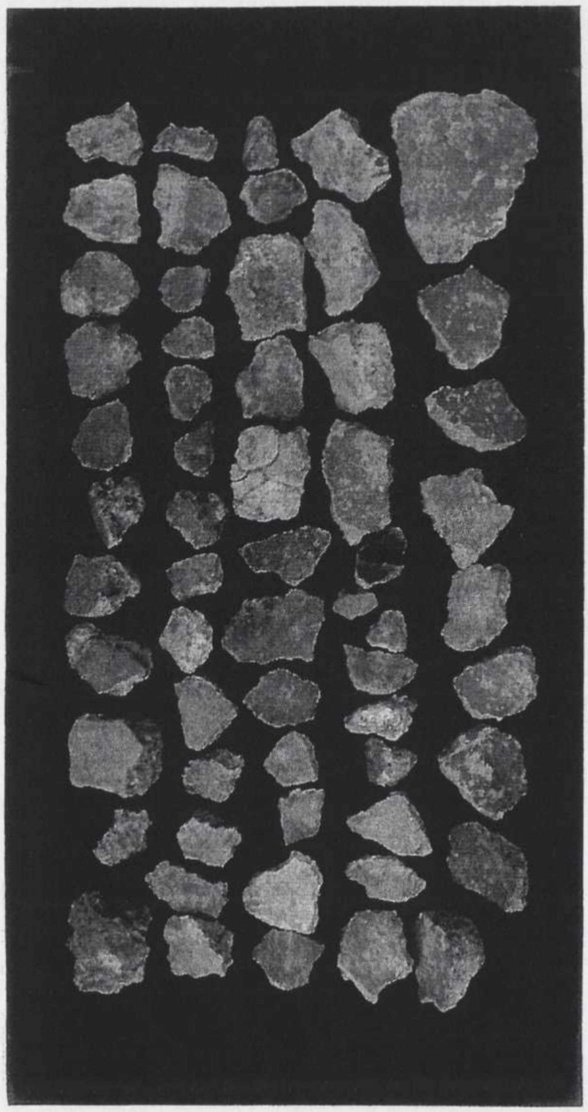


Fig. 11. Fragments of Roman wall paintings. Small fragments of various red colours. From excavations at San Lorenzo in Lucina, Rome.

[73] Johnson, 1995, p. 73; Dinsmore, 1988, p. 63; Barov, 1990, p. 20.

[74] Johnson, 1997, p. 100.

[75] Hillyer, 1984, pp. 7-8.

Ancient pigments, commonly used

The pigments which were most commonly used during the Roman period are presented below. These were described by Pliny, and are the pigments most commonly found in contemporary analyses of ancient paints. Beside these, several other pigments were available.

Black pigments

Black pigments generally contained carbon in some form. *Carbon black* could be prepared from bones, e.g. *ivory black*,[76] or wood, *charcoal*.[77] Other black pigments were made by *iron oxide*,[78] and *bitumen*, said to have been invented by Apelles.[79] Carbonised wine roots made a black pigment with a bluish black hue and ivory made a brownish black.[80]

White pigments

The white pigments used in Egypt mostly were prepared from calcium. Among the white colours were *limestone, chalk, lime* and *gypsum*. Greeks and Romans continued to use *lime*, *gypsum*, *chalk* and *china clay*, but also produced *ceruse*, which is *lead white*.[81] *Paraetonium*, was a white calcium pigment, made by crushed seashells.

Red pigments

Red ochre, a natural earth, owing its colour to anhydrous or hydrous iron oxide, was the most common red pigment during Antiquity.[82] Other natural reds were *natural ferric oxide* and *red lead*. Several artificial red pigments were used, like cinnabar,[83] and *dragons blood*,[84] an organic product, achieved from plants. *Purpurissum*, an organic *red lake*, was a dye extracted from the madder root. A less expensive madder originated from Greece.[85] This colour frequently occurs on objects from the Roman period in Egypt.

Yellow pigments

Yellow pigments generally were natural iron oxides like *ochres* or *limonite*. Pliny considered the *Attic sil*, dug in the silver mines of Athens, to be the best ochre.[86] *Orpiment*, also called Kings Yellow, was used in ancient Egypt.[87]

---

76 Lat. elephantinum.

77 Lat. atramentum.

78 Black hematite.

79 Berger, 1904, p. 262.

80 Doxiadis, 1995, p. 99.

81 Lat. cerussa.

82 Lat. rubrica.

83 Lat. minium.

84 Lat. cinnabaris.

85 Doxiadis, 1995, p. 99.

86 Lat. sil atticum, a yellow ochre from Attica. Sil, Latin for ochre.

87 Lat. auripigmentum, a natural sulphide of arsenic.

Blue pigments
Azurite, a basic copper carbonate, was much appreciated during Antiquity.[88] It was an expensive natural pigment, which was often substituted by the artificial product called *blue frit* or *Egyptian blue*. The blue frit was initially used as a glaze and later in a powdered form as a pigment. It was prepared by melting *silica*, *malachite*, *calcium carbonate* and *natron* for 24 hours at a temperature between 800-900ºC.[89] This colour was known to the Assyrians about 1500 BC, who used it for decorations as well as for shaping small objects. *Indigo*, a natural product made of plants, was another blue, and expensive pigment.[90]

Green pigments
Green earth pigments were known at a very early date.[91] A vivid green on base of copper, was achieved by powdering *malachite* or *chrysocolla*,[92] and an artificial *green frit* occurred in Egypt at the time of the 6th dynasty. The *blue frit* could be mixed with a *yellow ochre* to obtain a green colour.

Violet pigments
The only violet pigment was purple, prepared from the Murex mollusc.[93] Purple was the most expensive pigment during the Roman period.

How to prevent some pigments from altering

Some pigments were sensitive to light, and tended to alter when exposed to direct sunshine. Among these were *vermilion* or *cinnabar*. Vitruvius explains how to avoid the problem of alteration.[94] Vitruvius and Pliny agree that cinnabar, exposed to light, turns dark. This transformation depends on the ultraviolet rays of the sun, which turns the red mercury sulphide into black. Cinnabar also alters in contact with lime. Therefore, if used for painting *al fresco*, the decoration has to be protected with a coating.

Other colours, such as *purple* (Purpurissum), *indigo* (Indicum), *Egyptian blue* (Caeruleum), *Terra Melia* (Melinum), *orpiment* (Auripigmentum), *Appian green earth* (Appianum) and *lead white* (Cerussa) do not either remain intact when they are exposed to the ultraviolet rays of sunlight and in contact with lime. In order to avoid such transformation, an application of Punic wax mixed with oil could be spread to the painted wall, when the colour was dry. The wax then formed a protective coat and the colours remained unaltered.

---

88 Lat. Caeruleum.
89 Forbes, 1965, p. 215.
90 Lat. Indicum Purpurissum.
91 Lat. creta viridis.
92 Lat. aerugo.
93 Lat. Purpurissum.
94 Vitruvius. De Architectura VII. 9, 1-5.

Colours and pigments

Ancient philosophers formed theoretical systems to describe the nature of, and the connection between, colour and light. The formation of systematically documented discourse took place in Greece. Aristotle considered that "*all colours are the mixture of three facts, the light, the means through which light is percepted, like water or the air, and in the third place the objects...*".[95] According to Plato, vision is caused by light going out of the eye, round the object, and back to the eye. Seen in this way, observation of colour may be described as "a two-way communication, based upon the evolution of the faculty of vision of the observer".[96] Plato defined colour as "*an effluence of form commensurate with sight and palpable to sense*".[97] Democritus associated the four primary colours with the four elements in his general atomic theory.[98]

Colour appearing as pigment or paint has also been subject to interest, and more or less systematically analysed and described. Vitruvius divided the colours into *natural* and *artificial*.[99] Natural colours were those which can be found in the earth, such as yellow and red ochres, Paraetonium, melian white, and green chalk from Smyrne.[100] Artificial were those made by man in some kind of a process.[101] By this definition most colours are artificial, since some chemical process frequently is needed to make a pigment or a dye.

Pliny divided the pigments principally into *the vivid* (floridi) and *the subdue* (austeri). Vivid pigments, were *cinnabar*, *azurite*, *dragon blood resin*, *malachite*, *indigo*, and *Purpurissum* (an earth dyed with Tyrian purple). All other pigments were classified as subdue.[102] Pliny stated, however, that pigments may be classified differently, for example into the natural and the artificial.[103] This classification is rather similar to that formulated by Vitruvius.

Nowadays there are other ways of classifying pigments. For example, Selim Augusti, who studied the pigments found in Pompeian painting, presents five different ways of classification.[104] In brief, the different classification principles are according to Augusti:

A. According to colour. (Red, yellow, green, blue, violet, black and white).
B. According to nature and origin. (Natural and artificial colours).
C. According to commercial value. (Vivid and subdued colours).
D. According to chemical composition.
E. According to chemical components.

---

95 Aristotle, De Coloribus, 793, a, b.
96 Jensen, 1996, p. 25.
97 Plato, Meno, 76, D.
98 Lyons, 1996, p. 214.
99 Vitruvius, De architectura, the ten books on architecture, c. 10 B.C.
100 Vitruvius, De architectura, VII, 7.
101 Vitruvius, De architectura, VII, 8-14.
102 Plinius, NH XXXV, 30.
103 Plinius NH XXXV, 30.
104 Augusti, 1967.

Paint and conservation

Analysis and the successive determination of pigments and media are of great importance in modern conservation. Examinations of the paint has to be made, and microscopic samples may be removed for determination of the paint´s chemical composition. Pigments can be identified in various ways: by e.g. chemical analysis, optical investigation, x-ray diffraction, x-ray fluorescence, transmission electron microscopy, and scanning electron microscopy (SEM).[105] The latter can be combined with energy dispersive analysis of X-rays. The identification of the binding medium can be made by infra-red spectrometry, gas chromatography, mass spectrometry, nuclear magnetic resonance spectrometry and determination of the melting point.

The most common approach to conservation treatments nowadays is that the conservator should do as little as possible, but in other periods it has been normal to restore cracks and lacunae completely.[106] Decisions on how to proceed have to be made, methods and materials have to be chosen. Today it is commonly accepted that conservation materials have to be reversible and not provoke any further damage to the object.

Metamerism is a problem which may occur if modern pigments substitute ancient or old pigments or paints.[107] The problem is caused by differences in reflection and wavelengths between the old pigment and the modern substitute. The colour may be similar in some wavelength intervals, and therefore the colours may seem similar in one kind of light, but if light changes, differences become obvious. This may lead to unexpected effects. The retouched part of an object may be perfectly indistinguishable from the surrounding original paint when exposed to daylight, but not in the artificial light from a lamp, or from the flash when a photo is made. A way of avoiding this problem is by using modern products with similar reflection spectra as the ancient materials.

---

105 Jensen, 1996, p. 37.

106 Baldini, 1988, 1989; Casazza, 1989; Feilden, 1991; Jokilehto, 1986.

107 Staniforth, 1985, p. 101.

Painting Preparations

Plastering and painting

Materials such as *clay*, *lime*, *gypsum* and *chalk* were used as preparations for wall paintings in most ancient societies. The materials were mixed with water in order to achieve a suitable consistency, and the mixture obtained was applied to the wall where it was left to set for drying or carbonating as the water was evaporating.[108] Wall preparations of gypsum plaster, made as early as 3300 BC, have been found in Egypt. Such preparations are known from pre-dynastic wall paintings in Hieraconpolis, and in early-dynastic mastaba tombs at Saqqara.[109] Egyptian preparations were carefully made. At first a thick coating of straw and mud was applied to the rough-hewn walls and covered with layers of plaster, consisting of very fine sand and clay with calcium carbonate and gypsum.[110] The finishing coat was a *gesso*, a priming coat to which a glue had been added. The resilient straw and mud support has preserved the paintings from bad shrinkage and earth tremors, so that many of them have survived in an astonishingly fresh condition, though frequently damaged by the hand of man.[111] The painted decoration was made with tempera when the preparation had dried. This kind of plastering and painting remained the common method for the next 3000 years. The gesso primer was not used exclusively for mural paintings, however, but also was applied to other materials, such as wood or linen. Gesso was used as preparation on several panels for mummy portraits.

Roman wall paintings were not made *a secco* as were Egyptian murals, but rather in the *al fresco* technique. In both traditions, however, the thorough and systematic construction of the wall preparation was characteristic. The Roman wall plaster was basically made of slaked lime, sand and water. When this mixture sets, by taking up carbon dioxide from the air and drying out to form calcium carbonate, it becomes chemically similar to limestone and marble. The preparation of Roman murals from the first layer to the final painting consisted of defined parts of a well-structured process, the painting being part of that structure, not considered as an additive and superficial decoration.[112] To begin with, a rough layer was applied directly on the wall, continuing with one of finer structure, and proceeding with applications of even finer layers, until the preparation was completed. The ultimate and very fine layer served as a support for the painting.

The main source to understanding how Roman murals were made is Vitruvius' *De Architectura* from the first century BC. Among other subjects, Vitruvius described how to build a house, how to construct a standing wall and how to make a long-lasting wall preparation. His recommendations were followed by his contemporary to a certain extent. Pliny also made descriptions of

---

108 Aldred, 1994; Aletti, 1951; Forbes, 1965; Ling, 1991; Vitruvius.

109 James, 1988, p. 55.

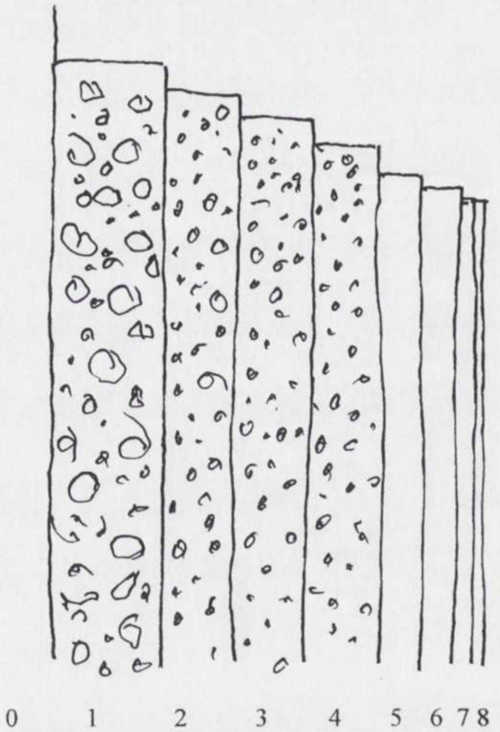
110 Rickerby, 1993, p. 45; Stulik et al, 1993, p. 57.

111 Aldred, 1994, p. 28.

112 Melucco Vaccaro, 1967, p. 20.

the Roman house and its decoration, and these two sources provide enough information to form an idea about the Roman building standard.

Roman wall preparations generally gained a considerable thickness, often as much as 7 or 8 cm. The combination of several applications of plaster and stucco layers and the intermediate compacting of these layers, made the walls acquire certain qualities such as being strong, which prevented surface cracking. The wall was compacted and smoothed with special plasterer´s tools, similar to those used today, the mason´s trowel, *trulla*, for applying the material and the float, *liaculum*, for smoothing and polishing it. Many such tools of metal and wood have been found at Pompeii and Herculaneum.[113]



0. The interior wall
1. Render coat
2. Plaster (lime and sand)
3. Plaster (lime and sand)
4. Plaster (lime and sand)
5. Stucco (lime and marble dust)
6. Stucco (lime and marble dust)
7. Stucco (lime and marble dust or alabaster dust)
8. The painting, made on the ultimate layer, carbonising in contact with the oxygen in the air and integrating with the preparation.

Fig. 12. The preparation of a wall, according to Vitruvius. The evaporation of water makes the calcium hydroxide migrate towards the surface, penetrating through the paint layer. It reacts with the carbon gas in the air CO_2 developing calcium carbonate, $CaCO_3$.

---

[113] Borrelli, 1980, p. 82; Ling, 1991, p. 200.

The thickness made the preparation maintain humidity for a rather long time and consequently the painter could work on the decoration without being limited too much by time. This considerable thickness and the slow drying may be among the reasons why the signs of different applications, the *giornate*, are not very apparent on Roman murals, but have been ascertained.[114] Burnishing with hard tools must be done while the plaster is wet, and is done to compact the plaster and harden it. Marks from tools have been identified on the surface of several Roman murals.[115] *The giornate* are indications of the areas upon which one day´s painting was done. Such areas are clearly visible on fresco-paintings from the Renaissance, when the thickness of the preparation was much reduced.[116]

The first step in plastering was to ensure good adhesion to the underlying wall construction. If the wall surface was too smooth it had to be prepared by pecking with a pickhammer or other implement but if it was rough enough the first layer of mortar could be applied directly to the wall surface. If there was any danger of dampness penetrating from the ground, crushed terracotta and *pozzolana*, a volcanic material, could be mixed into the plaster, forming a hydraulic mortar. The fired clay, mixed into the mortar, confers hydraulic properties and through hydration it hardens in damp conditions and subsequently becomes waterproof.[117] A keying pattern could be made in the rendering coat, in order to improve the adherence of the successive plaster layers.[118]

Vitruvius actually lived at the time when Roman mural paintings were at their highest technical standards, and according to him wall preparations should consist in as many as six layers in addition to the render coat.[119] The first three layers should be made of lime and river sand, while fine marble dust should replace the sand in the ultimate three layers.[120] The material constituting these last layers is called *stucco*, a term which refers to the *material* as well as to the *architectural decorations* frequently appearing in Roman architecture.[121] In this context the term *stucco* will be used for the material, and if a stucco relief is intended it will be specifically pointed out.

In the House of Livia at the Palatine, and at the house presumably belonging to Julia and Agrippa, excavated at the Farnesina Villa in Rome, six preparatory layers actually have been revealed. In the House of Livia the marble dust was substituted by alabaster-dust, a material which must have been extremely costly even at that time.[122] Recent analysis of decorations at Torre di Prima Porta and at the Villa of Livia at Prima Porta show that even in these houses marble dust was substituted by alabaster dust. (See: Case study 4).

---

[114] Barbet, 1988; Borrelli, 1980; Iacopi, 1997; Ling 1991.

[115] Borrelli, 1980, p. 82; Ling, 1991, p. 199.

[116] Laurie, 1910, pp. 83-85.

[117] Ling, 1991, p. 199.

[118] Barbet, 1998, p. 105.

[119] Vitruvius, VII, 3.

[120] Borrelli, 1980, p. 82.

[121] Ling, 1995, p. 1; Bordignon, 2000, p. 39.

[122] Ling, 1991, p. 199.

The Roman wall painting technique

There have been, and still are, different opinions among scholars concerning the technique used for Pompeian murals.[123] At the time of the early excavations, the lustre of these surfaces was most striking to the persons involved in excavating, and a lot of energy was concentrated on attempts to explain the reasons for this shiny appearance. Field studies of excavated murals were made and published. Painting descriptions were studied in ancient literature, principally in the books of Vitruvius and Pliny, but also by Aristotle, Plutarch and other writers.[124] In general, these painting are called "frescoes", which unfortunately is not an adequate denomination. During the last centuries it has been debated whether these murals should be considered as paintings *al fresco*,[125] *encausto*,[126] *tempera*,[127] or even *painting with polyments*.[128] Other alternatives have been suggested, and among them are *stucco-lustro*, *fresco-secco*, *tempera on fresco ground*, *painting with a mixture of milk and wax*, or with *oil paint with wax application*. It has also been suggested that they were made in *mixed techniques*.[129] Lately it has been suggested that the decorations were made with various lime-paints, *al fresco* as well as *a secco*.[130]

Already Vasari had posed this problem, according to Borrelli.[131] In some cases the differences in opinion are not really as far apart as it may seem. In order to understand the conceptions behind the terms, the characteristics of these techniques will be mentioned.

Al fresco means that a painting is made on wet plaster, and pigments traditionally are dispersed in lime-water. A fresco-painting can be identified by its rather uniform surface, the painted details appearing on the same level as the background colour. This happens because the fluid paint is applied while the lime-plaster is still wet. The lime-based colours integrate with the wall and form a unity with the lime-plaster, forming calcium carbonate (Ca CO_3) as it dries. The surface successively becomes extremely hard, due to the carbonating process. Any addition of paint, which has been applied upon the dry fresco-painting, may be recognised, since those colours do not integrate with the preparation but remains on the top, appearing slightly in relief.

A secco, means that the painting was made on a dry surface, and consequently a binder had to be added to the pigments, to secure the adhesion of the paint upon the preparation, as the decoration dried. In case the binder was a glue or a gum, the paint is commonly called *tempera*. But *tempera* does not explicitly

---

[123] Aletti, 1948, 1951; Augusti, 1950, 1961; Berger, 1904; Doxiadis, 1995, 1997; Forbes, 1965; Laurie, 1910; Mora, 1967; Schiavi, 1961.

[124] Aristotle, *De coloribus*; Dioscorides, *Materia medica*; Plutarch, *De glor. Ath.2*; Seneca, *Epist.* 121, Theophrastus, *De Lap.*,Varro, *Rerum rusticarum libri III, XVII*.

[125] Suggested by Winckelmann, Mengs, Wiegmann, J.F. John.

[126] Suggested by Requeno, Donner von Richter, Gros, Henry.

[127] Suggested by Carcani, Letronne, Mau, Gusman.

[128] Suggested by P. Mora. Polyments are natural earths, i.e fine clays of various colours.

[129] Suggested by Eastlake, von Raehlmann, Berger, Laurie.

[130] Bordignon, 2000, pp. 14-15.

[131] Borrelli, 1980, p. 84.

indicate any specific binder, and there are alternative binders existing. *Milk* (casein) has been used as a binder since antiquity, and mixed with pigments it becomes a tempera paint. Tempera paint consisting of pigments and with saponified wax as medium has been determined on mummy portraits from Roman Egypt. (See: Case study 2, Fayum portraits). Consequently any of the binders mentioned above may occur in a tempera paint. To be precise, the different paints could be further defined as casein tempera, egg tempera or wax tempera etc.

Stucco-lustro means lustrous stucco, and the *stucco-lustro* procedure technically is the same as that of Roman mural painting, consisting of smoothening the fine plaster layer in order to compact it and make it lustrous. The difference is that *stucco-lustro* is made with a lime-soap paint, while *fresco* is made without such an addition of soap. Another difference is that the metal tool which is used as a pressing agent has to be hot, not cold. The lime-soap in the paint helps the tool to gently slide over the surface, and the heat spreads the saponified particles uniformly over the surface. About a year after the decoration has been made, an application of beeswax is commonly applied as a surface protective, or to give the painting a finishing coat.

Polyments are fine clays, natural earths, used in traditional gilding on wood. Such polyments may probably be used as primers for painting as well, but this suggestion presented by Mora has not been considered as relevant in publications on the subject.

Encausto is a term with several significations. One of these is indicating the use of Punic wax as a treatment used to protect specific pigments on Roman murals. In this case, as a surface coating, the appropriate term is *ganosis*. Surface coating with Punic wax is compatible to *fresco-paintings* and to *stucco-lustro* and also to *tempera* painting, since the coating may be applied to any of them. Punic wax may also be used as a paint, on wet plaster as well as on dry. (See: Encaustic painting and *ganosis*).

Roman wall paintings generally present a smooth and shiny surface. Such a surface is not indicative for a fresco-painting, but rather for the Roman method of plastering and preparing the wall before painting it. A fresco may have a rather rough structure if painted on a rough surface. Two factors are required to make a smooth and shiny surface. One is to use a very fine-grained plaster for the preparation and the second is to smoothen, or burnish, the plaster carefully with a hard tool, which is possible only on a wet plaster. The ultimate preparative layer was either white or with the inclusion of some pigment. Upon this final layer the painted decoration was made. As long as the preparation was wet, pigments dissolved in water or lime-water could be used *al fresco*. If the plaster had dried, some other kind of paint was used *a secco*.

Fresco painting nowadays is made with special brushes, and there is no reason to believe that those used by Roman artists should have been very different. The bristle of such a brush is long and cylindrically shaped at the end of a long wooden stick. The bristle can contain a lot of fluid paint, which makes the brush perfect for painting *al fresco*.

It has been calculated that the Roman wall-painter had a little more time to his disposal than has the painter nowadays. This was due to the superior thickness of the Roman wall, which could contain more water and remain humid for a longer time than a modern wall preparation. A modern painter has roughly one hour per square metre at his disposal for painting before the wall becomes too dry.[132] Since painting has to be done in a short time, a full-size draft, a cartoon, is normally used in order to facilitate the painting process. It has not been ascertained that artists during the Roman period did use such a cartoon, but it has been suggested.[133] Cartoons are quite useful for the outlining of the motif in the decoration, as painting must be quickly executed and there is little room for corrections. Rapid sketches were, however, made in the wet plaster, and either incised or designed with *sinopia*, an ochre pigment.[134] That some kind of method was used for repeating a pattern has been shown in the Boscoreale *cubiculum* where the right and left walls are painted in mirror reversal.[135] This could easily have been done with a cartoon. It has been suggested that such drafts were kept and re-used.[136]

Not only corrections but also decorations were made upon the monochrome basis, as were, e.g. the famous Second style garden paintings in the Villa of Livia at Prima Porta outside Rome. The monochrome basis was probably made *al fresco*, while some binder was added to the pigments to make a paint for the decorations which were made upon the half-dry or dry surface.[137]

A problem which occurred in fresco-painting was that some pigments were altering during the carbonating process or in contact with lime and the carbon in the air. Vitruvius described how the public official, Faberius, found his peristyle black only a month after it was painted with *vermilion*, which would not have happened if he had been more cautious and let the painters protect the surface with an application of Punic wax. He stated that "*... a more discerning person, who wants his vermilion decoration to keep its colour, should, when the wall is well polished and dry, lay on with a stiff brush Pontic (Punic) wax melted in the fire and tempered with a little oil, then bringing an iron pan with glowing coals near to the wall, he must heat both it and the wall and make the wax sweat, and thereafter, to make the surface even, he must rub it with a candle and clean linen cloths, as nude marble statues are treated. This process is called ganosis by the Greeks*".[138]

The Punic wax application is mentioned by Vitruvius just for these two treatments, for cinnabar on plastered walls and for statues. In both cases it is used as a coating, forming a protective shield upon the colours. Analyses of

---

132 Andersen, 1985, p. 114.

133 Andersen, 1985, p. 114.

134 Barbet, 1998, p. 105; Clarke, 1991,p. 46; Ling, 1991, p. 203.

135 Clarke, 1991, p. 46.

136 Andersen, 1985, p. 125.

137 Andersen, 1985, p. 114; Barbet, 1998, p. 105; Clarke, 1991, pp. 45-46.

138 Vitruvius, *De architectura*, VII, 9, 3. Translation by Laurie. In the Italian translation referred to by Aletti *Pontic* is translated with *Punic*.

samples from murals in St-Rémy-de-Provence have revealed that a thin film of wax had been applied to cinnabar pigments in Antiquity.[139] At the same excavation part of a wall had to be restored, and while working on it some areas of the red surface was left unprotected. The colour turned black, transformed into meta-cinabro. Whether Punic wax was used upon other sensitive pigments or with the pigments mixed into the substance can not be traced in the descriptions by Vitruvius.

Roman murals very often reveal that paint has been applied after the carbonating process, and those, consequently, are not true frescoes. Flaking paint is obvious on many famous paintings, where fallen paint reveals the underlying monochrome paint layer, which probably was made *al fresco*. According to Ling the painted decorations on Roman murals were made in *buon fresco*, but if the surface was dry, the colours could be applied in *fresco secco*, which according to him means "mixed in a specially prepared solution of lime-water, or with an organic medium which would glue them to the surface (the tempera technique)".[140] But the term *fresco secco* is a contradiction, and what in fact is described is a mixed technique, fresco-painting followed by a tempera with undefined binder.

Recent analyses of samples from Roman murals show that in many cases those are true frescoes, as a thin skin of calcium carbonate was formed upon the surface and no traces of colours have been identified upon this layer. Analyses have also revealed that different techniques were used for these murals, showing all kinds of intermediate between true fresco and tempera. In many cases it has been possible to individuate two thin layers, one of *buon fresco* and one of *mezzo fresco*, i.e. the second paint layer was applied when the plaster had already started to dry. In many cases it is evident that the painted decorations are made in several layers, one superimposed on another, which makes it impossible to define these murals as frescoes. In most cases when tempera paint was applied upon underlying frescoes, the tempera binder is difficult to determine, primarily due to the minimal remains of the binder, caused by the passage of time and to the microscopic size of a sample. Roman murals were, however, often made in a *mixed technique*, starting with painting *al fresco* and successively using another technique upon the half-dry or dry surface.

The existence of terminological problems has recently been stated by Bordignon. He suggests that expressions such as “buon fresco”, “mezzo fresco”, “fresco secco” and “lime tempera” should be avoided when speaking about Roman wall paintings. Instead expressions such as painted on a wet preparation, on a humid or a dry preparation covered with a layer of lime water, or on a dry surface with a paint consisting of pigments and lime, would be to prefer, since these would not create any confusion.[141]

139 Barbet, 1998, p. 109.

140 Ling, 1991, p. 204.

141 Bordignon, 2000, p. 14.

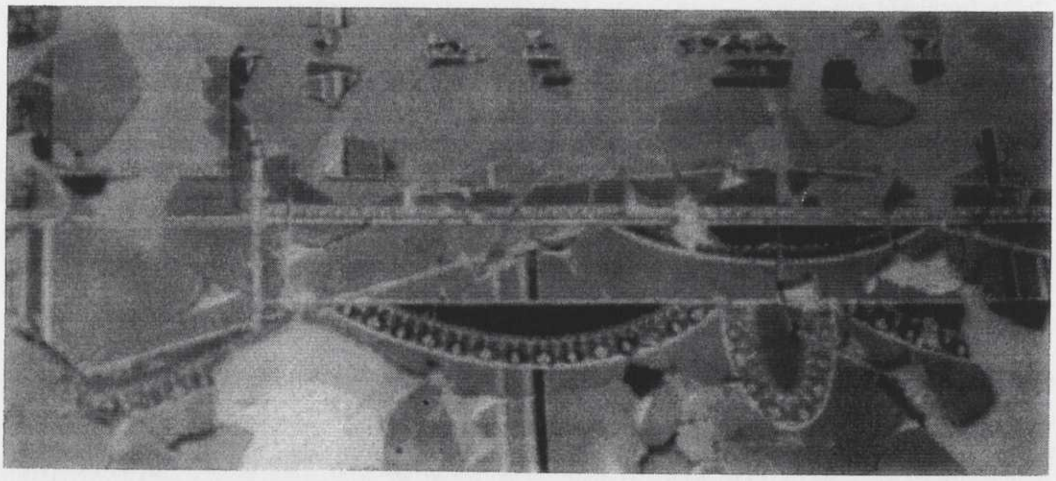


Fig. 13. *Above*: Roman wall painting representing Hercules. Overlaid paint peeling in some areas. Detail. Inv. 9003, Museo Archeologico, Naples.
Fig. 14. *Below*: Fragments of a Roman wall painting. Reassembly and conservation. From the conservation studios at Herculaneum.

Encaustic Painting and Ganosis

In ancient Greece it was a specific profession to be an encaustic painter. Such a profession is indicated in the payment list from 408 BC at the Erechteion in Athens, where the sums spent for encaustic paintings were registered.[142] Building inscriptions in the Temple of Asclepios in Epidaurus reveal that encaustic was used in that building too.[143] According to Plutarch there were three classes of decorators of marble sculpture; the encaustic painters, the gilders and the tempera painters.[144]

During the Roman era, encaustic still was one of the adapted painting techniques. According to Pliny, paintings made in this technique were highly esteemed and consequently paid for with high prices. A painting of Cydias, named *Argonauts*, was paid with 144.000 sesterzies.[145] A painting of Timomachus of Bysanz, depicting *Ajax and Medea*, was bought by Caesar for 80 Attic talents, and hung in the Temple of Venus Genitrix in Rome 46 BC. During the period of Augustus, a painting showing a two-horse chariot was inserted into the wall in the Curia at the Forum in Rome. On this painting Nikias had written that he had made it in encaustic.[146] Iaia of Kyzikos worked in Rome when Varro (116-27) was young. She is mentioned by Pliny as an artist working in encaustic. She was famous for making portraits, and her paintings were sold at high prices.[147] The Emperor Tiberius paid 6 billion sesterzies for a painting of Parrhasios, a portrait of an *archigallas*, a Cybelian priest.[148]

Coloured wax, used for painting, is mentioned not only by Pliny and Vitruvius, but also by Plato,[149] Plutarch,[150] Dioscorides,[151] and other Graeco-Roman writers.[152] Seneca described in Epistle 121.5 the working method of an encaustic painter: "*The painter chooses with great speed between his colours which he has placed in front of him in great quantity and variety of hues, in order to portray faithfully the naturalness of a scene, and he goes backwards*

---

[142] von Graeve, 1981, p.155; Laurie, 1910, p.56. "...In the inscription from Athens, which records the building of the Erechteion, occurs the entry of a sum paid to the encaustic painters for having painted the cymation on the epistylium of the interior...", and further "That the encaustic technique was used at a later date for ceiling decoration seems clear from the statement in Procopius that Justinian, on restoring the Imperial palace, had the ceiling decorated, not with paintings in melted wax, but with mosaic."

[143] Büll, 1963, p. 323.

[144] Aletti, 1951, pp. 5-46.

[145] Cydias, Greek painter 114-50 BC.

[146] Pollitt, 1995, p. 115.

[147] Pollitt, 1995, p. 87.

[148] Pollitt, 1995, p. 133.

[149] Plato, Greek philosopher, 427-347 BC. In *The Republic* he refers to painted statues. See: Aletti 1951, p. 46.

[150] Plutarch, Greek writer, c. 46-120 AD. Plutarch refers to different statue painters, and writes about the ganosis technique. See: Aletti, p. 46 and Berger p. 239.

[151] Dioscorides, Greek physician. Writer of a book on medicine.

[152] Aletti, 1951, pp. 45-46. Aletti presents a long list of ancient authors, among them Sammonico, Varro, Ovidius, Seneca, Stazio and Marziale.

and forwards with the eyes and with the hands between the waxes and the picture."[153]

Varro commented on the special metal boxes with compartments for various colours that were used by encaustic painters. A box fitting that description was found in a painter's tomb at the excavations of a Roman villa at S. Médard-des-Prés.[154]

Eusebius, who was active at the end of the Roman Imperial era, mentioned wax painting in his treatise concerning the life of Emperor Constantine, his benefactor.[155] He enjoyed the wax material, and appreciated the variations in light and darkness in the paintings, which he described as rich in colour. He defined the method as "... *a noble one, which will assure an eternal remembrance of the depicted person...*". Basilius,[156] made another remark about wax-painting, writing: "*The wooden panel, the wax and the skill of the artist makes the pictures immortal portraits of mortal beings*".[157] One of the latest notices about encaustic painting is in the "Mappae Clavicula", a Latin translation of a Greek text.[158] This Medieval written source of painting instructions informs, e.g. that wall paintings were made with unmixed paint and that wax paint with or without the addition of fish glue, was used for painting on wood and on parchment, while pure wax was used for paintings on cloth.

Still during the 11th and 12th centuries a wax tempera technique was used, according to information from a handbook in painting written by Dionysios from Mount Athos.[159] Andrea Pisano and other Renaissance artists used a wax mixture called *cera colla* for painted decorations on statues. This was probably a mixture of beeswax, egg and turpentine.[160] These ancient remarks and descriptions make it possible to follow the development of the encaustic techniques and also to estimate the span of time during which the techniques were used by artists, just as the physical remains provide us with material evidence.

Remaining physical evidence of wax-paintings are the Aegypto-Roman Fayum-portraits and some Early Christian icons, most of them dated to between the 6th and 9th centuries AD. At the convent of St. Catherines on Mount Sinai, there was previously a rich collection of such icons, about 2000 items, made of the same size and painted according to the same scheme as the mummy portraits. Other paintings, which may have been painted with wax, were recently discovered at the monastery Deir el-Surian in Wadi Natrun.[161] It has been suggested by the conservators that at least one of these early Coptic wall

---

153 Doxiadis, 1995, p. 93.

154 Berger, 1904, pp. 211-218, 230-236. According to Berger, Benjamin Fillon described the findings of S. Medard in 1849.

155 Eusebius Pamphili, Bishop in Cesarea, 263-339 AD.

156 Basilius the Great, Bishop in Cesarea, 330-379 AD.

157 Büll, 1963, p. 324.

158 Ibid, p. 237.

159 Dionysios from Mount Athos, 12th century AD. These recipes were written during the 19th century.

160 Büll, 1963, p. 350.

161 Deir el-Surian is one of the remaining Coptic monasteries in the Libyan desert.

decorations could have been made in the encaustic technique.[162] The colours appear brilliant and vivid and the surfaces of the paintings have a particular lustre. The paintings stylistically are closer to the Classical tradition than to the Early Christian or Coptic, since the volumes of bodies and movements of figures and cloths are naturalistically painted.

These short notes make evident that encaustic paintings were much appreciated, but also that the wax-painting technique was used for different purposes, such as painting statues and decorating architectural marble. It was also used for portrait painting and for painting on wooden panels. It is, therefore, possible to imagine many kinds of painting procedures. In addition to these early remarks, there have been many attempts to reconstruct these ancient techniques during the last centuries. Depending on individual interpretations of the Plinian and Vitruvian texts, the results of such attempts have varied. Among the very complex experiments made, were those by Count de Caylus, who made several tests during the 18th century.[163] What remains as indisputable facts are that the constant components in encaustic painting are beeswax and heat. In some cases a natural beeswax was used, in others a saponified wax. The wax could be pigmented for painting or used un-pigmented for surface protection. Heat was necessary to melt the wax, but was also used to "burn in" the paint into the surface. Aspects concerning encaustic materials and techniques will be discussed below, while the terminological aspects related to these techniques are presented under the heading "Terminology".

The three methods of encaustic painting

According to Pliny, there were three methods of encaustic painting.[164] "*In ancient times there were two methods of encaustic painting, with wax and on ivory with the cestrum, that is with a sharp pointed tool, until it became the custom to paint ships of war. Then the third method was added, that of melting the wax colours with fire and laying them on with a brush.*"

This description has caused differences in opinion between scholars, due to the unprecise description of the materials and techniques. Pliny does not mention the tool used for the first painting method. He is, in fact, not concise at all in the descriptions of materials and tools required for any of the methods, but leaves the door open to speculations. In another passage, concerning colours which are not suited for lime preparations, he states that "*...Waxes are stained with these same colours for painting encaustic, a kind of painting unsuitable for walls, but commonly used for ships of war, and now also for merchant ships...*".[165] According to Vitruvius, Punic wax with the addition of a little oil was applied as

---

162 Innemée, 1996, p. 5.

163 Caylus, A.C. Philippe de Tubières, 1692-1765. French writer, art historian, published several volumes on ancient art, of which the most important is *Mémoires sur la peinture à l'encaustique*, which was published in 1755.

164 *Cauterium*, *cestrum*, *stylus* are Latin terms for metal tools used for encaustic painting.

165 Plinius, XXXV, 49.

a surface coating to these delicate colours in order to prevent them from altering.[166] Also Pliny explicitly mentions Punic wax mixed with some oil, and spread on such colours in another passage.[167] These, and other fragmentary descriptions, have been examined as a collection of information, which, related to each other provide an idea about the ancient materials and techniques. Considering the descriptions on the encaustic methods, it seems natural to interpret them as follows: the first method consisted in using coloured and melted wax, the second in the use of coloured and melted wax on ivory which had an incised decoration made with a pointed tool, and the third was Punic wax applied with a brush. It remains, however, to identify the tools used for melted and pigmented wax. Since there is an alternative, the *cauterium*, that tool is in this study considered as the instrument used for melted wax-paint.

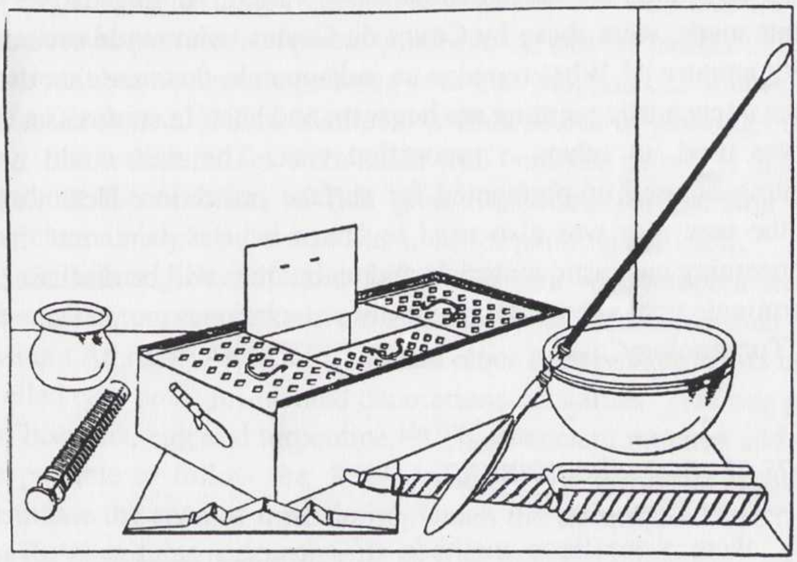


Fig. 15. Tools for encaustic painting. After Berger, 1904.

The first method was specified by the use of the *cauterium*, a tool made of bronze or iron, and shaped as a slender spoon at one end and as a spatula at the other.[168] Since tools were handmade in those days, remaining examples are all individually shaped. The spoon-like end of the tool was used to pour melted wax. Melted wax can be worked for just a short time, as it very quickly solidifies. The heated *cauterium* made it possible to pour, work and shape the wax on the painting. It has been assumed that artists generally had at least two tools to work with.[169] Encaustic paintings made this way appear slightly in relief, due to the relative thickness of the paint and due to the hard tool, used for shaping it. Marks of this kind have been observed on several Fayum portraits.

166 Vitruvius, D.A. VII, 9,3.

167 Plinius, XXXIII, 40.

168 Aletti, 1951, pp. 100-101; Berger, 1904, pp. 211-218. By defining the tool "cauterium" both authors are referring to the painter´s tomb in St. Médard-des-Prés, where such instruments were found. The tomb also contained amforas with wax, pigments and a box for the encaustic paint.

169 Büll, 1963, p. 330.

The second method was characterised by the use of a *cestrum*, a pointed metal tool used for engraving. Pliny states that the method was used on ivory, and the technique consisted, as far as we can imagine, in engraving patterns on objects of ivory and then filling the lines with melted and coloured wax. This method has been suggested to have been the oldest. Homer mentioned an engraving technique used in Asia Minor, which was used also for decorations in Greece.[170] Fragments of an ivory plate, dated to about 400 BC, have been found in southern Russia (Kertsch). The engraving on that plate was probably made with a *cestrum* and the lines filled with wax.[171] Some plates of bone, or possibly ivory, are shown at the Coptic Museum in Cairo. These small pictures suit very well the descriptions of encaustic painting on ivory. The decorations are engraved and the lines are filled with paint, maybe wax-paint.

Fig. 16. Decorated bone plate in the Coptic museum in Cairo. Inv. n. 7065. Encaustic on ivory?

The third method was, according to Pliny, invented for painting ships, and he explicitly states that brushes were used for spreading the paint.[172] This indicates that the paint was fluid when it was applied, and remained so during the painting process. It was, however, not so hot as to ruin the brushes. That would necessarily have occurred if melted and hot wax had been applied. The beeswax, consequently, must have been treated in some way in order to remain liquid at a lower temperature. Punic, or saponified wax, can be spread at any normal temperature. In addition, considering the time-consuming work with painting a ship, or even a boat, spreading the paint had to be relatively easy, otherwise such work would not have been done even then. Punic wax, therefore, fits the descriptions as well as the purpose.

---

170 Ibid, p. 336.

171 Ibid, p. 384.

172 Plinius, XXXV, 149.

The Greek tradition of painting their ships is well-documented in art and literature, and was mentioned already by Homer.[173] He refers to ships that had been painted with red or blue colours, and states that such painting was performed in a technique which had been invented in Asia Minor. Not only were the ships painted, they had decorations as well. Decorated ships were common motifs on Greek pottery, and pottery decorations therefore provide us with some idea of the motifs in ship decoration. Eyes painted at both ends of the ships, serpents and jumping fishes seem to have been particularly popular motifs. An investigation of ships depicted on Greek geometrical vases show that the eye as a decoration goes back to the 8th century BC.[174] The poet, Hipponax, wrote about the symbolic value of serpents as ship decorations.[175] On the famous crater, decorated by Exekias, *the Dionysos crater*, the decoration on the ship consists of two jumping fishes.[176] The habit of painting ships with wax must have been in use during the Classic, Hellenistic and Roman periods, since it was still adapted at the end of the Roman Imperial period. The tradition was recorded by Kallixenos in his book about Alexandria.[177] Kallixenos described how the ship of Ptolemaios Philipator was decorated with wax paintings in many colours. Ships and boats painted in vivid colours are still part of the Mediterranean tradition, although wax colours probably are not used anymore.

Fig. 17. Decorated boats, Alexandria 1997.

173 Büll, 1963, p. 336.

174 Ibid.

175 Hipponax, Greek poet, 6th century BC.

176 Exekias, Greek artist, active in the end of the 6th century BC.

177 Kallixenos, 3rd century AD.

Punic wax

Brushes and Punic wax were used for paintings in the third encaustic method. Pliny gives a long and quite poetic description about the method of making Punic wax.[178] He describes the yellow beeswax which changed from solid into liquid by a complex process. It was boiled and bleached and boiled again, and some *nitrum* was added. The product achieved had many qualities, and could be used for medical treatments as well as for the protection of leather or weapons. Punic wax was used for coating white marbles, for patination and it was also used as a coating on wall-paintings.

When Punic wax was used as a substance for patination of plastic art, it was diluted with some oil. Uncoloured wax was traditionally applied on the unpainted parts of marble statues, as a surface protective but also to reduce the striking whiteness of the fresh stone and to give it a warmer hue. The actual painting of the statues was probably made with any tempera with a binder that was compatible with heat, since the final part of the *ganosis* treatment consisted in heating the surface. The binder, therefore, might have been a gum, a glue or Punic wax.

Just like the term *encaustic*, *Punic wax* has been a source of disagreements. Some opinions regarding the material aspect are referred to below, while those regarding terms and interpretations are presented in "Terminology".

The main disagreement concerns the consistency of the product, whether it is hard and solid or if it is a soft emulsion. As mentioned above, experiments were made by some enthusiasts during the 18th century when Roman mural paintings were discovered at the Pompeian excavations. Among the encaustic devotees were the French Count de Caylus, who was the first to publish on the subject. The Italian abbot, Vincenzo Requeno, was also engaged in the matter and had his "Saggi sul ristabilimento dell´antica arte dei greci e romani pittori" published in 1784. The early experiments related were, on a whole, quite complex, and a great number of components were often mixed into the natural beeswax. The main concern seems, however, to have been to discover how to make the substance become and remain fluid and thereby spreadable without keeping it hot. In one of Requenos descriptions, soap, wax and water are mixed together, and he reported that painting with this emulsion gave excellent results. Very often, however, various resins and solvents were added into the mixtures. The final treatment for many of these early attempts was to heat the painted surface and to rub it when it was cold again, just as described by Vitruvius.

Berger made an emulsion of Punic wax, consisting of beeswax, potash and water.[179] This basic emulsion has been used for various tests by myself, since it was easily made, had a pleasant smell, could be used hot, tepid or cold, and in addition, other components could be mixed into the paste. These tests are described in "Experiments".

---

178 Plinius XXI, 49.

179 Berger, 1904.

Schiavi made several tests with the objective of rediscovering the ancient method, which she also claims to have done.[180] She used *natron* and beeswax, and used the same procedure as described by Pliny. When this was tested by me, it did not work out well. The paint became hard and unusable for painting. Maybe dissolved in some solvent it would function as a paint.

The list could be made long, discussing the methods which have been tested for the purpose of making Punic wax. Some German scholars, among them Eibner and Stois, claimed that Punic wax was not an emulsion but a solid product.[181] They consider it to be an emulsion at one stage, just between the first and the second boiling, but then it becomes hard again, due to the chemicals in sea water. The main achievement of such boiling is, according to them, that the chemical transformation of the wax raises its melting point as it successively becomes harder. This wax product consequently must be very hot when spread. A Swedish artist, Göran von Matern, has produced a Punic wax following these guidelines. Since the wax becomes very hard it has to be diluted with turpentine for painting.[182]

Lately some experiments have been made by Doxiadis, who divides wax paint into two types - wax to be used hot and wax which can be used cold.[183] Wax to be used cold is defined as Punic wax, which according to Doxiadis, requires emulsification or saponification. A similar definition is made by Kühn, who states that Punic wax is "...a beeswax containing salts of fatty acids (soaps). He refers to the Plinian recommendation of boiling and bleaching the wax with "some form of soda", followed by a description of the chemical process which leads to the conversion of the esters and free fatty acids in the beeswax reacting with the soda, converting it to sodium salts, i.e. soaps. The soaps emulsify the beeswax, "allowing it to mix with water to form a paste". It seems that the consented opinion in recent research is, that Punic wax is an emulsion. Being an emulsion the paint is easily spread with a brush, and can be used for painting as well as for surface coating, and with final heating, if desired.

Ganosis and circumlitio

In ancient literature there are some remarks on painted statues. Polychrome treatment, *circumlitio*, was the common way of finishing the work on a statue, and painting was made in order to heighten the artistic value. Some parts were particularly accentuated, such as eyes, lips and hair. Plato explained that the works of the stonecarvers received their full effect when they were finally painted.[184] The famous painter in Classical Greece, Nicias, was employed by Praxiteles to make the *circumlitio* on his statues.[185] Hermes from Olympia, the

---

180 Schiavi, 1961.

181 Hoppe, 1991, pp. 273-277.

182 von Matern, personal communication, June 1998.

183 Doxiadis, 1995, pp. 97-98.

184 Büll, 1963, p. 360.

185 Ibid, p. 56.

only work of Praxiteles′ hand still remaining, presents traces of red and golden colours on the ribbons on his sandals.[186] Traces of polychromy have been found on several objects, and consequently the pigments are well known. Pigments were primarily carbon black and earth pigments, such as yellow and red ochres, but blue and green colours, achieved by copper glazes, azurite and malachite, have been identified as well. Bright red was generally cinnabar. The binders used are hardly known at all, and the issues concerning binders are still under debate.

Binders generally are difficult to identify, since their original quantity in the paint is very limited. As time passes, such binders are successively decomposed and worn off and consequently even more difficult to determine. This fact, combined with the relatively small areas of thin paint which remain on the objects, makes sampling difficult. In order to take a sample large enough to make a valid analysis, too much paint would have to be removed from the original paint layer. This can not be accepted, but even if enough paint would be provided, a trustworthy result would not necessarily be achieved, due to the presence of other substances on the painted surface. Such additional materials might consist of dirt or previous surface applications. The techniques for making analyses have become very advanced, but there are still some limits to what may be achieved. If the binder is a wax, its presence is easily determined by FTIR, for example.[187] But also in this case a later surface application of wax may not be excluded, and such an application might be wrongly interpreted as a binder. In order to make an absolutely reliable determination it would, therefore, be necessary to take samples from objects which have not been cleaned or exposed to the application of any surface protective after excavation. It is generally assumed, however, that tempera paint was used for plastic art.[188]

The term *tempera*, as explained before, does not imply that any specific kind of binder is used, but that the pigments usually are mixed with a binder and the paint is diluted with water.[189] Some media are not very resistant to water. One way of solving the problem with fading colour was to protect the surface with *Punic wax*, a procedure described by, e.g. Vitruvius, Pliny and Dioscorides.[190]

Pliny described how Greek artists used *Punic wax* to give the marble statues a protective coating, and that this had the double function of being a protective as well as giving a coat of patina. The substance was diluted with some oil and then spread on the marble surface with a stiff brush. When the surface had dried it was heated in order to melt the wax. In this process a shield of wax was formed, which protected the pigments and made them adhere to the stone.

---

[186] Ibid, p. 361.

[187] Fourier Transform Infra-Red Microscopy.

[188] Forbes, 1965; Melucco Vaccaro, 1967; Moorman, 1988; Pratt, 1976; Richter, 1928; von Graeve 1981.

[189] It. *temperare* - mix, *stemperare* - dissolve.

[190] Vitruvius, Marcus V. Pollio, Roman architect, active during the last decades BC. He wrote *De architectura* (The ten books on architecture), which has had great influence on architecture especially during the Renaissance; Plinius, Gaius P. Secundus, Roman official and writer, 23 BC - AD 79. He wrote *Naturalis Historia*, which is an important source for knowledge about ancient culture and science; Dioscorides Pedanius from Anazarba, military doctor during the period of Claudius and Nero. The most famous pharmacologist during Antiquity. He wrote *Materia Medica*.

As the surface again was cooled and dry, it was rubbed with a cloth. As a result the surface of the stone became shiny. According to Pliny, this process was called *ganosis*.[191] Plutarch described the tradition of impregnating statues with wax after they had been gilded or painted.[192] The term *circumlitio* indicates that statues were painted in order to receive their final polychrome appearance. *Circumlitio* also indicates that the statue, after performed treatment, had received a protective shield. It therefore seems natural to assume that *circumlitio* may have been performed in the *ganosis* process.

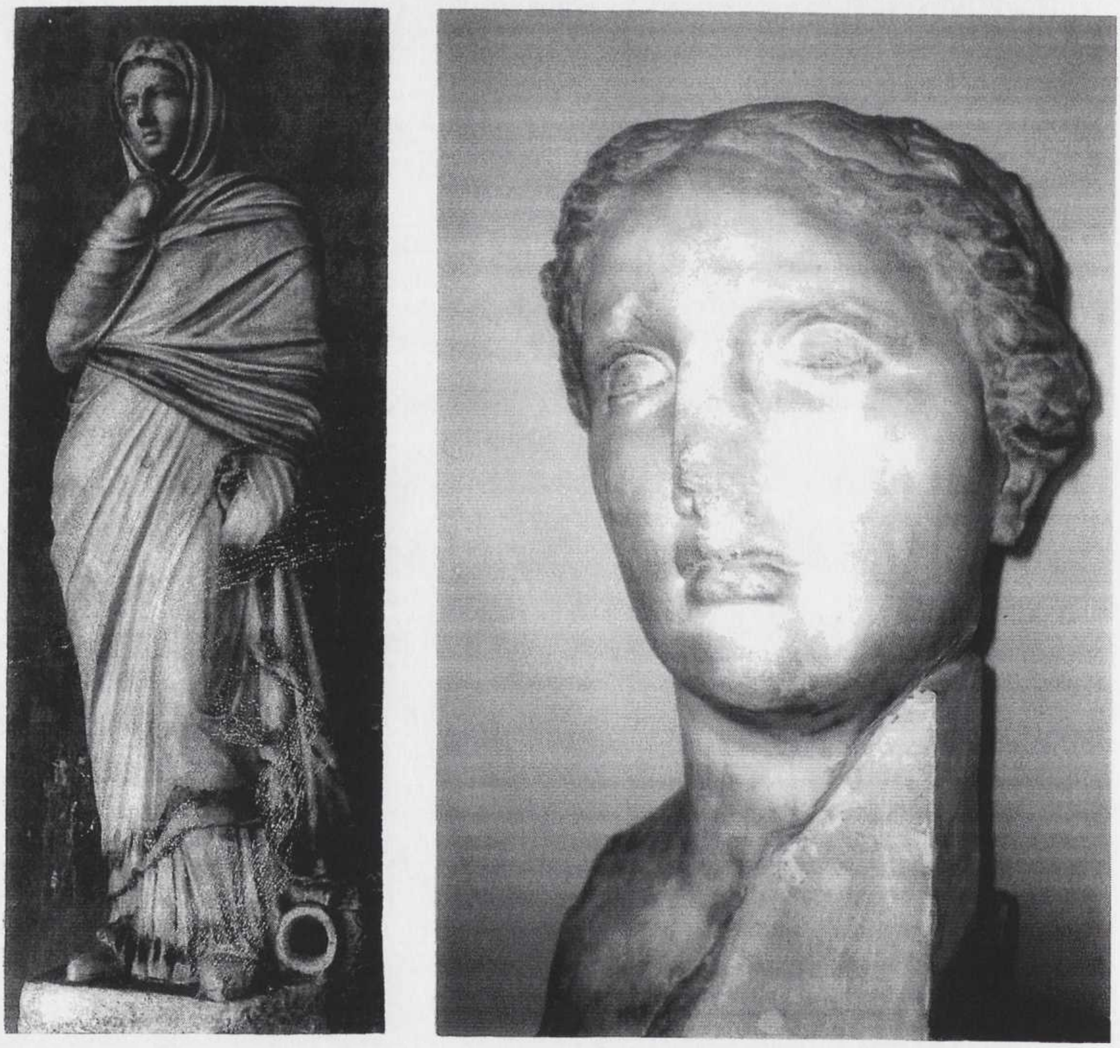


Fig. 18. Polychromy on Roman statues.
To the left: Statue of a woman, probably a fountain figure. Traces of a red-brown colour still remain in the hair, yellow and light blue on the dress, with edging in dark red. Inv. 105, Museo delle Terme, Roma.
To the right: Marble head with traces of red-brown paint on the hair, black outlining of the eyes and eyebrows, bright red on her lips. The head may be a portrait of a Ptolemean queen. Inv. 3908, Graeco-Roman Museum, Alexandria.

---

191 Plinius, NH XXXV, 49, XXXV, 149.

192 Büll 1963, p. 360.

Discussion

Building constructions and objects of art and handicraft, which have remained since Antiquity, provide us with observable evidence of ancient technology. By studying these objects, we may identify the materials which they were made of, and define the techniques which were used for their production. Paint, and its components pigments and binders, was described by ancient writers, just as were painting preparations and coatings, applied to protect the painted surfaces from a rapid decay. In modern publications on the conservation of ancient materials and the corresponding techniques, often consisting of research reports, these ancient descriptions are generally confirmed. Pigments have been given a particular interest as research objects, and the list of publications concerning the identification of pigments might be made very long.

Nowadays there is a considerable knowledge of the materials and techniques used by the ancients. Some artists′ materials, such as beeswax can be traced back to Dynastic times in Ancient Egypt, while earth pigments were used earlier than 3000 BC. Painting preparations made of lime or gypsum are dated to the same early periods.

Bees wax, as a paint and as a surface coating, has been at focus in this dissertation. Issues concerning the composition of such materials, the necessity of heat, the tools required and the sizes of encaustic paintings have been examined, just as the characteristics of Punic wax and its connection to *ganosis*, applied on marble statues as well as on plastered walls, which leads to the issues of the paints and coatings used on Roman wall paintings. The conclusions regarding the material aspects are presented below, at first considering the encaustic techniques and then Roman wall painting.

Literary evidence as well as remaining objects and chemical-technical analyses prove that encaustic painting was one of the painting techniques used during Antiquity. Wax paints were either made of melted and pigmented natural beeswax or by saponified beeswax, i.e. Punic wax. Both kinds of mixtures are paints, but the differences are striking, not the least regarding the applicability and solubility. For the sake of simplicity, below they are called wax paint and Punic wax paint. The later could just as well be named wax tempera, since the paint is dissolved in water, but becomes hard when the paint has dried.

Wax paint was used to fill the decorations engraved on ivory, to paint *pinakes*, e.g. the Fayum portraits, and for architectural decorations. Punic wax was used for surface coatings on statues and on plastered walls.

Undisputed remaining evidence of these materials and techniques consist of engraved decorations on ivory or bone and the Fayum portraits, which are excellent examples of portraits painted with wax paint as well as with Punic wax paint. Beeswax, probably Punic wax, has also been identified on Roman wall-paintings, as a coating and as a paint. In addition, there are tomb stones, e.g. the stelae of Demetrias, which have been regarded as encaustic paintings.

Heat

Several opinions have been expressed on the subject regarding the necessity of heat in connection to encaustic. Questions such as if the supporting material should be heated before, during and/or after painting have been ventilated. Another set of questions regard the paint, whether heat was needed to melt the beeswax when making the paint, if the paint should be kept hot during application, add/or if the paint should be heated when the painting was finished. These questions are in particular concerning Punic wax, and its characteristics. Minor issues are e.g. encaustic painting being a slow technique. In my opinion, no craftsman wants to complicate things more than necessary, and consequently the materials are used in the most suitable manner, considering their nature.

Wax paint is fluid only when it is hot, and therefore heat was used to melt the wax when the pigments were added, just as it had to be melted and hot when the engraved lines on ivory were filled. The ivory would preferably have been warm too, in order to facilitate the perfect penetration of the wax paint into the lines. The object could, if desired, be heated as a final procedure, to remove any superfluous paint, surrounding the decoration, but that would not be necessary, since the wax on the surface could easily be scraped or rubbed off, just leaving the coloured decorations in the incised lines.

It was stated by Pliny that encaustic was a slow technique, used for small paintings. This engraving technique was, of course, time-consuming and used only for small-sized objects. Portraits, and other decorations made on wooden panels, could obviously not be painted the same way as were the ivory decorations, even though the same kind of paint was used. Paint was used for filling lines in the first case, while in the second case the paint was intended to remain upon the surface of the panel. It would, consequently, not have been advisable to heat the finished painting, since such treatment would, most certainly, result in a melted painting, and heating would probably, in addition, provoke changes within the wood. Some scholars have believed, however, that encaustic paintings should be heated as a final treatment. Wax paint on Fayum portraits in many cases was heated to consolidate the material at the time of excavation, and effects of overheating have frequently been noted. This, unfortunately shows, that any kind of final heating is not compatible to encaustic paintings made with wax paint on panels.

Encaustic paintings such as the Fayum portraits, were made with hot, and consequently fluid paint, which was worked with hard tools to finish the painting. Such tools were made of metal, and could be used to scrape off superfluous paint, or used to pour additional hot paint on the painting. The same tools could, in addition, be heated and used to shape the paint already applied. Marks upon the surfaces of the encaustic Fayum portraits suggest such a procedure.

Punic wax was used for painting and as a surface coating on mural paintings and marble. It was applied with a brush and, therefore, a rather fluid substance, otherwise the application would have been complicated. Some scholars claim that Punic wax was solid and should be applied in a very hot state. These scholars refer to the same ancient sources as this author , but interpret the texts in a different way. There are some problems with a solid product, especially if, in addition, this product is harder than natural beeswax, and its melting point is higher. Extreme heat might ruin the marble. The process of keeping the substance hot and the supporting material warm enough not to cause a rapid solidification, would be extremely time-consuming and difficult. One possible alternative to heat is a solvent, e.g. turpentine, which might soften the hard wax and make it spreadable with a brush. Such a method is not mentioned in any ancient sources. Solvents evaporate and do not show when examined in chemical-technical analyses, and therefore it is not possible to prove if solvents were used.

Saponified wax, or Punic wax, may be diluted in water and applied whether it is hot or cold, which is convenient when large areas have to be painted. When applied on a wall or on a statue, it could easily be heated as described by Vitruvius. This final heating would not burn the marble or the plaster preparation, just "burn it in", i.e. melt the thin layer of wax and make it, to some extent, penetrate the surface. An emulsion is easier to handle, especially when applied on large areas.

Consequently, there was not one method only, but three, as mentioned by Pliny. Wax paint was heated when it was made and when it was used. Supporting materials such as marble or metal were heated, if the decoration was incised, and probably were warm but not hot, when used for painting. Wooden panels were not heated. Encaustic paintings made with wax paint were not heated when the colour had dried. Punic wax was heated when it was boiled, and the painting, or coating was heated when the surface was dry.

Dimensions

Encaustic paintings made with wax paint and a *cauterium* necessarily must have their limits in dimensions, depending on the properties of wax. The reasons for such limits are at least two. First of all, the melted and hot wax has to be used on a more or less horizontal surface, or there would be great difficulties in controlling the fluid substance, which, by nature, would slip downwards, especially if the support was warm. If, on the other hand the supporting material was cold, the wax would solidify too quickly to be useful in painting. Therefore, the supporting material should at least have a temperature of 18-30° C. Wax quickly returns to its normal, solid state, and the paint can be worked with hot or cold tools, independently if the painting is horizontally kept, made on a standing wall, or on a ceiling. In order to facilitate work, the painting should, however, be made on a rather horizontal surface, since it is impractical, to paint with hot and fluid paint directly on a wall, considering the aspects mentioned above. The horizontal position of the support, is another factor indicating that there were limitations in size for these paintings. The size could not be more extended than the area possible to reach for human arms, which, on a painting put in a horizontal position is definitely much smaller than the space within reach on a vertical area. Therefore, this technique must be considered as a slow one, and only used for small-sized paintings, just as described by Pliny.

Punic wax, on the other hand, might be used on horizontal as well as on vertical areas, and without any limitation of the size, since the substance was applied with a brush, and the temperature of the paint and of the support was of minor importance. According to Pliny, the third encaustic method was invented for painting ships, and such work would be possible with saponified wax. The conclusion must be that the first two encaustic methods were slow methods, used for small paintings, while the third method might be used on small as well as on large areas.

Ganosis

The *ganosis* procedure may shortly be described as an application of Punic wax on wall-paintings or statues, a treatment concluded with a final heating of the surface. Some oil was mixed into the Punic wax, probably to make it more fluid and to harden the coating, thereby making it form a protective shield upon the supporting material. Surplus oil on the surface was disposed of by heating it and making it "sweat", penetrating into the marble. Heat might also have had the effect of accelerating the chemical process, thus making the wax harden, and loose its rather sticky nature, more rapidly. Wax, which has been applied to a surface and thereafter heated, reaches a much higher melting point than raw beeswax. The oil which was used for this purpose is not mentioned by Pliny nor by Vitruvius, but it may have been olive oil, since that was used for many purposes. Heating was, in ancient times, made by bringing a box containing glowing charcoal close to the surface, but today there are other heating methods available, e.g. by using a hairdryer or a hot-air pistol.

Ganosis on wall-paintings

Some pigments have to be encapsulated in wax to remain unaltered when they are used for painting on wet lime-plaster. Already during Antiquity, some of these pigments were known to alter, e.g. *vermilion*, *caeruleum* and *cerussa*. They were not suitable for fresco-paintings, since they became dark by oxidation in the carbonisation process. An application of Punic wax, was suggested by Vitruvius, to avoid such transformation. He described what happened in the house of Faberius at the Palatine, when all the walls of the peristyle had been decorated with *vermilion*. Faberius saw them change and darken, and that would not have happened if they had been coated with wax, according to Vitruvius.

Beeswax protects some delicate pigments, and in addition the surface becomes quite resistant to water, as wax has excellent water repellent properties and closes out humidity. This quality makes wax suitable to use for paintings in humid rooms, where the vapour will remain on the surface. Even though wax is water repellent it permits the painted material to breathe, and does not close its pores.

Ganosis on marble

The *ganosis* process as surface coating on marble, has been studied and discussed by some scholars. Experiments following the descriptions given by Pliny and Vitruvius were the starting-point for experiments made by Richter and a group of co-workers. The results documented were considered as satisfactory or even excellent. Since the *ganosis* method is well documented in ancient scripts, there is no need to question its existence, as described in Antiquity. Wax mixtures, were used as coatings on statues not only during Antiquity, but through the Medieval and the Renaissance periods, until quite recently, when modern chemicals have substituted these ancient materials.

Ganosis and circumlitio

Polychromy on three-dimensional art was part of the classical tradition. In ancient literature there are some remarks concerning the painting of statues. Polychrome treatment, *circumlitio*, was the common way of concluding the work on a statue, and it was made in order to heighten the artistic value. Some parts of the statues were particularly accentuated, such as eyes, lips and hair.

Traces of polychromy have been found on several objects, and consequently the pigments are well known. The binders used are hardly known at all, and the issues concerning binders are still under debate. It generally is assumed that tempera paint was the usual medium for plastic art. The term *tempera*, as explained before, does not imply that any specific kind of binder is used, but that the pigments are mixed with a binder and the paint diluted with water. Since the colours easily disappear if exposed to rain, wind and sunshine, the problem with fading colour was solved by a protective application of *Punic wax*.

The coating made with Punic wax, also was a means for patination. The substance was spread on the marble with a stiff brush, and when the surface had dried, it was heated in order to melt the wax. In this process a shield of wax was formed, which protected the pigments and fixed them to the stone. As the surface again was cooled and dry, it was rubbed with a cloth, resulting in a shiny appearance.

The term *tempera* does not reveal the binder, and the term *circumlitio* is equally indistinct. It just seems to indicate that statues were painted in order to receive their final polychrome appearance, and that the statue, after this treatment, had received a protective shield. It therefore seems natural to assume that *circumlitio* was performed in the *ganosis* process. Punic wax was used as a surface coating to maintain the painted details, and it may have been used as binder in the paint as well. Just by mixing the desired pigments into the Punic wax, a mixture suited for patination as well as for painting could be achieved. In addition, this substance did not need any additive protective coating.

TERMINOLOGY

Terms, translations and interpretations, Pliny on Punic wax and Comments Discussion

Terms and conceptions regarding *encausto*, *ganosis* and *Punic wax* are briefly examined in this chapter. Pliny´s description of the method of making Punic wax is related, and commented. Some passages of important texts, frequently quoted in publications on ancient Greek and Roman art and architecture, are presented and commented upon in appendix II. The quoted parts appear in many different publications, often with the intention of proving one or another point of view. Those parts have been presented to the reader with the objective to show the constituents of this matter, hoping to create a basis for general understanding.

Personal reflections of the author upon the interaction between the actual use and meaning of terms and techniques are described, since those constitute the basis for this argument. Already at the beginning of this study the unclarities concerning terms and conceptions related to *encausto* became apparent. Consequently, one of the initial concerns was to search for the reasons for such obscurities, which eventually had led to terms being used with different intentions at various occasions. One initial assumption was that the existing disparity in definitions of materials or techniques might be due to imprecise methods of material determination, caused by terminological unclarities. The intention in this chapter, therefore, is primarily to discuss some important terms and conceptions in order to see which are the relevant factors that define the encaustic techniques and *ganosis*, and to make a suggestion on what might be intended with Punic wax, as well as making some suggestions for an adequate vocabulary.

It is reasonable to assume that these linguistic and terminological problems are caused by a) incoherences in translations and transcriptions from Latin, b) various interpretations of these translations and c) a general lack of knowledge about materials. By identifying these problems, it was possible to create a systematic working-plan which allowed looking into the background and development of each specific problem. No problem is an isolated issue since there are, of course, interactions between these perspectives, making a linguistic problem also part of the technical sphere. The quality of original scripts and of later transcriptions has to be considered. From there originates, not only our theoretical knowledge but also the uncertainties and questions regarding ancient polycrome art and painting in general, and encaustic painting in particular. Most often, only a few lines are quoted from the documents mentioned above, and this absence of more complete information can, at times, be rather unsatisfactory, at least for a non-expert in Classical Greek, Latin as this author.[1] Somehow problems seem easier to understand and react to, if they are presented as a whole, and not only in minor details. When examining each of the main problems, it becomes apparent that there are obscurities connected with the original documents, either in the form of inadequate transcriptions,[2] or as a result of inaccurate translations.[3] The fact that there are variations in transcriptions and translations often leaves the door open to speculation.[4] Consequently, it seems even more important to read, not just a sentence but an entire passage, since possible unclarities in the sentence may be satisfactorily explained later on.

It has not been my intention to give a full presentation of these problems, but merely to point them out. Most problems of terminological nature are connected to the very vital terms in this context, *encausto, kausis*, *ganosis*, and *cera punica* (Punic wax), but some other terms are not clearly defined. Existing obscurities have at times led to some amazing assumptions and conclusions.[5] To begin with, *encausto* and some of its ordinary forms will be given some attention, continuing with *ganosis*, *cera punica* and various forms of *politio*, concluding with some comments on *natron*. Pliny's description of Punic wax is then related and commented upon.

---

[1] In order to have an expert opinion on Classical Greek terminology, Ove Strid, Ph. D. in Greek, at the Institution of Classical languages, Stockholm University, was asked for advice. The Greek writer living in Sweden, Theodor Kallifatides, was asked about the conceptions behind some Greek terms. For help with interpretations of Latin terms, Hans Aili, Ph. D. in Latin at the Institution for Classical languages at Stockholm University and Göran Bäärnhielm Ph. D. at the Royal National Library in Stockholm were contacted. All parties kindly gave their opinions on the questions asked.

[2] There are many examples of errors in transcriptions. Some examples are given in the chapter "Ancient sources". In later surviving Pliny manuscripts one of the transcriptions that caused much confusion is the one speaking of "nudo" (bare) instead of "udo" (damp). Forbes, p. 253. Pliny has been accused by many authors of not being correct, either in citing Vitruvius or just by not being precise. One example of the first kind is the following; "Pliny evidently copied some of his facts from Vitruvius, and in many cases copied inaccurately." Laurie, p. 17. Another example concerns the passage where Pliny describes how to make Punic wax, where he uses the word "nitrum", which according to some scholars should be replaced by "natron", a product suitable for many purposes including making Punic wax.

[3] All translations differ to some degree from others, and when the basic Latin manuscripts vary, the translations must obviously vary too. In some cases it has been suggested that a specific word at some specific time has been changed into another. For example the word "cauterium" in Plinius description of the three methods of encaustic painting has, by somebody's mistake been changed to the word "cera", according to some scholars.

[4] One example of bad communication can be observed in Pliny's explanation of the three methods of encaustic painting. He does not connect any tool with the first method as he does with the second (stylus) and the third (brush). It has been suggested that the tool connected with the first method should be "cauterium", since he refers to it as a tool for encaustic painting in the Index for book XXXV. The inconsistency has caused polemics, but most authors seem to be of the opinion that the cauterium, stylus and brush are the tools for the three different techniques of encaustic painting.

[5] Much has been said about the technique of the Pompeian wall-paintings, and it has been suggested that they are encaustic (Schiavi, 1961), that they are in stucco lustro (Berger, 1904), the result of a specific polyment-lime technique (Mora, 1967) and that they could have been painted with a mixture of Punic wax and lime (Augusti), 1950. The same kind of chemical analyses are presented as evidences for these different theories.

Terms, translations and interpretations

Encausto

The meaning of *encausto* is philologically very simple and clear. The term in its different forms, concerns the "burning in" or heating the paint, which has been applied to a surface, creating encaustic paintings. This signifies that the only paintings which should be correctly defined as encaustic, based on a linguistic judgement, are those which have been "burned in", i.e. heated by glowing charcoal or any other kind of heat, intense enough to melt the wax upon the surface.

In some 19th and 20th century publications the term *encausto* was often followed by a translation in Greek, in any grammatical form, and of course, written with Greek letters. For a person lacking knowledge in Classical Greek, it seemed rather strange that one word could have so many ways of appearing in Greek, until it became clear that the Latin word was not always translated with the corresponding Greek word. In sum, the following translations and interpretations are generally accepted nowadays:

Encausto is a Latinized form of the Greek term enkaustos, which means "burned in".
Enkausis is the substantive form, meaning "burning in".
Enkaustai and *enkaustes* are plural and singular forms of the word, signifying "someone who is burning in (something)", "creator of encaustic paintings".
Enkaio, enekaen, enekaiein, are different forms of the same verb, meaning "I am burning in", "to burn in", "to paint with colours which are burned into the surface".
Enkaumasi, enkauma, means "that which has been burned in", "brand mark", "painting which has been burned in".
Kausis is a feminine substantive form, meaning "burning" (of something)

Ganosis

Ganosis comes from a Greek verb, signifying "making lustrous", "polishing", "glazing". It can also signify "to tin". Generally it is used to describe the process of surface coating on marble statues with Punic wax, but occasionally this treatment is, as stated above, called *encausto*. To add some more confusion there have been suggestions that *ganosis* should be used exclusively in referring to the treatment of marble statues and not used for the same kind of protective treatment on murals.[6] Vitruvius, on the other hand, uses the word when describing how to treat certain pigments on plastered walls, followed by the

[6] Cagiano de Azevedo (1952) proposes a terminology for mural painting that one could agree on, or at least discuss, and one of the proposals is that *ganosis* should be used when referring to sculpture and *kausis* would be the correct word for the same treatment on murals.

remark "as nude marble statues are treated. This process is called *ganosis* by the Greeks".[7] As far as I can understand the term refers to the treatment as such, not to the underlying material. In order to have an additional view on the meaning of *encausto*, *kausis* and *ganosis*, Theodor Kallifatides was asked to give his opinion, and his answers to my questions were the following:

Encausto is the adjective, indicating that something is "burned" or "burned in".
Kausis indicates, generally, that something is "burned in".
Ganosis is the method, the technical process which is possible to control.

According to Kallifatides, the terms *ganosis* and *kausis* cannot be used in place of each other, since they refer to different things. As mentioned before, Michelangelo Cagiano de Azevedo has proposed a commonly accepted terminology for painting techniques, as he finds the existing one very unsatisfactory.[8] In that context his own definition of what characterizes *encausto, kausis* and *ganosis* is the following:
Encausto is the definition of a painting which has been made with a paint consisting of pigments mixed into beeswax. The term *encausto* may not be used if the wax is spread upon some previously applied paint, then functioning instead like a varnish.
Kausis is the correct word for the protective treatment or varnishing with wax when the procedure is made on any kind of painting, but also on architectural elements in general.
Ganosis is the same protective treatment upon statues of marble.

There is a great difference between the philological facts and the statements by de Azevedo. This becomes important since he aimed at a correct vocabulary, and suggested an adequate use of terms. de Azevedo's idea of *encausto* is not based on the ancient conception, meaning the "burning in" of paint, but refers to a technique which ought to be called *wax painting*. On the other hand, terms are given new significance as time passes, and in modern terminology *encausto* is generally understood as synonymous to *wax-painting*. We, therefore, have to consider that the initial concept of the term is not equal to later or recent conceptions.

The suggestion that *kausis* and *ganosis* should be used on different occasions for the same treatment is a personal opinion of de Azevedo. There are no philological or technical reasons to make such a change, as can be seen from the previous discussion. If such a division was accorded, terminology would not be more clear, but rather more confused. The word *encausto* signifies that something has been "burned in", and since the word, traditionally, has been connected to wax paintings, one might claim that the word simply means paintings on which paint or wax has been burned into the surface. To be correct, from a linguistic point of view, the main focus is "burned in", not wax. If one

---

7 De Architectura VII. 9.3.

8 Cagiano de Azevedo, 1952, pp. 145-153.

accepts this argument it would be natural to claim that paintings made of heated and melted wax are not encaustic, but simply wax paintings, unless the paint has become "burned into" the surface. This implies that a group of the famous Fayum portraits, constantly referred to as *encaustic* portraits, should rather be called *wax-paintings*. Nothing would really be won by making a demand for a change of terms, and therefore the present use of *encausto* signifying painting made with wax paint should to be accepted, even though it is not correct, philologically speaking. The important thing is to be aware of the actual meaning of terms, and when needed, to be able to explain exactly what is meant. Spoken languages are constantly changing, and that has to be kept in mind.

On a terminological basis, a much later mural technique, the *stucco lustro*, could be considered as (ancient) *encausto*, according to the initial definition, "burning in", since the colours are really "burned into" the surface with hot iron tools. This comment is not, however, a proposal to rename *stucco lustro*, a well-defined painting method, which, for technical reasons, appears to be closer to the Classical Greek conception of *encausto* than are the encaustic Fayum portraits made during the Roman Imperial period.

Punic wax

Punic wax is a concept that does not present any difficulty in understanding from a philological point of view. It means Punic wax, i.e. wax of Punic origin. One might presume that either the wax, or any important component of the mixture, originated from explicitly Karthago or, if *Punic* was used synonymous to North African, it may have been a reference to any other country along the Mediterranean south coast. Traditionally the *natron* salt, one of the constituents in Punic wax, was collected at the salt lakes in Egypt.[9]

Punic wax is a substance based on beeswax, which as a result of a chemical process, can be diluted with water. This substance, with the addition of some oil, was used on marble surfaces and also as a protective on murals in the *ganosis* process. The only terminological confusion about Punic wax is connected to the description in Book VII by Vitruvius, where he calls it Pontic wax.[10] This has, however, not had any vital influence on the discussions, but is occasionally mentioned. Punic wax is the accepted denomination. The term *ganosis*, therefore, is the proper word for any surface coating with Punic wax.

Politiones

There are a few more words which are of vital interest in this context, and those are *politiones*, *politionem*, *politionibus*, *expolitiones*, *expolitionem* and *expolitionibus*. These different forms of the Latin word *politio* are used by Vitruvius in De Architectura. The reason why interest is given to these terms in

[9] Natron, trona. $Na_3(HCO_3)(CO_3) \cdot 2H_2O$.

[10] Vitruvius, VII.9.3.

this specific study, is due to the proposition made by Paolo Mora, who suggests that the final layer on Roman murals was made of a polyment.[11] He has also presented the hypothesis that Roman mural paintings were entirely made by such polyments. Professor Mora and his students have performed experiments with this technique at the ICR, and the results show, according to information I have received from a former student, a great resemblance to ancient Roman wall paintings. As an argument for his suggestion that polyments were used, Mora refers to Vitruvius, who uses the Latin words *politionibus* or *politiones* when describing the preparation of the last coating for mural painting.[12] It is, of course an interesting hypothesis, which seems to have turned out quite well in reality, but it is difficult to find evidence for such assumptions by referring solely to the descriptions made by Vitruvius.

The interpretation by Mora seems to be unique, and he is obviously the only person who has interpreted the terms this way. In all other documents studied, those words have, in their different grammatical forms, been translated and interpreted as connected to the plastering process. Most frequently, *politiones* is translated with the word *smoothing*, while other terms are *lustrous* and *shiny*. *Politiones* is used by Vitruvius when describing the plastering of walls, explaining how to beat and rub the walls to make them hard and shiny.

Politionibus, *politiones* etc. signifies *smoothing*. The words are used 15 times by Vitruvius in De Architectura, and appear, not only to signify smoothing or polishing, but also plastering. Only in one case is the word *politionem* used in a way which is not quite clear.[13] In this passage Vitruvius describes the natural pigments that are taken from the earth, and he tells how the Greeks happened to find a yellow ochre in the silver mines in Athens, a pigment which they valued as much as if it had been silver. But even in this passage it is not possible to claim that he distinctly means that these earth pigments were *polyments*. They could have been, as we know that *polyments* are natural earth's. According to Bäärnhielm nothing in the Vitruvian text indicates that a specific type of preparation was intended, but the words are used in general terms, signifying smooth, smoothing and referring in general to the plastering process. The clay, called *polyment*, in Italian *bolo*, in Swedish and some other languages called *polyment*, is a very fine natural clay, which is commonly used by gilders as a preparation for gilding with gold-foils. The clays exist in different shades, like yellow, red, green, brown and black. Used in an adequate way, they are easily polished by using a piece of agate or marble, which makes the surface become very smooth, hard and lustrous. The distinction between earth, ochre, polyment and clay is rather subtle. A red ochre is a red earth. A red earth may be a clay called polyment. All clays are not polyments, and all red ochres are not polyments either. Polyments and ochres are natural earths of various compositions and pigmented by various minerals. Polyments are not equal to

[11] Mora, 1967, pp. 63-68.

[12] The terms are used 15 times; 14 of them in book VII, once in book VI.

[13] Vitruvius, VII.7.2.

pigments or vice versa. A polyment may be used as a foundation colour in a wall painting, just as suggested by Mora. It may also be used for the same purpose on a wooden panel.

Natron

The term *natron* is, as mentioned above, another term with great significance in this context. Pliny states that Punic wax was made of beeswax, water from the sea, i.e. salt water with the addition of some *nitro*. *Nitro* is a form of the latin word *Nitrum*, in Greek called *Natron*, and in English chemical terminology it is called *Trona*.[14] Many speculations have been made in trying to explain the word *nitro* in the Plinian text. It has been translated to "nitro and soda" by Ferri in his Italian translation with comments. This translation has created some problems, regarding the nature of *nitro*. It should be sprayed upon the wax while it is boiling in water, a comment which seems rather strange.[15] It has also been suggested by E. Schiavi that *nitro* was a bad translation of the word *natron*.[16] She claims to have identified, with the assistance of a chemist, the originally intended chemical, which is not an improper claim to make, since the terms refer to the same salt. Terminologically both words mean soda. Chemically there is a difference between the impure double salt, *natron* and the purified product, *soda*.

Schiavi describes how Punic wax became a perfect paint when *natron*, which she had brought from Egypt, was used instead of ordinary sodium carbonate.[17] This might lead to the assumption that the natural salt *natron* contains impurities which could be of great importance in this case. *Natron* is a double salt, which can be found in salt lakes in Egypt, for example in Wadi Natrun in the Libyan desert, a lake named after the *natron* salt. This district had a well-established trade of salt already during the Pharaonic dynasties. Therefore it may be assumed that the salt used for making Punic wax came from Wadi Natrun. There are, however, other salt lakes in Egypt, and maybe in Tunisia and other North African countries. Whether or not these lakes or other possibly existing lakes contain the same kind of *natron* salt as that found in Wadi Natrun has not been investigated. The question if *punica* signified specifically Punic Cartage or if the word indicated any country along the Mediterranean south coast is not mentioned by Pliny or any other ancient writer, and therefore an explicit answer to provide.

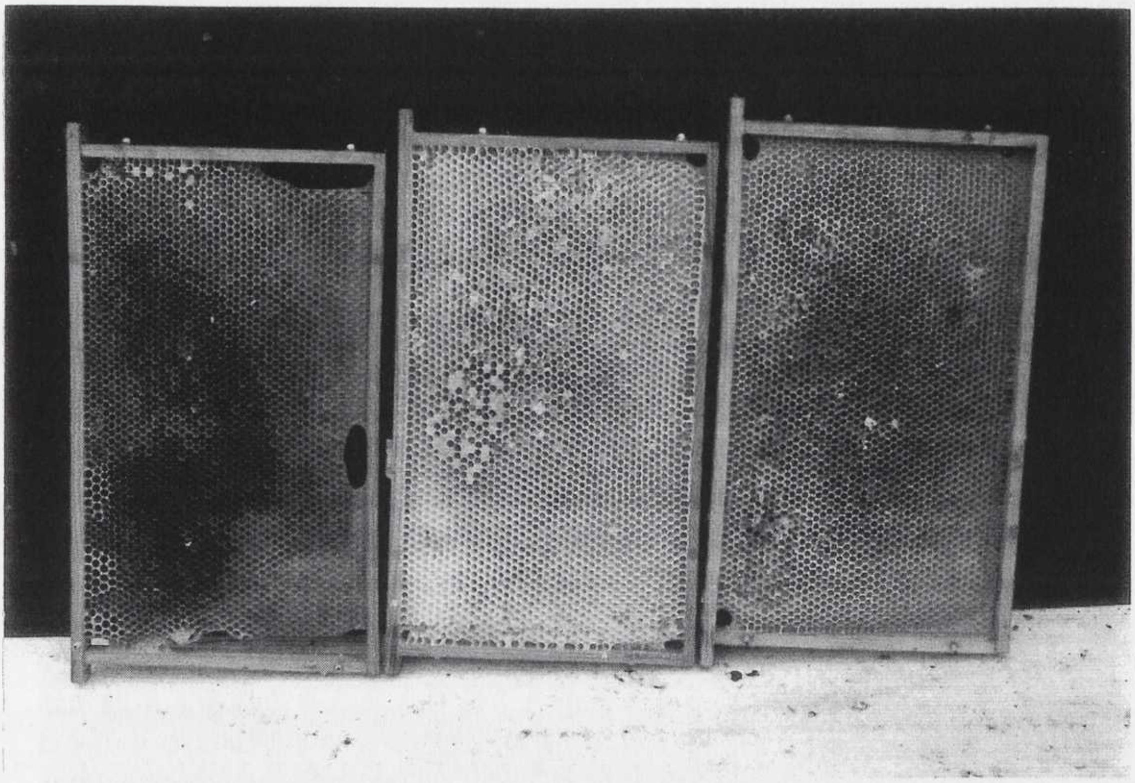
---

[14] The double salt Natriumsesqvicarbonate, $Na_3\ (HCO_3)\ (CO_3) \cdot 2H_2O$.

[15] Piva, 1964, p. 104.

[16] Schiavi, 1961, pp. 155-158.

[17] Schiavi, *Il sale della terra*.



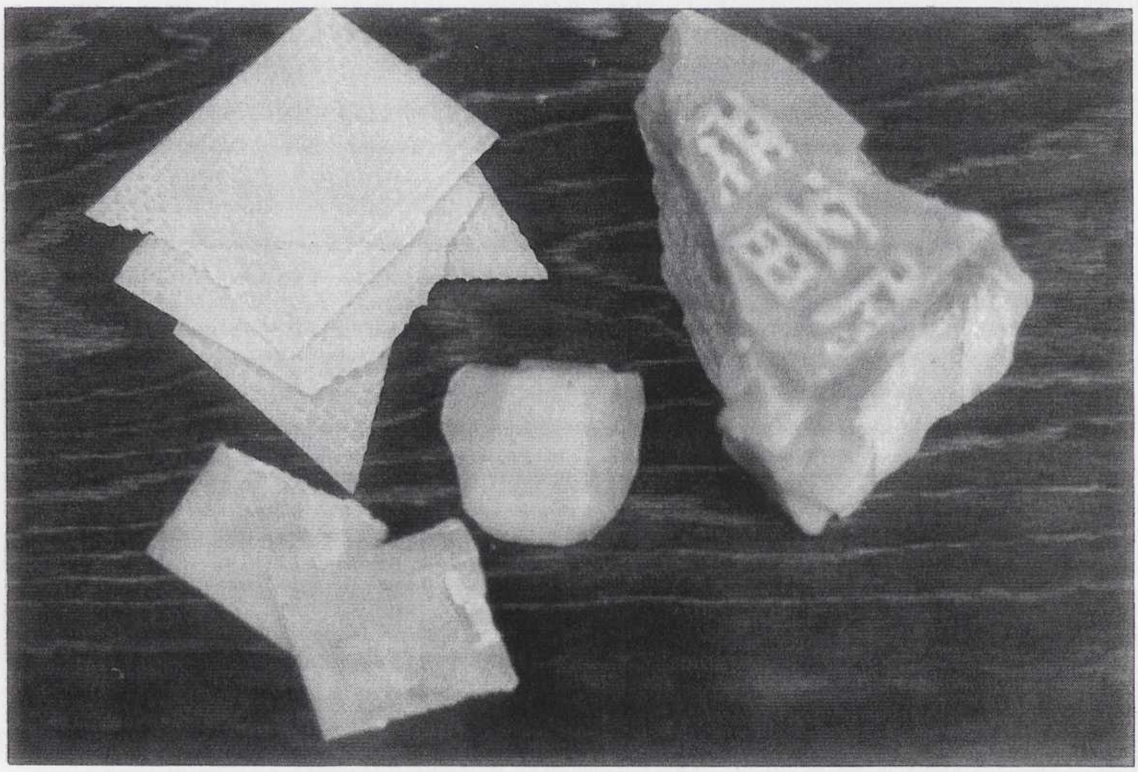


Fig. 19. Honeycombs.
Fig. 20. Beeswax from different manufacturers.

Pliny on Punic wax, with Comments

PLINIUS, NH XXI, 49

Punica fit hoc modo: ventilatur sub diu saepis cera fulva, dein fervet in aqua marina ex alto petita, addito nitro. Inde lingulis hauriunt florem, id est candidissima quaeque, transfunduntque in vas, quod exiguum frigidae habeat, et rursus marina decocunt separatim, dein vas ipsum aut aquam refrigerant. Et cum hoc ter fecere, iuncea crate sub diu siccant sole lunaque. Haec enim candorem facit, sol siccat, et, ne liquefaciat, protegunt tenui linteo. Candidissima vero fit post insolationem etiamnum recocta. Punica medicinis utilissima. Nigrescit cera addito chartarum cinere, sicut anchusa admixta rubet, variosque in in colores pigmentis trahitur ad reddendas similitudines, et innumeros mortalium usus parietunque etiam et armorum tutelam. Cetera de melle apibusque in natura earum dicta sunt.

"Punic wax is prepared as follows: Yellow wax is exposed to the outside air for some time, then boiled in sea-water taken from the open sea, with nitrum added. Then the flower, that is, the whitest part, is skimmed off and poured into a vessel containing a little cold water. Again it is boiled in sea-water by itself, then the vessel, or at least the water, cooled. When this has been done three times the wax is dried in the open air on a mat of rushes in the light of the sun and of the moon. For the latter makes it white, the sun dries it, and lest it should melt it is covered with a thin linen cloth. It will become exceedingly white if it is boiled again after the exposure to the sun. Punic wax is the most useful for medicines. Wax becomes black when papyrus ash is added to it. It becomes red when mixed with alkanet; With pigments it is made to assume various colours in order to represent true likeness of objects. It is useful to men in numberless ways, even serving as protection for walls and weapons.[18]

The wax

Yellow wax is exposed to the outside air for some time

This phrase indicates a natural beeswax, yellow, because it was not bleached. It seems probable that beeswax in those days was delivered uncleaned, and consequently containing waste products from the bees, otherwise there would be no reason to start with leaving it in the open air for some time. A cleaned wax left outside would become dirty from dust, falling leaves etc, but an uncleaned wax would probably loose some unwanted remains from the bees production, and in addition become whiter.

The sea water

boiled in sea water - in salt water (water containing different chemicals, mainly sodium chloride (Na Cl), sodium sulphate ($Na_2\ SO_4 \cdot 10\ H_2O$), sodium bicarbonate (Na HCO_3), potassium chlorate (K Cl O3), magnesium chloride ($Mg\ Cl_2 \cdot 6\ H_2O$) and gypsum ($Ca\ SO_4 \cdot 2\ H_2O$).

---

[18] Laurie,1910, p. 39. From the edition of Pliny's Natural History edited by Carl Mayhoff in 1906.

Taken from the open sea - may signify salt water without the inclusion of sand or sea fauna. The natural chemical composition of the seawater must be rather the same over large distances, but sand, sea fauna or soil water may be additions to the water in closer contact to the shores. *Taken from the open sea*, therefore, must be interpreted as clean sea water. The sea water intended by Pliny probably was the Mediterranean water, which is rather salt. In sea water there are several chemicals, such as those mentioned above. In a laboratory-made, medium salt sea water, the quantities of the most important chemicals are as follows: sodium chloride (table salt) in major quantity (24 g/litre), followed by magnesium chloride (11 g/litre) sodium sulphate (4 gr/litre) and calcium sulphate (1.47g/litre). Other chemicals are less than 1 g/litre. Sodium bicarbonate is a minor part, only 0.17 g/litre.[19] We do not know if all the chemicals in sea water were important for making the Punic wax, or just the sodium chloride. To verify the importance or non-importance of the different chemicals, experiments have to be made.

Nitrum

with the addition of some nitrum - *nitrum* (Lat.), *natron* (Gr.) and *trona* (Eng.) are referring to the same salt, $Na_3 (HCO_3) CO_3 \cdot 2H_2O$, a natural double salt containing impurities.

Natron exists in a natural form in salt lakes in the Egyptian desert.[20] This salt may have been the *nitrum* suggested by Pliny. If, on the other hand, Pliny used the word *nitrum* just to indicate *soda*, then the question is what kind of *soda* he intended. It could mean *natron* but also signify any *saponifying agent*, which might be *soda* or *potash*, as they both are alkaline salts, which react with the beeswax in similar ways. The wax mixture could still be called Punic wax, connecting the product with some kind of North African origin. In order to establish whether or not *natron* was necessary for making Punic wax, experiments need to be performed. It is only in that way the importance of *natron* (nitrum) and *nitrum* (soda) can be determined.

The boiling

When this has been done three times - may be interpreted as a double process of cleaning and of transforming the wax.

The question is which was the most important factor when boiling the wax. By using sea water a double effect may have been achieved: boiling to clean the natural beeswax and in addition exposing it to a chemical process. Natural beeswax is "dirty" when it is collected, containing remains from the bees´production, and it must necessarily be boiled before it can be used. This is the way cleaning is still done by bee-keepers. By boiling it three times with soda it definitely becomes clean, and in addition rather white, since soda also has a bleaching property. By boiling the wax as described, and at repeated times, the

---

[19] Dr. Stig Aleby, personal communication.

[20] One such place is Wadi Natrun, near Cairo.

chemicals may have accumulated in the beeswax. If that was the intention, the question is whether it was necessary to repeat the boiling treatment, or if a higher concentration of chemicals in only one water would have had the same effect. In order to understand the effect/effects of repeatedly boiling the bees wax in salt water experiments have to be made. Only in that way can it be determined what is happening and why.

The drying and the sunshine

The wax is dried on a mat of rushes in the light of the sun and the moon - this sentence is definitely describing a combined drying and bleaching process, which is further pronounced by the following lines; *for the latter makes it white, the sun dries it.*

Of course Pliny makes a mistake about the moon´s capacity of bleaching the wax, and the quoted line may just be regarded as a poetic description of a real process. The important information is that the boiled wax should be left outdoors day and night for some time in order to bleach and dry. By being exposed to the heat in the sun, water will evaporate, leaving a dried beeswax, containing only a little water. This process led to the production of a white wax, especially if the wax contained bleaching salts. As water evaporated wax probably achieved quite a solid nature as well.

The cloth

And lest it should melt it is covered by a thin cloth - this indicates that wax, even though transformed, and in a more or less solid state, caused by the evaporation of water, might still melt in the sunshine.

This means that the melting point of the wax had not changed very much by the previous boilings, but remained about the same as the melting point for natural beeswax (about 64° C).

The last boiling

it will become exceedingly white if you boil it again after exposure to the sun - this is further proof for bleaching the wax being an important factor.

No statement is made about the water for the ultimate boiling, if sea water is still intended or if ordinary drinking water might be used as well. It is not clear either if these words are meant just as a statement or if it is a suggestion.

The last lines of the quoted part concern pigments which could be added for making a paint and also some other ways of using Punic wax, and are, therefore, not commented upon in this context, in which focus is placed on the process of making the white substance called *Punic wax*. The product was consequently achieved by boiling the yellow beeswax in salt water. The exact composition of the water can only be determined by testing the different possibilities and comparing the results with the product described.

Discussion

In modern publications concerning ancient Greek and Roman polychrome art, the *ganosis* method, as described by Pliny and Vitruvius, is commonly referred to as the *encaustic painting technique*, which seems to be an expression both right and wrong at the same time. *Encausto* indicating the process of "burning in", is an adequate term for the *ganosis* procedure, and so far the concepts are linked together. *Ganosis* however, was not principally a painting method but a technique for surface coating. Furthermore, the encaustic painting techniques were considered to have been three already during the Roman era. Consequently, encaustic is not one, but several, techniques. At least one of these, the first method, was not compatible with heat. Examples of paintings made in that technique are some of the Fayum portraits, which have a surface appearing slightly in relief. Such relief texture would not remain if the painting had been heated. Nowadays the term *encaustic* is commonly used to define the material of these mummy portraits.

It is evident that there is no total reliability as far as the ancient sources are concerned. This is partially due to the existing inconsistency of those transcriptions and to the various translations of these ancient scripts. There are later translations than those studied in this context. These have not been related, since the issue was not to make any comparison between, and evaluation of, translations, but just to illustrate the problem. Any presentation of further, updated translations, would not eliminate the problem, just add some more examples.

It must be pointed out that Pliny is not quite reliable when discussing the encaustic methods and how to make Punic wax, but he seems to have been reliable as a narrator of events and opinions of his time. This can be inferred from comparisons with other documents of more or less contemporary authors. In some cases he was obviously mistaken, and in such cases he was either relying on ancient beliefs or he did not have accurate information. This may be exemplified by his statements about

a) painting being invented 6000 years before it was introduced in Greece and
b) bleaching the wax by the sun and the moon.

In the first case, a) we have a more correct calculation of time today, based on additional knowledge and more refined methods of determination. In the second case, b) our understanding of the planets and their impact is different today.

Therefore, Pliny can be regarded as a reliable source as long as he made general observations and descriptions, and as a sufficiently reliable source for precise information. In some cases he was mistaken about specific facts, and those cases may have consisted of facts of a very precise character, of which he was unaware, or that were not known at all at that time. As far as his descriptions of the methods investigated in this study, one cause of his vagueness may have been, that he had no personal experience of these matters, but narrated them in the way he had understood. Consequently he must not be understood literally, but rather be accepted as a narrator of facts, as interpreted by himself.

Vitruvius, on the other hand, obviously had a personal, practical knowledge, about how to plaster a wall for painting, and therefore there is no discrepancy between his description and remaining physical evidence, i.e. Roman wall constructions and preparations. This difference between Pliny and Vitruvius most probably is related to their different professions. Vitruvius, as an architect, had to be aware of building construction, while Pliny, the historian, had a more vague conception about practical details. This does not, however, make Pliny unreliable, since he obviously had a great knowledge of the practices of previous periods as well as of his own time.

Based on the studies which have led to the considerations mentioned above, and confirmed by the terminological investigation, I have come to some conclusions about the three encaustic methods. The first method consisted in the use of melted beeswax, which was applied, and worked with, a hard metal tool, the *cauterium*. For the second method, the same kind of paint was used to fill the engraved lines on hard materials such as ivory. A stylus, or *cestrum*, was used for the engraving. The third method, was painting with Punic wax, and for this kind of painting a brush was used. Punic wax was a chemically transformed beeswax, which by repeated boilings was cleaned, bleached and saponified.

As far as the terminological issues are concerned, it is obvious that terminology has changed, and that the original conception behind the word *encausto* is not equal to the modern use of the word. Since such evolution is normal and has to be accepted, there is no use in suggesting a return to the ancient conception, and neither to introduce new words, such as *kausis*, which only bring confusion to terminology. It is therefore suggested that encaustic today should be accepted as a conclusive term, indicating paintings made with wax as the binder. When defining the specific encaustic technique of any object, this definition may be either *painted with melted and pigmented wax*, or *painted with Punic wax*. *Wax tempera* is another adequate word for paintings made with Punic wax, since this kind of paint is diluted with water.

The issue regarding the heating of the paint, or of the painting, is, in my opinion, easily resolved. Paintings made according to the first technique were not, for obvious reasons, heated, since they would melt and be ruined. Paintings made according to the second technique, were probably heated, since one of the objectives was to fill the lines with colour. Paintings made with Punic wax probably were heated, if made on walls, but probably not if they were made on wooden panels, since there would not be any good reason for this procedure. This issue is, however, difficult to determine, and the suggestions made are based on personal experiences of paints and preparations.

The terms *natron*, *nitrum* and *nitro* indicate the same impure salt, and consequently these terms are interchangeable. This product is often called soda. There may be chemical differences between *natron* and *soda*, and therefore one of these words may not substitute the other. In this context, *natron* indicates a natural salt from the Wadi Natrun.

Mora presented the hypothesis that Roman mural paitings were made with natural fine clays. According to himself he based this conviction on the statements made by Vitruvius, which have been explained above. Such hypothesis must be rejected, on the following grounds:

a) the word *politionibus* means smoothing as well as lustre. The word is not equal to later, similar words in other languages,
b) there is a connection between politionibus – smoothing, and lustre, which is the effect of smoothing (the Roman wall plaster preparations, but also polyments),
c) *polyment* is a fine clay used by gilders, and *bolo* is the Italian word for the same clay. Polyments might have been used for Roman wall-painting, but there is no ground for claiming that Vitruvius intended that Roman wall paintings were made with bolo.

ROMAN PAINTING
AND POLYCHROME PLASTIC ART

Roman Art in Context

In order to better understand the consciously formulated intentions and intangible image conceptions as well as underlying conventions in Roman plastic art and painting, a brief summary of the cultural, social and political background will be presented. The general architectural scheme and decorative system is briefly described in order to outline the designed context into which the paintings were inserted. Private buildings, situated in Rome, Ostia and Pompeii, and belonging either to the imperial family or to middle class families, have been at focus in this study. Public buildings, such as baths, temples and basilicas have not been taken into consideration, since it seemed natural to confine to either public or private buildings in this limited study. Stylistic changes in arts are reflected in decorations in either category of building. The period investigated, is roughly between the Late Republic and the third century AD, a period of great changes in Roman society.

The social context

The utilitarian aspect of Roman art has been pointed out by several scholars.[1] Such a statement necessarily leads to the forming of two important questions, which have to be answered; utilitarian for whom and for what purpose. The answers to these questions are quite complex, but will be briefly pointed out.

Art in Roman society, as in any other, was essentially commissioned by members of the ruling class, who possessed the economical means necessary to invest in architectural structures and art. The purpose of such investment was to manifest economic and social power, but also to create a personal or public milieu of culture and refinement. Power could be shown in official places as well as in the private sphere by exposing impressive, suitable and commonly understood topics and objects of art, which furthermore were aimed to underline the rituals taking place in each specific environment.[2] Art contributed to offer each setting its distinctive identity.

Roman society was highly stratified.[3] During the Republic, its ruling class consisted of the old aristocracy, the *patricians*, members of the families who first settled in Rome.[4] This small group of families, approximately thirty, ruled on basis of the wealth and prestige of their bloodlines.[5] Below the *patricians* in

[1] Bartman 1994, Clarke 1991, 1994, Dwyer 1994, Hamberg 1945, Kellum 1993, Leach 1993, Marta 1986, Marvin 1993, Nodelman 1993, Poulsen 1978, Richter 1955, Scagliarini Corlàita 1998, Wallace Hadrill 1994.

[2] Marvin, 1993, p. 166.

[3] Goodman, 1997, p. 16.

[4] Wells, 1984, p. 94.

[5] D'Ambra, 1988, p. 17.

Roman hierarchy were the equestrians, *equites*, who could advance in their political career after military training.[6] The military recruitment system changed during this period and even men without property could enlist, resulting in the possibility for male persons of different origins to rise from simple backgrounds to become rich and influential citizens of Rome, as was the case for several African soldiers.[7] Although there was a possibility of transition from a lower to an upper class for a competent man, especially if wealthy, such transition was slow, and not possible in a single generation.[8]

A wealthy upper class was gradually developing during the 2nd century BC, which did not only include the old families, but also successful persons from other social backgrounds. With the reign of Augustus the circle was enlarged. As a result of the contact with the Hellenistic world, there was a gradual change in the self-definition of the elite class. New ideals were formed by Augustus, aiming at peace and personal security for the Roman people.[9] The Augustan political programme, its background, its aims and the visual evidences, have been thoroughly described by Zanker.[10] In official art the potency of emperors and other important public persons was expressed, e.g. in the iconographic schemes and in the size of the statues.

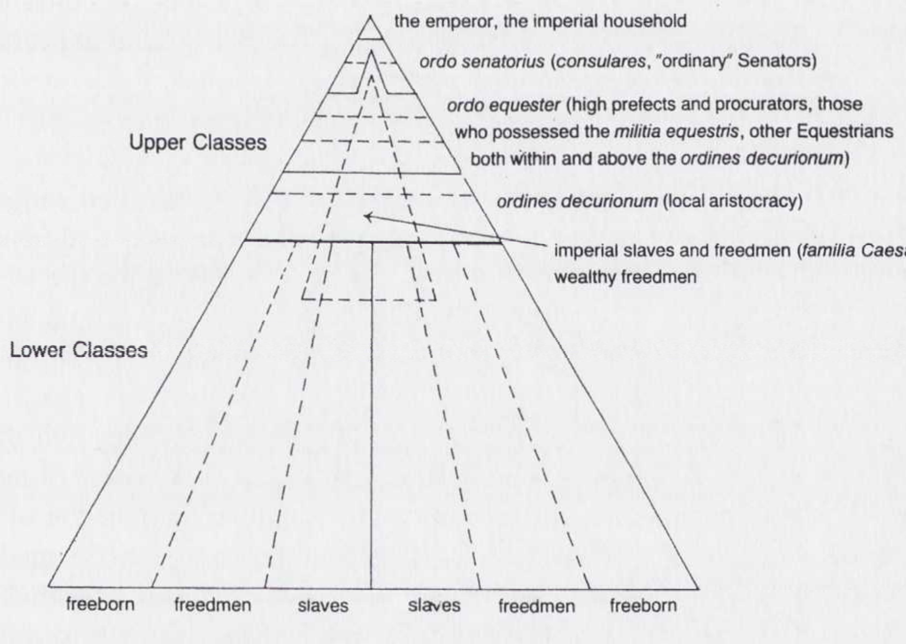


Fig. 21. The pyramidal structure of Roman society in the Imperial Age. After Zanker, 1988.

---

[6] Ibid.

[7] Goodman, 1997, pp. 22-23; Wells, 1984, pp. 250-251.

[8] Zanker, 1988, p. 151.

[9] Ibid, p. 78.

[10] Zanker, 1988.

In the private sphere, the size and decoration of the *domus* was a measure of the owner's wealth.[11] Ancestral portraits were exhibited in the reception rooms and used as further details to underline the social background of the family. At first sight these portraits seem to depict individuals, but the portraits rather represent a type or a character than different individuals.[12] This can be observed in the veristic portraits of the Republic which generally show middle-aged or old men and women with their faces marked by wrinkles, severe persons engaged in public life and politics, men to respect. During the Augustan period a novel tendency in the official portraiture appeared, expressing the new ideals for identification with the new, Golden age, but also linking the present to the honourable past. This transformation can be noted in the official portraits of Augustus, which show him in different symbolic functions, such as the chief priest, the military general, the orator or the godlike hero.[13] Portraits of the young Augustus show a man with a sensitive expression, maybe somewhat tense and nervous. Such representations later were replaced by portraits quoting Classical sculpture, the expression of the face calm, decisive and controlled. A similar iconographical transformation may be noted in statuary.[14] Portraits with propagandistic messages were disposed in public places in Rome and in the provinces, representing the various functions of the emperor and expressing his ideals about himself as a ruler. The official portraits of the ever young and active Augustus became the model for many successive rulers, just as the portraits of the women within the Imperial family, their hairstyles and general appearance were imitated by women within the Empire.

The Roman villa

Life of the Romans was filled with rituals, not only in public and religious ambiences, but also in the private spheres. Any villa or *domus*, was traditionally built according to certain principles, in order to be appropriate for the rituals performed within its walls.[15] It was the family residence, and as such the entire structure was designed to insure the security of family members.[16] The house, however, was not just the sphere of domestic life but also the place of official duties, where the *pater familias* every morning received his clients, and other persons connected to the family. Professional activities were taken care of in the house, and it was therefore built and decorated to underline the position of the owner, a fact repeatedly mentioned in ancient sources as well as in modern scholarly literature.[17] Since domestic and public life was taken care of within the same walls, the house had to be planned in a way suitable for these different uses, considering in each specific case the surrounding milieu and the social

[11] Dwyer, 1994, p. 34.

[12] D'Ambra, 1988, p. 28.

[13] Ibid, p. 31.

[14] Zanker, 1988, p. 239.

[15] Clarke, 1991, pp. 2-6.

[16] Dwyer, 1994, p. 28.

[17] Wallace-Hadrill, 1994, p. 4; D'Ambra, 1988, p. 40.

position of the owner. Some characteristics were individuated independently of the actual size of the building and these remained constant through the centuries.[18]

According to Wallace Hadrill, the Romans were, in their architecture, obsessively concerned with distinctions of social rank.[19] The distinctions were only not manifest between one house and an another, but especially within the social space of the house. Differences were emphasised by the plan and size of the house and by its decorations. The fact that the size of the house was related to the social status of the family, was stated by Cicero as well as by Vitruvius. Both agree that some men must have larger houses in order to fulfil their social obligations.[20] Voices were raised against increasing luxury in the private homes, when influences from the Greek-Hellenistic culture gradually were overthrowing and exceeding the more strict tradition of the Republic. Pliny and Cicero both claimed that the Roman people disliked private luxury, but appreciated it in public environments.[21] Varro stated in "De re rustica" that "... *in a country house the fruit rooms should be admired, not the picture galleries* ...".[22] He was proud himself of his elegant and luxurious buildings, which obviously surpassed the limits of utility and modesty prescribed by himself.

The Greek and the Roman house were similar in many aspects, since the Greek tradition had a great impact on Roman culture as a whole. One cultural distinction, however, was connected to the accessibility of the house for visitors, and another was the organisation of the social and family life within this structure. The easiest accessible part in the Greek house was exclusively used for male members of the family and their likewise male friends, while women lived in the back of the house, where also the kitchen was situated. The Roman house, contrary to the Greek, had no division of zones between male and female life, but rather between public and private areas, within which all family members moved freely.[23] The interior parts of the house was accessible only for the family. It has been pointed out that early Roman houses had various degrees of privacy, and that the depth to which a guest penetrated the building emphasised his degree of intimacy with the owner.[24] Privacy, as understood by modern people, was unknown to the Romans, since the Roman house was a constant focus for public life.

Normally the Roman house had few outside doors, one or two at most, and few, if any windows on the ground floor.[25] As a consequence the rooms were rather dark. The *atrium* and *peristyle* in the centre of the building were the only two sources of natural light, and all rooms received their light from these open

---

[18] Dwyer, 1994, p. 39.

[19] Wallace Hadrill, 1994, p. 10.

[20] Dwyer, 1994, p. 33.

[21] Salvetti, 1998, p. 85.

[22] Leach, 1993, p. 145.

[23] Wallace Hadrill, 1994, p. 8; D'Ambra, 1988, p. 41.

[24] Ellis, 1994, p. 123.

[25] Dwyer, 1994, p. 28.

spaces.[26] The traditional *peristyle* was a square court, surrounded by colonnades.[27] Columns were generally erected on all four sides, supporting a narrow roof, which had the double function of protecting from direct sunshine as well as from rain. Occasionally the peristyle was provided with colonnades just on two or three sides. The atrium-house, with the rooms symmetrically grouped around a central court-yard, was not a Greek, but an Etrusco-Roman invention.[28] This was recognised by Vitruvius who pointed out that some features in Roman architecture are Italic and others are Greek. He stated that the Greeks did not use atria as the Etruscans and the Romans did.[29]

From the 3rd century BC and onwards, the Roman house was strictly axial and symmetric and generally built with the main entrance facing the street, from where the visitor, by passing a small hall, *fauces*, entered the main room of the building, the *atrium*.[30] In the middle of this stonepaved area was the open space over the *impluvium*, which contained the collected rainwater. The *atrium* and the adjoining *tablinum* were used as locations for the owner, with respect to his role in religious and other social rituals.[31] From this central position he had a good view over movements within the house. Centrally exhibited in the house were death-masks, made of wax, together with other representations of the family´s ancestors.[32] Such images were, as mentioned above, important exponents of the family origin and consequently of social importance, since the right of keeping ancestral pictures properly belonged to the heads of patrician families. During the late Republic and early Empire it was the undistinguished ambition of *novi hommes*, i.e. men elevated to patrician status, to have such pictures.[33] The *atrium* also contained the *lararium*, a shrine for daily offerings, with the picture of the two *lares*, the household gods.[34] The *lares* were usually represented as two young men in country style clothes, holding *rhytons*, drinking horns. Between the *lares* was a representation of the spirit of the *pater familias*, the *genius*, holding an offering dish, a *patera* and sometimes a cornucopia.[35] The dining-room, *triclinium*, was a place for social communication in the Roman villa.[36] It had three couches at the back and side walls of the room, an inheritance of Greek tradition. A guest could not simply sit down at the table as a strict etiquette surrounded the Roman banquet, and each person received his or her place at the table according to the person´s rank at the ceremony.[37]

---

[26] Wallace Hadrill, 1994, p. 83.

[27] Boëthius, 1970, p. 155.

[28] Sears, 1998, p. 12.

[29] Boëthius, p. 116.

[30] Ibid, pp. 152-153.

[31] Dwyer, 1994, p. 27; Wallace Hadrill, 1994, p. 12.

[32] Wheeler, 1969, p. 162; Richter, 1948, p. 1.

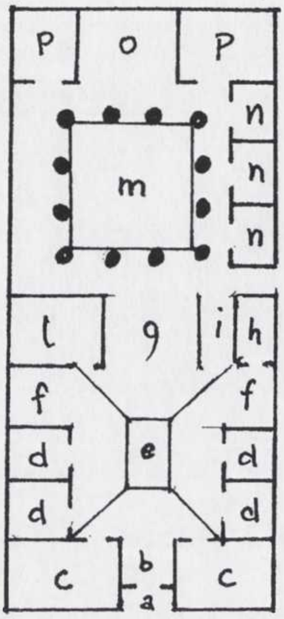
[33] Dwyer, 1994, p. 26.

[34] Marta, 1986, p. 166.

[35] Clarke, 1991, p. 9.

[36] Zanker, 1998, p. 19.

[37] Clarke, 1991, p. 17.



a = vestibulum
b = fauces
c = cellae
d = cubicula
e = atrium
f = alae
g = tablinum
h = apotheca
i = andron
l = triclinium
m = peristylium
n = cubicula
o = exedra
p = oeci

Fig. 22. Schematical plan over a Pompeian house. After Maiuri, 1931.

Early villas in the countryside were often built on slopes with extensive and beautiful views.[38] Nature was part of the urban house in the form of the small garden situated in the peristyle or beyond the back of the house. At Pompeii, terrace houses with splendid views over the landscape appeared during the 1st century BC.[39] Other private places for wealthy Romans, representing nature, were the *horti*, pleasure gardens within the city walls, created for resting and pleasure as a contrast to public life at the Forum. According to Pliny the elder, Epicurus was the inventor of such gardens, and Epicurean ideals were important in planning the garden as a place of retreat from the politic life in public in favour of tranquillity and spiritual preoccupations.[40]

The first *hortus* mentioned in ancient literature was the garden of Lucullus, a place to which he retired after his triumph over Mithridates in 63 BC.[41] During the reign of Augustus, these gardens became important evidences of luxury and wealth for prominent Romans, and by the time of Nero the *horti* had become numerous and were successively forming a chain around the centre of Rome. Such *horti* were also part of the town plan of Pompeii.[42]

---

[38] Zanker, 1988, p. 136.

[39] Zanker, 1993, pp. 158-159.

[40] Wallace Hadrill, 1995, p. 6.

[41] Boatwright, 1995, p. 73.

[42] Wallace Hadrill, 1995, p. 6.

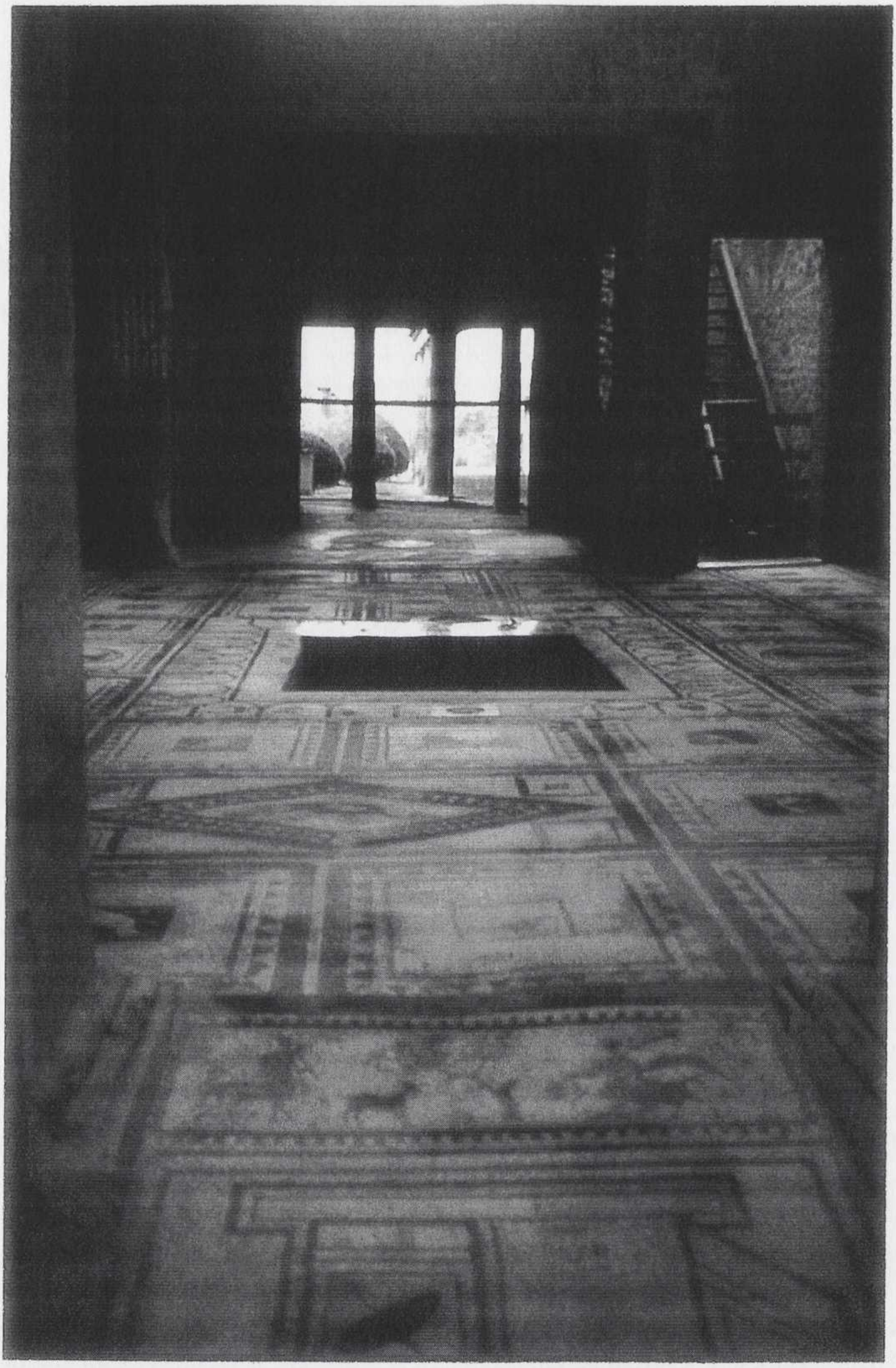


Fig. 23. The house of Paquius Proculus, Pompeii. View from the streetside to the peristyle garden, through *fauces*, *atrium* and *tablinum*.

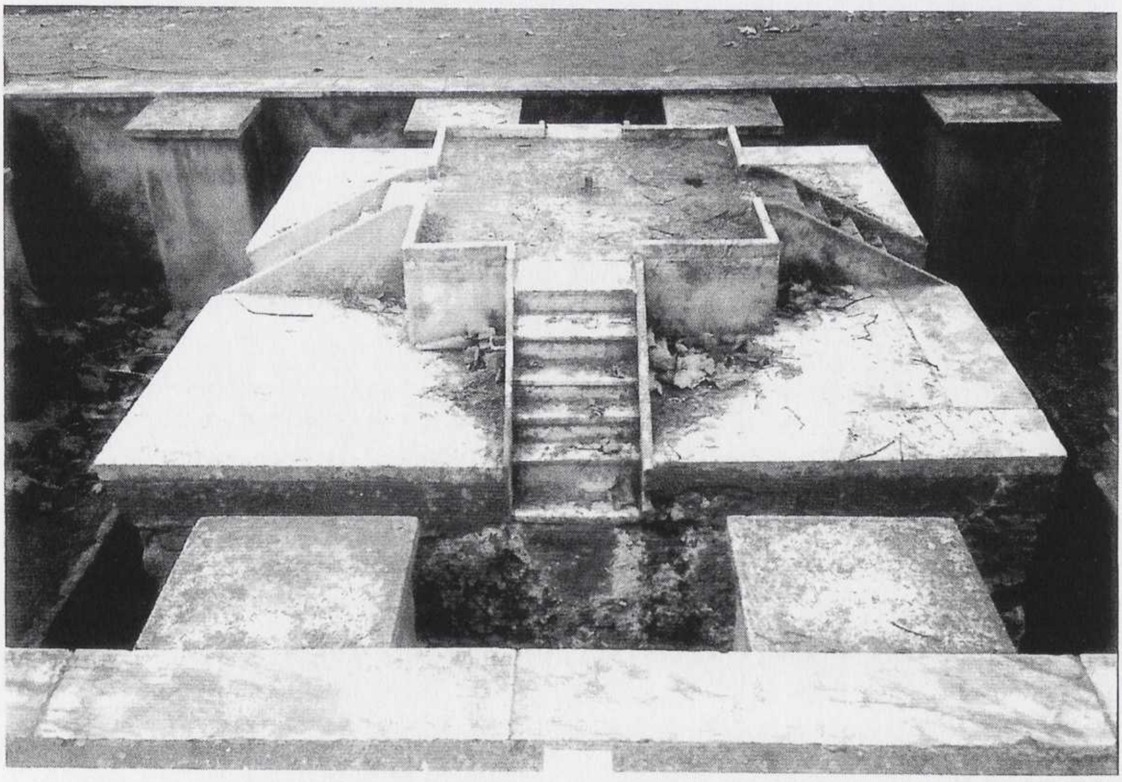


Fig. 24. Above: Casa di Venere in conchiglia, Pompeii. Garden painting.
Fig. 25. The house of Loreius Tiburtinus. Garden with nympheum.

Suetonius, commenting on Nero's Golden House, is of the opinion that "Rome has become a house: citizens emigrate to Veii", arguing against Nero's aggrandisement, which led to too much space being taken away from the citizens in favour of the construction of these private, luxurious pleasure gardens.[43] The extension of the palace complex was, in fact, about 80 hectare, and consisted of several blocks of buildings, terraces and porticoes, distributed in large garden areas.[44] Famous was also the garden of Maecenas, where Augustus chose to stay when he felt ill and where Tiberius retired, when he returned from Rhodes in AD 2, and lived a private life until he retreated to Capri in AD 27.[45]

Gardens were planned according to a conventional scheme, with colonnades and fountains, enclosures surrounding the various plantings and elaborate settings of marble statuary and mural paintings, as well as panels and masks suspended in the air.[46] Mural paintings, representing gardens, were often part of the setting, made on the garden walls as imaginary enlargements of the real garden.[47] There were, of course, regional traditions how the Roman house and garden were planned, and houses in the provinces did not totally adopt the same principles as those mentioned above.[48] The visual axis, however, was always kept in mind. The dominating axis was leading from the entrance, viewing through the atrium, and if possible, ending up through the peristyle, leading to a fountain or a statue, which was a focal point. This structure, of course, depended on the size and the shape of the house, which generally was built and planned in order to impress the visitor with the views before reaching the atrium zone.[49]

As the population in Rome rapidly increased during the 1st century AD, a new structure of buildings developed. These were the *insulae*, multi-storey apartment houses, built of kiln-fired bricks, and containing flats which were let out.[50] In Ostia there were different kinds of *insulae*. Some had simple apartments, probably inhabited by poor people, while patrician families seem to have lived at the ground floor level in larger and more comfortable apartments, at least during the 2nd and 3rd centuries AD.[51] Small flats could comprise of just one or two rooms, but the average size seems to have been between three and five rooms, generally built around a central courtyard, the *medianum*.[52] Wealthier families could afford a larger apartment, such as, e.g. in the House of the Yellow Walls in Ostia with its six rooms around the courtyard, or the House of the Muses with at least 11 rooms, corridors and the large courtyard. At the ground floor a row of tabernae often faced the streetside.[53]

---

[43] Beard, 1995, p. 25.

[44] Iacopi, 1999, p. 9.

[45] Boatwright, 1995, p. 76.

[46] Wallace Hadrill, 1994, p. 9.

[47] D'Ambra, 1988, p. 137.

[48] Ellis, 1994, p. 118.

[49] Clarke, 1991, pp. 4, 16; Wallace Hadrill, 1994, p. 12.

[50] Goodman, 1997, p. 185; Sears, 1988, p. 33.

[51] Pohl, 1983, pp. 33-35.

[52] Marta, 1986, p. 173.

[53] Boëthius, 1960, p. 140; Pohl, 1983, p. 12.

The building materials

The architectural scheme of a Roman house did not undergo much change during the centuries, since the functions of private and public spheres were important and the utility of its protected and open areas had to be regarded. The development of materials used in buildings can be followed through the centuries, and observations of the wall construction technique is useful for the dating of a Roman villa. All Roman wall constructions but one, the *opus quadratum*, were made of concrete. The nucleus, *opus caementicium*, was made up with stone chips, *caementa*, mixed with mortar of lime and sand, contained between forms of, e.g. tufa wedges or terracotta bricks.[54] By the 2nd century BC Romans had developed the *opus caementicum* into an all-important material in architecture.[55] The concrete was made by sand from deposits in the volcanic areas of central Italy, making an extremely durable mortar, which combined with *pozzolana*, could be used even for constructions under water. This material, with its great strength and versatility made possible the huge vaulted interiors of the Imperial baths and the arch structures in various types of buildings.[56]

Walls in buildings from the Hellenistic and Republican periods were made in *opus quadratum*, rectangular blocks dry jointed, i.e. fit together without cement. This building technique was known already from the Archaic age in the Etruscan area.[57] Stone-coatings were used in Roman architecture already from the Hellenistic times, but for revetment, not for the wall structure.[58] *Opus reticulatum*, consisting of square tufa wedges set in cement with the larger base in the facade, forming a diagonal net-pattern, was the technique most used from the Augustan to the Antonine age.[59] This system was improved by delimiting frames of rectangular terracotta bricks, *opus mixtum*, which strengthened the wall construction. *Opus mixtum* was common during the Hadrianic period, but known from the first half of the 1st century to the beginning of the 3rd. Beside these easily recognisable standardised wall constructions, there were various intermediate stages.

According to Suetonius, Augustus claimed to have transformed the city of Rome, and "left in marble that which he found made in brick".[60] Sears states that Augustus, in his building programme, used only the best materials, and that Rome was rapidly transformed when white marble buildings took place of the old tufa ones. Tufa and peperino were in future only used for the subsidiary parts of the buildings.[61] A flourishing marble trade was established and soon extended itself throughout the Empire. This highly developed trade also included ready-made statues and architectural elements.

---

54 Ling, 1991, p. 25; Marta, 1986, p. 15.

55 Boëthius, 1970, p. 30.

56 Carter, 1989, p. 37.

57 Marta, 1986, p. 11.

58 Clarke, 1991, p. 27.

59 Marta, 1986, p. 22.

60 Suetonius, The divine Augustus XXVIII, 3 ff.

61 Sears, 1988, pp. 49-51.

The external surface of the wall was often covered with several layers of plaster, successively painted. Otherwise, small pieces of terracotta or marble could be inserted into the plaster, and then the surface was covered with thin panels of marble.

The formal architectural scheme was the unity into which details were set. There were many materials possible to use to achieve a pleasant and functional house decoration, and these were used in various combinations. Marble, mosaics, terracotta, stucco and wall paintings were the basic artistic materials in a Roman house. Various marbles were imported, and used for columns, architectural elements and statues. Thin panels in many cases covered the walls. Marble cut into rather large pieces and composed in elaborate patterns to form a geometric pattern or a figurative design, *opus sectile marmoreum*, was a luxurious floor-cover which was only used in the most dignified buildings.[62]

Mosaics were, however, the most common material for floor decorations in the houses of wealthy families. The tradition of mosaic floor decoration can be traced back to the 5th century in Greece, when decorations made of conic mosaic pieces were introduced in public places.[63] Mosaics laid with *tesserae* appear during the 3rd century BC.[64] It is possible to date the floors by the size of the *tesserae*, e.g. the extremely small-sized *tesserae*, belonging to the Second style, which are dated from around 100 BC, while larger pieces of black and white *tesserae* are typical of the Hadrianic period, AD 117-138. Mosaics could be complex decorations with a central picture, *emblemata*, made with extremely small pieces of mosaics, *opus vermiculatum*, or they could be laid as simple black-and-white compositions. Simple floors, e.g. in court-yards, terraces and warehouses, were made of small bricks of terracotta, placed diagonally in herring-bone pattern, *opus spicatum*.[65] Such floors, were common during the Pompeian Second style.[66]

Ceilings and vaults were commonly made in *stucco* relief, and generally kept white. Pompeian First style stuccoes are mostly made in geometric patterns, representing cassette ceilings, but these decorations gradually developed into elaborate patterns containing floral and figurative motifs. In order to ascertain a good adherence of the stucco to the underlying structure, canes were nailed to vaults and ceilings.[67] There are examples of painted stuccoes, sometimes with inserted pieces of marbles or with partial gilding, as well.[68] Examples of such multi-coloured stuccoes are plenty in the Domus Aurea, e.g. the rich and complex decorations of the golden ceiling, *la volta dorata*, in room 80 or the precious stucco decorations in room 129, also called the room with the stuccoes or of Hector and Andromace.[69]

---

62 Marta, 1986, p. 50.

63 Baldassare, 1985, p. 205.

64 Ibid, p. 211.

65 Marta, 1986, p. 24.

66 Dr. Lars Karlsson, lecture at the Forum, September 29, 1998.

67 Barbet, 1998, p. 105.

68 Salvetti, 1998, p. 87.

69 Iacopi, 1999, pp. 41-46, 73.

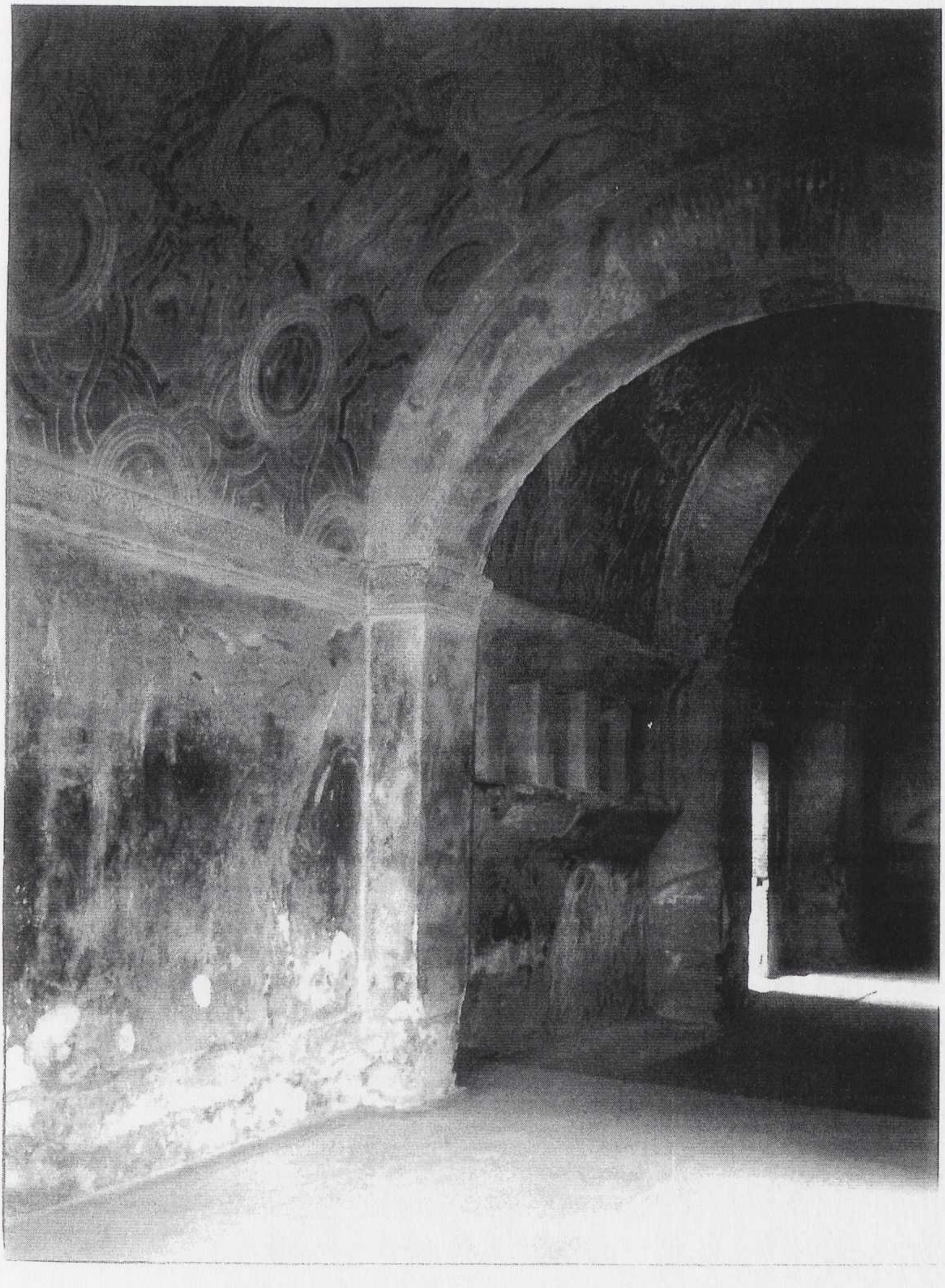


Fig. 26. Stucco decoration. From the Forum baths, Pompeii.

The decorative system

The ritual and utilitarian aspects of Roman culture are observable also in the decorations of the Roman buildings. The sense of *decor*, i.e. the selection of a style for each setting, was characteristic for the Romans, and rooms were decorated thematically according to their use. Mythological motifs were, however, preferred in public as well as in private spaces.[70] Official persons such as magistrates, politicians and lawyers, who received their clients in the public part of their home, had their rooms for receptions painted with heroic motifs to manifest the official, public and severe and character of the room.[71] Simple decorations were made for spaces where people were just passing through, and complex paintings were made for rooms where people stayed, and had time to look at the paintings.[72]

In the private rooms of the villas there was less need for public manifestations, and consequently the paintings often had a more intimate character, such as garden paintings on walls close to the peristyle and erotic motifs in bedrooms, *cubicula*.[73] Still lifes or masks frequently occur as motifs in the dining-room, illustrating the Roman habit of combining dining with music and other forms of entertainment. The emperor Augustus was, according to Suetonius, known for giving very formal dinner parties, which were enlivened by musicians, actors or even men who gave turns at the circus, but more often by professional story tellers.[74] When the dining-room eventually became a room for receptions, decorations became more official. The dining rituals in the house of a wealthy freedman have been narrated by Petronius, who lived, and died, during the reign of Nero.[75] Even though the scenes he describes in Satyricon maybe are a little exaggerated, the story gives a glimpse of what could be comprised in a Roman dinner party.

The manner of combining materials and motifs varied within the decorative system and the periods it is therefore possible to distinguish the one from the other. During the Republic, for example, the Pompeian First style in painting was combined with rather geometrical stucco decorations and with dominating floor decorations, often with the insertion of a central *emblemata*. Successively attention was deliberately drawn to the wall decoration and consequently the floor design became less elaborate. A study of the distribution of mythological motifs and mosaics in Pompeian houses has been made by Wallace Hadrill, who states as a fact that such features strongly correspond with the size of the house, and therefore are mainly found in the larger houses.[76] Mosaic floors, for example, occur in about one fifth of the excavated houses.

---

70 Ling, 1999, XII, p. 247.

71 Scagliarini Corlàita, 1998, p. 57.

72 Clarke, 1991, p. 16.

73 Scagliarini Corlàita, 1998, p. 59.

74 Suetonius, Aug. LXXIV.

75 Petronius was a friend of Nero, and by him forced to commit suicide in AD 66.

76 Wallace Hadrill, 1994, p. 154.

In addition to paintings, mosaics, and stucco-vaults, there were statues of marble or bronze in the homes of the wealthy. Statues could also be painted and part of the mural decorations, for example as motifs integrated in garden paintings.[77] Mural paintings representing statues have been studied by Moorman, who used these pictures as a source for understanding the development in Roman statuary, and found that Second style painted statues have an expressive plasticity while Third style statues generally have a more restrained Classic character.[78] Consequently these painted statues are expressions of the general ideals in art during each period and closely correspond with the fashions in three-dimensional art. Fourth style painted do not have general characteristics as those mentioned above, but appear to have been painted in any of those manners, and are often symmetrically disposed on the walls.[79]

The roots in Greek and Etruscan traditions

Greek and Etruscan traditions had, as mentioned above, an unambiguous influence on the progress of Roman culture, and this is clearly noted in the fields of painting and sculpture. A local Roman art tradition may have existed, but there is no remaining evidence which might be taken as undeniable evidence. Ancient sources reveal the tradition of triumphs, public feasts, celebrations of victories and other important accomplishments. These events were, according to tradition, depicted and the pictures, *pitture trionfali* in Italian, were exposed in public places to be recognised and remembered.[80] The tradition of the *pitture trionfali* seems to have been established before the 3rd century BC.[81] Since there is no surviving evidence of these paintings, their actual appearance is not known, and any suggestion of their appearance must be regarded as a more or less qualified guess. There are, however, reasons to assume that a public tradition existed, and flourished under patronage as late as in the late Republic and Early empire alongside with the many Greek paintings then on display.[82]

Early Etruscan art shows influence of Eastern origin, but around 600 BC there was a genesis of change, and an evident influence from Greek geometric tradition has been observed.[83] Etruscan tomb paintings with figural motifs, closely related to Greek tradition, appear already as early as around 500 BC.[84] One such tomb at Paestum, *Tomba del Truffatore,* with mural decorations made by Greek artists, was found in 1968.[85] The decorations, dated to 480 BC, are among the very few remaining works of art made by Greek artists. The Etruscan

---

77 Reuterswärd, 1966, pp. 181-183.

78 Moorman, 1988, p. 64.

79 Ibid, pp. 65-66.

80 Borda, 1958, p. 150; D'Ambra, 1988, p. 18; Wheeler, 1969, p. 174.

81 Paris, 1998, p. 75.

82 Leach, 1993, p. 134.

83 Richter, 1955, p. 8; Sears, 1988, p. 12.

84 Bianchi Bandinelli, 1980, pp. 7, 106.

85 Charbonneaux, 1993, p. 230.

tomb paintings from the early period are, however, clearly indebted to Greek tradition, but very few paintings, according to Ling, rise above the mediocre.[86] Only towards the end of the fourth century and during the Hellenistic period there are hints of a greater independence, with the emergence of new subjects based on local history and ceremonial customs.

According to Pliny all artists in Rome were Etruscan, until in 493 BC, when two Greek artists arrived in the city. This seems probable, since Rome was conquered by the Etruscan in the mid 7th century BC, and the last Etruscan king was expelled in 509 BC.[87] The first known painter of Roman origin was Fabius Pictor, a member of the aristocratic Fabii family. He won fame by decorating the Temple of Health in 304 BC. In a Republican tomb at the Esquiline a narrative painting representing a historical scene with soldiers was found in 1875.[88] One of the depicted is representing a man from the Fabii family. The picture, which appears to be associated with the Samnite war, was painted in a manner related to the Etruscan tradition of tomb-painting.[89] The painting was made in four narrative borders, thereby resembling also the relief fields on the Trajan column.[90] The epic technique, using repetitive categories, has been described and explained by Hamberg.[91]

By the end of the Punic War (212-202 BC), Rome was the greatest power in the Mediterranean area. The fall of Syracuse in 212 BC had brought a flood of Greek art to the capital, and the flow was to continue throughout the 2nd century BC. The sack of Corinth in 146 BC brought Greece under Roman control, and Rome was inundated by a further flood of work of art.[92]

Greek art history begins around 1100 BC but the achievements during the first centuries are rather obscure, and the tradition can not be clearly distinguished until towards about 800. In 776 the Olympic games started. During this Archaic period the geometrical style was dominant, but gradually abandoned between the 7th and the 5th centuries BC. New ideas in plastic art and painting were developing, based on studies of human nature and visual perceptions. The new discoveries were expressed in painting and in plastic art, but also as written treatises on these subjects. One such theoretic treatise was Polykleitos′ *Kanon*, in which he defined the rules for the proportions of the human body. In statuary the most important innovation was the introduction of the movement of the human body, which during Antiquity had been frontal and stiff. In painting and relief works, the discovery of how to make foreshortenings and the illusion of perspective, were characteristic of this new period, and for painting, in addition, the invention of a *chiaroscuro* painting technique.

---

86 Ling, 1991, p. 8.

87 Sears, 1988, p. 12.

88 The decoration is now in the Palazzo dei Conservatori in Rome.

89 Strong, 1976, p. 40.

90 La Rocca, 1998, p. 173.

91 Hamberg, 1945, pp. 108-119.

92 Sears, 1988, p. 19.

According to all ancient writers, the great age of Greek painting spanned the late 5th and 4th centuries BC.[93] Literary evidence consists of complete books, as well as of notes, facts and anecdotes, which provide us with a conception of the development of painting.[94] Since there is hardly any physical evidence of painting itself, these ancient sources have to represent art from the most ancient periods, by reference. By undertaking a careful study of these sources it is possible to understand the development of the new inventions in Greek painting.[95] As support for the ideas concerning such a development other kinds of pictures are available and these substitutes may be used as examples. Decorations made by contemporary Greek craftsmen, on various objects, such as pottery or tomb stones, *stelae*, may provide an idea of what the large size paintings looked like, just as the Roman copies of Greek paintings do.

More than one hundred painted stelae from the Greek-Hellenistic period have been found in two ancient Thessalian towns, Pagasae and Demetrias, situated on the shore at lake Volos.[96] This group of paintings was preserved since the stones were used as building blocks and sealed up in a wall in Antiquity, so that when they were excavated, the colours were in many cases still fairly fresh.[97] These tombstones are dated between the 4th and the 2nd centuries BC.[98] Usually the motifs are simple and representing one or two figure subjects, but at least in one case, the stone of Hediste, a more complex picture is painted on the gravestone, which may indicate the elaborate Greek painting.[99] Other Greek originals are a group of monochromatic paintings on marble panels, which were found at excavations of Herculaneum. One of these small size paintings shows five women playing astragoli. The picture, dated to the Hellenistic period, was signed by Alexander from Athens.[100]

Contemporary ancient sculpture may also be used as a source for understanding and reference to the possible appearance of Greek painting. Even though, by these means, it is possible to form a conception of Greek painting, it must be remembered that such an understanding is very subjective, based on personal interpretations and imaginations.

Painting is supposed to have initiated with a linear and monochromatic phase, which successively developed into a new oligochromacy.[101] Under the influence of some artists during the 5th century BC, many important discoveries were made, which to a great extent form the base of the the Western painting tradition. Polygnotos from Thasos was known for using only four colours: white,

---

93 Ling, 1991, p. 5.

94 Luciano, *Zeusio Antico*; Pausanias, *Pereigese della Grecia*; Plinius, *Naturalis Historia*; Plutarch, *Vite parallelle*; Suetonius, *De vita XXI Caesarum*; Quintilianus, *Instirutio oratoria*, etc.

95 Baldassare, 1985, p. 203.

96 von Graeve, 1981, pp. 122-127.

97 Bruno, 1977, p. 26.

98 Bianchi Bandinelli, 1980, p. 19.

99 Ling, 1991, p. 7.

100 Salvetti, 1998, p. 89.

101 Plinius, NH XXXV, 15.

black, red and yellow.[102] He was much admired for his talent of expressing feelings in his paintings, and he had a special preference for making pictures composed with numerous persons.[103]

Contemporary with and a rival to Polygnotos, was Micion from Athens, known as a painter of battles. In one of these paintings, the battle at Marathon, he portrayed the Athenian generals and behind them the Phoenician fleet. In the background, behind the flat battle fields, high mountains were depicted. From the remaining written description this painting seems to have been an early attempt at perspective painting.[104]

Kymon from Kleonai, also active in the middle of the 5th century, discovered how to make foreshortenings in the drawings of human bodies, and at the end of the same century Agatarchos from Samos invented the perspective, a pictorial problem on which he wrote a treatise.[105] He was using perspective when painting scenographic decorations for the tragedies of Aeschylus.[106] The knowledge of linear perspective remained, however, incomplete, since the different parts of objects presented in painting were not correlated to a singular vanishing point. This partial perspective was used by the whole ancient and medieval worlds.[107] Another painter of the century was Agatarchos, who was regarded as a modern painter with great originality.[108] At one time he was more or less kidnapped by Alcibiades who ordered him to paint the walls in his house.[109] This behaviour provoked a scandal at that time. Whether the scandal was related to the conductment of Alcibiades or to the fact that Agatarchos had to make wall-paintings instead of *pinakes*, is not clear. It has also been suggested that the hard reactions from the Greek public might be due to the *hybris* of Alcibiades to decorate his private home, a habit not adopted by the Greeks, who had only their public places decorated.[110]

During the 4th century BC Greek art reached its peak as far as perfection of techniques is concerned. Artists had discovered how to express physical movement and human emotions. Foreshortenings in the drawing of the human body and an imperfect form of perspective were known. Artists of this century invented an impressionistic painting technique, defined as *compendiaria* by the Romans.[111] The style was characterised by a rapid drawing with soft outlinings, gradations of hues in the vision of shadows and light, and a final addition of bright highlights.[112]

---

[102] Polygnotos from Thasos, Greek painter, active in Athens about 470-440 BC. Büll, p. 338.

[103] Villard, 1993, p. 246.

[104] Ibid, p. 246.

[105] Ibid, p. 307.

[106] Aeschylus, Greek drama writer, active between 490-456 BC.

[107] Richter, 1955, p. 85.

[108] Kjellberg, 1932, p. 177.

[109] Alcibiades, Athenian noble man, 431-404 BC.

[110] Baldassare, 1985, p. 210.

[111] Plinius, NH XXXV, 110; Petronius 2,2.

[112] Iacopi, 1999, pp. 23-24.

Artists of this period were representing single persons as well as making complex figure scenes and landscapes. Landscape paintings later became much appreciated, especially during the Hellenistic period.[113] When Pliny points out Ludius as the inventor of landscape paintings, this obviously is not correct, but Ludius was possibly the artist who transformed the Greek landscape prototypes into views of actual Italian villas and scenes.

Chiaroscuro and perspective were, as mentioned above, new accomplishments in painting during the Classical period, and gradually these inventions developed into a kind of impressionist painting. Plato, who was rather conservative in his opinion of art, did not approve of the paintings of his time. He found that the artists did not depict the structural reality of things, but rather created illusions of sensations, which he considered doubly deceiving. Aristotle on the other hand, accepted the poetic qualities of art as representations of human truth.[114] Some centuries later Vitruvius expressed similar complaints as Plato, about his contemporary art.

The most famous of all Greek painters was Apelles, who was the only painter allowed to depict Alexander the Great, just as Lysippos had the same privilege as a sculptor.[115] According to Pliny, Apelles worked in tempera which he preferred to wax paint, and he used only four colours, but with those he could create infinite variations. He had made a portrait of Alexander, with the attribute of Zeus, the flash of lightning, in his hand, a painting which made great impression on the public, since for the first time a ruler was portrayed with the attributes of a god, and consequently was associated to the god.[116] The first portraits representing Romans as Hellenistic heroes or gods, appeared during the Republic, e.g. the honorific statue of a Roman general, c. 180-150 BC, who is depicted as a Hellenistic king. Such a figure was unfamiliar to Roman traditions.[117] During the Hellenistic and Roman Imperial periods such representation appeared quite frequently, and was used by the Emperors Augustus and, above all, by Nero, who was fond of manifesting himself as correlated to the Sun-god, Helios.[118]

Greek paintings as well as sculptures were brought as spoils of war to Rome in large numbers and these booties subsequently were exhibited in public places in Rome, according to Livy, Polybius and Pliny.[119] Consequently there were many original works of art for artists, living in Italy, to copy already during the 1st century BC and also later, during the Imperial period. The Emperor Augustus highly esteemed Classical Greek art, and under his patronage and that of his intimate friends, artists and writers were drawn to the capital city from the

---

113 Richter, 1955, p. 82.

114 Bianchi Bandinelli, 1980, pp. 12-13.

115 Lysippos, Greek sculptor, born 390 BC, active during most part of the 4th century.

116 Kjellberg, 1932, p. 242.

117 Zanker, 1988, p. 4-8.

118 Iacopi, 1999, p. 31.

119 Richter, 1955, p. 75.

provinces as well as from other parts of Italy, and consequently the face of the Latin culture changed within a few years.[120]

Most artists who worked for the Romans were Greek, many of them from Athens, but also from other places within the Magna Grecia.[121] The style of all artists was however the same, based on their common heritage from the Greek Classical and Hellenistic periods.[122]

Pinakes and Fayum portraits

Small picture panels, *pinakes*, which were inserted into the walls and integrated in the pictorial scheme, were another reflection of the Graeco-Roman tradition. Such easel-paintings appeared in Greece towards the end of the 5th century BC, and during the following century they became a popular kind of decoration. In fact *pinakes* were considered by the Greek to be an art form superior to wall-painting. They were also much appreciated by the Romans, who brought many of these small size paintings to Rome between the 5th and the 1st centuries BC.[123] These paintings served as models for artists working in Rome.

Early Roman *pinakes* from the Second style were principally framed wooden panels with wooden shutters, like those of later triptychs. Such paintings were exposed in large collections, *pinakothecae*, at occasions open to the public, with the intention to show the wealth of its owner.[124] These galleries included original Greek works of art.[125] The fashion of decorating rooms to look like *pinakothekae* reached Rome at the very end of the Republic.[126] These wallpaintings were not necessarily substitutes for real galleries, since they are also found in even the most expensive houses.[127] Rather they create a symbolic system in which luxury articles actually present in many villas are combined with imagined spaces and objects. The appearance of these small paintings changed through the period. Early *pinakes* were generally made in a sketchy way in contrast to the carefully painted illusionistic architecture into which they were set.[128] The motifs were mostly human figures or still lifes, a genre known since the Greek-Hellenistic times. Vitruvius speaks about the *xenia*, guest gifts, which was a class of paintings depicting the provisions made by the hosts to their guests, given as self-supports while being visitors.[129] During the progress of the Second style the *pinakes* were more often set directly into the wall, and the real shutters gradually disappeared in favour of painted ones. Landscapes with human figures and mythological motifs were new kinds of sceneries, more carefully modelled than earlier, and surrounded by illusory painted frames, made to resemble real

---

120 Goodman, 1997, p. 179.

121 Schefold, 1962, p.18; Sears 1988, p. 19.

122 Richter, 1955, p. 88.

123 Bianchi Bandinelli, 1980, p. 36; table at pp. 228-231.

124 Moorman,1998, p. 21.

125 Zanker, 1998, p. 21.

126 Wallace Hadrill, 1994, p. 30.

127 Zanker, 1998, p. 22.

128 Ling, 1991, p. 112.

129 Bianchi Bandinelli, 1980, p. 78; Curtius, 1929, p. 151; Ling, 1991, p. 154.

wooden or stucco frames. The pictures, occasionally, were painted as if standing on an easel, to give the impression of them being presented in a picture gallery.[130] More or less the same painting technique was used for the pictures and for the surrounding decorations, and consequently the difference between the "inserted" pictures and the general room decorations was not so far apart anymore.

A specific type of small size Roman painting appeared in Egypt during the Imperial period, namely the Fayum portraits. These portraits stylistically resemble painted portraits found in Pompeii, and the depicted personalities wear tunics and mantles of Roman style. Hairstyles of both women and men follow the fashion set in Rome. Even though these portraits are part of the Egyptian sepulchral tradition, they ought primarily to be considered as exponents of Roman art. The Fayum portraits are painted on thin wooden panels, which were superimposed on the face of the mummy and inserted into the mummy bandages. Many of these portraits were painted in encaustic, other in tempera or with Punic wax. This painting tradition is described in a separate publication.[131]

Originals and copies

Subjects presented in Roman art were to a great extent of Greek origin, and there are surprisingly few paintings with genuinely Roman motifs. In fact the figures repeat familiar Greek types from the 4th to the 2nd century in painting as well as in three-dimensional art. Even though the painted architecture changes within the four Pompeian styles, the painted figures remained the same.[132] Due to the existence, in some cases, of several copies of the same subject, it has been suggested that there existed some kind of common source.[133] The same kind of repetition of specific motifs can be observed in mural painting and plastic art.

The re-use of drafts for mural paintings has been suggested.[134] How copying was done is guesswork, according to Richter. The practice of copying famous paintings was established during Antiquity, and was recorded as such by, e.g. Pliny the younger and Lucian.[135] It has been suggested that copies of popular paintings might have been collected in albums or pattern-books. According to Ling the existence of artists' pattern-books has been questioned, but he states that their evidence has been considered as overwhelming.[136] Andersen has questioned the existence of such pattern-books, but admits that there might have existed artists' personal sketchbooks, containing a collection of stock figures and a fairly large repertoire of iconographical schemes as well as details for different settings, useful for the artist.[137] This seems very likely, since artists' sketchbooks

[130] Ling, 1991, p. 135.

[131] *Fayum portraits in Nationalmuseum. Documentation and scientific analyses of portraits belonging to Nationalmuseum in Stockholm.*

[132] Richter, 1955, p. 77.

[133] Moorman,1998, p. 21.

[134] Andersen, 1985, p. 125.

[135] Richter, 1955, p. 76.

[136] Ling, 1991, p. 218.

[137] Andersen, 1985, p. 123-124.

usually contain elaborate pictures as well as rapid sketches and studies of details. In my own opinion, pattern-book may be just another word for sketch-book, since the drawings collected, or made by the artist, were used as models for the subjects in the painted decoration. The painters did not, however, copy these drawings exactly, but rather adapted and altered them just as much as was needed to fit Roman taste and the spaces given them to fill.[138] This leads to the issue of copying as such. Definitions of the terms and concepts behind terms such as *original*, *copy*, *replica*, *model*, *prototype* etc, have been thoroughly made by Leander Touati.[139]

Specific for Roman art was the repetition of popular motifs, which resulted in a large number of copies and replicas of paintings as well as statues. From the reign of Augustus until the middle of the 3rd century AD there was an intense activity in producing copies of Greek sculpture.[140] For several centuries, numerous generations of sculptors were mainly occupied in repeating or slightly varying Greek motifs.[141] The marble copies of the Tyrant-slayers, made from the original Greek bronze statues, have been described in a study by Brunnsåker.[142] Vast numbers of replicas of official statues representing the Emperor and his family were also made and sent to the provinces.

Accurate, mechanically produced copies in marble were made by use of the copying machine, which had been invented about 100 BC.[143] This process, still in use today, consists in the transference of measures from a statue to a block of marble, which then is cut according to the measures indicated by the little dots marked on the marble block. It has been possible to reconstruct missing parts of copies by using a cast from Greek originals. The pieces, when brought together, did match without difficulty.[144]

Further, freely executed copies exist in many different forms. Some were reduced in size in contrast to the original, while others were made as replicas of well-known statues with the attachment of different portrait heads. There were changes in gestures, rearrangements of folds of the drapery or additions of details.[145]

A popular statue, the Resting Satyr, has been found in more than one hundred replicas, while satyrs represented in other poses not have been found copied so frequently.[146] This over-representation of one motif may have been due to the availability of copies offered by the studios. Another possible explanation is that some statues may have been preferred by the public, considered as more beautiful than others, and consequently ordered. Some of the statues most

---

138 Leach, 1993, p. 149; Ling, 1991, p. 221.

139 Leander Touati, 1998, pp. 82-86.

140 Poulsen, 1949, p. 89.

141 Leander Touati, 1998, p. 82.

142 Brunnsåker, 1971, pp. 45-46.

143 Richter, 1955, p. 37.

144 Richter, 1955, p. 38; Brunnsåker, 1971.

145 Richter, 1955, pp. 41-43.

146 Bartman, 1994, p. 75.

esteemed nowadays were virtually ignored by the Roman copying industry, as for example the Apoxyoumenos of Lysippos.[147]

Like in other sectors of life, Romans had a utilitarian approach towards art. Not only private houses but also public buildings were enriched with statues, works whose associations were immediately recognizable by everyone.[148] The use of art as a means of propagandistic messages during the Augustan period has been pointed out by, e.g. Kellum, Nodelman and Zanker.[149] This aspect has been acknowledged by Kleiner in her study of the connection between the Augustan family programme and the family groups represented on the reliefs on the Ara Pacis Augustae.[150] These aspects of Roman portraiture, thoroughly studied by Bartman, have been presented in a publication of the political role of Livia, as envisioned in her portraits.[151]

There are indications suggesting that one important aspect for the choice of an object was the suitability of the theme within the frames set by milieu, and that this aspect was more important than the beauty of the singular object or the name of the artist who had made it.[152] Sculpture contributed to offer each setting its distinctive identity. Consequently there was a great need for replicas, and numerous variations on some themes were endlessly repeated. Art obviously played an important role in Roman society.

Marble statues were, as mentioned above, serially reproduced in various workshops within the Roman Empire. Such reproduction was, however, rather time-consuming, since each statue had to be individually carved. Copies of bronze statues were relatively more easily made. Lucian refers to the practice of having casts taken from popular Greek bronze statues, such as the Hermes in the Agora of Athens, which he claims to have been taken casts from, every day.[153] Casts of polychrome marble statues were probably made just as often to satisfy the great need of Roman plaster casts in the copying industry.

Painters and workshops

The uniformity in mural decoration has been discussed by de Vos, who has pointed out the fact that the decorators from different workshops, *botteghe*, in Pompeii used the same motifs, subjects and colours, all based on models, which might have consisted of iconographic cartoons for the paintings and wooden stamps for the stuccoes.[154]

In Greek tradition painters either were wall-painters or *pinake*-painters, the last indicating painters of small size pictures, either made in tempera or encaustic. The Roman tradition was, as mentioned above, quite different. The

---

147 Ibid, p. 77.

148 Marvin, 1993, p. 169.

149 Kellum, 1993; Nodelman, 1993; Zanker, 1998.

150 Kleiner, 1993, pp. 27-52.

151 Bartman, 1999.

152 Marvin, 1993, p. 166.

153 Lucian, Zeus Tragodos 33, Richter, 1955, p. 39.

154 de Vos, 1985, p. 119.

wall-painter was in Greek tradition not as highly valued as the *pinake*-painter. It has been supposed that such professional differentiation did not exist in Roman culture, where painters commonly painted directly on the wall. The distinction was rather between the *pictor colorator*, who painted the wall, the *pictor parietarius*, who decorated the walls, and the *pictor imaginarius* who was the motif and figure painter.[155] These terms are commonly used in scholarly publications concerning Pompeian painting, but objections to these distinctions have been raised, since there are no indications that the terms were used before the Edict of Diocletian VII 8-9.[156] This edict has been quoted by Barbet as the source for the above mentioned professional classification, and the terms are commonly used today, by her and other scholars.[157] According to Andersen integrated painted architectural and figural motifs had gone out of fashion during the time of Diocletian, and he is therefore suggesting that the term *parietarius* indicated a wall-painter while *imaginarius* indicated a portrait painter. According to Andersen the terms *painter* and *decorator* thus are more adequate, which seems reasonable, since a *painter* of the Roman period, in contemporary inscriptions was referred to just as *pictor*.[158] Iacopi states that the decorative programme in the room of Acilles at Scyros in Domus Aurea was an artistic unity, where the most simple decorations were made by the *parietarii* and that the *pictor imaginarius* made the figure scenes.[159]

Disregarding these terminological disputes, it has been observed that more than one painter worked on large size murals. That so was the case becomes obvious, when studying the so called "room of the painters" in Casa degli Casti Amanti a Pompeii. The room was being re-decorated at the time of the Vesuvian eruption, and one can see that work progressed at different phases contemporaneously. It therefore seems quite correct to assume that some painters, maybe assistants or pupils, were applying the background colours, others painted the general setting and the master painted the figure motif. In such case, and with the Anderson terminology the master may be identified with the *painter (pictor imaginarius)* while the background decorator was the *decorator (pictor parietarius)* who might or might not have had some help from an assistant. The *painter* may have created portraits or figures of any kind, while the *decorator* contributed with the painted environmental setting.

Remains from the Vesuvian towns of Antiquity, provide evidence that one and the same figure painter, *pictor imaginarius*, could have been employed by several workshops, and also that a singular workshop could have employed more than one figure painter.[160]

---

155 Borda, 1958, p. 381; Iacopi, 1999, p. 51.

156 Andersen, 1985, p. 113.

157 Barbet, 1998, p. 104.

158 Andersen, 1985, p. 113.

159 Iacopi, 1999, p. 51.

160 de Vos, 1985, p. 121.

Wall Paintings

The development of the four so called Pompeian styles and their main characteristics will be briefly delineated. Technical aspects such as how Roman walls were plastered, what materials were used and how the paintings were made will be presented.

Wall decoration

It is generally accepted that the Roman custom of painting interiors was established with the First Pompeian style, but fragments of painted plaster from Archaic houses on the Via Sacra in Rome indicate that the tradition of mural decoration is even older.[161]

Evolution in mural painting can be followed from the early geometric patterns, imitating the marble coatings of Hellenistic palaces from the beginning of the 2nd century BC, and up to the mature state of the Pompeian Fourth style paintings at the end of the Julio-Claudian period.[162] These kinds of observations are, mainly, possible due to the discoveries in the Vesuvian region, where large areas of land were covered with a thick layer of volcanic ash, lava and mud, by the eruption of Vesuvius in AD 79. This marked the end of life in several small Campanian towns. From the archaeological point of view this has been most fortunate since there is a limited period within which all activities of the sites can be dated. The sites remained almost completely untouched by man from AD 79 until the excavations in the area started in 1738 and 1748. Also in the city of Rome, and its surroundings, several buildings have been found having paintings preserved from the different, so called, Pompeian styles, and those paintings are by some scholars considered to be of a higher quality than those from the Vesuvian area.[163] It is generally supposed that the paintings in Pompeii were stylistically influenced by those made in the city of Rome and not the other way around.[164] One reason, indicating such a development, is that the loots of Greek art from the imperialistic war campaigns that arrived in Rome, were shown there and consequently first became known to the inhabitants of the capital. As Greek art rapidly became popular in the ruling classes, it was spread by them, not only to the Vesuvian area but within the entire Roman empire. As far as the Second style paintings are concerned, murals in this style appeared in Pompeii during the early first century BC, while paintings from the Casa dei Grifi in Rome are dated to the same period or a little earlier.[165]

The Greeks had considered easel painting as the superior art form, which the Romans did not. In Roman art the architectural scheme and the decorative system were of major importance, and into this context the decorative details

161 Leach, 1993, p. 135.

162 Barbet, 1985; Bianchi Bandinelli, 1980; Bragantini, 1985; Clarke, 1991; Curtius, 1929; De Vos, 1985; Ling, 1991; Maiuri, 1931, 1961; Mau, 1908; Moorman, 1998; Wallace Hadrill, 1994.

163 Paris, 1998, p. 73.

164 Iacopi, 1997; Ling, 1991.

165 Ling, 1991, p. 23.

were set. The iconographical programme of a room has often proved to be a unity.[166] Therefore the decorations and inserted paintings must be viewed in their context, as an integral part of architecture.[167] There were great varieties in the performance of wall decorations, but the architectural scheme was followed rather strictly. The main characteristic was the division of the walls in three horizontal fields, the socle, the main field and the upper field, sometimes with the addition or reduction of one field.[168] The upper field often presented a frieze, either painted or in stucco, and the main field successively developed into the pictorial field, with figure paintings or landscapes inserted into the arcitectural setting. The insertion of a central painting in the main field is traceable from the second phase of the Second style. In some houses at the Palatine in Rome, such paintings are still *in situ*.[169] The socle was generally kept monochrome, or just simply decorated, e.g. with floral motifs. The horizontal areas were intersected by verticals, such as by stucco semi-pilasters in relief, thus dividing the wall into sections.

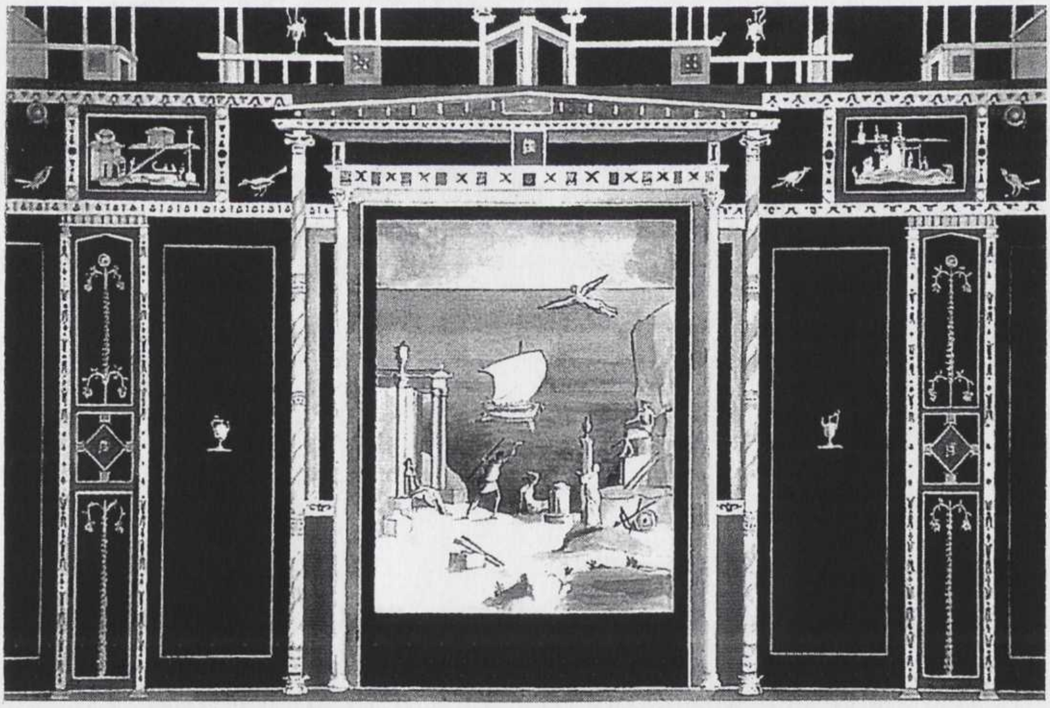


Fig. 28. The division of the wall, Third style. After Nicholas Wood, *Sotto i lapilli*, 1998, p.35.

166 De Vos, 1985, p. 271.

167 Moorman, 1998, p. 14.

168 Moorman, 1998, p. 17.

169 Bragantini and Badoni, 1985, p. 257.

The four Pompeian styles

Pompeian mural decorations are divided into four styles, which have been thoroughly defined and described ever since Mau made this classification in 1882.[170] Mau based his style identification on Vitruvius′ written descriptions of the successive changes in Roman painting. Vitruvius had pointed out (7.5.1-3), that a development and transformation in painting had taken place, from the ancient, *antiqui*, i.e. the Etrusco-Roman and Graeco-Hellenistic decorations imitating marble, to the degenerate style of his own period.[171] These phases roughly correspond with the First, Second and Third styles defined by Mau, who also identified a following Fourth style. This classification system is still followed today, even though there are different opinions on how to define the styles and date them, some of them rather complex, such as the categories defined by Barbet. She divides, e.g. each of the Second and the Third styles into three major phases, and in addition the transitional phases in between the styles.[172] In this context just the general lines will be pointed out, and the dating by Ling is principally followed.

The First style

First style decorations are stylistically homogeneous and were used during a long period.[173] Such decorations in Pompeii and Herculaneum may be dated approximately between the 2nd and 1st centuries BC.[174] The First style, also called the incrustation style, derived from the Hellenistic tradition, where marble-coated walls seem to have been used since they were first recorded at the Palace of Mausollos in Halicarnassos, in the middle of the 4th century BC.[175] Rather than being a painting style it is a plaster cast of architectural forms.[176] This style was basically consisted of geometric decorations, the walls divided in stucco relief blocks and painted as imitations of marble and masonry.[177]

Even though the First style was inspired by Hellenistic tradition it was in some aspects different to its precursors already from the beginning. One distinction is that the Roman socle became much higher, from about 30 cm to 100 cm. The Greek base, consisting of standing orthostates, had an architectonic function, while the high Roman base generally was flat, and successively became decorated. These factors led to the Roman socle losing its architectonic function and becoming a part of the decoration.[178] Another difference is that polychromy became richer.[179]

---

170 August Mau, German scholar.

171 Leach, 1993, p. 136; Borda, 1958, p. 5.

172 Barbet 1985, pp. 36-42, 96-127.

173 Ibid, p. 12.

174 Ling, 1991, p. 13.

175 Ortolani, 1989, p. 31.

176 Clarke, 1991, p. 39.

177 Mau, 1908, p. 39; Borda, 1958, pp. 5-7.

178 Schefold, 1962, p. 21.

179 Barbet, 1985, p. 25; Borda, 1958, p. 15.

For the families who could afford to pay for decorations with real marble, the possibilities of choice were many. A vast selection of coloured marble was imported to Rome during the 2nd century BC, and during the Augustan period a great number of different marbles arrived from all over the Empire.[180] These decorations were, of course, extremely expensive and consequently could only be afforded by wealthy families.[181] Painted imitations on the other hand provided a similar impression, and were available at a lower cost. There are many examples of mural decorations in the First style across the former Hellenistic world, and in particular on the island of Delos in Greece. The painted marble blocks could either be imitating real marbles, or they could be pure decorative inventions. Above the marble blocks in the main field in the, so called, upper field, were often paintings of ornamental decorations or with figural motifs.[182] The figural motifs were generally monochrome, painted on the basis of imitating marble.[183] First style decorations occur in the Casa del Fauno in Pompeii, where also the famous mosaic floor decoration, representing the battle between Alexander and Darius was found. This large size mosaic decoration, 2.17 x 5.12 m, was made in *opus vermiculatum* and signed by Philoxenos from Eretria. The picture, mentioned by Pliny, was a copy of a painting which was brought to Rome where it was much admired.[184] Mosaics made with extremely small tesserae such as these are typical for the late phase of the First style about 100-80 BC. Often the size of the tesserae were just between 1 and 5 mm.[185] Mosaics from the early period were mainly simple cement pavements, decorated with rows of tesserae, either in black (*lava pesto*) or red (*coccio pesto*), forming geometric patterns.[186]

The Second style

The following Second style is also called the architectonic style.[187] As Schefold says, in the First style the details in the decorative system are treated as singular unites, while in the Second style, the optical unity of these elements are aimed at.[188] This style may be divided into two major phases, and dated roughly between 80 and 40 BC, and from 40 to 15 BC respectively, i.e. during the years from Sulla to Caesar and from the Second Triumvirate to the early years of the reign of Augustus.[189]

---

180 Gnoli, 1989, p. 13.

181 Among the marbles imported were, e.g. *pavonazzetto* from Phrygia, *cippollino* from Greece, *giallo antico* from Numibia, and from Turkey arrived red and green *africano*. Red and grey *granite*, various kinds of *alabaster* and red and black *porphyry* were imported from Egypt. Green *porphyry* was imported from Sparta. White *marble* arrived from Greece, and also from the Luna quarry at Carrarra in Italy, opened by Julius Caesar.

182 Moorman, 1998, p. 23.

183 Barbet, 1985, p. 27.

184 Salvetti, 1998, p. 90.

185 Clarke, 1991, p. 40.

186 Ibid.

187 Curtius, 1929, pp. 51, 80; Mau, 1908, p. 41.

188 Schefold, 1962, p. 27.

189 Ling, 1991, p. 23. According to Moorman, 1988, p. 37, the second phase of the Second Style is dated

This style was preferred by Vitruvius, who described the development from the First to the Second style as follows:

"Then they proceeded to imitate the contours of buildings, the outstanding projections of columns and gables; in open spaces, like exedrae, they designed scenery on a large scale in tragic, comic or satyric style."[190]

Early motifs in the transition between the First and Second styles are cubes seen in perspective and the motif of painted closed doors, a well known motif also in Egyptian and Macedonian tombs.[191] The Second style is characterised by illusionistic environments, combined with real architectural structures. The architectonic interior setting was complex, since there were real doors and openings, real columns and pillars, but also three-dimensional insertions of architectonic elements made in stucco relief. Illusionistic apertures were painted, through which an imaginary architectonic milieu, sometimes with human figures, could be seen. Also floral or garden motifs were common in these painted openings. Compositions with mythic, heroic, or religious motifs appear during this period, painted in the main field of the wall.[192] At the introduction of such motifs, the *emblemata* decorations in the centre of the mosaic floors tend to disappear.[193] These picture mosaics were mostly prefabricated and portable and could therefore be removed from one floor and laid in another environment if the owner desired.[194] An additive complexity during the Second style consisted of paintings inserted into the walls, which could be real *pinakes* or otherwise decorations painted to look like *pinakes*. It may be stated in brief, that the Second style developed from massive architectural forms in the early phase into light and elegant decorations at the end of the period.

The transition of the Second into the Third style is indicated by the end of realism in the representation of architectonic details such as columns and pillars, which tended to become linear decorations without any illusive supporting function. Motifs from Ptolemean Egypt appear already during the Second style, and symbols, such as the lotus blossom and the snake, connected with the Isis cult became frequent.[195] Other Egyptian motifs were sacral landscapes with crocodiles, Amor as a scorpion, waterbirds, etc. A representative example of the early Second style is the Casa dei Grifi in Rome, dated to about 80 BC, and the earliest known example of this style.[196] The massive architectural forms are new inventions, combined with imitations of marble and alabaster, which are remains of the previous period.[197] In addition there is a cubic pattern appearing on the

---

to between 30 or 20 to 10 BC.

190 Vitruvius, VII.5.2.

191 Barbet, 1985, p. 29.

192 Maiuri, 1931, p. 12.

193 Bragantini and Badoni, 1985, p. 257.

194 Clarke, 1991, p. 41.

195 Schefold, 1962, p. 29.

196 Clarke, 1991, p. 41.

197 Borda, 1958, p. 23.

socle in Room II and an orthostate decoration in Room IV. Such patterns were known from *opus sectile* pavings, but are in Casa dei Grifi appearing on the walls, painted in red, black and white.[198] Another characteristic of this early Second style is the asymmetrical perspective characterised by the lack of a vanishing point, toward which orthogonals can converge in the middle of the right or left walls.[199] A good example of the late phase Second style is the painting cycles of the House of Augustus – House of Livia at the Palatine and Villa della Farnesina, dated to about 30-20 BC.[200] The paintings in Aula Isiaca may also be related to the cycle of paintings mentioned above and dated to the end of the period, about 20 BC, in the transitional period between the Second and the Third style.[201] Rizzo interprets this space as a cult-room, and based on this opinion he dates the paintings to a much later period, the reign of Caligula (AD 37-41). Since the Isis cult had been forbidden by Augustus in 20 BC, the room could not, according to Rizzo, have been decorated during this period, but must have been made during the reign of Caligula, who officially re-established the cult.[202] According to Barbet this dating, based on the assumption that the Aula was a cult-room, is too late, and archaeological evidences confirm a dating of about 20 BC.[203]

The houses of Livia and of Augustus at the Palatine reveal rooms which are preserved with first class paintings from the second phase of the Second style. The House of Augustus was found at the beginning of the 1960s on the south-east side of the Palatine, and excavations have shown that a ramp connected the house directly to the forecourt of the temple of Apollo. According to Suetonius, the temple was built on that part of his house which the soothsayers declared was desired by the god since it had been hit by lightning.[204] The house consists of a group of private and public rooms situated along the peristyle connected to the House of Livia. In the upper bedroom, for the first time, a fully integrated composition of painting and stucco relief occurs.[205] Augustus was known by his contemporaries, not to be addicted to luxury, but chose to live in modesty. Suetonius describes with evident surprise that Augustus had only one bedroom, which he, during forty years, used in both summer and winter.[206] This is confirmed by the remains of a rather modest building, but since the temple of Apollo was erected in close proximity, the various buildings became like a part of a whole complex. Costly materials were, however, used for the pavements in *opus sectile*, and the wall decorations were made by first class painters. The public part of the building is decorated with traditional motifs, possibly dated to

[198] Barbet, 1985, p. 29; Ling, 1991, p. 24.
[199] Clarke, 1991, p. 43.
[200] Iacopi, 1997, p. 5.
[201] Barbet, 1985, p. 97.
[202] Iacopi, 1997, p. 5.
[203] Barbet, 1985, p. 97.
[204] Suetonius, The divine Augustus, XXVIII, 3ff.
[205] Ling, 1991, p. 45.
[206] Suetonius, Aug.LXXII.

the middle of the 1st century BC, while the private rooms are decorated in a less strict manner.[207] Lately, some of the large amounts of fragments of wall paintings, excavated about three decades ago, have been given new attention, and conservators are working with the material. Presumably these fragments will give important additional knowledge of the decorations in the House of Augustus. A preliminary impression is, however, that the paintings were of highest quality, and, at least partly, decorated in a style indicating the Republican period.

The origin of the Second style has been debated, and the two main alternatives are relating it to contemporary stage scenery and contemporary actual architecture. The decorations in the *Stanza delle Maschere* in the House of Augustus are unmistakable allusions to stage decoration respectively.[208] The remains of a Roman villa which probably belonged to Giulia, the daughter of Augustus, and her husband Agrippa, have been found and excavated at the Villa della Farnesina in Rome, considered to be from the transitional phase of the Second style into the Third style.[209] The paintings, made in the four buildings mentioned above, are similar in style, and it has been suggested that one main workshop was charged with commissions by Augustus and Agrippa.[210] Floral patterns and mythological motifs as well as a preference for animals and figures growing from tendrils are common, and the delicate and elegant drawing is significant for those mural decorations.[211] Also Barbet is of the opinion that the decorations in the *Stanza delle Maschere* must have been painted by the same artist who worked in the House of Livia.[212]

Art of the Augustan period was inspired by the Classical Greek tradition, and adapted to Roman taste. The classicising tendency of the period depended on the intimate contact with the Hellenistic culture, after the Roman conquest of Greece.[213] This is evident in sculpture but also in the elegant and linear mural decorations. Initially favoured by the emperors and noble classes, the classic style was soon adopted by the bourgeois patrons, which led to the popularisation of aristocratic taste.[214] A different kind of Second style decoration is seen in the *megalographiae*, an expression used by Vitruvius, which actually means paintings of large dimensions.[215] These paintings were compositions with figures of natural size, often depicting initiation rites, such as in the Villa of the Mysteries.[216] The rites depicted on these walls have been interpreted as rites of marriage, of fertility or as Dionisiac rites.[217]

---

207 Moorman, 1998, p. 29.

208 Wallace Hadrill, 1994, pp. 26-27.

209 Clarke, 1991, p. 52.

210 Clarke, 1991, p. 56.

211 Ling, 1991, p. 216.

212 Barbet, 1985, p. 42.

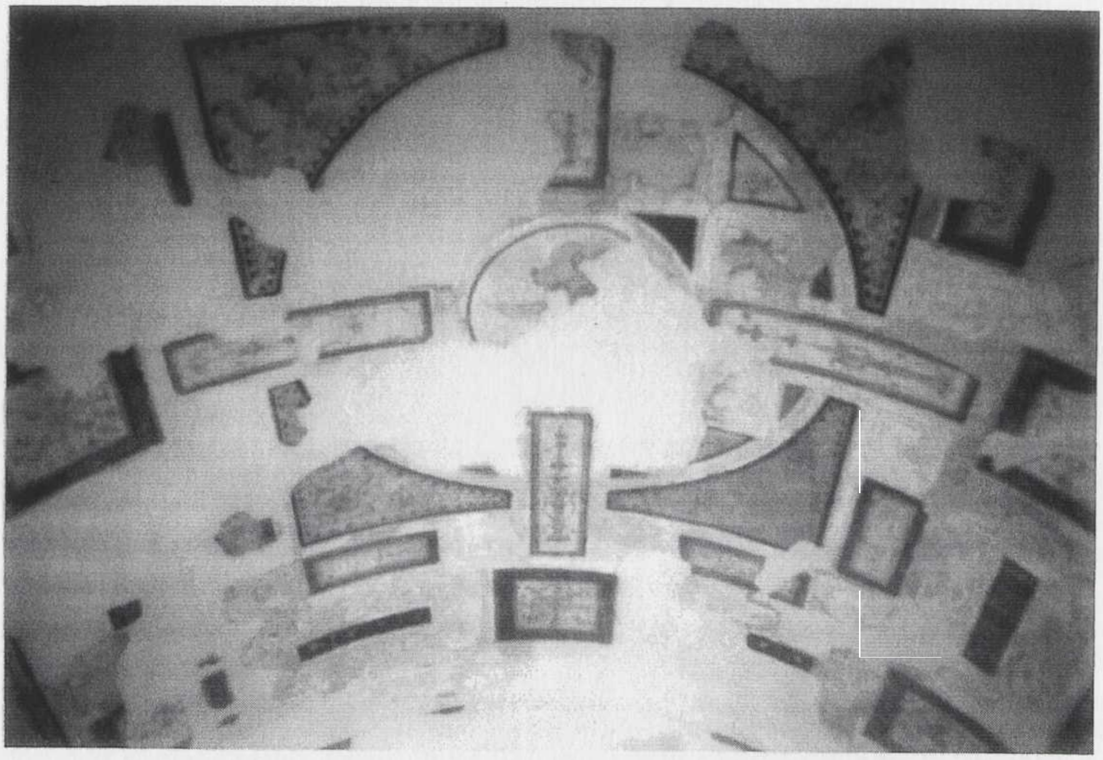
213 Borda, 1958, p. 187.

214 Goodman, 1997, p. 186.

215 Vitruvius, VII, 5.

216 Scagliarini Corlàita, 1998, p. 63.

217 Barbet, 1985, p. 52.



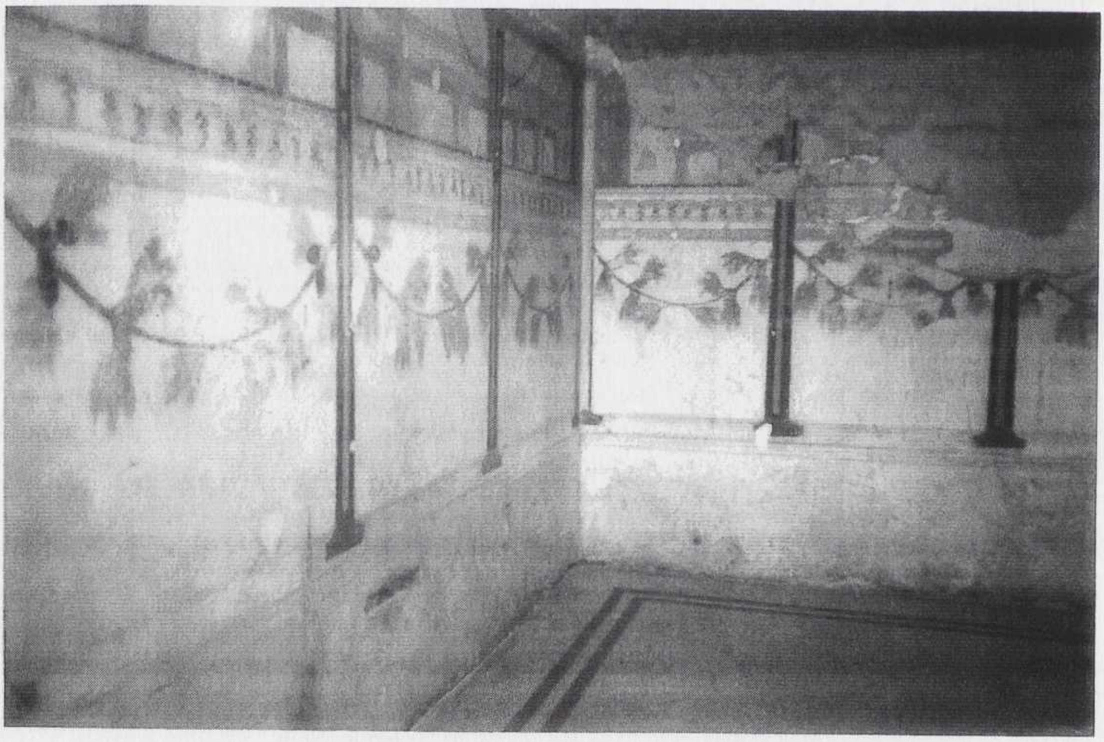


Fig. 27. Second style paintings from the House of Augustus at the Palatine in Rome.
Above. Vault in the upstairs *cubiculum*, c. 30-20 BC.
Below: *La stanza dei pini*, c. 30-20 BC.

Fig 28. The House of Augustus, decorations in the upstairs cubiculum, c. 30-20 BC.

Philosophical or historical allegories were other grand Second style motifs as were also entire rooms painted as gardens, such as in the Villa of Livia at Prima Porta, now exposed at the Museo Nazionale in Palazzo Massimo in Rome. These garden paintings contain a lot of information regarding plants and birds. There are indications that Livia inherited the country estate at Prima Porta, which was known to have been in the possession of her family for generations. According to Pliny, Livia was on one occasion seated in this house when she was engaged to Octavianus, later to become Augustus, and an eagle, passing in the sky, dropped a white hen into her lap, without hurting it.[218] Another miracle was that the hen, in its beak, held a laurel branch bearing its berries. Since this was interpreted as a good omen, the augurs ordered that the hen should be protected and that the laurel branch should be planted. The house thereafter was called *ad gallinas albas* referring to the white hen. Also Suetonius tells a similar story.

Excavations at the villa are still in progress, and fragments of wall paintings have been found quite recently, dateable to the Augustan era. Among them is a narrow Third Style fragment with elegant decorations on a black background, close to a base in the atrium. The position and the size of the base have raised the idea that this may have been the place of the famous statue of Augustus, found during the last century at an undefined spot at the villa. On the other hand, such a base could have been the base for the chest containing the family treasury. Except for wall constructions and mural decorations, several floors with mosaic decorations or in *opus sectile* have been found, dateable from between the Augustan to the Hadrian periods.[219]

The most well-known painter of the Augustan period was Ludius (or Studius), suggested as the painter who made the decorations at the House of Livia at the Palatine, the Villa of Livia at Prima Porta, the house in the ground of the Villa Farnesina, and the Villa at Boscotrecase just north of Pompeii. Bianchi Bandinelli states that Ludius made either the paintings at Prima Porta or those at Villa della Farnesina, as he could not have been the master of both.[220] Gabriel, on the other hand, indicates the probability that the garden paintings are decorations made by several artists, since she is certain to have identified the hand of the master, a second painter and two minor painters.[221] Ling has convincingly argued that Ludius was probably active during the first 30 years of the Augustan period, i.e. working at the time of the Second and early Third Styles.[222] Ludius was highly esteemed for his beautiful landscapes, views of beaches and harbours, seaside villages, small woods, and other idyllic motifs, and it seems reasonable to assume that the most famous artist during that period worked for the circle close to the Imperial family.

It is, however, probable that mural paintings covering large areas were made by teams of craftsmen from a workshop rather than by a single master. It has not

[218] Gabriel, 1955, pp. 1-3.

[219] Mr. Peter Liljenstolpe, head of the Swedish excavations at Prima Porta. Lecture at the site, October 3, 1998.

[220] Bianchi Bandinelli, 1980, p. 22.

[221] Gabriel, 1955, pp. 28-31.

[222] Ling, 1999, VIII.

yet been established who was the master or masters working at these specific houses. Neither has it been established if the master worked with one team of collaborators, belonging to his studio, or if a team of painters was selected for each commission. It is a well-known general fact that each artist has an individual touch, by which it is normally possible to determine works by his or her hand, a comparative work much used for example in the analysis of pottery painters. To determine the painter of one or more specific decorations is comparatively more difficult, since the painter is not just an artisan, but an inventive person, which means that he probably discovers new solutions in painting while working. Due to this, early paintings by the artist and later ones, are necessarily different in appearance, an important fact to keep in mind when analysing ancient material. The Second style was succeeded by the Third in a relatively short period of time, much due to the Augustan political programme. This evidently must have had an impact on the individual artist's and the stylistic changes which may have taken place for each artist, if adapting to the demands of the commissioners.

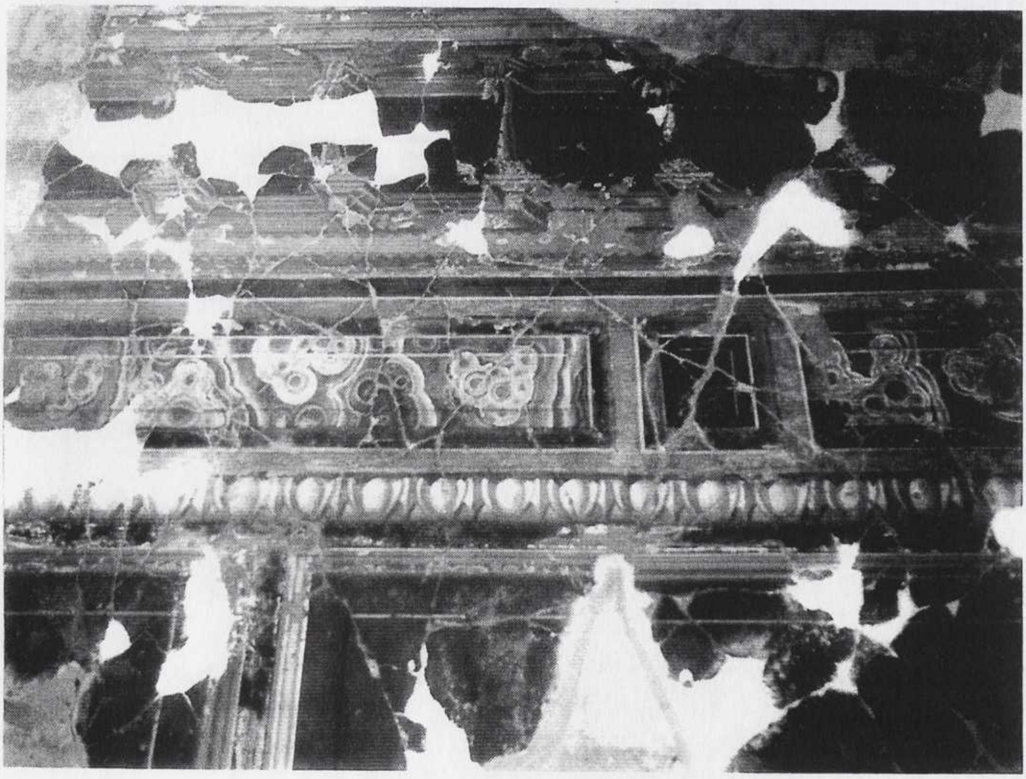


Fig. 29. Villa of Oplontis. Second style marble imitations.

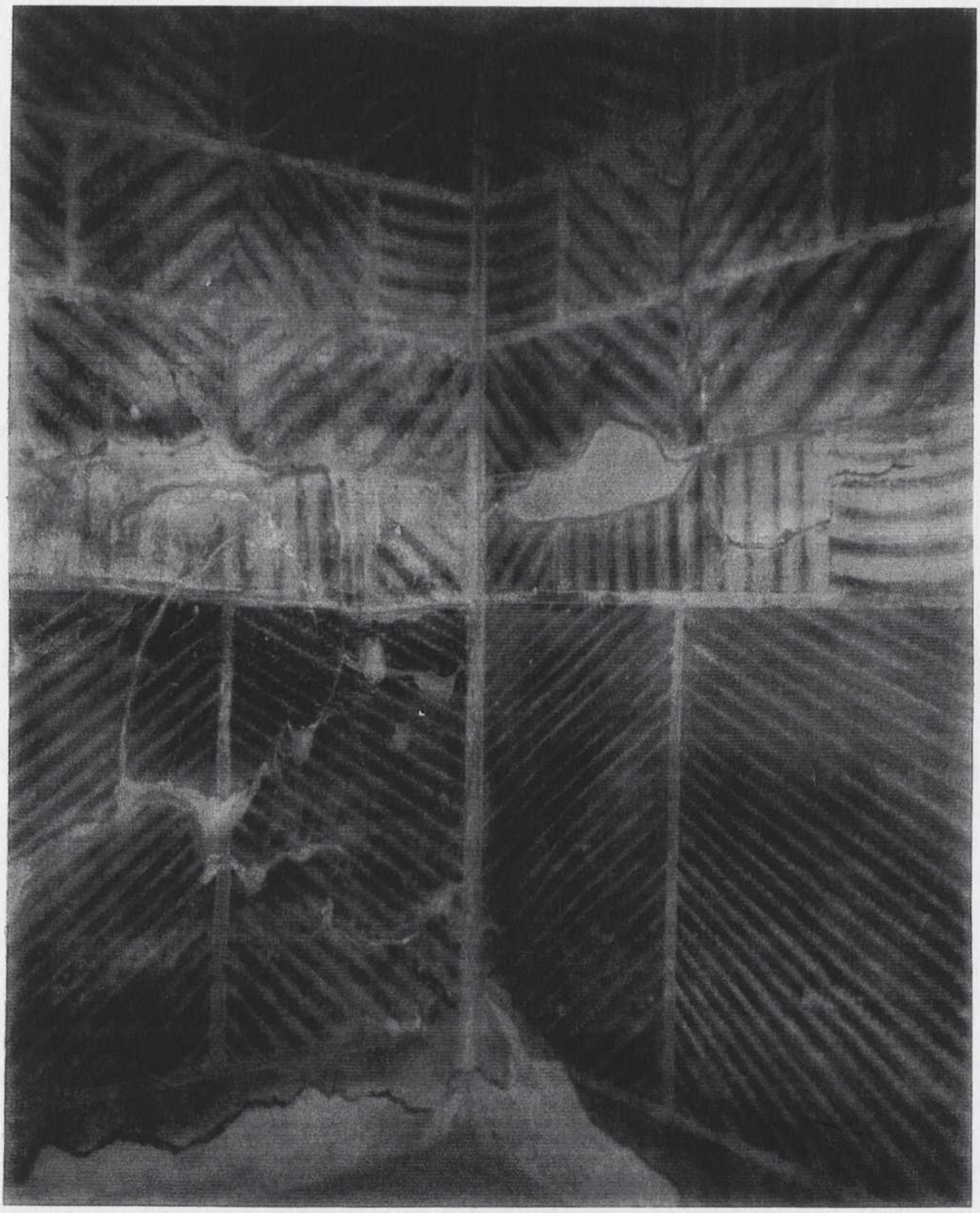


Fig. 30. Villa of Oplontis. Wall decorations in the service quarters.

The Third style

The candelabrum style may be regarded as an independent style contemporary with the late Second and the early Third styles.[223] It is characterised by decorative patterns, in particular floral motifs and slender candelabra. Vitruvius objected to the paintings of this period, which he considered as outbreaks of bad taste, since the naturalistic reality had been abandoned in favour of monsters and fantastic creatures.[224] During his lifetime motifs such as herms, centaurs and arabesques were commonly used.[225]

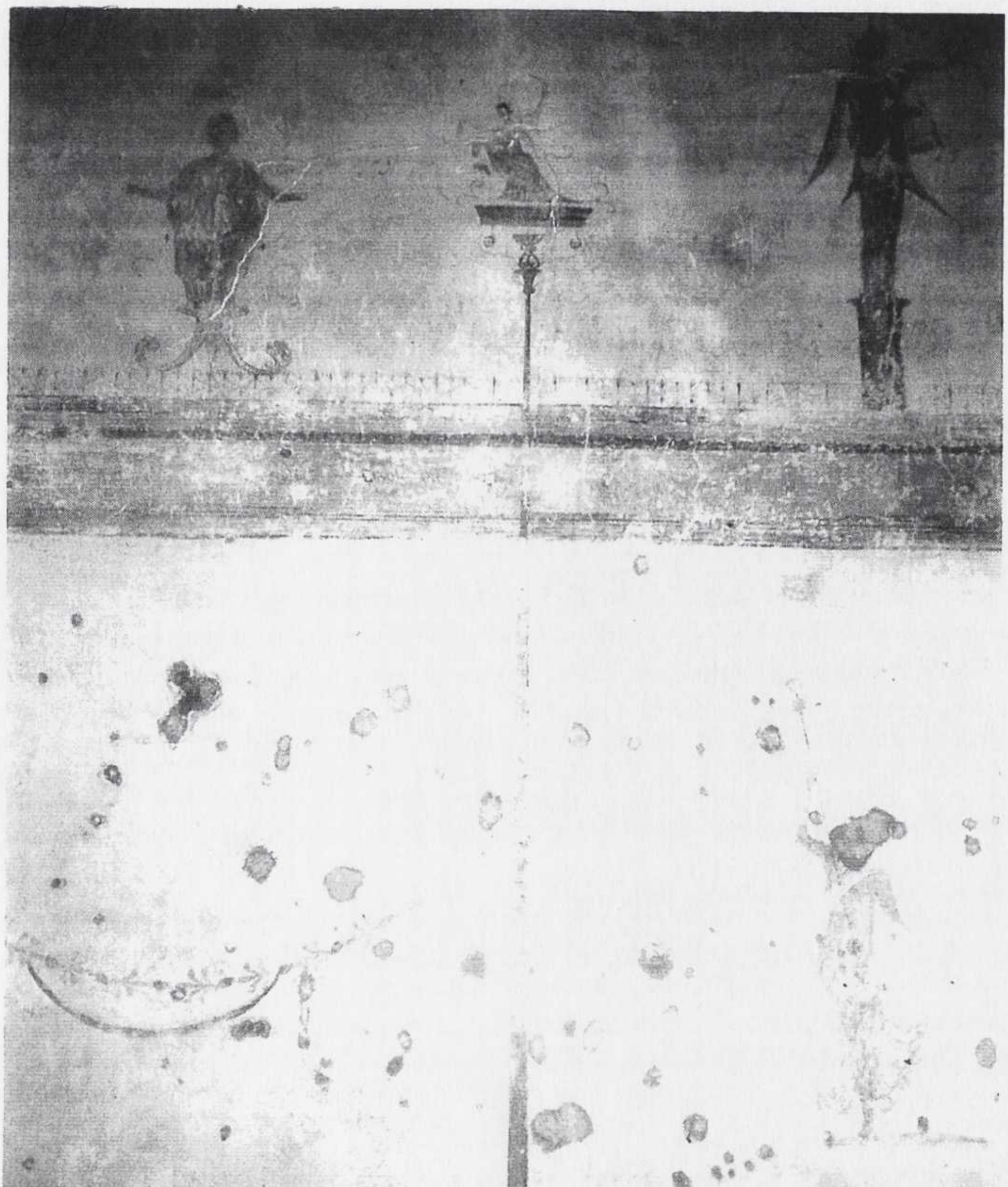


Fig. 31. Decoration made in the Candelabrum style. Caserma degli Gladiatori, Pompeii.

---

223 Staub Gierow, personal communication, October 2000.

224 Vitruvius, VII, 5.

225 Borda, 1958, p. 51.

The Third style, by Maiuri referred to as the Egyptisizing style, developed during the reigns of Augustus and Tiberius, and may be described as a two-dimensional and ornamental style, based purely on colour as the forming modality.[226] Even though painted architectural structures were still part of the decorative system, there was evidently no attempt at achieving any illusion of depth. Exotic motifs appear, such as representations of impressions from countries far away, in particular from Egypt. There was also an increasing number of paintings with mythical figures represented in idyllic and unrealistic landscapes. This style has been described as the classicism of the ruling classes.[227] The decorations become simpler, and the architectural motifs disappear in favour of large monochrome areas and a clear delineation of socle, wall, ornament and picture field. The classisistic and restrained structures and forms combined with a quiet colour scheme, in the individual rooms, express a longing for calm, order and clarity.[228] During this period the central painting in the main field was expanding, and its figural motif became the dominant painting of the room. The first known examples of the Third style are located inside the Pyramid of Cestius in Rome, dated about AD12. Third style paintings were made, e.g. in the Casa di Lucius Fronto in Pompeii. In mosaic art polychromy disappears in favour of black and white motifs, and become floors to be walked on, not to be looked at.[229]

The Fourth style

The Fourth style has been defined as eclectic, and may roughly be described as a combination of Second style architecture and the decorative patterns of the Third style. The period is roughly from between the reigns of Claudius and Nero, until the Vespasianic period, i.e from AD 45 until 79 at the eruption of Vesuvius. There is no longer any attempt of creating a realistic visual structure in the paintings, which are merely ornamental.[230] Various repetitive patterns occur as subdivisions of the walls. This is often referred to as the *tapestry manner*, due to the resemblance of modern wall paper.[231]

One significant characteristic of the Fourth style period is the introduction of repetitive patterns, *embroidery borders*, which appear as if stencilled to the background.[232] These patterns, sometimes called *filigree patterns*, are by Clarke referred to as *carpet borders*.[233] Such borders derive from textiles and constitute a diagnostic trait for all Fourth style walls.[234] Flying figures or pictures decorate

---

226 Maiuri, 1931, p. 12.
227 Moorman, 1998, p. 23.
228 Zanker, 1988, p. 283.
229 Clarke, 1991, p. 61-63.
230 Maiuri, 1931, p. 10.
231 Clarke, 1991, pp. 167-168.
232 Ling, 1991, p. 71.
233 Clarke, 1991, p. 168.
234 Ibid, p. 66.

the centres of these imaginary tapestries. *Embroidery border* is not an appropriate term, according to Barbet, instead suggesting the introduction of an adequate terminology to identify motifs in Roman wall decoration.[235]

One reason for the appearance of repetitive motifs during this period, may have been a consequence of the earthquake in Pompeii in AD 62. It has been pointed out by Clarke that the disaster of the earthquake brought a collapse of the Pompeian economy.[236] The wealthy left and those who remained were left with the long lasting task of rebuilding houses and public monuments. Severe damages were caused by the disaster, and many walls were partially destroyed and had to be repaired, a situation favoring rapidly made decorations.[237]

The Fourth style appeared in Rome during the reign of Nero, or maybe a little earlier. Intense building activities took place also in Rome, especially after the great fire in AD 64, when large areas of central Rome and the Neronian palace Domus Transitoria, had been completely or partially destroyed. After the fire the construction of Domus Aurea, the Golden House of Nero, was started, integrating parts of the Domus Transitoria.[238] The large building complex was constructed according to the agricultural functions of a Roman villa.[239] The palace was extended from the temple of Claudius on the Caelian hill to the present Via Merulana, where the gardens of Mecenas were set out.[240] It was completed in its essential parts before the death of Nero in 68, and was called Domus Aurea because the façade of the main building was gilded.[241] The complex was used until 104, and the major part of the decorations were made during the Neronian period.[242] Since the period is well determined and the paintings were mainly made in a homogeneous style, it has been suggested that the style was created or developed for this huge monument.[243] According to Iacopi there is actually no unity of style in the Domus Aurea.[244] Even though the major part of the decorations have been made in the Fourth style, some paintings chronologically-stylistically belong to the Third style. This enormous building complex was discovered at the end of the 15th century, and its paintings, the so called *grottesche*, inspired Renaissance artists such as Raphael, Giovanni da Udine and Zuccari.[245]

---

235 Barbet, 1981, p. 917.

236 Clarke, 1991, p. 165.

237 Ling, 1991, p. 72.

238 Boethius, 1960, p. 107.

239 Boethius, 1960, p. 95, 112; Ward Perkins, 1970, p. 214.

240 Boethius, 1960, pp. 107-108.

241 Ibid, p. 103.

242 Ling, 1991, p. 72.

243 Moorman, 1988, p. 5.

244 Iacopi, 1999, p. 19.

245 Borda, 1958, p. 71; Ward Perkins, 1970, p. 216.

Fig. 32. Fourth style decoration in the Domus Aurea. Detail of the pictorial decoration with slender architectonic elements on a white ground. Cryptoporticus no. 92, room no. 86. Photo: Soprintendenza Archaeologica di Roma.

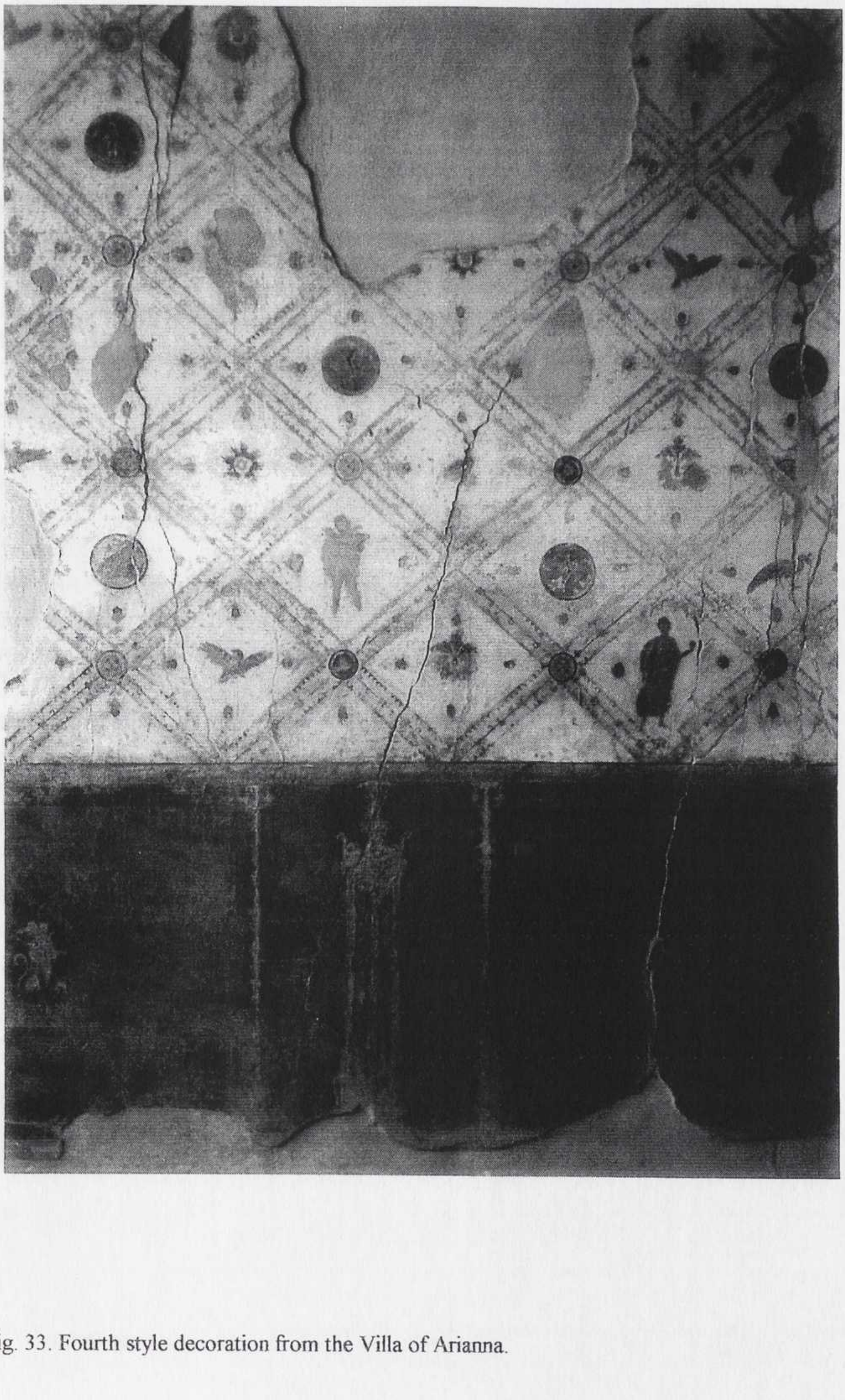


Fig. 33. Fourth style decoration from the Villa of Arianna.

New inventions from the period are the figures placed into niches or doorways, represented as living beings and very seldom as statues. Gilded stucco decorations became common, sometimes with glass beads set into the centre of the flowers.[246] Statues representing popular figures from Greek tragedies were inserted into the pictorial context in the *scaenae frons*, stage fronts, and also used as Fourth style decorations in, e.g. the Domus Aurea.[247]

Fabullus (or Famulus) was the most famous painter during the Neronian period, and is known to have painted on panels as well as making mural decorations, a rarity during the Roman period.[248] He was known for using brilliant background colours such as red and blue.[249] He may have been the inventor of the Fourth style, since he spent many years of his life decorating walls, first in Domus Transitoria and later in the Domus Aurea, which according to Pliny became the "*prison of his art*".[250] He was, however, not the only artist engaged in these decorations. Investigations of the decorations, in connection with the conservation project in the late 1990s presented by Iacopi, have shown that the differences in artistic style and quality are too diversified to have been the work of just one person.[251]

A simplified version of the Fourth style continued to be used in Rome and throughout the Roman Empire at least during the following two centuries. The later period, after Vespasian, is not so well-documented, since, as far as we know, there are only a few well-preserved houses or walls after that period. The mosaic floors of the Hadrianic period are, however, rather well-documented, e.g. in the Villa Adriana at Tivoli and in the remains from contemporary building activities of Ostia.[252] There are also some remaining examples of decorations in buildings from the Antonine period. Those are often all-white or all-yellow rooms.[253]

Wall decorations in Pompeii may be dated fairly well in the period from the first century BC to AD 79. One event, convenient for dating, is the earthquake in Pompeii which took place on February 5, AD 62. Several evidences of repairs or unrepaired cracks in the walls are still evident. Paintings presenting such damages were definitely made before the earthquake, while those made upon repairs after the disaster were made later.[254] Undamaged walls were either saved from damage at the earthquake, or made later. There may, however, have been more than one earthquake preceding the eruption of Vesuvius.

---

246 Ling, 1991, p. 87.

247 Moorman, 1998, p. 25; Clarke, 1991, p. 71.

248 Iacopi, 1999, p. 25.

249 Ibid, p. 49.

250 Plinius, NH XXXV, 120.

251 Iacopi, 1999, p. 9.

252 Clarke, 1991, p. 73.

253 Ibid, p. 74.

254 Ling, 1991, p. 72.

Polychrome Plastic Art

Ancient and Classical art in Greece and Rome were partially or entirely painted, just as were architectural elements. Polychromy is intimately connected to the subject of this study - paint materials and the use of beeswax in the process called *ganosis*.

Form and colour were, during Antiquity, considered as two elements that complimented each other.[255] In Greek tradition, where the use of white marble or limestone dominated, polychromy seems to have been adapted since the Archaic period.[256] Statues and reliefs were integral parts of architecture, just as painting. Painted details and uncoloured parts were probably brought together within the architectural scheme to form a harmonious unity. Nowadays it is commonly accepted that Greek and Roman architecture and marble statues were not white but painted. Just some decades ago such polychromy was hardly accepted, since the opinions formed by first Palladio and then by Winckelmann, still had a great impact on Western views on Graeco-Roman art.[257]

Polychromy on statues was registered by 18th century scholars during excavations at Pompeii. Among these were Quatremère de Quincy, Caylus and Visconti, who, in addition, noted that traces of colours were visible also on the Classical, and most sacred Greek architecture, such as the Parthenon and the Theseion in Athens.[258] Contemporaneously with these surprising discoveries of the preference for painted marble during Antiquity, Winckelmann declared that ancient Greek marble was not painted, but white, and explained the objects excavated at Pompeii as evidence of a merely provincial degeneration. Winckelmann was convinced that beauty had culminated in Greece, and Greek statues, were masterpieces of "*noble simplicity and serene beauty*".[259]

In 1764, Winckelmann introduced the idea that classical Greek sculpture was white; pure, clean and unpainted white marble.[260] He thought that the statues had been created to be white for reasons of beauty, and stated that: "... *the colour contributes to beauty but is not beauty itself - just as white is the colour that reflects light most and so is more sensitive, so in the same way a beautiful body will be more beautiful the whiter it is...*".[261]

---

255 Manzelli, 1994, p. 93.

256 The habit of painting statues is mentioned by several ancient writers, e.g. Platon *De rep.* IV 420c, Plutarch *De Gloria Atheniensum*, 6, Lucian, *Eikones*, 27, and Plinius, *NH XXXV*, 133.

257 Manzelli, 1994, p. 11.

258 Manzelli, 1994, p. 21. Caylus, *Recueil d'Antiquités Egiptiennes, Etrusques et Romaines*, VI, Paris 1762; E.Q. Visconti, *Il museo Pio Clementino*, II, Roma 1785; Quatremère de Quincy, *Le Jupiter Olimpien, ou l'art de la sculpture antique consideree sons un noveu point de vue*, Paris 1814,

259 Jokilehto, 1986, p. 492. (*edle Einfalt und stille Grösse*).

260 Winckelmann, *Geschichte der Kunst des Altertums*, Dresden 1764.

261 Winckelmann, *Geschichte*, 1764. "*Die farbe trägt zur Schönheit bei, aber sie ist nicht die Schönheit selbst, sonder sie erhebt dieselbe überhaupt und ihre Formen. Da nun die weiße Farbe diejänige ist, welche die meisten Lichtstrahlen zurückschicht, folglich sich empfindlicher macht, so wird auch ein schöner Körper desto schöner sein, je weißer es ist...*".

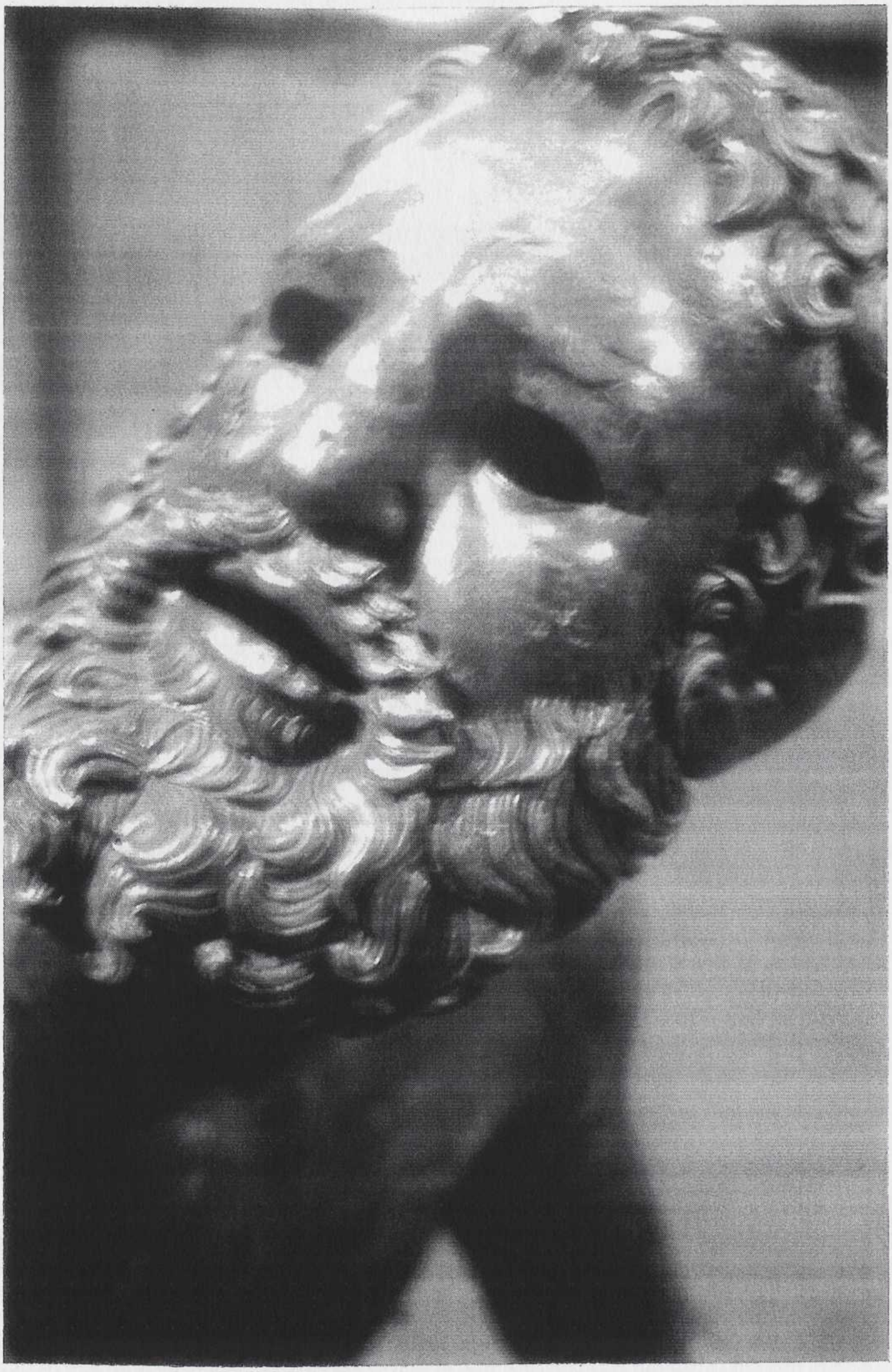


Fig. 34. Polychrome Hellenistic statue. The seated boxer.

The evidences of polychromy were, however, not completely ignored or misunderstood. Accepting the indisputable remains of colour, the rules for its use within the decorative system in architecture was studied by Hittorf. He found that colours, for the ancients, were an integral part of plastic art and not of secondary value.[262] In 1830 he started examining the *Temple of Empedocle* in Salinunte, and discovered that porous stone, following a firm tradition, was completely covered with *stucco*, i.e. a thick layer of plastering. Stucco was the ground for paint on the metopes, friezes and other architectural elements.[263] The function of polychromy on marble buildings was further studied by Semper. These investigations allowed him to form the opinion that all parts of marble architecture, whether coloured or not, was originally covered with stucco. The stucco layer, probably had the double function of protecting the marble and making the contrast between coloured and naked parts less striking.[264]

Methops, triglyphs and other architectural elements were coloured, in contrast to the unpainted parts of the buildings. Vitruvius mentions blue wax as being traditionally used on the triglyphs attached to the extremities of beams on ancient temple roof constructions, a tradition which led to the arrangement of methops and triglyphs in the Doric order.[265] The Doric frieze at the temple of Zeus at Olympia shows that colour was used as a complement to the white marble.[266] Traces of colour have been found on several buildings at the Acropolis in Athens, as for example, on the reliefs on the Parthenon frieze, on the friezes of the Theseum and on the ceiling of the Propylei.

According to Büll, inscriptions at the Erechteion on the Acropolis in Athens show that craftsmen worked with encaustic decorations on the kymation and the gable panels of marble. The Erechteion inscriptions reveal that walls and mouldings were painted, while paint on the doors and the architraves was explicitly painted in the encaustic technique.

Polychromy within the sculptural tradition

During the Archaic period in Greece, colouring seems to have followed a rather stylised common scheme.[267] The skin of female figures was usually given a warm hue, while male figures from the Archaic period were traditionally painted with an opaque red colour, and the hair was painted black. Female statues had lips and hair painted in red, while pupils and eyebrows were black, with the obvious intention of contrast to the white marble of the nude parts.[268] Eyes were generally painted in an opaque colour, but more precious materials could

[262] Jacques Ignace Hittorf, 1792-1867. French-German architect who explored Greek temples in Sicily during the 1820s and published studies on his thoughts in the 1840s. His studies became of central importance in the discussion of polychromy in architecture.

[263] Melucco Vaccaro, 1967, pp. 20-22.

[264] Manzelli, 1994, p. 24.

[265] Vitruvius, 4.2,2.

[266] Ashmole, 1972, pp. 60, 77.

[267] Reuterswärd, 1966, pp. 78-80.

[268] Ibid, p. 115.

occasionally be inlaid. The appearance of plastic art changed during the centuries, and by the time of the Classical period a rich polychromy had been developed. Dresses were brightly painted in red, green and blue, and cloaks often had an edging with a decorative pattern. A vast number of okra found at the Acropolis in Athens still having traces of polychromy, manifest that red, green, blue and black colours dominate. These remains of decoration are mainly found on the vestment, the eyes and the hair.[269] Vivid colours in statuary were, as is seems, much appreciated.[270]

Very little remains of the original polychromy, due to the conditions in which the objects were preserved for centuries, and also due to later cleaning, moulding and conservation interventions. Some remains of paint may occasionally be observed in cavities, where it has been difficult to clean the objects. Traces of colour appear rather frequently on objects from recent excavations, but are rare on objects which have been kept in museums for a long time.[271]

Since sculpture with remaining polycromy are rare, statues represented on wall paintings may studied, providing valuable information of how polychromy was used.[272] According to Moorman, monochrome white statues do not occur on Pompeian wall decorations, and those presenting a partial polychromy are most common. Generally, statues of white marble had a contrasting polychromy on details, and wax was usually applied on the nude parts of the statues.[273] Most frequently occurring in painted representations are, however, completely polychrome statues.[274] A yellow statue in a wall decoration may indicate an unstained bronze statue or one of gold.[275]

Statues of marble, terracotta or bronze could be monochrome, polychrome, gilded or having partial additions of colour and gold.[276] Golden or gilded equestrian statues were common during the Roman Imperial period. Gold was generally used on statues representing goddesses and gods, such as Venus or Mithras, Serapis and Asclepios.[277] One Venus statue with remaining gilding is the so called *Venus with bikini*, now in the Museo Nazionale di Napoli. From the 1st century BC gilding occurs on portraits of famous individuals.

One of numerous statues that still had remains of polychromy when it was found, is the famous statue, *Augusto della Prima Porta*, representing the Emperor Augustus. The statue, which was made in the years immediately following the victory over the Parthians, was found in the Villa of Livia at Prima Porta during excavations in 1863.[278] Like many other statues and portraits it presented, at the time of excavation, a rich polychromy, which successively has

---

269 Manzelli, 1994.

270 Ashmole, 1972, p. 26; Kjellberg, 1932, p. 189.

271 Salvetti, 1998, p. 86.

272 Moorman, 1988, p. 71.

273 Reuterswärd, 1966, pp. 208-209.

274 Moorman, 1988, pp. 73-74.

275 Moorman, 1988, p. 73.

276 Reuterswärd, 1966, pp. 181-182.

277 Ibid, pp. 195-196.

278 Zanker, 1988, p. 188.

been lost, and today the statue has very little evidence of colour.[279] Semper and Morey reported traces of colours in 1833, e.g. large areas of yellow ochre and some traces of red and green colours.[280] In the Vatican catalogue from 1902, Amelung reported a great variety of colours remaining on the statue.[281] Among the colours noted were yellow, blue and dark blue, red, pink and brown. The statue is today preserved in 170 replicas and variations, and obviously was Augustus′ primary portrait type.[282] This statue, as well as the sculptures of the Ara Pacis, set the norm for Imperial portraiture for generations.[283]

The statue of Livia, found in the Villa of the Mysteries in Pompeii, had rich traces of polychromy when it was found in 1929. There were pale reddish colours on her hair and eyebrows, the eyes were painted brown with black pupils and red signs at the corners of her lips showed that they had previously had a carmine red hue. Traces of purple-red were found on the borders of her mantle.[284] Another example is the Hellenistic marble statue of a young woman, which was probably intended as a fountain figure, belonging to the Museo Nazionale in Rome.[285] The statue presents traces of several colours, such as a red-brown colour in the hair, yellow and light blue colours on the dress which in addition has a border in a dark red hue. Traces of remaining polychromy have been found on many Roman portraits. One of these, in the Graeco-Roman Museum in Alexandria, is a marble head representing a goddess, which actually may be the portrait of a Ptolemean queen. There are traces of red colour on her lips and on the hair surrounding her face, and still a black colour is partly outlining the eyes. Eyebrows and hair also show traces of a black colour.

Statues of marble had traditionally been painted, but polychromy was sometimes achieved by the use of different marbles in classical monuments.[286] In Roman Imperial statuary the coloured marbles were mainly used for the clothing while the portraits were made in white marble.[287] Barbarians were often depicted entirely in coloured marble.[288]

279 Reutersward, 1966, pp. 212-214.

280 Melucco Vaccaro, 1967, p. 21.

281 Reutersward, 1966, pp. 213-214.

282 Kleiner, 1992, p. 63.

283 Goodman, 1997, p. 186.

284 Maiuri, 1931, p. 224; Maiuri 1961, p. 104.

285 Inv. no. 105 in Museo Nazionale Romano.

286 Ortolani, 1989, p. 29.

287 Gnoli, 1989, p. 14.

288 Pensabene, 1989, p. 43.

Bronze statues had often additions of other materials, inserted to create some polychromy. Copper could be added to the lips, and the eyes were generally made with inlaid stones or metals. One such example is the more than life size Hellenistic bronze statue showing a seated boxer, resting after a fight.[289] The signs of wounds after the fight have been indicated by copper inlays. His lips are also covered with an application of copper. The eyes, now lost, were in different material too, as was the practice in ancient Greece.[290] Statues of bronze, represented in wall painting, appear as monochrome, either yellow, red, brown or green. The practice of utilising other materials on eyes, lips and attributes are not imitated on the murals.[291]

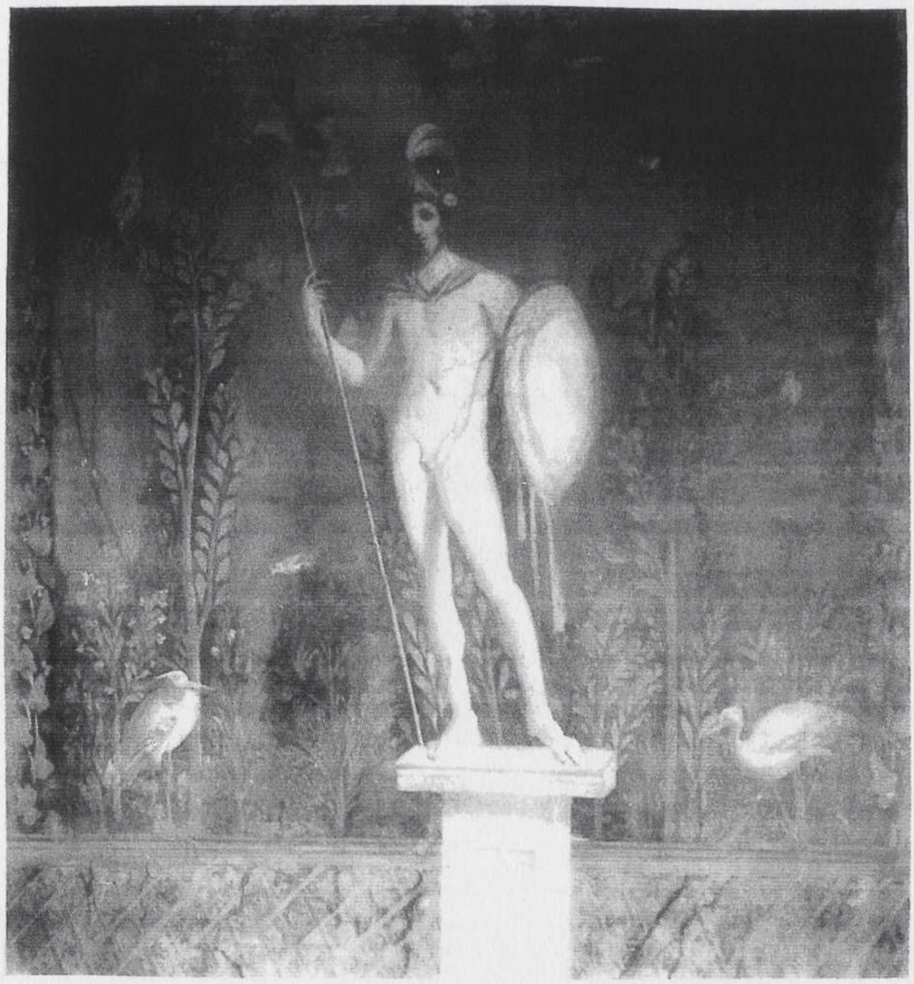


Fig. 35. Painted statue in a garden painting. From the *Casa di Venere in conchiglia*, Pompeii.

---

[289] The statue, dated to the 1st century BC, is exposed in the Terme di Diocleziano, Aula ottagona.

[290] Reutersward, 1966, p. 116.

[291] Moorman, 1988, p. 72.

Discussion

Roman culture was, in earlier publications, principally, focused on art and architecture, and being so, they were mainly descriptive. Architects observed and measured the surviving parts of sacred and profane buildings, and identified their interior spaces and structures. Roman town planning was part of these studies, and has been given constant interest through the years, just as the monuments representing the urban structure, i.e. its streets, places, bridges and town walls.

Art historians, mainly paid a great attention to remaining statues, paintings and various kinds of handicraft which had been found. Based on principles, referable to stylistic analyses, their suggestions on dating, and assumptions regarding the artistic tradition, were presented. Such analyses traditionally are made according to analytical schemes and value systems, into which the different objects are classified, according to their formal appearance, but also described with regard to some more subtle values, such as their supposed beauty, the technical quality, or the objects as being part of any specific tradition. These, later, kinds of criteria are not generally mentioned, but are still existing as unspoken preferences, or as undeclared expressions of the common taste during any specific period. Preferences are changing at intervals, but some principles seem to be constant. Among those constant values are e.g. the unmentioned conviction, that some art forms have greater value than others, such as well executed painted portraits being superior to well made pottery decorations, or original Greek statues being of higher value than Roman copies of Greek statues. Since there are such latent personal preferences and prejudices among all people, descriptions of art necessarily are, personal opinions. Opinions are formed, expressed and may be related to any specific period, and are therefore mirroring also the value systems of the period in which the descriptions are made. Having a personal opinion, and expressing it, simply means that human beings are subjective in their feelings, but not, as a consequence, in their research methods.

Statues from the Hellenistic-Roman cultures, traditionally have been classified primarily as Greek originals or Roman copies, the prior considered to be of superior quality than the later, much due to the theoretical impact and personal taste of Winckelmann. Romans did copy, or made replica series of Greek statues, and these copies constitute the main source for our knowledge of Greek art. Nowadays, the phenomenon of copying, or reproducing, is investigated as such, and the statues are studied as part of the decorative system, i.e. as readable signs which have a significate within their context.

The attitude towards plastic art has changed in more than one way during the centuries. Until quite recently, remaining polychromy on ancient statues was cleaned off, since marble statues were supposed to have been white. Nowadays the remains of original polychromy, which occasionally are found, is very much appreciated. Along with this new conception of art, the attitude towards cleaning has changed, and is made with more delicate methods than those used before. Another change in opinion has led to that reconstructions of missing pieces are not made anymore, while such interventions, previously, were part of the maintenance programme of the statue.

In earlier descriptions, much attention was given to the stories depicted, mainly mythological motifs, which were represented in visual art. Among scholars who paid great attention to the interpretation of mythological motifs were Curtius and Maiuri, later followed by Schefold. Investigations of mythological motifs are still performed, such as in the study of Pompeian paintings representing the abandoned Ariadne, made by Gallo, or the study of Aula Isiaca by Iacopi. Iacopi is, however, not principally interested in describing the myths, but rather to put them into a context, with the objective of dating the Aula and determining what was the original use of the space. This approach towards art and art history is representative for present scholarly investigations.

Enormous amounts of statues, paintings, and other works of art were found at the discovery of Pompeii and the other Campanian towns, which had become buried in ash and lava, at the eruption of Vesuvius in AD 79. The paintings discovered at Pompeii were systematically studied and classified at the beginning of this century, by Mau, who divided them into Four styles. The Roman wall construction techniques, and the various covering materials traditionally used for aesthetic reasons, and their decorative elements were studied, and dated. The decorative motifs, i.e. the pictures on floors, ceilings and walls were given particular interest, but always with regard to the indisputable inheritance of Greek art.

It seems only natural that the aspect of classification of styles and buildings was important in earlier research, since these issues provide the basic information for understanding the structures into which further information may be added. Due to this continuos development, issues studied during an earlier period may be investigated once again, and then, undisputedly, from another perspective. In recent research focus is set on somewhat different issues than those mentioned above. The classification systems have been further defined, and disputed. The stylistic problems have been thoroughly discussed, just as the Greek influence on Roman art. Today focus is rather set on the characteristics of the Roman tradition and how it has been expressed in various fields. Instead of stating the superiority of Greek artists in painting and sculpture, Roman art is studied for its own sake. The indeptment to Greek tradition is so well accepted that there is no challenge to point it out. Instead the Roman way of transforming and adapting Greek models for their own needs, has been investigated by several scholars and from various aspects. The utilitarian aspect of Roman art has been pointed out as a very important characteristic, by earlier as well as later scholars, and it has been stated, that art to a great extent was used to manifest the political or economic power and also the social influence of the owner. Other topics investigated have been the social context of the Roman house, as well as the private spheres of the buildings. In connection to such issues, much interest has been devoted the ethics and moral of the Romans, aspects which, maybe, could be defined as studies of the Roman spirit. Studies of Roman culture therefore has changed from principally having a function of descriptions of art objects, to become studies concerning the social and private lives of the Romans, values and preferences which were visualised as images, in the form of building constructions and in the appearance of their art. Instead of mainly concentrating on the pictures with figural motifs in painting, and focusing on stylistic questions, the pictures rather are viewed and explained as parts of the decorative schemes, and the decoration is interpreted as such. The materials used within the decorative system have been carefully studied and described, often as a result of conservation interventions performed. In connection to such studies, the artists have been given some regards, and attempts have been made to identify works made by specific workshops, to establish how they prepared and proceeded their work, as well as how they were contracted.

Roman art and architecture consequently were signals, used to announce the social status of its owner. In the house of a public person, his power and importance was manifested by impressive decorations, not only on the walls, but also on the floors and ceilings, which means that the milieu was covered with decorations, distinctly chosen for the place. Studies have revealed that each environment required its own theme, constructed by a setting of motifs, with understandable signs for each person entering the space, and underlining the intentional message of the place.

Due to this utilitarian approach to art, the setting as such was of higher importance than were the single details, which may explain the repetition of motifs. A copy, or a replica of a work of art was given a similar value as an original, the importance was the motif and its capacity of underlining the theme of the environment into which it was placed. The single piece of art was a symbol, and as such it had a message, which was emphasised by that of the space within which it was placed. Seen from this perspective, a copy, or the repetition of a type, was suitable, because a well known motif was not misunderstood, but had the immediate function of signalling a message.

The materials used within the building, and observable as the surface, was also of highest importance. The ceilings, walls and floors of the Roman house were decorated, and a vast selection of materials were used. Architectural details were made of white or coloured marble, or made of painted stucco. The floors were made in mosaic or marble, often laid in impressive decorations, i.e. in the houses of the wealthy, otherwise the floors were made of simple materials, such as terracotta. The decoration on walls and ceiling were appearing in relief as well as in a symphony of vivid colours. This variety in forms and colours, mildered by the relative darkness in the rooms, was part of the manifestive programme, just as the variety of materials, real or fake, which were used. Much attention was given to the structures of the walls. Their smoothness and silky lustre were, along with the painted decorations, signals of wealth, in contrast to the simple walls in the home of a poor family. Real or fake, original or copy, were issues of less importance than was the social manifestation.

The Fayum portraits appear in Egypt during the Roman period, and therefore they are part of the Roman tradition and the Roman value system. These pictures may, therefore, be studied and interpreted according to the Roman value and aspect of art, as esthetical objects for manifestation or propaganda. Also these portraits appear as signals of the owner's position. Consequently, the material and the artistic quality of the portrait are measures which show the social status of the commissioner. The families who could afford to pay a first class portrait painter, did so, and those who could not, had to be satisfied with a less well made representation of the subject, or maybe a rapid sketch from an artist's workshop. This may explain the fact that there are different, contemporary artistic styles, represented among the Fayum portraits. Some pictures are naturalistic and expressive portraits of individuals, often manifesting their wealth or social status by wearing beautiful jewels, a uniform or a golden wreath. These portraits were probably seen by the public, including painters from various workshops, and served as models for other portrait painters. There are several examples of repetitions of characters, which can not be explained otherwise. Finally, there are a group of portraits, which artistically represent the opposite to the naturalistic tradition in portraiture. Those pictures are schematical representations of persons, often appearing more like a symbolic sign for a person, than an actual portrait of an individual.

At present, the scholars studying Roman art and architecture seem to take most perspectives into consideration. It is, however, difficult to make any indubitable determinations about issues such as the Roman spirit, or ethics and moral in Ancient Rome. Neither is it possible to determine the social standard of a family on the basis of the decorations and the size of a house. It seems reasonable to presume that the owner of a large property with vast decorations was a wealthy person, but modern standards maybe, are not equal to those during the Roman period. In my opinion, taking into consideration all information available, it is adequate to formulate a reasonably valid hypothesis about Roman society and some of its individuals. But even if we feel affinity to, or are inspired by, the Roman world as expressed in its art, times have changed and we can only imagine the spirit of the past.

APPLICATIVE IMPLICATIONS IN CONSERVATION

Conservation of Plastic Art

Stone is expected to be an everlasting material, but, nevertheless it is exposed to various forms of decay. The majority of stones are subject to a gradual deterioration.[1] In open-air environments deterioration is normally very slow, and in protected milieus almost ignorable. Deterioration may be caused by various factors, and the three most common are physical, chemical and biological factors, acting and interacting on the artefact in a complex manner, thereby modifying the structure as well as the composition.[2] Some kinds of environments cause a rapid deterioration of stone, such as air pollution in modern cities, or the biological growth in environments situated close to the sea, where factors such as exposure to changes in temperature, and to wind, dampness and salt in the air also contribute to the deterioration of stone objects.[3] Thermal shocks in hot and dry climates is another factor for deterioration.[4] The degradation of stone may also be due to capillary suction, frost and salt crystallisation.[5]
The effects of air pollution have been given much attention during the last decades, but even though awareness about the reasons and the effects have increased the problems still are unsolved.[6] Biological attacks through the physical and chemical influence of vegetation and bacteria is another natural cause of decay. The negative effects of biological growth upon works of art has been known and studied for a long time. Most of modern research has been centred on algae, lichens and bacteria.[7] Secrete lichen acids, e.g., attack the stone and extract nutrients necessary for lichen growth.[8]

Due to these circumstances, which can not be avoided, a systematic maintenance of the objects should be made to keep the objects well preserved and to prolong their lifetime. Such caretaking of works of art seem to have been accepted as a natural and inevitable procedure by the Greeks and Romans. Regular maintenance of statues, apparently, consisted of cleaning, followed by renewed application of Punic wax, in the *ganosis* process. Damaged or lost parts of statues were reconstructed, a fact mentioned by several ancient authors.[9] Maintenance in the form of cleaning, surface protections, repair and reconstructions made works of art survive in a natural ageing process, respecting their symbolic, artistic, aestethic and historic values. Lack of maintenance must be regarded as disrespect for such values, nowadays as well as during antiquity.

---

1 Lazzarini and Laurenzo Tabasso, 1989, pp. 16-17; Löfvendahl, 1991, pp. 15-16; Price, 1987, p. 4.

2 Tiano, 1991, p. 56; Price, 1987, p. 9.

3 Löfvendahl,1991, p. 17; Lazzarini and Laurenzi Tabasso, 1989, p. 24.

4 Lazzarini and Laurenzo Tabasso, 1989, p. 24.

5 Torracca, 1988, pp. 8, 31-33; Lindqvist et.al ,1989, p. 302.

6 Price, 1987, p. 9; Rosvall, 1988, p. 33; Rosvall and Lagerqvist, 1992, p. 2.

7 Price, 1987, p. 10.

8 Löfvendahl, 1991, p. 17; Lazzarini and Laurenzi Tabasso, 1989, p. 39.

9 Cagiano de Azevedo, 1952, p. 57.

Today, as stated above, works of art become continuously impregnated with chemicals in order to make them resist the effects of air pollution and biological attacks. Since we have not been able to solve the problem of air pollution and do not spend enough time and money on maintenance, other solutions must be looked for, otherwise part of our cultural heritage will disappear. One way of saving important works of art is by disposing them in museums and letting copies be exposed in the open-air environment.

Fig. 36. Stone decay. Black crusts on white marble. The Protestant cemetery, Rome.

The aspects of restoration, copy and fake, is slightly different when paintings are concerned, since paintings mostly are protected, while statues in many cases are not. Issues concerning the conservation of paintings consists mainly of if and how to confront losses of the painted surface. In antiquity copies of famous paintings were made, as is evident, e.g. at Pompeii and Herculaneum. Copies of paintings seem to have had a slightly different story than sculpture, since there are indications that corrections of common motifs were constantly made to suit the place and the taste of the commissioner.[10] Issues of authenticity do not seem to have been a problem.

The formerly common repaintings of lost areas on a painting, normally made in the same style and material or as to look like the original, are today considered as falsifications, since they are later interpretations of an original artistic image. "*The restoration must aim at the re-establishment of the potential unity of the work of art, provided that it is possible without committing artistic and historic falsifications, and without cancelling any traces of the objects' passage in time...*".[11] In order to avoid misinterpretations or misapprehensions, the re-painted area should be made with different material and in a different manner, in order to make possible to distinguish between the "integration" and the original. Furthermore the materials used for integrations are demanded to be "reversible", or, rather "re-treatable". This means, e.g. that an integration made on painting is made with water coloour paint, whether the painting was made on a plastered wall or with oil or tempera on a prepared cloth or panel. Aquarell paint has a different structure, is not opaque, and is therefore possible to distinguish from existing original materials, and also possible to remove. In practice, however, such adequate integration is often treated with an application of Paraloid B72, frequently diluted in Diluente Nitro, with the intent of making the surface of the integrated area more durable. It has to be underlined, that in reality this kind of application is not reversible.

Roman wall paintings have been described and investigated by scholars and chemists in numerous publications, often presenting contradicting results.[12] There are no diverging ideas about how the carrying structure, i.e. the plaster preparations were made, since they more or less strictly follow the recommendations expressed by Vitruvius in De Architectura VII.[13] An unsolved problem, still, is an uncertainty concerning the techniques and materials used for the paint layers, in spite of the fact that methods for scientific analysis have gradually become more refined.[14] Roman murals have also been successively exposed to the most various kinds of conservation treatments. One of the most

[10] Ling,1991, p. 21.

[11] Brandi, 1977, p. 8. ("...il restauro deve mirare al ristabilimento della unità potenziale dell'opera d'arte, purché ciò sia possibile senza commettere un falso artistico o un falso storico, e senza cancellare ogni traccia del passaggio dell'opera d'arte nel tempo...").

[12] Augusti, 1961, p. 189.

[13] Augusti, 1961, p. 189.

[14] Brandi, 1977, p. 82.

devastating substances used on Pompeian wall decorations was the protective composed by Morriconi, and adapted as a surface protective for many years. This remarkable substance consisted of turpentine, alcohol, amber, copal varnish, rubber and sandarac, but had the disadvantage of turning yellow and sometimes it even provoked the detachment of the colours.[15]

When studying the history of some wall decorations, it is remarkable that the paintings still exist. The paintings in the Casa di Livia on the Palatine were unearthed in 1875, and they suffered successively from continuos restoration interventions until 1915 when they were detached from the walls and transferred to a panel of Portland cement with the objective of saving them. In contact with Portland cement the original problems did not disappear, instead they increased, due to the flourishing of salts on the surface of the paintings, which derived from the wet and slowly drying cement.[16] At an intervention in 1949, cement as well as various surface coatings were removed.

The list could be made very long indeed, if referring to all known examples of conservation methods on Roman wall paintings, considering such objects within the areas of Rome and of Naples. Much space would also be required in order to refer to all the different treatments which these paintings have been exposed to during the roughly two centuries since they were first discovered. The conservation problems and successive treatments can be followed, e.g. in many annual reports from the excavation sites.

Paintings have deteriorated successively or even disappeared due to badly performed conservation but mainly due to a lack of maintenance. Wall paintings that were registered and copied a century ago or earlier, can in many cases hardly be identified anymore, since there are not enough remains of the decorations.[17] Knowing that this was the situation from the start of experimentation with conservation methods until quite recently, the present situation will be described by examining a few examples.

One example is the decorated room with garden paintings from the Villa of Livia at Prima Porta just outside Rome, which has been exposed to an incredible amount of interventions. The villa was found and partially excavated in 1863, the most important art objects successively removed and the site filled up and abandoned. The restoration history of the garden paintings is astonishing. They were exposed to a great number of interventions until 1951 when they were finally detached and moved to Museo Nazionale Romano.[18] Among the different surface treatments made on these paintings can be mentioned cleaning with bread, with alcohol and various solvents, various applications of fluid wax and paraffin diluted in turpentine. It is a wonder that anything of the paintings remains. Quite recently these paintings have been (finally?) re-restored and moved to a permanent exhibition at Palazzo Massimo. It must be said though,

---

15 Borrelli, 1980, p. 81.

16 Cagiano de Azevedo, 1949, pp. 145-146.

17 Dr. Staub Gierow, unpublished paper presented at *Il settecento romano*, at Istituto Svedese di Studi Classici a Roma 21-23 September 1998.

18 Cagiano de Azevedo, 1953, pp. 13-16.

that at any occasion, the methods used were accepted by those persons responsible, i.e. thought to be adequate and, hopefully, harmless interventions. Time has shown they were not.

At the Palatine Hill, in close connection to House of Livia and the temples of Apollo and Magna Mater, is the so called, House of Augustus. These buildings are all constructed during the Roman era and dated to the last decades BC. The House of Augustus is situated on a relatively elevated level of the hill with good ventilation and limited problems of humidity, and there is no car traffic in the vicinity. This means that the building is not exposed to some of the most common modern conservation problems, such as penetration of water and exposure to heavy carbons from the combustion of petroleum etc. The remaining two-floor building is roofed, and thereby its paintings, stuccoes and mosaic floors are protected from rain as well as from sunshine, and sheltered from direct airborne pollution. In this complex of rooms, close to the Temple of Apollo, there are several Second style paintings preserved.

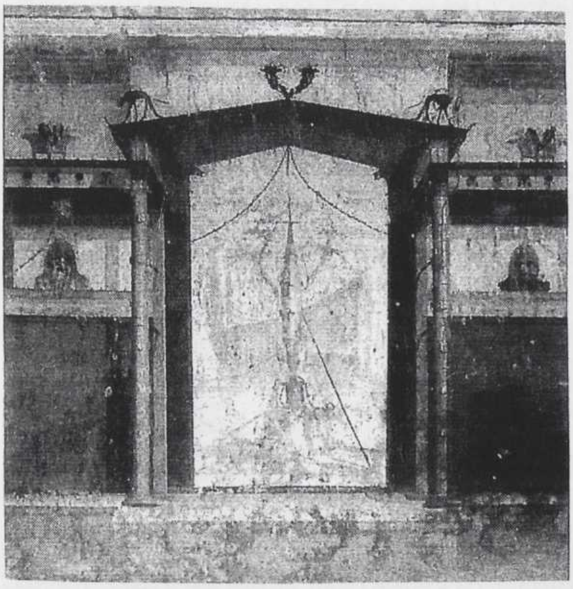
Conservation treatments have been performed and at this moment (Autumn 1998) are still in progress. Where conservation is terminated the rooms have been closed by the insertion of Plexiglas sheets into the door-openings, making it possible to look into the rooms, but not to enter. The Plexiglas sheets are slightly inferior in size to the door-openings, thus allowing some circulation of air. The conservation of painted surfaces has been made in roughly the following way; stuccoing of lacunae, painted integrations of the stuccoing with water-colour paint in the tratteggio technique, and a final protection with Paraloid B72 diluted in Diluente Nitro. Two rooms will be described, situated close to each other on the ground floor. One is the so called *Stanza delle maschere* and the other the *Stanza dei pini*.

Stanza delle maschere has received its name from some painted theatrical masks which are part of the architectural decoration. The conservation of this room is more or less complete, and there were just some details that still had to be filled in at my visit in October 1998. The immediate impression of the room is that too much conservation treatments seem to have been executed, since the colours appear too brilliant and the outlining of details is hard, not authentic. The total impression is that of standing in front of a fake. Some photos were made by myself, and those were later compared to rather recent photos found in the publication of Ling, Roman art, and there was an obvious difference. The retouching of the paintings have not been made just on limited areas, where stuccoing demanded some intervention, but also on perfectly legible areas, where the painting previously had a worn surface.

In *Stanza dei pini*, the conservation is not yet finished, though stuccoing and some pictorial integrations have been made. The immediate impression of the decorations was quite different to the impressions of the prior room, since the decorations in *Stanza dei pini* seem authentic, the surface not too lustrous, and the colours not too brilliant, i.e. not overrestored. When asking some questions to the conservation technician, I was informed that further interventions were planned, including retouches of some painted areas, in order to "strengthen the design", and finally that the walls were going to be protected with the application of Paraloid B 72, diluted in Diluente Nitro.[19]

Standing before these paintings some issues concerning conservation methods automatically arise. We must consider that the environmental quality of the surroundings are quite good, seen from the conservation point of view, including the protection of the paintings. Since the decorations are not exhibited to strong variations in temperature and are protected from man, from rain and winds etc, there would maybe be no need to use a surface protective such as Paraloid. Comparing the result presented in the Stanza delle maschere to that of Stanza dei pini, the difference in appearance is very notable, and not in favour of the first mentioned.

Returning to the issues of authenticity and the ideal of minimum intervention, the interventions can be judged by the means presented in conservation theory. In *Stanza delle maschere* conservation did not stop at minimum intervention, since work continued with retouches, even on the surface of the paintings, treatments which are absolutely contradictory to established guidelines, since such retouches are falsifications.[20] According to Brandi, the object is not to refresh the colours on paintings, nor to bring them back to a hypothetical original state.[21] Since the *Stanza delle Maschere* has already been impregnated with Paraloid, and this application cannot be reversed, it would be convenient to stop interventions at the intermediate phase, represented by *Stanza dei pini* and let some time pass in order to observe the long term effects in the two rooms. Maybe it will be discovered that application of Paraloid is not necessary, due to the preventive measures taken.



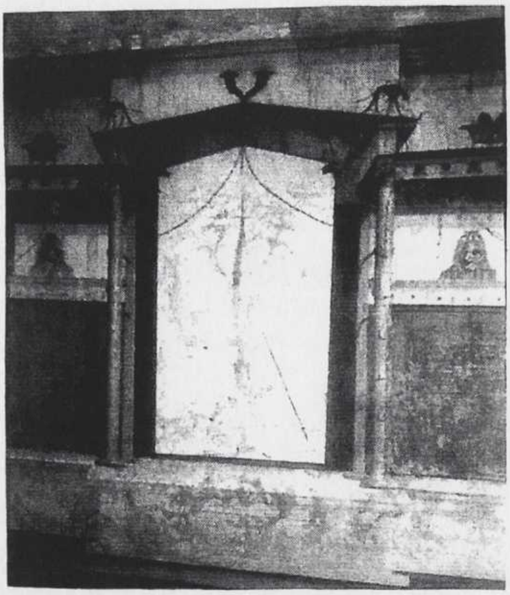


Fig. 37. *To the left*: The House of Augustus, detail. *Stanza delle maschere*, after Ling 1991.
Fig. 38. *To the right*: The House of Augustus, detail. *Stanza delle maschere,* autumn 1998.

---

[19] Marina Cavalieri, conservation technician (tecnico di restauro), personal communication October 1998.
[20] Brandi, 1977; Cagiano de Azevedo, 1953; Melucco Vaccaro, 1989; Marconi, 1984.
[21] Brandi, 1977, p. 84.

Pictorial integrations in the *tratteggio* technique made with water-colour paint, is adequate in this kind of environment, and in accordance with conservation theory. The water-colour is estimated to be reversible and it is compatible with the lime plaster. The *tratteggio* technique makes an "invisible" integration, when looked upon at a close distance, but the integrated parts are clearly distinguished at a closer look. Paraloid B 72 is not reversible and it is not compatible with lime plaster. If applied the impression of the surface will change. Therefore Paraloid should not be used unless absolutely necessary.

At the Domus Aurea in Rome extensive conservation work was in progress before the building was opened to the public in 1999. This building of enormous size, was built by Emperor Nero after the great fire in AD 64, and completed in its essential parts before his death in 68.[22] At present about 100 rooms have been discovered, which is roughly the estimated extension of the right wing of the complex. Most of the building is covered with earth and by later buildings. The most severe problem at the site, according to the director of the conservation programme, is the penetration of rainwater and humidity from above.[23] After heavy rain, water continues to penetrate the rooms for days, making the surroundings wet and constantly humid. Penetration of water results in calcareous depositions on the walls, thus hiding the paintings behind a white efflorescence of calcium and salts.

Conservation interventions have been performed inside the building. Restoration of the Fourth style wall decorations have been made. The interventions, to a great extent, consist of the removal of calcareous deposits, mainly of calcareous type. Tests have been made which reveal that the colours of the murals are brilliant and intact underneath the deposits. Different methods for removal and cleaning are used, such as impacks of ammonium carbonate, to make the deposits more easily disposed of, and for the thicker deposits, removal with a scalpel is occasionally used. Various conservation methods are tested, such as treatment with barium hydroxide, which hopefully will slow down the speed of formations of new calcareous layers, according to the director of surface conservation.[24] The only way of solving this problem entirely, is by preventing the penetration of water from the ground, which is an enormous problem to resolve, due to the environmental circumstances.

It has, however, been decided to leave an extremely thin calcareous deposit upon the paintings in order not to expose them to biological or environmental aggressions. The paintings remain fully visible and are protected by this thin film. Such a simple solution has the advantage of returning the paintings to visibility without harming them in their material aspect and, as it seems, without need for any immediate application of a surface protective which may later be regretted. This may be considered as an excellent example of a minimum intervention, since according to the conservation theory, the interventions do not interfere with the authenticity of the paintings. When I returned to the Domus

[22] Ling, 1991, p. 72.

[23] Antonello Vodret, personal communication.

[24] Elio Paparatti, personal communication.

Aurea for a visit in September 1999, conservation work in the rooms open for visitors was terminated, and the result must be described as very impressive, the settings of the spaces as sublime. This enormous conservation work must, in my opinion be held as an example for conservation at its best, from the theoretic basis to the interventions made in real life, and finally the aesthetically performed presentation of the huge spaces to the public.

When large painted areas are missing, the conservator stands before a different kind of problem. One rule in conservation is, not to invent a content in a missing area. On the other hand, also fragments of a painting on a wall needs to be conserved otherwise decay continues and soon the remains will be lost. Taking these considerations into account, conservation interventions may result in "islands" of paint within a monochrome background. There is no method which can be used at all occasions, but in my opinion, the reconstruction made in the Villa of Oplontis shows one possible way of solving the problem. The thin lines, reproducing the pictorial scheme, facilitates the understanding of the motif without the addition of a false interpretation.

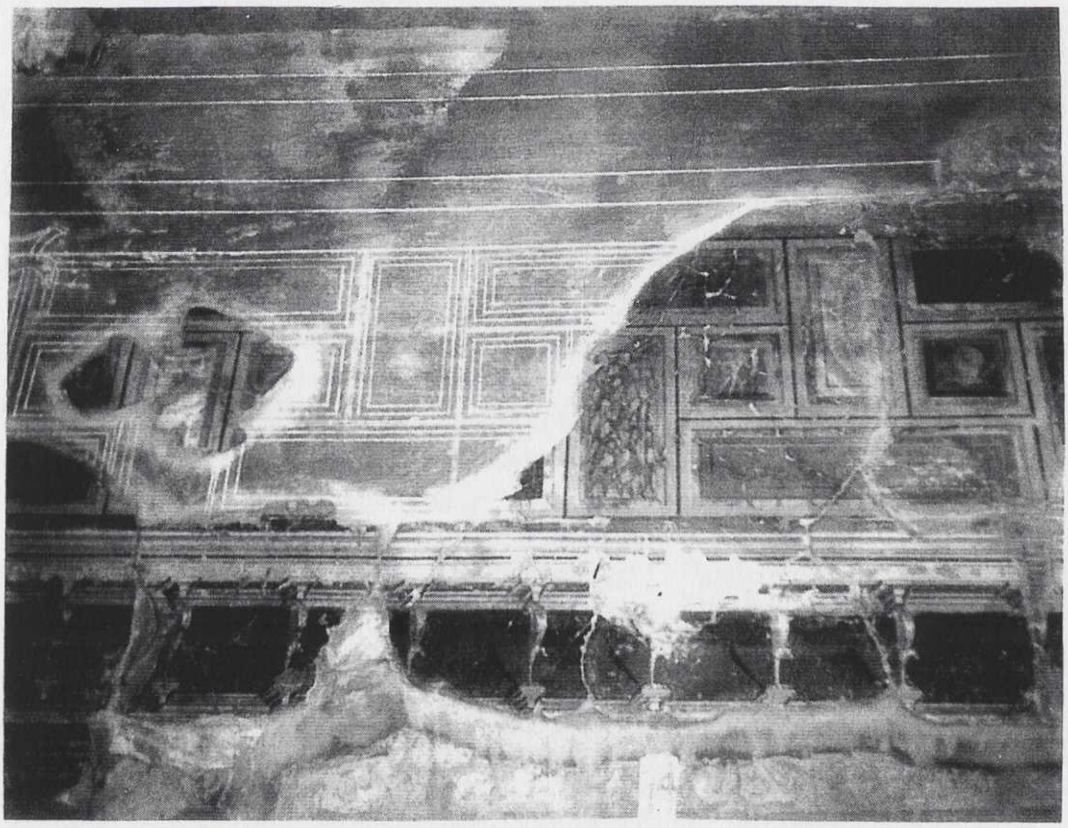


Fig. 39. The Villa of Oplontis. Reconstructed area of a wall decoration.

Use of Encaustic as a Modern Surface Coating

It must be stated at once, that at this moment, it is not safe to say whether encaustic is a valid method for surface coating or not. The various mixtures of wax must be tested for a longer period, and on some more materials, during various controlled circumstances. Nevertheless, a systematic testing has been made as part of this research project, and in all cases performed, the result has been satisfying. The various applications which have been made according to a specially developed research design, are described in the case studies. At this point it may, however, be relevant to make a short summing up.

Various mixtures of Punic wax have been tested, mainly as a surface coating, and at one occasion, as a paint. Before these applications were used in real life, some series of experiments were made. The first application of Punic wax was made in 1995 on a statue of white marble. The statue, being placed in a garden, was covered with biological growth. After cleaning, Punic wax was applied, and later the surface heated. When the surface had cooled it was rubbed with a cloth. The stone received a slightly darker hue, notable to a trained eye. In 1999 the statue was cleaned with water and a soft brush. Cleaning was easy to make, and the application on the marble had not undergone any changes. In 1995 I used Punic wax with the addition of some Venetian turpentine as a paint on a wall in an entrance. The supporting material was concrete. The paint was used directly on the wall, and so far, there have been no visible changes in the material. In the period 1997-1998 Punic wax was used as a surface coating on some bronze statues, and the artist was very satisfied with the substance and the result. No changes in the material have been noted. Finally, a few tests have been made on fragments of Roman wall paintings. The negative effect is that the hue of the underlying structure immediately becomes somewhat darker, the positive is that the lustre is beautiful and that no changes in the material have been noted, so far. On one fragment, Punic wax and Paraloid B72 were compared. At the time of application, Paraloid was absolutely colourless, a positive quality, but a year later the Paraloid-treated surface had become darker than that of the Punic wax. The lustre of Paraloid is the most negative factor, from the aesthetic point of view, since the surface recieves hard lustre.

It is my intention to continue experimenting with various applications of Punic wax. When the number of performed applications have increased, and more applications of these mixtures have been studied, it will be possible to state whether Punic wax is an adequate material for coatings, or not.

Presentation of ancient art

Statues or fragments of statues, which are destined to exhibitions in museums, are today generally, after cleaning, kept the way they were found, without any material additions to their form. The exhibited fragment, often combined with elegant constructions of black iron or lustrous steel and Plexiglas, thus becomes a work of art in its own. Presentations are often simple as well as dramatic, and illumination of the fragment is made with well-placed spotlights, just as for the lone actor on the theatre stage. This leads to the focusing of all interest, partly on the fragmentary statue and partly on its bearing construction, which together with its illumination becomes a separate, and exclusive work of art. Statues, which are presented outside in the open air, are generally restored in their material aspect. Surface lacunae will mostly be stuccoed with a lime/marble putty pigmented to resemble the colour of the stone surface. This stucco may be diluted with water or with water and acrylic resin. Old repairs with Portland cement will be removed, if present, and replaced with reconstructed parts in a more suitable lime/marbledust putty, as mentioned above. Consolidation is a general custom, and a final impregnation of the stone is often considered as necessary. As a result, these kinds of statues maintain their morphological visual shape, but become transformed as matter.

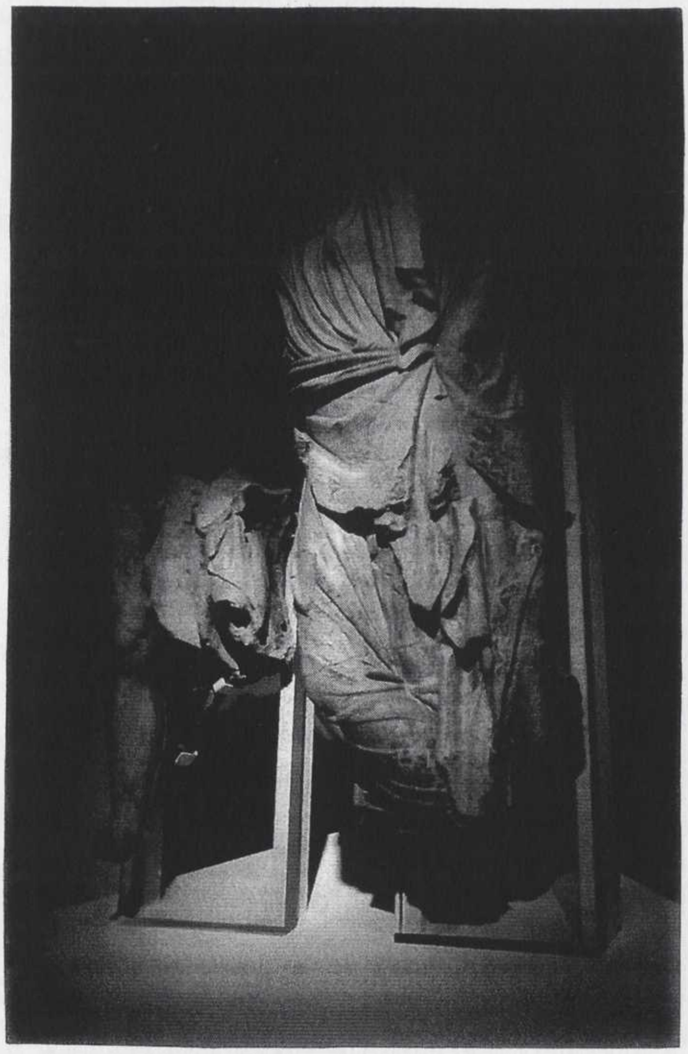


Fig. 40. Exhibited fragments of polychrome terra cotta statues. Museo Etrusco, Villa Giulia, Rome.

Important three-dimensional sculptural works of art in open-air environments are often transferred into museums, as a final resource to maintain them as matter and as works of art. Such solutions have to be accepted, due to the complexity of modern environmental problems, consisting in a general air pollution, traceable as, e.g. smog and, so called, acid rains.[25] Since the polluted air corrodes marbles as well as metals, it has become necessary to transfer some selected statues into museums in order to save them, and if possible replace them with copies. As a result it must obviously be accepted to interpret copies as substitutes, rather than as fakes.

Discussion

There is, and has, always been a problem of discrepancy between conservation in theory and practice. Winckelmann stated the importance of documentation of conservation interventions, at least in publications. Cavaceppi agreed with Winckelmann, but when restoring, he performed reconstructions of losses up to 1/3rd of the size of the object. Whether the reconstructions were shown on the object or in publications needs a separate study to determine.

Wall paintings are part of the immovable cultural heritage, but are often transferred from the archaeological sites for various reasons, and have often become overrestored by ambitious persons responsible. As a rule, stone objects, when treated, are nowadays impregnated with various chemical substances, with the good intention of preserving them for the future. The problem is, that due to efforts in saving objects, they are often transformed, chemically and physically, and when trying in one respect to maintain their authenticity, this is destroyed or at least irreversibly changed, in another respect.

The issue of minimum intervention in conservation seems to be a proper guideline in conservation, when combined with the rule of making a critically and consciously performed restoration. By critically judging the problems related to each conservation intervention, and searching for the most adequate solutions in each separate situation, and by respecting the rule of performing the absolute minimum intervention, it would be possible to end up with doing as little harm as necessary, or maybe not causing any material changes at all. Some consideration should also be given to the negative effects of chemicals to humans and to nature, i.e. in "real life" conservation there should be an equilibrated approach to art, culture, nature and life. There seems to be a point, when we have to ask ourselves, whether the massive chemical treatments of objects, accepted at an international level, are justified if they endanger health and the quality of life.

[25] Rosvall, 1988, p. 33.

CASE STUDIES

Some issues are common factors for the case studies presented below. The *decision process* connected to conservation interventions is such a factor, and so is the approach to *documentation*, which in these cases has been verbal, photographic and graphic. Chemical-technical investigations have been made on the material presented in case study 2 and 4. These methods are thoroughly presented only in case study 2, since the analyses performed are the same, and there is no need for repetition. The results achieved are, however, presented in both cases. Ocular investigations have been made of the material observed in case study 3, but the investigations were not as complete as those made in the studies mentioned above. *Historic and art historic studies* and *co-operation with other professionals* are important common aspects of the studies.

The studies concern objects related to different contexts. Case study 1 concerns architecture - an open air exposed graffito façade. Case study 2 concerns museum objects - Roman portraiture in protected environment. Case study 3 concerns archaeological finds – fragments of Roman wall paintings planned to be exhibited in connection to their find context. Case study 4, concerns archaeological finds from a relatively long period, defined in Pompeian styles, and presents the process of documentation, sampling and determination of materials, all documented during the various phases of the investigation.

The Roman context is a common factor for Case studies 2, 3 and 4 and the material analyses consequently deal with the determination of materials used by the Romans. The possible presence of wax has been investigated. Materials in Case study 1 are considered to be from the Renaissance and the results are not presented in this context, since those materials are not within the limits of the present dissertation. The decision process concerning conservation is a link between the projects, although the situations and materials differ. The specific process of each project will be presented below.

Case study 5 concerns experiments which have been made in order to reconstruct Punic wax, and to understand the practical differences between the different wax-paints and painting methods which have been investigated in this dissertation.

Case Study 1:

Palazzo Calabresi at Viterbo

Introduction

The present study is describing a working process leading to suggestions on the conservation of the graffiti decorated façade of Palazzo Calabresi at Viterbo. The considerations were made by a group of professionals and students as an integrated part of the international co-operation program, aiming at the restoration of the façade and suggestions for future use of the building complex, nowadays owned by Comune di Viterbo. The building has been abandoned since long, and therefore presents a vast selection of damages, in addition to its many architectural components representing a range of historical phases. Due to the specific characteristics of the palace, the conservation project was supported as a Raphael Project by the European Union, with participating parties from three nations: Italy, Sweden and Great Britain. Integrated in the conservation study, which follows recommendations of ICOMOS, ICOM, ICCROM and ICR as well as other relevant authorities, are professional groups of art historians, archivists, architects, conservators and chemists, also co-involving the local authorities etc.

This study illustrates issues connected with planning of the conservation of the graffito decorated façade. In focus are ethical questions such as *how* and *for what purpose* to restore the building and its façade. The necessity of documentation of the building through its historic periods is stressed, as is also the need of documentation of remaining decorations. The overall objective has been to perform analyses of materials used in construction of the façade, with the objective to provide the necessary information needed to consciously decide on the issues mentioned above.

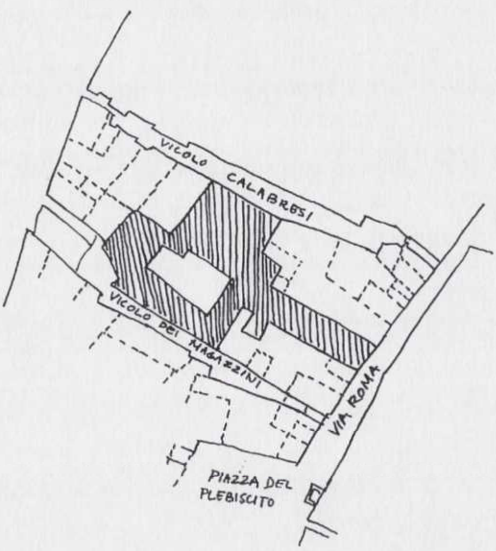
The theoretical frames within which decisions about conservation interventions should be taken are examined, not only in general but on public property in particular, since Palazzo Calabresi is a public building, not in use. The fact that the building is not in use leaves open for any relevant suggestion for its future use. The importance and need for documentation of the various historical periods which might be observed in form of changes in the structure of the building is stressed, since these documents are the base for an understanding of the building itself, and constitute the base for decisions on *why* and *how* to act leading to the questions on *how* to restore and transform it.

Also stressed is the importance of chemical-technical analyses of the material which constitute the areas which are to be restored, in this case the graffito facade, since the results of such investigations are the necessary means for decisions concerning the conservation interventions.

Finally the over-all importance of collaboration in groups of professionals with continuos discussions on discoveries made, methods to use, results achieved and goals to work for is pointed out.

The building complex

Palazzo Calabresi is a building in an evident state of decay, and not inhabited since long. It was selected for a conservation program, with the intent of rescuing the building from becoming a ruin. The *palazzo* is situated within the ancient town walls of Viterbo, indicating that the building may origin from after the 13th century. A date before that is not likely, since these quarters date from between 12 and 1300.[1] The exact dating of this particular palace is not known, but at present it may be defined as a medieval building, rebuilt and transformed into a renaissance palace. The 16th century palace was extended across the block, with a larger frontage facing Vicolo dei Magazzini and a smaller facing Via Calabresi. Annexes also reached Via Roma. Palazzo Calabresi originally was organised with a central courtyard, still possible to individuate. Nowadays only the central part of the palace remains, with the main entrance towards Via Calabresi. Other exterior remains are the loggia at the *piano nobile* and a secondary entrance located in the building, facing the former courtyard. There are vaulted ceilings at the *piano terra* and coffered ceilings with painted original decorations at the *piano nobile*. A staircase with varying characteristics connect the floors, and at the second floor a few steps also connect the palace with the adjoining annex building.



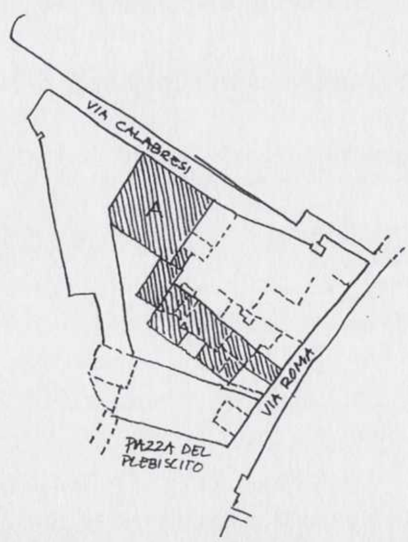


Fig. 41. *To the left*: Palazzo Calabresi and its annexes, according to the original 17th century plan.
Fig. 42. *To the right*: The present Palazzo Calabresi and its annexes.

[1] Silvia Silvestri, art historian and participant of the project, personal communication.

The palace has a graffito façade towards Via Calabrese. This façade has reached an advanced state of decay. The stone mouldings framing windows and doors and the front-door are made in a local volcanic tuff, *peperino*, just as the cornices dividing the front in horizontal sections. Due to the specific characteristics of the palace, the conservation project of Palazzo Calabresi was supported by the EU in a Raphael Project in 1998.[2]

Incorporated in the project, which followed professional and scholarly-scientific principles of ICR and other authorities were art historians, archivists, conservation architects, conservators and chemists, environmentalists, media representatives and at the same time co-involving local regional authorities etc. The objective of the study has been to analyse, explain and understand the history of the palace through its different phases and during different ownerships, to define its location in the urban structure and to study the materials of which it was built and decorated, all aiming at correct conservation. Suggestions for preventive conservation were important issues of the program, including anticipated maintenance and future use of the building, taking into consideration the facts mentioned above. With preventive conservation is intended elimination of anything harmful for the object and to provide for the most favourable circumstances possible.[3] Documentation consisting in descriptions, drawings and photography was consistently made, thus following the recommendations by Lagerquist, Wolters etc.[4] The Italian recommendations NORMAL were followed when documentation of decay was made. The importance of following standardised forms for documentations has been pointed out by e.g. Nordblad and Rosvall.[5]

The professional formation of the group working with the project must be considered as responding to the demands of Marconi, who argues for the necessity of such collaboration teams of professionals.[6] It was a great convenience to be able to ventilate problems as they appeared, with persons representing different professions. As pointed out by Zanardi, restoration is located academically in between art theory and science, and there has to be a communication between the different disciplines, in order to achieve serious and valid results.[7] Conclusions of the same kind are presented by Degni, after completed conservation of the facade of the church S. Carlino in Rome.[8] These discussions must be considered as good experience and are advantageous when the practical work of conservation begins, since the solutions and the final aims have been jointly considered by many complementary parts.

---

[2] The Swedish group were at Viterbo for field work during one week in October 1998.

[3] Melucco Vaccaro 1986, p. 179.

[4] Coles, 1995, p. 59; Lagerquist, 1996, pp. 23-40; Lange, 1993, pp. 115-116; Melucco Vaccaro, 1986, p. 179; Mora, 1995, p. 93; Price, 1987, pp. 25-31; Wolters, 1988, p. 123.

[5] Nordbladh and Rosvall, 1975, p. 58.

[6] Marconi, 1988, p. 105.

[7] Zanardi, 1982, pp. 19-21.

[8] Degni, pp. 10-11.

Graffito

Graffito façades appeared during the 15th century in Florence, and were successively spread to other towns in central Italy. The first known example is Palazzo Davanzati in Florence, built in 1427, and in Rome there are examples of such decorations from the middle of the century.[9] Simple geometric decoration, imitating stone, is known since the Middle Ages.[10] Those simple decorations developed into more complex motifs, such as geometric ornaments with fields of decorative floral motifs in a rather linear style, imitating carved reliefs and stone structures. Towards the end of the century several Florentine palaces appeared with figure motifs in renaissance style, later followed by baroque decorations, covering most of such walls. The initial aspect, depicting stone, combined with the illusion of decoration in low relief, however, was generally kept in mind.[11]

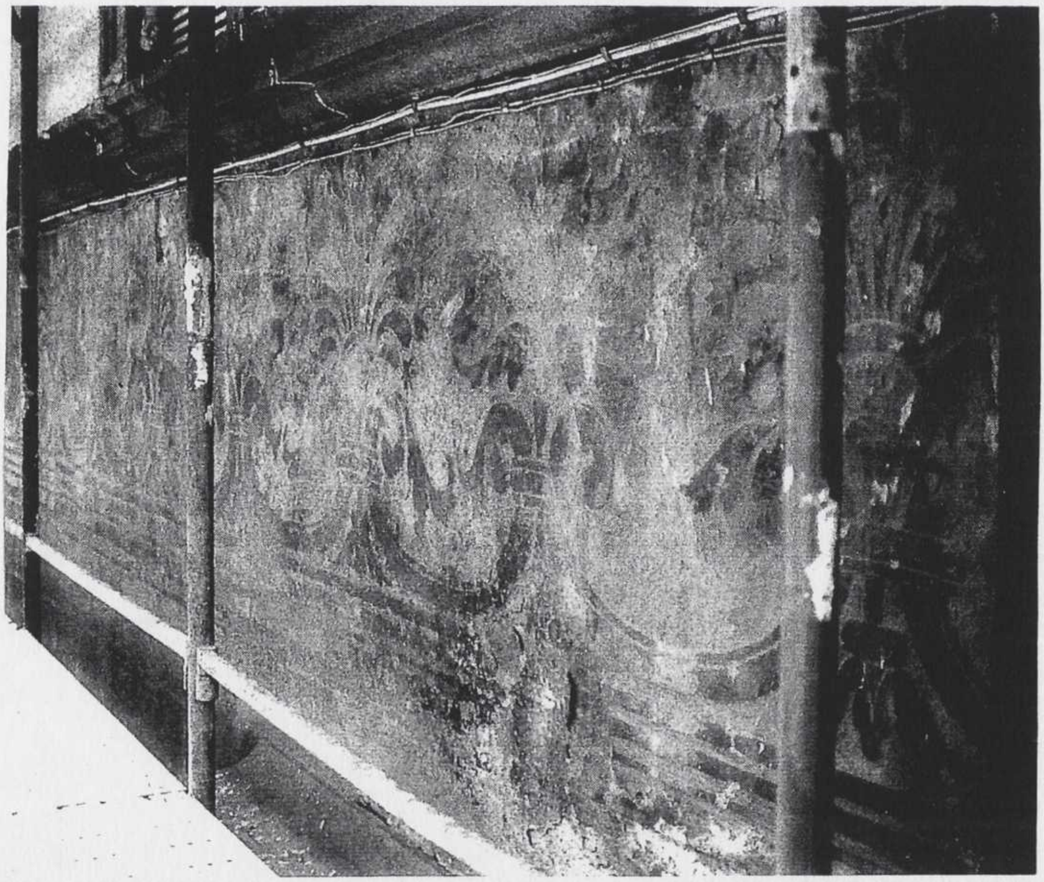


Fig. 43. Palazzo Calabresi, façade, graffito decoration. The palmette motifs at the *piano nobile*.

---

[9] Thiem, 1964, p. 19.

[10] Errico, 1985, p. 57.

[11] Forcellino, 1988, p. 130.

The decoration of Palazzo Calabresi is similar to early decoration in Florence, Rome and other central Italian cities. The conclusion may be drawn that the Calabresi decoration may be dated from the end of the 15th to the first decade of the 16th century. This dating is based upon two main considerations. The first is taking into account that the graffito fashion probably arrived to Viterbo some decades later than to Rome, where the fashion had been introduced by the Medicean popes.[12] Secondly the style of decoration was outdated at the beginning of the 16th century, since more complex decoration with figure motifs appeared during renaissance.

The material used for this kind of decoration were coloured plaster layers. Upon the first rough layer, the *arriccio*, a layer of dark grey or black plaster, generally containing pozzolano, and pigmented with charcoal or burned straw, was applied. Occasionally the first plaster layer was pigmented in some other colour, such as yellow, red or blue.[13] While this mortar still was wet, an ultimate and very thin white layer of lime was applied. As soon as these layers had set, the motif could be scratched into the surface, by means of partial removal of the white layer, thus creating a black and white image.[14]

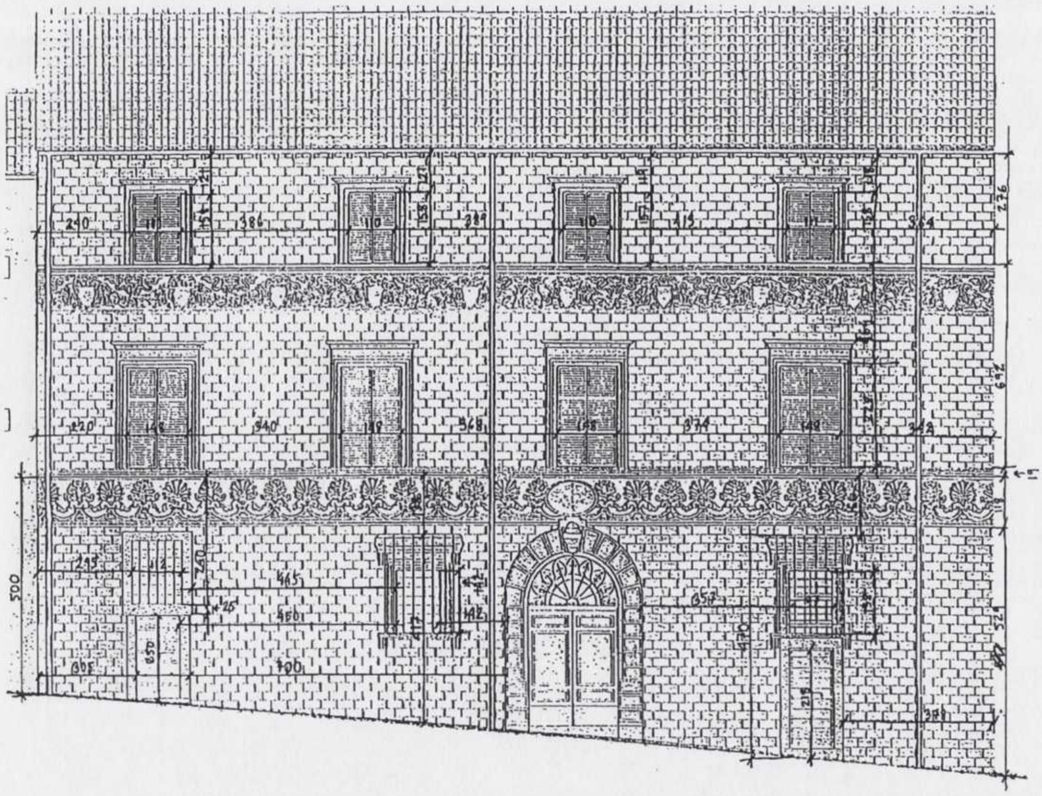


Fig. 44. Palazzo Calabresi. The façade towards Via Calabresi. Measures of the façade.

---

[12] Errico, 1985, p. 55.

[13] Errico, 1985, p. 58.

[14] Lange, 1993, p. 46; Thiem, 1964, pp. 18-19.

The conservation program

As initially mentioned, Palazzo Calabresi is situated in a slightly bent, narrow street, ending in a semi-closed area, from where Via Roma is reached through a vaulted opening. The façade is not exposed to direct sunshine, and therefore the façade is protected from great changes in temperature, a problem resulting in thermal shocks, and neither it is exposed to extreme winds causing problems of entropy.[15] The building consequently is not exposed to particular thermodynamic problems which might cause severe problems, and therefore should have to be regarded with respect to future maintenance. Even though the actual climatic circumstances were recorded only during one single autumn week, with some observed changes in temperature and dampness, no evidence provided reasons to believe that this specific façade would ever be exposed neither to extreme sunshine nor to heavily winds, since it is situated in a sheltered area.

The façade of Palazzo Calabresi is, as stated above, extremely weathered, but there are no severe problems with its architectural legibility, since much enough of its decoration remains to make a reconstruction possible, at least presented as a tentative proposal. The graffito decoration has been made the usual way, with black mortar applied before the ultimate white layer of the surface, into which the decoration has been scratched, thus revealing the underlying black colour. Two ornamental friezes with floral motifs in black and white are integrated in the decorative system of the façade. The same combination of colours appear in a false *bugnato*, i.e. a decoration imitating rectangular stones, the stones being black and defined by white lines.

The very damaged upper decoration was tentatively reconstructed with the use of raking light, and graphically transferred to large plastic sheets. Three different coats of arms were observed in the decoration, disposed at equal distances and nine in total. The three different figures were also transmitted to plastic sheets. Two of the coats of arms, one presenting a pattern of lozenges and the other an eagle, were identified as belonging to the nobile family Almadiani, the first known owners of the palace.[16] The third escutcheon consisting in horizontal stripes, belongs to the Florentine family Mancini.[17] The last private owner, the Calabresi family did not possess any coats of arms. By observing and documenting the decoration as a whole as well as the escutcheons separately it was possible:

a) to define a probable period within which the decoration was made,
b) to identify the escutcheons, providing a means for identifying the families who previously have owned the building,
c) to enable a decision whether to reconstruct the decorations or not,
d) to provide accurate measures of elements, making possible comparisons with similar decoration on other buildings, and
e) to organise documentary material for future needs.

---

15 Massa and Paribene, 1982, pp. 13,16.

16 Scriattoli, 1988, pp. 274, 280.

17 Silvestri, 1998, p. 2.

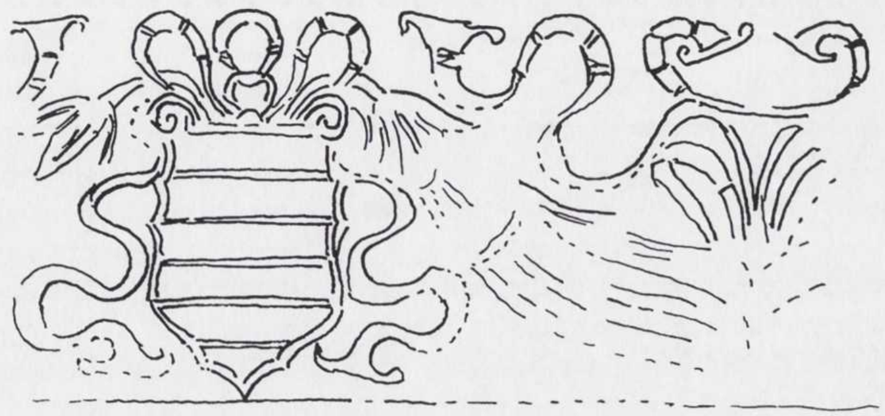


Fig. 45. Reconstruction of the upper decoration based on documentation made with use of raking light.

A painted decoration above the front-door was documented the same way as described above. Samples of the materials were taken from different parts of the façade in order to make possible the determination of the composition of plaster used, pigments, binders etc. Since there was no existing correct drawing of the building, the façade was thoroughly measured, with the objective to construct an accurate drawing of the façade. All kinds of deterioration and other kinds of information observed were documented on preliminary drawings, which later were transferred by the architect to the ultimate drawings, with correct measures and decorative elements inserted.

The above described documentation led to the following results:

a) the decoration was probably made around 1500, since i) the family Mancini is known in Viterbo since then, and ii) the Mancini coats of arms could not possibly be represented on the façade during the ownership of Almadiani, (the question of why coats of arms representing two families on this façade is further studied in archives by the art historians) and iii) the style of the graffiti decoration indicates a dating to this period.
b) b) the coats of arms of the Almadiani family usually consists of an eagle with its wings spread out at the upper part of the escutcheon, and the lozenge pattern below. In this case the decoration has been divided into two separate decorations, and appear at intervals with the Mancini family coats of arms. This may possibly be due to a marriage between the families or other another form of unity.
c) it was decided not to reconstruct the decoration, but to make a reconstruction on paper, which may serve as information.
d) the full size decoration on plastic sheets may be transported and compared with other similar decorations, thereby it will be possible to link decorations to a common source, or a common decorator.
e) by keeping all documentation collected it is possible to show the gradual changes of the palace e.g. in an exhibition. Also the deterioration registered and the suggestion, decisions and actions taken are this way recorded, and may be discussed.

Responsibility

At this point it may be appropriate to mention a few words about responsibility. In the Italian context, the architect is ultimately responsible for the conservation program, and consequently his program normally is followed. If the architect wants to, he may agree to discuss the conservation program with conservators or historians etc, and maybe, to consider some changes in a program. This is important, since the decisions concerning a specific conservation program does not depend on the opinion and the competence of the conservator. The architect, on the other hand needs the support of superior authority, e.g. a soprintendenza or a commissioner. Therefore a program must be based on serious interaction between all parties involved. Wolters argues about the necessity to make continuos controls while operating at a building, since there are always new and important observations and discoveries to be made.[18] This probably will be followed, if the architect in charge of a conservation project considers such observations necessary, and if there is enough time, money and education to permit such interaction and consideration.

Conservation suggestions

As to the issue of defining conservation methods, the group of conservators had a slightly different approach than the architect. He presented on the other hand a "full program", consisting in elimination of car traffic in Via Calabresi, elimination of wires, lamps and other recent additions to the façade, cleaning with brushes, chemical wood treatments to kill possible wood-worms, and ions to convert rust on corroded iron. With respect for interventions on stone material he suggested biocide treatment, consolidation, cleaning with impacks of ammonium carbonate or resins, and finally a protective treatment.[19]

The conservators very much agreed on transforming the narrow lane to a space primarily for pedestrians, since car traffic is a major environmental problem. Elimination of the non-functional elements such as e.g. old electric wires on the façade also seemed quite justified, in spite of awareness of the fact that later additions are part of the history of the buildings and should therefore generally not be removed.[20] The Swedish group agreed on starting cleaning by brushing off the dirt, but found it adequate to use biocides only on limited areas where biological growth could be determined, since there were no signs of any extreme biological growth. Further recommendations from the group were to make initial tests of different solutions for cleaning, to observe the actions and later decide what to use. Impacks of ammonium carbonate on certain areas may not be excluded, since there were some incrustations on the un-washed side of many of the architectonic details.

The Swedish group did not agree on a general consolidation of the stone, since there was no particularly pronounced problem of decay, but agreed

---

18 Wolters, 1988, p. 123.

19 Either RC 80, a product produced by Rhône-Poulenc or a similar product by Akeogard.

20 Brandi, 1952, p. 118.

however on consolidation of such parts which were either flaking or sugaring.[21] Finally, the conservators agreed on a surface protection with traditional methods, but not to a chemical impregnation of the stone, at least not prior to testing alternatives. Which surface protection would be the best choice in this specific case was not possible to decide in advance, but it may be convenient also to test *scialbature* on lime basis in different compositions. At renewed reasoning about the surface protection, the architect agreed to make some tests with *scialbature*.

The question was raised, why a *scialbatura* and not the commercial product RC 80? To begin with, a *scialbatura* is a lime wash, a conventional method used since antiquity. In this case, a local *peperino* was planned to be coated. A fine grained dust from such stone might be favourable, if it was desired to keep the visual impression of the natural stone. By using this mixture the hue might be expected to be somewhat lighter than the stone itself, due to the lime component. First of all, stone materials like *peperino* and tuff were generally covered with stuccoing or lime wash during renaissance.[22] Therefore, it is according to tradition to cover such stones with a light lime-wash, since they probably were covered in such manner in the first place.

A lime wash is preferable to stuccoing, since it is not known if a stuccoing was actually made in this case, and if so, how it was executed. It could be applied just as a protective, resembling the actual colour of the stone. It is not transparent, and therefore it is of great importance to consider the colour from case to case. A *scialbatura* further has the advantage not to transform the material of the stone, since it just protects it, for some years.

The chemical products on the other hand are transparent, and they are produced to integrate and impregnate the stone, and they will normally not be washed off, but generally it is not known how they will alter, at least not in a longer perspective. When choosing a lime wash the choice is a non-transparent sacrificial coating, and choosing a chemical implies a transparent application, with the intent to leave visible the stone. Small scale tests with applications of alternative products on relevant materials should be performed to determine the most suitable products to use in this specific case. It may be done by spreading the proposed products on similar stone surfaces, and compare the results to test-results achieved by using the substances offered by the chemical industry. Before finalised result from trustworthy such testing it is impossible to conclude on what is the better alternative.

The Swedish conservators and the architect involved in the project agreed upon the conservation program of the graffito decoration and the mortar areas, using old compositions of mortar. Since degradation of the façade varied from one level to another, the conservation program should adapted to suit the problems observed for each register, but with the over-all intent to re-establish the stability of the façade material and to return a homogeneous unity of the entire decoration.

---

[21] *Flaking* means lifting paint. *Sugaring* means that the stone, due to decay, becomes brittle and when touched, the crystals fall off, looking like sugar.

[22] Forcellino, 1988, p. 126.

The future use of the building has been ventilated. In this particular case it is not possible to follow the recommendations by Carta Venezia to let the building precisely serve its traditional functions, since the building has been transformed several times and does not exist in its original shape.[23] An appropriate use of the building has been carefully planned by the Swedish group, taking into consideration its characteristics, its size and location in the town. The experiences from the project and the issues of future maintenance and use of the building will be presented in a separate project report.[24]

Conclusions

It was a great experience to participate in the planning process of this conservation project, practising to follow guidelines and recommendations in conservation. The discrepancy between theory and practice has been stated by scholars and scientists, and also by conservators operating in the field. Experiences even in this partially didactic project confirm that there is a gap between theory and practice. As mentioned above, the restoration of the building had been decided before the Swedish participants were contacted. Italian conservators and building contractors had been contacted, indicating that conservation interventions had been planned before the Swedish group arrived. During the week *in situ* at Viterbo, there were daily contacts between the participants at the field work, and vital discussions around the table. At the end of the period, a complete conservation programme was presented by the architect. The Swedish group could not agree on that programme, mainly due to the intention of consolidating stone with RC 80, a relatively new product of which the long-term effect was not known. The group from ICUG returned to Sweden with samples for material analyses of plasters, binders and pigments, to be examined and analysed at ICUG. These samples should be the base for decisions concerning what conservation materials to use. It was important that analyses should be performed very soon, in order to have the results available before the actual conservation of the façade started. Some tests were never carried out, due to questions regarding the didactic situation and the analyses equipment at the institute. The results from examinations of some samples, were available in springtime 1999, when conservation of the façade had already begun. Consequently, analyses results were not available before conservation started, and neither there were any demands for such results from the Italian participants. Finally, the Swedish report was not accepted for publication, and information about actually performed conservation interventions or the final result never reached the group of Swedish conservators. The experiences from this EU project have been inspiring and there are questions which require an answer. It would be interesting to study the EU declarations of cultural policy, to study which projects were supported economically and how these projects were carried through.

---

[23] Feilden, 1993, p. 60.

[24] Report…

Case Study 2:

Fayum Portraits in Nationalmuseum

Introduction

This case study is dealing with observations, documentation and analysis of some Fayum portraits, belonging to Nationalmuseum in Stockholm.[1] With the objective to determine the materials used for these paintings, an initial general survey was made, followed by a material-technical investigation of some selected paintings. The selection of objects for an in depth study was made, according to the principle to ascertain, as far as possible, that the different encaustic techniques, *wax-painting* and *painting with Punic wax* as well as *tempera painting* would be included. The working process, aiming at a better understanding of some Fayum portraits is presented below. The considerations and the following decisions, on *what* to investigate, and *how* to proceed, are briefly pointed out. The documentation, sampling and material analysis is described, and the questions set in the process, are related to established guidelines in conservation theory. The overall objective was to present some adequate documentation about these objects, in order to provide for facts, which would form the necessary basis for a plan to follow, for the maintenance and the future display of the portraits.

Some important issues are left out of this study, due to its very limited size. Historical aspects, such as the methods of 19th century excavations and early conservation treatments, have not been considered in the present case study, and neither have the investigations leading to suggestions on a new dating and provenance. Issues concerning tradition and context in which the portraits belong have also been left out in this study, but all issues mentioned above are described in the complete investigation report, published by ICUG in 2000,[2] and in a revised form, written in Swedish, as the yearbook 2000 by Nationalmuseum.[3]

Background to the project

In autumn 1996 contacts were made with the Chief conservator John Rothlind, Head of Conservation department at Nationalmuseum in Stockholm, in order to receive information about some Fayum portraits in the Nationalmuseum. At that time I was working on a study concerning the encaustic painting techniques, which were part of my Ph.Lic. thesis.[4] Some questions regarding those techniques, as well as of their provenance, state of preservation and previous conservation interventions, were answered, but not all, due to the lack of previous documentation. The general impression was at that time, that no analyses of the mummy portraits in Nationalmuseum, or of those deposited in

---

[1] The National Museum of Fine Arts.

[2] *Fayum Portraits*. Documentation and scientific analyses of mummy portraits belonging to Nationalmuseum in Stockholm Göteborg 2000.

[3] *Mumieporträtt*. Stockholm 2000.

[4] Wax painting, encausto and ganosis. Göteborg 1997.

Medelhavsmuseet, had been made.[5] No interventions of conservation were known to have taken place, and no reliable data concerning their original provenance were available. In summer 1997 new contacts were made, this time including the Chief Curator Dr. Görel Cavalli-Björkman, Head of research department at Nationalmuseum, who gave her approval to the project of studying the Fayum portraits from the perspectives mentioned above. Contacts were made with Il Soprintendente, Dr. Giorgio Bonsanti at Opificio delle Pietre Dure in Florence and Dr. Mauro Matteini, Director of the Scientific laboratory at the Opificio, who approved to participate in the project, contributing by performing the necessary scientific analyses, together with laboratory staff.[6]

Ancient materials and techniques

The Fayum portraits are generally made on standing, rectangular wooden panels, the grain of the wood following the height of the board. The panels are mostly very thin, from about 1-2 mm to a maximum of 7-8 mm. Many panels are slightly convex, and it has been assumed, that this is related to the insertion of the paintings into the mummy bandages, when they were bent in order to make the panels better fit in, than a flat panel would do. The upper edges of these panels were commonly cut back, before being attached to mummy bandages, resulting in irregular shapes at the top. The different ways of cutting back the tops are, however, considered as indicative for different local traditions. The arched top was frequent in Hawara, the chipped in er-Rubayat and the shouldered in Antinoopolis.[7] These portraits are traditionally considered as either being *encaustic* or *tempera* paintings. Between the paint layer and the supporting wood was a *primer*, e.g. a glue, or a *gesso* preparation, in Egypt, mostly made of gypsum and a glue. If just a glue was applied, this would form a thin, almost invisible film between the support and the paint layer, while the gesso appears as a distinct layer, mostly white. At occasions, dark khaki or grey gypsum grounds occur.[8]

---

[5] The Museum of Mediterranean and Near Eastern Antiquities.

[6] Dr. Archangelo Moles, Dr. Carlo Lalli and Dr. Giancarlo Lanterna.

[7] Walker, 1997, p. 15; Corcoran, 1995, pp. 44-45.

[8] Ibid.

[9] Doxiadis, 1997, p. 21.

[10] Berger, 1904, p. 219.

[11] Parlasca, 1966, pp. 27-28.

The *tempera* technique was well known in Ancient Egypt, as also in other old cultures. Tempera indicates that the pigments were dispersed in water, with some kind of binder added, usually an animal glue.[9] *Encaustic paintings* were made either with natural beeswax, melted and pigmented, or with Punic wax, which is a chemically treated and partially saponified beeswax. *Encausto* is the Latin form of the Greek word *enkaostos*, which means "to burn in, burning in". The term was in antiquity referring to a specific technique of painting with wax, when the paint became heated and burned into the surface. Today the term is used for wax-paintings in general. The significant, practical difference between natural beeswax and Punic wax is, that the melted beeswax solidifies very rapidly and has to be worked quickly, while Punic wax solidifies slowly, and may be applied without haste. It has been assumed that a specific metal tool, a *cauterium*, was used for encaustic paintings to shape and mix the wax during the painting process.[10] Encaustic paintings have some characteristics in common, such as the marks of tools which appear on the surface, and in addition, a lustrous appearance, specific for wax. Punic wax paintings have not been clearly defined, and such definition has been one of the objects of this study. Since this paint may be spread with a brush it may present certain characteristics significant for a tempera painting, but the presence of beeswax might, on the other hand, be noted in a possible mixed working technique, with the characteristic signs of hard tools as well as the lustrous appearance.

Mummy portraits in Nationalmuseum

Nationalmuseum in Stockholm owns 15 mummy portraits and 12 fragments of portraits, all painted on wooden panels. They are, according to the inventory records, painted either in tempera or encaustic. These paintings represent the common styles, current during the Roman Imperial era. Some of the paintings are of a high quality, technically as well as artistically.

The original provenance of the portraits is known in just a few cases. Most of the paintings were previously in the Graf collection. This has mainly been evidenced by the circular marks made at the backsides of the panels, which occur on paintings in the so called Second Graf collection. Responsible for marking the paintings was the Viennese art dealer Bruno Kertzmar, who had this collection documented, labelled and numbered, after the death of Graf. The negative number of the photo was glued to the panel, and a violet stamped circular mark, was made to indicate the number in the collection given by Kertzmar. According to Parlasca, the last number is 228.[11] The portraits in this second collection are considered as having been less restored than those of the first, which consist of the paintings exhibited, published and sold by Graf. Many of the portraits in Nationalmuseum present marks, such as described above.

Graf was excavating in the area around er-Rubayat, and therefore it has been assumed, that the major part of his collection origins from that area. This leads to the assumption, that many of the paintings in the Nationalmuseum do, as well. Two paintings were sold to the museum as early as in 1890, by F.R. Martin, "who brought them home from Egypt", and six portraits were bought from N.V.

Löfgren, Stockholm, in 1954. The major part of the portraits were, however, donated to the museum by Dr. Max Dinkelspiel, Stockholm, in 1953. Ten of the paintings that had belonged to Dinkelspiel were documented as previously being part of the Second Graf collection. The portraits were accompanied with an undated certificate, typed in German, together with some register forms and documentary photographs of the paintings, which now are in the archives at the Nationalmuseum. In this document, it is stated that the paintings had been described, measured and photographed by a Dutch scholar, Heinrich Drerup, who, in fact, was the first to examine the portraits in the Graf collection one by one, and dating them.

Dating

In the museum inventories, all mummy portraits are defined with provenance from Fayum. This is, of course, a correct definition, but since Fayum is a large area, consisting of many find sites, it was important to try to determine a more precise location, and to give an updated opinion on dating as well. There have been, and are still, disagreements in dating of the Fayum portraits, from earlier suggestions such as by Graf, dating some portraits to the Hellenistic period and Drerup suggesting the end of the tradition in AD 393. Nowadays, dating is made within a much more limited period, beginning in about 14 AD, and ending roughly at the middle of the third century AD.[12]

The documentary phase

At the first meeting with Astrid von Hofsten, at that time working as a conservator at Nationalmuseum, a working plan was set up, with the objective to outline the project, and to define how to document its progress. It was decided to initiate by creating documents adequate for this occasion, which included a photographic representation of each portrait in the inventory. All objects were carefully observed by von Hofsten and the author, and the observations were noted in the register forms, which consequently contain all available and relevant information about the objects investigated, listed under headings. The importance of documentation in conservation has often been stressed.[13]

Available information in the museum inventories, was noted to begin with. The scarce information mainly consisted in measures of the object, a short note on the technique, a note on the subject, and on when and how the object was incorporated in the museum collection. In a few cases there was also a note on some kind of conservation interventions, and on decay observed. All information available was very limited, mostly consisting in a couple of lines in the inventory. Photographic documentation of all objects was accessible in the museum archives. In addition, there was the document, mentioned above, concerning the 10 portraits from the Second Graf collection.

---

[12] Borg, 1995, 1996, 1998; Doxiadis, 1995; Walker, 1997, 1999.

[13] Coles, 1995; Feilden, 1998; Lagerqvist, 1996; Rosvall, 1972; Zander, 1993.

Each object was then observed and its characteristics were documented. The visual analyses consisted in studying the surface, and in listing the types of deterioration observed. Beside the verbal description, any form of decay was indicated with graphic representations on plastic sheets placed upon the photos made at the museum archives. Except for notes about the observed decay, the paint surface was studied, with the intent to make a preliminary definition of the paint material. The impressions regarding the paint structure, i.e. whether it was lustrous or dull, were noted, as were the various kinds of tool-marks. Based on this information the paintings were classified as probable tempera, probable encaustic or probable Punic wax paintings. In addition, the visual appearance of the colours was registered, since that might be an indication of pigments used. The absolute necessity of collecting only valid information, based on scholarly-scientific methods, including formulated hypothesis, has been pointed out by Lagerqvist.[14] After the first phase the registers contained necessary information about:

a) inventory number, measures,
b) previous owner, and information from the museum inventories,
c) a description of the subject,
d) the state of conservation of the wooden panel,
e) the state of conservation of the paint surface,
f) an observation of the paint, suggesting painting technique,
g) a description of the colours, with indication of specific pigments,
h) definition of how the top of the panel had been cut back,
i) any remains of mummy bandages,
j) indication of previous conservation interventions, and
k) indication of retouches

Based on the information collected, the next phase was planned, since it now was possible to make a decision on how to make a selection of paintings for further investigation. In order not to provoke further damage on paintings with severe problems of material stability, such items were immediately excluded from further investigation. Also such paintings presenting obvious signs of conservation treatments, were excluded, in order to avoid inadequate information at the material analysis.

The determination of paint binders was the main objective, since the binder is indicating the paint, and consequently the painting technique. The ground layers had to be studied, in order to determine if there was any correlation between the paint material and the ground layer, which has been suggested.[15] If such correlation could be ascertained, this knowledge would be possible to apply to other similar portraits. Any possible connection between paint and preparation, and the actual state of decay, was observed. The decision was to make a choice, at first according to the main objectives, and secondarily in order to receive a varied set of samples, including also pigments, gold, bitumen and linen. After discussions, the issues to be studied were defined as follows:

---

[14] Lagerqvist, 1996, p. 99.
[15] Doxiadis, 1997, p. 94.

a) the composition of paint binder,
b) the composition of ground layer,
c) correlation between paint and ground layer,
d) determination of a few pigments,
e) the presence of gold,
f) the presence of probable bitumen, and
g) the presence of probable linen bandages

Some pigments were considered as interesting to study, because they frequently occur on mummy portraits. The intention was to make a determination of some pigments, known to have been used during the Roman Imperial period, with the objective to verify their connection to the period. Pigments available during Antiquity have been described, in several publications, by various authors.[16] Any presence of pigments from later periods, would indicate, either that additions had been made on the painting after excavation, or that the painting was not an original. Analysis of possible bitumen and linen, was considered to be of interest, and such analyses should be made, only in case there was time enough and possibility. The only objective for such complementary analyses, would be to confirm that those materials were occasionally used. As far as gold was concerned, it was interesting to find out, if possible, if gold was used together with other expensive materials, and also that was to be made if there was time and possibility. Eight paintings were finally selected for further investigation. Three of them were considered as possible encaustic paintings (nos. NMAnt 2302, 2315 and 2321), two as possibly painted with Punic wax (nos. NMAnt 2313 and 2320) and the remaining three as probable tempera paintings (nos. NMAnt 2304, 2305 and 2306).

Photographic methods

The paintings were at first photographed with colour slide films in normal day-light and then in tangential or raking-light. Photography in daylight provides a picture of the painting seen from the front, which presents the shape, the object and the general aspect of the painting without focusing on anything specific. Raking-light can provide valuable information on the state of preservation of the paintings and on the painter´s technique, since focus is set on the appearance of the surface, e.g. if there is a relief in paint or if there is lifting paint. A large-size black-and-white photograph of each painting was used as a location diagram.

Observations in ultra-violet fluorescence light

The paintings were observed in UV-light, with the objective to study the possible fluorescence, resulting from, e.g. specific *pigments*, such as any organic lake, and *glues*, *binding media* or *surface coatings*. UV-light has the property of causing fluorescence in various substances. This invisible ray is immediately

[16] Aldred, 1994; Augusti, 1967; Barov, 1990; Berger, 1904; Dinsmore, 1988; Forbes, 1965; Johnson, et al, 1995.

adjacent to visible light; the light source used has a wavelength of c. 365nm (UV 400-100nm).

Selection of samples

The surfaces of the selected paintings were viewed under magnification, ranging from 4 to 16 x. For media analysis and pigment identification, some minimal samples of paint were removed with a pointed scalpel and tungsten needle, under 10 x binocular magnification. The samples were taken around areas presenting damage, such as lifting paint, and near the edges, and the exact location of these areas, was marked on the location diagram. Microscopical samples were selected for analysis of binding media, and placed between laboratory glass lids, locked with adhesive tape. Samples containing all layers, were kept in sample glass bottles, and later mounted as cross-sections. In a few cases, an additional sample was selected, for possible future pigment analyses. In one case, NMAnt 2305, samples were also selected from the possible bitumen and linen bandages. The samples were removed by von Hofsten and myself in concordance with staff at the laboratory of Opificio delle Pietre Dure, and brought to Florence for examination.

Scientific investigation techniques at the Opificio

The investigation techniques adapted for the present study have been, the stratigraphic analysis of sections in optical microscopy, which was made in diffusion light, and in addition under UV-radiation, for the examination of fluorescence caused by the materials. For that purpose the selected samples were enclosed in polyester resin and the surfaces were orthogonally grounded. An optical microscope, Zeiss Axioplan equipped with objectives from 5 x to 20 x, and with a lamp of mercurium vapour, was used. Each cross-section was documented in the observation techniques mentioned above. The same sections were utilised for SEM investigation, using an electronic scanning microscope, Stereo-Scan 440 Leica Cambridge, and examined by elementary microanalysis EDS, using a system Link-Gem from Oxford. Other samples, in powder form, were selected, and their compositions analysed in the Spectrophotometer FTIR, (Fourier Transform Infrared Spectrometer), using an equipment Perkin Elmer 1725X adapting the technique of making micropellets (Ø 1,5mm) in KBr.

Conclusions

The documents, i.e. the verbal conservation register form, the graphic representations of decay, the colour slides in normal light and in raking light, as well as in UV-light, proved to be of value during the project, as were also the large-size black-and-white photographs, used as location diagrams. The combination of those documents, provided the necessary information, and were most useful at occasions when questions arose during the analytical progress of the study.

The chemical-technical questions set, were answered, and in many cases, more facts than expected, were revealed. Encaustic, as well as Punic wax paint, were determined, but no traditional tempera paint, since those paintings selected as probable temperas, had been made with a paint containing saponified beeswax. The tempera paint used, only contained minor traces of beeswax and soaps, indication of a diluted Punic wax. Encaustic painting on gesso preparations, as well as on a primer, were determined. In no case there was any sign of a paraffin wax, which was a commonly applied substance at the excavation sites.[17] Neither were any additions of later pigments noted. A few samples contained materials of which the presence could not be explained.

The scholarly aspects of the investigation needs to be studied much more, since there are no definite answers to be given, according to the nature of the humanistic discipline. Based on the information presented on each portrait register, and comparing with the in-depth study results made by the Opificio, it will be possible to act consciously and to make decisions on curative measures and future display of the objects.

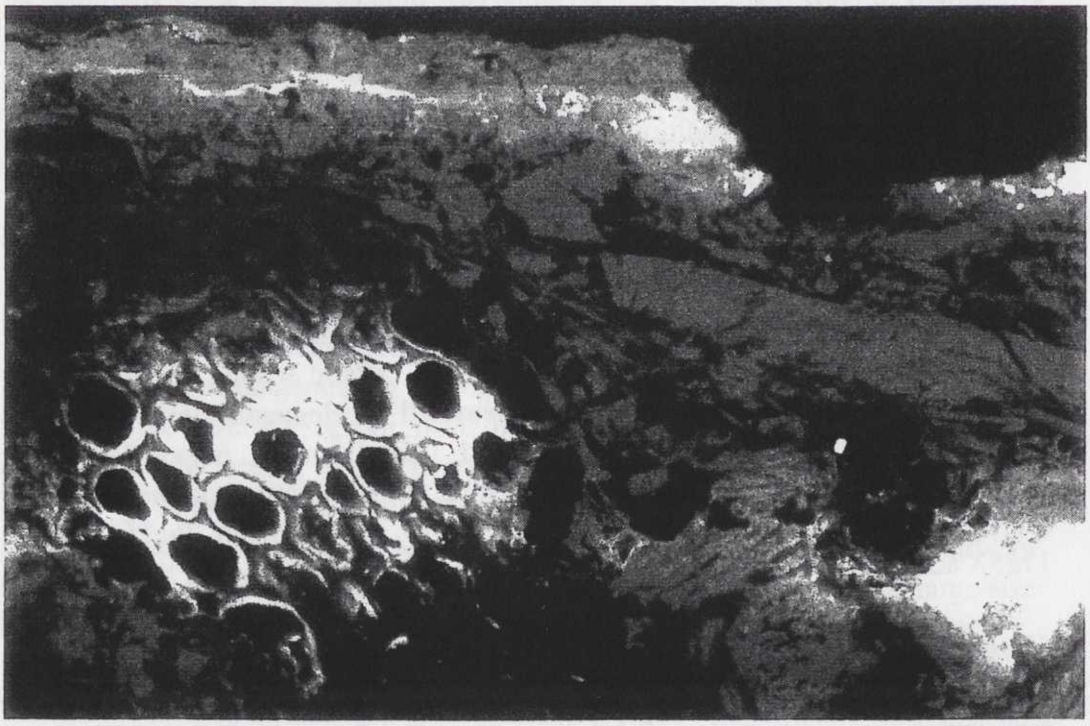


Fig. 46. Sample 2305. SEM examination – EDS analysis. The photograph reveals the different materials in the sample. To the left, the tubular structure of a microscopical piece of wood which was attached to the sample.

[17] Norman, 1988, p. 15.

Case Study 3:

San Lorenzo in Lucina

Introduction

The present case study illustrates issues connected to material investigation, conservation, and the successive presentation of material excavated beneath San Lorenzo in Lucina by the Swedish Institute of Classical studies in Rome in 1993, 1995 and 1998. At focus are questions such as *why* and *how* to conserve the material, *how* and *for whom* to present it. The objective has been to study how some Roman wall decorations were made, what pigments were used and which were the binders. A final objective has been to test various conservation methods. The five strata excavated mainly consist of filling materials such as earth, clay and sand, constituting at least two known floors or levels of a courtyard or a street. These "floors" are sealing periods 2 and 3 (see fig.1). Period 1 constitutes the foundation wall, and part of a *bipedalis*-brick wall, remains from the building which are older than the 3rd century *insula*. Period 4 is the filling for the construction for the 5th century church (432-440 AD). Period 5 and above, are fillings deriving from medieval building activities. Among the materials excavated were mural fragments from various periods. Considerations made during the conservation process, as well as results achieved, are presented in this paper.

In autumn 1998 I was asked by the archaeologist Olof Brandt, directing the excavations at San Lorenzo, to conserve and study the fragments. Since then the project has developed and expanded. In springtime 2000, scholars from various disciplines, forming a research school, have been studying issues concerning the building, the piazza and its history. The reports, including a revised paper concerning the present investigation, are planned to be published by the Swedish Institute of Classical studies in Rome in 2001.

One of the recommendations, which has been born in mind during this project, formulated by Feilden and colleagues at the symposium "*Air pollution and Conservation in Rome 1986, was, that "Interventions should be limited to actions strictly necessary to insure the continuing conservation of this heritage, but the techniques and materials used should not impede future treatment or examination*".[1]

[1] Feilden & Jokilehto, 1993.

Stratigraphical unit (US)	Description	Finds	Period	Interpretation
US 44	Filling	Medieval pottery, green porfid	Period 8	Filling for the 15th century chapel
US 81	Child's tomb dug through upper layers down through US 77	Infiltrated pottery		
US 77	Filling	Much pottery, tesserae, bones, glass, coin (find 1)	Period 4? (=C)	Filling for the 5th century church (432-440?)
US 78	Thin floor layer	Pottery	Period 3 (=B)	Second known floor level
US 80	Plaster	Pottery, tesserae, nail (find 2)	Period 3	Preparation for floor
US 82	Earth	Much pottery, painted plaster, bones, gold fragment (find 8)	Period 3	Filling for floor
US 83	Earth	Little pottery, painted plaster, bones		Filling for floor
US 84	Ash, plaster, marble	Marble pieces, bronze pieces (find 4), nail (find 5)	Period 3	Destruction? Fire?
US 85	Thin floor layer	Pottery, glass fragments	Period 2	First known floor, covers earlier building = building of the insula ca 200 AD?
US 87	Plaster	Painted plaster (from period1?), little pottery	Period 2	Preparation for floor
US 88=US 49	Earth	Painted plaster, marble, bones	Period 2	Filling for floor
US 89	Foundation wall		Period 1	Building older than the insula
US 38	"bipedalis"-brick, part of the foundation wall US 89		Period 1	

Fig. 47. Stratigraphic description of the excavation at San Lorenzo in Lucina. After Olof Brandt.

San Lorenzo in Lucina, the excavation site

The 5th century church San Lorenzo in Lucina is situated on the *Campus Martius*, in central Rome, in the area where the Emperor Augustus constructed his huge Mausoleum, the Ara Pacis and the sundial, *Horologium*. The church was constructed upon an early Christian baptistery, below which are preserved the remains of a 3rd century Roman *insula*. Below these are remains left of an even earlier *domus*, a building not excavated. The baptistery is situated at the level of 1,99 m and the *insula* at 3,12 m below the level of the church floor. Due to the high level of the ground water, it was decided not to excavate below the upper level of the Roman *insula*.

A Roman *insula* was, generally speaking, a multistore and multifamily house in an urban environment.[2] Such buildings could be as much as five stories high, and became, due to the increasing Roman population, a common type of urban house from the 1st century AD and onwards. At the ground floor a row of *tabernae*, small shops and bars, often faced the streetside.[3] If there were any paintings in *tabernae* these generally were plain, just as in the small *insula* apartments.[4] The size and character varied between apartments within the *insula*. Some apartments were large, often situated at the ground level and organised around the open courtyard, others were small and rather dark, containing just one or two rooms.[5] The *insula* was not the dwelling of a wealthy Roman family, simply because there would not be space enough for the need of a public person.[6] The fact that the fragments were found in filling material makes determination of their original context uncertain. Some fragments may in addition have changed position from one level to another at the time of a successive elevation or at the time of an earlier excavation. One possible hypothesis is however, that the original wall decorations were torn down and replaced with new decorations when the building was re-built and re-decorated in the 3rd and in the early 5th century.

Material investigation

The walls of the *domus*, situated at the lowest level excavated, have been dated to the Hadrianic period, and consequently the mural fragments are roughly dated from the middle of the 2nd century AD and later. Most fragments are very small, and, in addition, not as many as needed for the reconstruction of any representative area.

---

[2] Boëthius, 1970; Clarke, 1991; Pohl, 1983; Macdonald, 1986; Ward Perkins, 1970.

[3] Boëthius, 1960, p. 140; Pohl, 1983, p. 12.

[4] Wallace Hadrill, 1994, p. 157.

[5] Marta, 1986, p. 173.

[6] Wallace Hadrill, 1994, p. 72.

According to Vitruvius, describing the construction and plastering of walls, and successive preparation of paintings, as many as six layers of plaster and stucco should be applied on the rough render coat.[7] He recommended that plaster should be applied with three layers consisting of lime and sand, followed by three stucco layers, made of fine lime-marbledust, in order to make sure, that the walls would be smooth and strong, and not easily subject to any damage. The stucco layers should be rubbed and smoothed between one application and another, with the objective to compact the preparation, and also making the water extract through the applications to the surface of the last one. By preparing the walls this way, the surfaces not only became very hard and smooth but also well suited for painting. An additional achievement was that the wall plaster did not dry very rapidly, and the limited time available for painting *al fresco* therefore could be prolonged.

Preparations such as those described by Vitruvius have been found for example in the Villa of Livia at Prima Porta and in other buildings belonging to the Imperial family or to other persons of high rank.[8] Roman murals were at the highest standard during the Augustan period, when Vitruvius was active, after which a gradual technical decline incurred. Even though the Vitruvian recommendations on wall preparations were followed to some extent, observations of actual mural preparations show that 2-4 stucco and plaster layers were generally used.[9] Plastered walls of the Augustan period are characterised by a smooth and lustrous surface and saturated colours.[10] Colours such as cinnabar, wine red, green and violet, as well as a rich variation of blue colours, violet, purple and pink were used also in the previous First style, but then to imitate many-coloured blocks of marble.

A well made preparation, such as recommended by Vitruvius, may be dated to the Augustan period, but also to a later period, if the high standard was kept by the following generations. Well made preparations may have existed before the Augustan period, and in that case Vitruvius only referred what was common knowledge. In any case, high standard preparations were ordered only by a person of rank, who could afford to pay for qualified workmanship. A simple wall preparation, consisting of e.g. plaster and one or maybe two stucco layers, may be attributed to a modest house at any Roman period. Another fact to consider is the decoration in itself and the pigments which were used. Based on examinations of techniques, materials and styles, it may be possible to make a valid dating, when there is much enough remaining, and/or if the fragments are indicative.

The decorations in San Lorenzo probably date from the 2nd century AD and later, indicating that 4th Style and late Roman paintings can be expected. Maybe some fragments of an earlier decoration has survived.

---

[7] Vitruvius, VII,3.

[8] Ling, 1991, p. 1991.

[9] Bo Ossian Lindberg, personal communication, May 1997.

[10] Barbet, 1998, p. 109.

Pigments

High class wall paintings of the Augustan period are smooth and shiny and the colours are saturated.[11] During the Hadrianic period a classisistic revival was shown, e.g. in the choice of colours and materials. There are only few remains of high quality decorations from the Antonine and later periods.[12] The existence of elaborate wall decorations can, however, not be excluded.

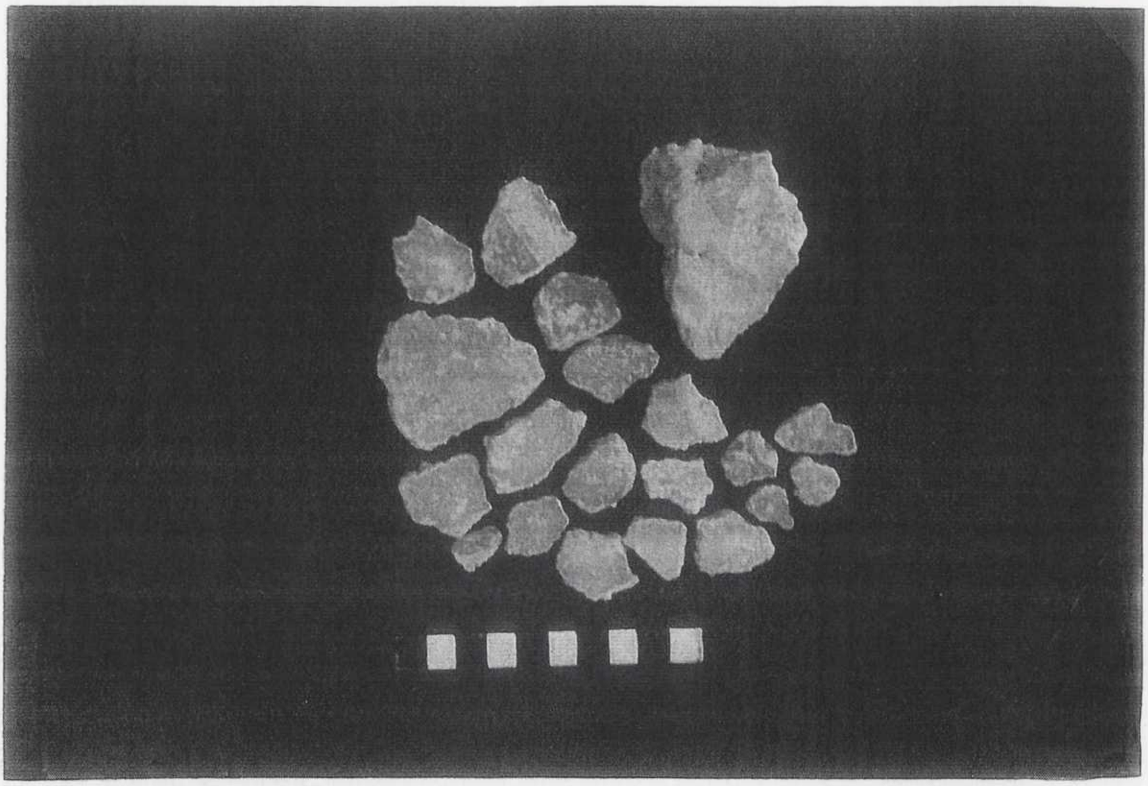
A variety of earth colours were commonly in use for mural paintings, e.g. red and yellow ochres, ferric oxides and green earth.[13] The most frequent green pigment was celadonite, a green earth.[14] Egyptian blue was the common blue pigment, and is in fact the only blue pigment used for mural paintings identified by Bearat.[15] Black pigments was carbon, obtained either from charcoal, soot or bone.[16] White pigments were generally white clays such as ancient *paraetonium* and other earths, chalk or calcite.[17] A white colour could also be obtained by sparing out the lime or lime-marbledust preparation in mural paintings.

Vessels containing ancient pigments have been found at several excavations, and their chemical composition has been analysed. The results have been compared with the information given by Plinius and Vitruvius on pigments available in ancient times.[18] Most pigments mentioned in those ancient sources and analysed with modern methods have been identified.[19] Comparisons between pigments found in vessels and those used for paintings in the same rooms as the finds, reveal that there is a distinct correspondence.[20] Since the results have been published, there is a rather vast selection of descriptions and photographs which are useful for comparison as far as the fragments in this study are concerned.

Cinnabar, ancient *minium*, the natural form of mercuric sulphide, was very expensive and has been found only in the richest decorations.[21] Due to its cost it was probably ordered only by wealthy families and used for decorations in noble houses, while earth pigments were primarily used for decorations in more modest environments. Cinnabar was often applied upon a yellow ochre.[22] Maybe this combination of layers was used to give a golden hue to the cinnabar, or to increase the brilliance of the red colour and in addition reducing the cost. Another explanation may be that the yellow undercoat had the function of a protective coat between the lime plaster and the sensitive cinnabar pigment.

---

[11] Barbet, 1998, p. 109.
[12] Mols, personal communication, February 2000.
[13] Ling, 1991, pp. 207-208.
[14] Bearat, 1997, p. 269.
[15] Bearat, 1997, pp. 14, 24-25.
[16] Ling, 1991, pp. 208-209.
[17] Augusti, 1967, pp. 51-61; Bearat, 1997, pp. 14, 16: Rozenberg, 1997, p. 65.
[18] Augusti, 1967; Barbet, 1997; Varone and Bearat 1997.
[19] Bearat, 1997, p. 14.
[20] Rozenberg, 1997, pp. 65-71.
[21] Ling,1991, p. 209; Rozenberg, 1997, p. 67.
[22] Barbet, 1998, p. 109.



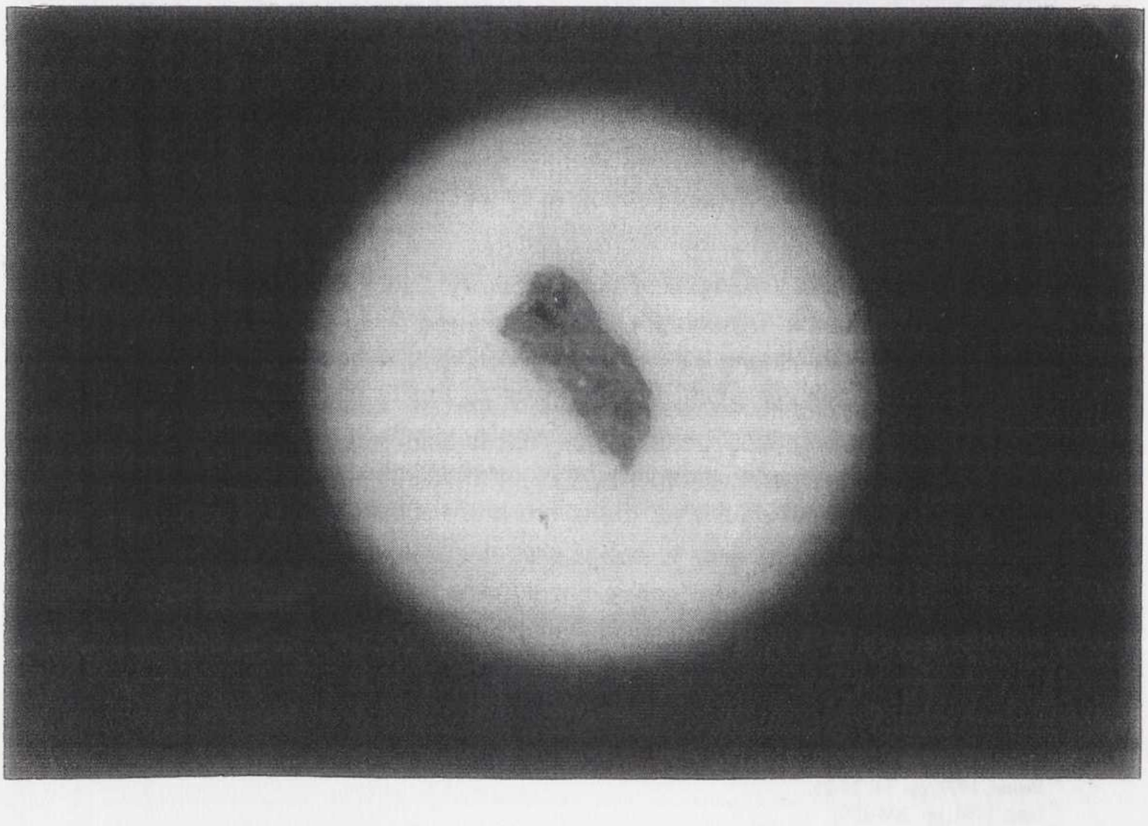


Fig. 48. *Above*. Fragments from US 80, with cinnabar decoration.
Fig. 49. *Below*. Sample 80:II, photographed in 75x magnification. Microscopical black mineral grains appear in the cinnabar red surface. At the lower left side of the sample, some of the ochre layer is visible.

At Herod's palace at Jericho high quality Roman murals have been found and studied. There were no traces of any special undercoat beneath the cinnabar colour at those 2nd style paintings, which may indicate that the colour was protected with Punic wax.[23] Cinnabar has the disadvantage to turn black when exposed to bright light, and should therefore be protected with Punic wax which formed a protective shield upon the painted surface.[24] According to Augusti, cinnabar was not used for *al fresco* painting, but was employed for a special wax-tempera technique, i.e. using saponified beeswax.[25] In either case the cinnabar pigment was protected from

a) direct contact with the lime base, or
b) from contact with the oxygen in the air, which were the two factors mentioned in ancient literature causing the transformation of cinnabar. Fragments of possible cinnabar on a yellow ochre have been found in San Lorenzo in Lucina. Samples were removed for analysis of pigments, binders and the determination of a possible application of saponified wax.

The fragments in San Lorenzo in Lucina

Dating may in this case principally be done by referring to the level where the fragments were found, since the decorations were made before the time when the different fillings were added. Some fragments may have been moved within the fillings during previous excavation or construction periods.

The structure and material composition of the fragments may be used for dating. Due to the small size of the fragments, mainly monochrome, it may not be possible to reconstruct a significant area. The pieces may, in addition, not necessarily belong to the same wall, even at each specific level. One would expect to find 2-4 applications of plaster and stucco, based on the observations regarding the environment to which the fragments probably origin, and to the period to which they may probably be dated. These observations confronted to other known facts such as the variations in Roman decoration depending on the ambience, and finally the actual context may provide some valid information concerning the fragments. The characteristics of the fragments are presented in appendix III.

Samples

When the loose deposits had been removed and the surfaces been cleaned with deionized water, representative samples were taken from fragments found at the stratigraphical units 88, 87, 80 and 44. The two red colours (probable cinnabar and red ochre), the yellow (probable yellow ochre), black (probable carbon black), white (probable lime), green and violet. The cinnabar colour was

---

[23] Rozenberg, 1997, p. 67.

[24] Vitruvius, De Arch. VII, 9,3.

[25] Augusti, 1967, pp. 79-80.

particularly interesting to study, since such a colour was found on white as well as on yellow preparation. The samples were removed with a pointed scalpel under magnification and disposed in plastic sample bottles. Two samples from each spot were taken, in order to have duplicates. One set of samples was sent to Institute of Conservation, Göteborg University (ICUG) for analyses of pigments and binders, and in particular to investigate the possible application of Punic wax upon the cinnabar fragments. The samples were removed with a scalpel under magnification and disposed in sample bottles of plastic, and later sent for laboratory tests to the ICUG. The following samples were taken:

88 I-II	Dark red colour on white layer, powder.
88 III-IV	Green colour on white layer, powder.
88 V-VI	Yellow colour, powder and flake.
88 VII-VIII	Violet colour, powder.
87 I-II	Dark red colour, powder and flake.
80 I-III	Cinnabar (?), wax (?) small flake.
80 IV-V	Cinnabar (?), yellow, wax (?) all layers.
80 VI-VII	Dark red. Powder.
80 VIII	Paint or dirt? greyish layer.
44 I	Stucco. Pigment (?).

Some observations could be made while cleaning the fragments.

a) Some colours were well fixed and integrated with the plaster. Those were mainly yellow and red earth colours, applied al fresco. Other colours had not integrated, but could easily have been removed, indicating painting a secco. It was therefore necessary to work with a very light hand, in order not to unwillingly remove parts of the paint layer.

b) Underneath the probable cinnabar red on some fragments, there was a yellow layer, probably a yellow ochre, just as described by Barbet.[26] The underlying yellow layer was hard, while the superimposed brilliant layer had a greasy character, which may indicate that Punic wax was applied.

c) Some fragments were very brittle and could hardly be touched, while other were hard and stable. Most of the brittle fragments were white. Some of these had remains of an indefinable decoration. Among the brittle fragments, some seemed to have lost their original shape, since they presented deformation and surface cracks, suggesting that the layers had been rapidly and carelessly laid. These fragments were probably part of a wall in a simple room.

---

[26] Barbet, 1998, p. 109.

Chemical-technical analysis

A few samples were observed in microscope with the objective to study and photograph the particles included. A binocular microscope, Nikon SM2-U with photographic attachment Microflex HFX and 7.5 – 75 magnification. The investigation was made at the Central Board of National Heritage in Stockholm, under the supervision of Dr. Runo Löfvendahl.

Sample 80:II, probable cinnabar and ochre. (Photos 1-4, the upper side in 75x magnification). A thin layer of cinnabar red was identified on an ochre layer. Below these layers, the lime plaster was noted. Microscopical black grains, mainly biotite and horneblende, were observed. The upper red layer had a lustrous surface, and the ochre coloured layer was less shiny. (Photo nos. 5-7, the back side in 75x magnification). The ochre coloured layer was quite distinct, and also on this side there were black grains and in addition some fibres which may be residues from a plant. The sample was saved for future analysis to determine the binder.

Sample 80:IV, probable cinnabar on a white layer. (Photo nos. 16-20 in 30-60x magnification). The red pigment had inclusions of black mineral grains, probably biotite. A vitreous, greenish tourmaline crystal was identified. The extremely thin paint layer was applied on a very fine grained white lime plaster.

Sample 80:VI, a dark, brown-red layer on white preparation. (Photo nos. 8–10 in 60-75x magnification). Various brown shades were noted, and the pigment is probably a dark red or brown ochre.

Sample 80:IX, a black pigment on white preparation. (Photo nos. 11–15 in 60-75x magnification). The pigment was very fine-grained. Three distinct layers were observed. The upper, thin and pale layer was probably a surface coating, applied on the black paint layer, and at the bottom was the white preparation. The sample was saved for future analysis of the coating.

Sample 88:III, a green pigment on white preparation. (Photo nos. 33-36 in 75x magnification): This brilliant green pigment had inclusions of minor black mineral grains. The colour derived from one pigment and was not a mixture of blue and yellow. It may be appianum.[27] The sample was saved for further analyses.

Sample 88:VI, a yellow pigment, probable ochre. (Photo nos. 33-36 in 75x magnification). The brilliant yellow pigment corresponds to samples presented by Augusti as sil atticum.[28] Saved for future analysis of the pigment.

A partial chemical-technical investigation of three samples, selected as probable cinnabar, was made at ICUG. Samples 80:II and 80:III resulted to contain mercury or quicksilver (Hg), aluminium (Al) and iron oxide (Fe), sample 80:V just Hg and Fe. The traces of Fe indicate an ochre. Cinnabar, ancient *minium*, is a mercury sulphide, i.e. quicksilver, confirming that the red pigment is cinnabar. The presence of aluminium may so far just be registered, but not clearly explained. Aluminium has been traced as one of several chemical components in many red-brown colours at Pompeii.[29] Aluminium and silicates are present in natural clays. Consequently, some earth pigment or fine clay may have been mixed into the upper preparation. Aluminium was also used for the production

[27] Augusti, 1967, p. 101, sample 215B.
[28] Augusti, 1967, p. 95, sample 89.
[29] Augusti, 1967, pp. 82, 90.

of red lakes. An application of a red lake upon red ochre can have been made in order to increase the brilliance of the red colour. According to Augusti, cinnabar was frequently falsified during antiquity, and there are several ways of obtaining a bright red colour. The most common substitutes were red ochres and *minium*, lead oxide ($Pb_3 O_4$).

Since the important question regarding beeswax was not resolved at ICUG, the sample was brought to the scientific laboratory at Opificio delle Pietre Dure in Florence, where Dr. Moles helpfully studied the sample in a binocular microscope, and identified an organic matter, below and surrounding the pigment, indicating that the substance was not applied upon the red paint layer, but used as a binder. The transparent matter was not dark as could be expected of ageing oil, egg is excluded on lime plaster, and the binder therefore was considered as beeswax or saponified beeswax.

Conservation of the fragments, objectives and methods

Being part of filling materials, the original context is uncertain. One reasonable assumption is that wall decorations were torn down, at first in the early 3rd century, when the domus was perhaps rebuilt and then during the successive periods of building activity.

The fragments in this study were found:

a) In the US 88 and 87, i.e. below the first known floor, at the construction level of the 3rd century insula,
b) in US 83 an 82, i.e. between the first and the second floor, below the basilica, and finally
c) in US 44, where two fragments of painted plaster were excavated at the level of the filling for the 15th century chapel.

To begin with, the fragments were cleaned, in order to get a better view of the surfaces and colours. While cleaning progressed it became obvious that reconstruction of any decoration was excluded, even though some fragments could be fitted together. Most fragments were very small, in measures ranging from 5x10 mm – 55x65 mm. 12 fragments were much larger and measured roughly 80-100 mm. Some fragments consisted of plaster layers and stucco, while on others, only the stucco was preserved. They therefore presented thicknesses from about 5-25 mm, and the larger about 35-60 mm. The stucco varied between 4-8 mm, and occasionally a 10-12 mm layer was measured. In some cases it was possible to distinguish two stucco layers. The remaining plaster mostly was fragile, with a tendency to pulverise when touched. Next question was therefore *if* the plaster should be removed *or not*.

By *removing* the plaster it would be possible to obtain:

a) an unchanged material composition, with authentic characteristics,
b) a relatively homogeneous thickness of the fragments,
c) the fragments would not pulverise and fall apart in the exhibition stand,
d) no addition of consolidation material would be necessary,
e) presentation could be made in a thin layer of suitable plaster or stucco,
f) it would be easy to number the fragments on the flat back surface.

By *not removing* the plaster one would obtain:

a) the material structure would remain unaltered and authentic,
b) the fragments would remain of various thickness,
c) the fragments had to be consolidated in order not to pulverise,
d) the material composition of the fragments would change,
e) a rather thick layer of plaster should have to be used in presentation,
f) areas for identification numbers should have to be made on the plaster.

Independently on which decision was made, the fragments would not be "original" after intervention. In the first case the material composition would be unchanged, but not the structure, since plaster would be removed. In the second case the structure would be unchanged, but the material composition would not, since some consolidation material would be applied.

There is not one method which is always carried out, but the procedure has to be decided from one case to another. In some conservation reports the total removal of plaster from the back side of mural fragments is described.[30] Other reports refer to the decision to let the plaster layer remain and become consolidated.[31] The general impression after discussing the matter with different conservators seems to be that nowadays the plaster generally is not removed, but remaining on the fragments, occasionally ground to a suitable thickness. Before making a final decision, removal of the plaster was tested on a few fragments, but excluded, since there might be problems if performed on larger fragments. These may fall apart, due to their size and brittle constitution. Consequently samples had to be removed before any consolidation treatment was made.

Cleaning

Cleaning tests were made by
a) dry cleaning with a brush, and
b) cleaning with deionized water and use of brush, Japanese rice paper, or
c) with a special sponge, Wallmaster, used for the cleaning of murals.

---

30 Moreno, 1997, p. 305.
31 Stajkowski, 1997, p. 293.

The use of water and sponge was most efficient and delicate. A scalpel was used to remove earth from the plaster, the sides of the fragments, and when necessary to remove limited layers of earth upon the paint surface. These combined methods are frequently used for cleaning excavated murals and mural fragments.[32] Hard deposits were left upon the surface at this initial cleaning. Salts were extracted from the fragments by use of deionized water in paper pulp, which was applied to the fragments and left to dry. It was then removed and the remains of paper were brushed off with a soft nylon brush. While cleaning the fragments and removing the samples the following observations were made:

An additional cleaning with a 10 minute application of Viscor, a water-based cleaning gel, was tested on a few fragments (80:11, 80:95, 82:1, 83:1 and 9) with the object to remove some of the remaining incrustations. This treatment was very effective on the 82-83 fragments, which are painted al fresco, but tended to dissolve deposits as well as some colour on the fragments from US 80, which consequently had been applied *a secco*. The treatment was followed by cleaning with deionized water. It must be considered as easy to clean fragments from frescoes, compared to decorations with layers applied *a secco*, having binders composed of organic materials which easily soften, dissolve and disappear.

Consolidation

Consolidation tests with casein was made on a few fragments. Casein is an organic consolidation substance from milk/cheese production, which was used for consolidation of materials during Antiquity, but also until recent times, when it has become substituted by inorganic compounds, provided by the chemical industry. Casein was used in various dilutions of deionized water and a few drops of ammonia, and was applied to the plaster with a brush. In 24 hours the fragments had regained resistance to touch, and did not sugar when moved. There was no obvious difference between the different solutions, which indicates that casein can be used very diluted, almost watery, on small objects such as these.

Three of the treated fragments were brought to San Lorenzo in Lucina and placed in a shelter with the objective to study if and how any change in the treated material would appear, as for example the development of mould, fungus etc. The natural environment in San Lorenzo is quite damp, and since the fragments are planned to be exposed in the building, it was important to test the casein solution before a general application. If the result proved to be good, casein would be used. A few other fragments were treated with an ethyl silicate based consolidant (Estel), which is known not to alter in humid environments. The negative part of this product is that it contains chemicals which are negative for human health, and a mask should be used at applications.

After having been disposed in San Lorenzo for one month, the fragments were observed. There were no visible signs of moulds etc, and no particular smell

[32] Mora, 1995, p. 93.

either. The papers upon which the fragments had been placed were damp and had a smell of humidity. All fragments were therefore consolidated with casein with the addition of a few drops of ammonia, either by application with a brush, or by partial immersion into the liquid.

It was important to move around the fragments with the objective to try to unite some of them, and look for a figurative pattern. A method of marking them was therefore tested, and used, since it proved to work. After consolidation a dot of Paraloid B72 was applied to the plaster, and when that had dried, the identification number was written upon the thin film created. The fragments were given identification numbers, consisting of the original layer number plus an individual number starting from 1.

Layer	*Fragments*	*Period*	*Finds*
44	44:1-2	8	medieval pottery, stucco, porphyry
77		4	pottery, stucco, tesserae, glass, bone, coin
78		3	pottery
80	80:1-135	3	pottery, stucco, tesserae, nail
82	82:1-14	3	pottery, stucco, bone, golden plate
83	83:1-9	3	pottery, stucco, bone
84	84:1-22	3	stucco, marble, bronze, nail, glass
85	85:1-3	2	stucco, marble, pottery
87	87:1-67	2	stucco, pottery
88/49	88:1-89/49:1-18	2	stucco, marble, bone
89		1	wall of the insula

Fig. 50. Numbers of fragments, 359 pieces, and their find context (stucco = mural fragments).

Surface coating

Ten fragments were selected for a test with saponified wax as a surface protective.[33] The fragments were selected being singular and representing a wide range of pigments. A thin application of saponified wax emulsion was applied and left to dry for some minutes, and then the surfaces were heated with a hair dryer in order to make the wax sweat. When the pieces had cooled the surfaces were gently rubbed with a cloth.

[33] 80:13, black; 80:17, violet with a white stripe on red ground; 80:27, yellow, stripe in terra; 80:28, striped in red, black, yellow, black; 80:35, light blue; 80:50, bright red with decoration; 80:127, terra; 84:20, white; 49:8, white, marble decoration; 49:18, bright red.

One fragment, no US 1, was selected for comparative testing of surface applications. The surface was divided in three parts, and at each end of the fragment a protective was applied. Area 1: saponified beeswax, area 2: no surface protective, and area 3: Paraloid B72. A considerable difference between these areas could be noted. The Paraloid-treated surface received a uniform and hard lustre, but the colour did not change. The wax-treated area gained a soft lustre, but became slightly darker. At inspection in February 2000, the Paraloid-treated area had darkened and become rather brownish, while the wax-treated area had not changed at all.

All treated fragments were then brought to San Lorenzo in Lucina with the intent to study any change in the material. At inspection some weeks later there were no visible change. At a later date, however, some fragments were left on the earth floor in the crypt for a period, and were shortly afterwards covered with some unpleasantly smelling growth, probably mould. Those having been placed on a level above the floor, did not present any growth. This experience made clear that the crypt was not suitable for the exhibition planned, since also other materials such as paper and wood showed the same kind of decay.

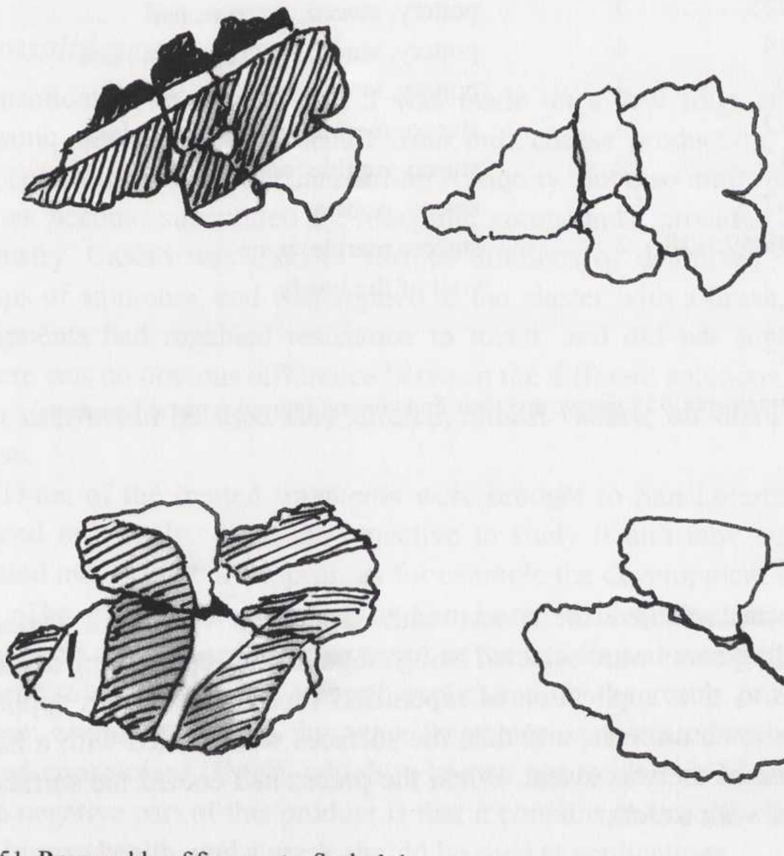


Fig 51. Reassembly of fragments. Scale 1:1.
Above. 87:25, 29, 30, 31. *To the left*: The decoration. *To the right*: The joints.
Below. 88:33, 34, 35. *To the left*: The decoration. *To the right*: The joints.

Documentation

Photos of the fragments were made before the investigation started. Just a few were photographed separately, others in small groups and the major part in their boxes. This seemed to be adequate way to document the fragments in this particular case. The initial photos were made to record the status of the fragments, and the quantity within each group, i.e. finds at each specific level.

Some photos were made showing fragments before and after cleaning with deionized water. Other photos were made to show the thickness and the number of layers of plaster and stucco. Stucco layers were measured and the thickest as well as thinnest measures noted. An estimate of the average thickness within each group was made. The characteristics of each fragment was studied and the main characteristics within the fragments from each level was described (see appendix).

After consolidation and marking of the fragments some were selected for further photos, to show examples of possible joining and gluing of fragments, colours, patterns etc. (see appendix). Photos were made of fragments which were glued together and drawings were made to show the joints of the small pieces, and finally the ten wax-treated fragments were photographed.

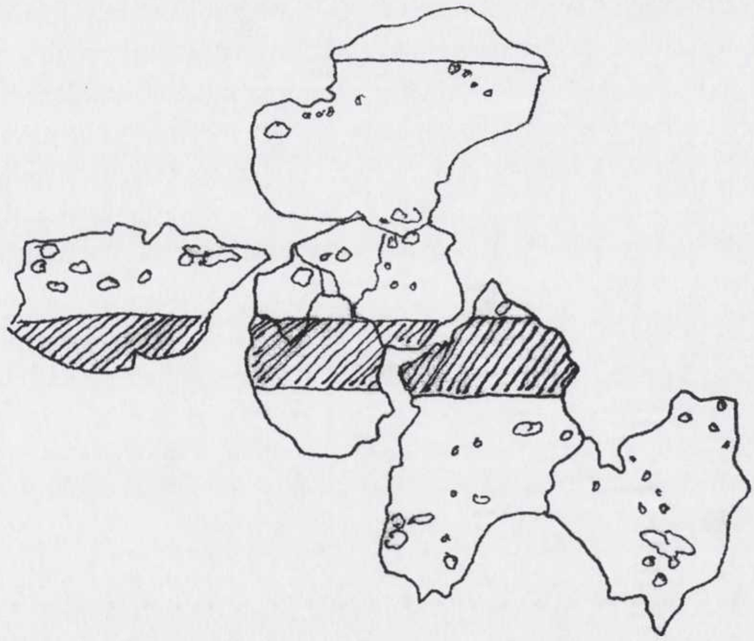


Fig. 52. Some fragments at Unit 87, presenting white stains and a black band on the dark red surface. The upper fragment has a white area at the top. Hypothetical reconstruction. Scale 1:1.

Presentation

The fragments excavated at San Lorenzo in Lucina were, as mentioned above, found in filling materials at different levels below the 15th century chapel, and in addition, they are of very small size. Since it would not be possible to reconstruct any figural decoration, it was decided that the fragments should be shown as instructive material in a didactic exhibition. Thus the material might be exhibited in combination with brief information about ancient descriptions and modern analytical results, with illustrations showing how Roman murals were built up, what pigments were used etc.

As work within the research school proceeded, and other kinds of excavated materials were cleaned and documented, it was decided to plan for an exhibition area containing all kinds of archaeological materials. Planning of the exhibition area was made in collaboration with Olof Brandt and the architect Mats Fahlander, who made the drawings. The final decisions and the realisation of the exhibition area is planned to 2001.

Conclusions

Period 2: levels 88/49, 87, 85

US 88/49. The large group of white fragments with an unpainted top-layer probably belong to the same wall. Some have a band decoration painted with red ochre, some present red stains and some have an illegible violet decoration. The fragments are built up with a 2-4 mm stucco layer, on a plaster layer with red and brown inclusions (terra cotta). Some stucco layers present deformations and cracks. A group of fragments with yellow and red ochre decoration probably belong to the same wall as well. Finally, there is a group of larger white fragments, with remains of rough plaster. Five of these are not totally white but show various earth-coloured hues, maybe due to discoloration or perhaps a deliberate attempt of imitating marble. One has remains of a relief decoration.

US 87. The white fragments with red ochre decoration are similar to the large group at US 88/49, mentioned above. Also these present the same kind of deformation and cracks. Such deformations are characteristic also for many of the dark red, white-dotted fragments, indicating that these were all part of the same wall, at different levels.

US 85. Two of the white fragments are similar to those mentioned above. The third fragment is different, since the top layer is very thin and showing various minerals. This fragment resembles the white group in US 84.

Period 3: US 80, 82, 83, 84

US 84. All fragments except two are white, most of them with unpainted stucco, and resembling those at units 88/89, 87 and 85.

US 83. 6 fragments present parts of a simple figural decoration, made on a rough plaster layer consisting of lime and sand and including black minerals. There is not much enough remaining of the decoration to understand the motif. The

decoration was made with earth colours. The remaining fragments are painted with red ochre, and one is monochrome white.
US 82. Fragments painted in various hues of yellow ochre, similar to those at US 80, form a group within this unit. The red fragments resemble those at US 83. One fragment is distinctly different, and belongs to the decorated fragments at unit 83.
US 80. The fragments from this unit mainly have a smooth stucco, some with remains of a decoration, and appear similar to the white fragments at US 88/49, 87 and 85. The dark red dotted fragments are very similar to those found at unit 87. There is a large group of yellow ochre fragments with a smooth surface, typical for the Antonine period. The main group consists of bright red cinnabar fragments, some of them with remains of a many-coloured decoration. A rich variety of colours are represented within this unit, such as various shades of yellow, red and brown earth colours, as well as hues of violet, blue green, grey, black and white.

Period 8: US 44
Two white fragments, similar to those at 88/49, 87, 85 and 82. These fragments belong to the medieval context.

Most of the fragments did not fit together, but surprisingly many could be joined. Groups of fragments presenting similar structures or colours may be identified at each level, even though disparate pieces occur. The cinnabar fragments occur only at US 80. These are probably related to the yellow ochre fragments at the same level, and consequently dating to the middle of the 2nd century AD, i.e. to the Hadrianic, or maybe the Antonine period. Since cinnabar was a costly pigment, and the wall preparation well made, it is suggested that these fragments belong to an elaborate decoration in a public room in the *domus*.

The white-dotted, dark red fragments, some with traces of a black stripe, probably belonged to the same wall as the white fragments at this unit, since the cracks and deformations in the stucco is a common item. Deformations such as these were noted also at groups of fragments at US 88/49 and 85, i.e. within period 2. Since the colours and preparations within these layers are similar, most of them may origin from the same room. Decorations made with this kind of stains are known from e.g. service rooms, and used e.g. for high socles. It is therefore possible that the fragments were part of the socle, and that the decoration made on a white surface belonged to the upper part of the same wall. The very similar dotted fragments at US 80 may also have been part of this decoration. One of these, 80.46, partly presents a white, partly a dotted decoration, divided by a black line.

The six fragments with an illegible decoration at US 83, are definitely made later than the groups mentioned above. These, as well as the single fragment from US 82, which perfectly fits with the others, have been painted on a rough plaster layer, and there are no other similar fragments present in this investigation. These fragments are probably dateable to the Severan period.

The white fragments which appear at all levels, either have a 3-6 mm or a 2-3 mm well made and smooth stucco layer, or a very thin top layer with grainy appearance, due to the inclusions of minerals that are seen through the preparation. Some of the white fragments have rich remains of plaster, of a different composition to major part of the fragments. These rough fragments instead resemble some slightly coloured fragments at US 88/49.

To conclude, it seems probable that most of the fragments originally belonged to the excavated room or a nearby room. The cinnabar decoration, maybe connected to the smooth yellow ochre fragments, probably was part of an elaborate ambience from the Hadrianic-Antonine period, i.e. in the *domus*. All other fragments indicate a simpler type of decoration, and probably was part of the 3rd century *insula*. Some correlation between fragments within each period has been noted, even though there is an evident disorder between the units, caused by successive diggings and fillings.

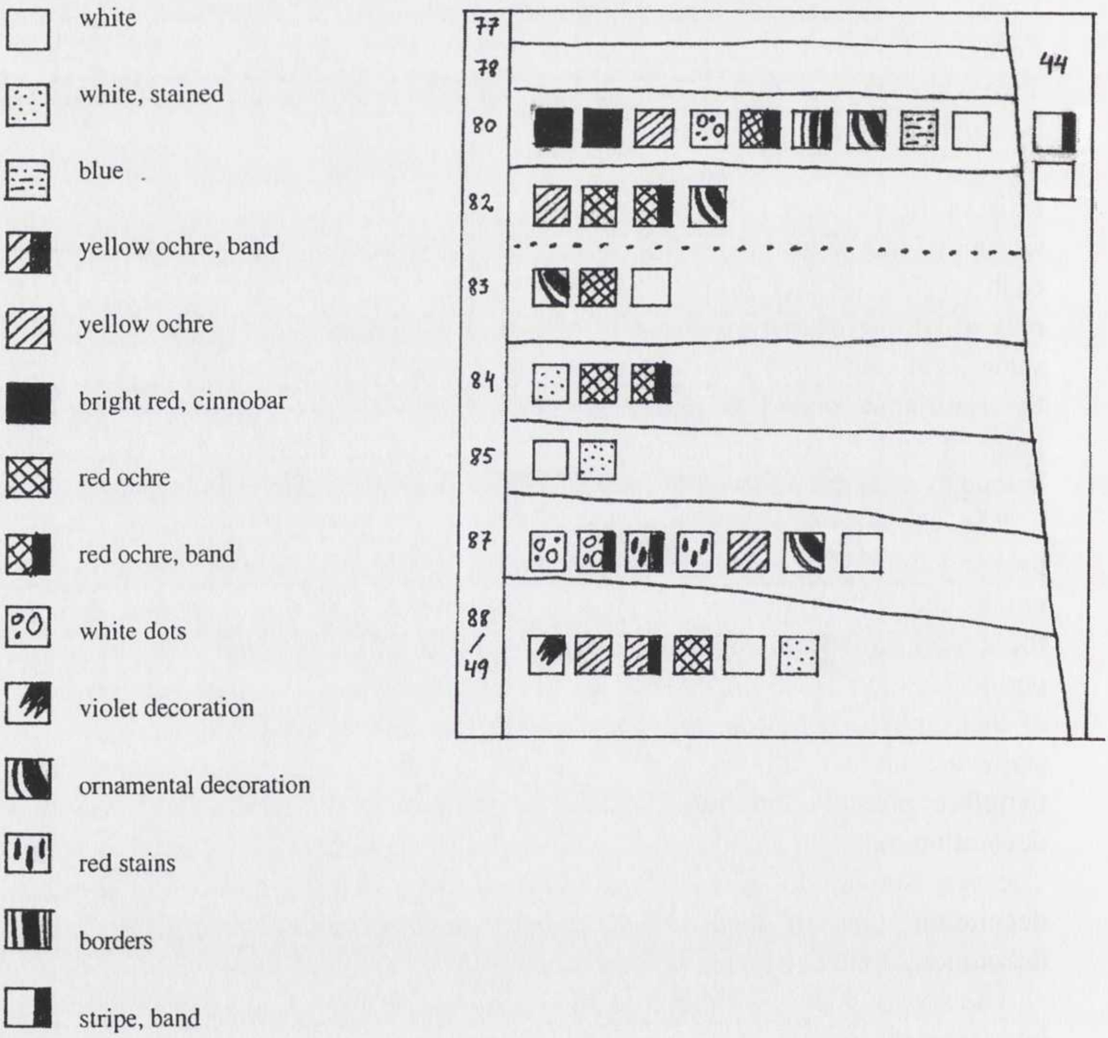


Fig. 53. Representation of the fragments.
To the left: The symbols used.
To the right: The fragments within the stratigraphical units.

Case Studies 4a, b and c:

Introduction

The objective of the present study has been to investigate some methods for identification of the original context and the dating of Roman wall paintings, based on the analyses of stucco and plaster layers, pigments and binders. With the original context is intended factors such as what kind of building, e.g. villa or *insula*, or room, e.g. service room or atrium, the painting was made for. The methods have been 1) identifying and measuring the stucco and plaster layers, 2) studying their characteristics, e.g. grain size and inclusions, 3) studying the paint surface – colour and structure, and 4) a chemical-technical investigation of samples of selected material. The assumption that determination of materials might contribute to a better understanding of the environment for which Roman wall painting were made is

a) the statement by Vitruvius concerning wall-preparations for mural painting,[1]
b) the fact that murals, composed of six layers of plaster have been found,[2]
c) the fact that most murals were made of less than 6 plaster layers,[3]
d) the assumption, that Roman murals were at their highest standard at the time when Vitruvius was active, i.e. during the Augustan period,[4]
e) that simple preparations might either be dated before or after the Augustan period or be part of a decoration in a simple house or service room during the Augustan period,
e) the assumption that manifesting social status was important in Roman society. This indicates, that costly and high class materials, used for wall paintings were ordered only for official spaces or by wealthy families, while materials used in buildings of the lower classes, consequently were of a lower standard,[5]and
f) the fact that the study of plaster composition has been found successful in Pompeii.[6]

Dating is traditionally made on stylistic grounds, and the Four Pompeian styles have been thoroughly investigated, ever since the classification of Mau in 1882. Such classification is the basic tool for dating, since interpretation of form, colour, and painting technique, makes it possible to define a range of time, within which a painting could have been made. There are, however, disagreements in dating, due to variations in the stylistic interpretation.

---

[1] Vitruvius VII.
[2] Ling, 1991, p. 199.
[3] Dr. Bo Ossian Lindberg, personal communication, May 1997.
[4] Borrelli, 1980, p. 82.
[5] Leach, 1993, p. 145; Clarke, 1991, p. 16; Scagliarini Corlàita, 1998, p.57; Wallace Hadrill, 1994, p. 154.
[6] Meyer Graft, 1997, pp. 318, 319.

Difficulties in dating may in addition be due to the fact that some persons in any period of time may prefer old-fashioned paintings while other wants the latest in fashion, which may lead to a continuous use of an earlier style, while the succeeding style has already been established. A completely reliable dating is, therefore, rather difficult to make, and to be agreed upon.

Measuring, may be an additional dating tool, revealing if there is a definite correlation between material composition and the different periods as represented by the Four Pompeian styles. The material composition and the quality of craftsmanship should, on the other hand, be possible to link to the owners′ status, which would provide valuable information about the context, for which the murals were made. By studying the material composition it is also possible to see whether repairs or structural changes in walls were made after the original mural painting was made.[7] Finally, measuring is a non-destructive method.

The fragments in this study origin from Prima Porta outside Rome. For some reasons this investigation has been divided into a, b and c, although the materials are closely related. To start with, I was given the opportunity to study some First style fragments, and at a later time one fragment found at the atrium in the Villa of Livia. It seemed natural to present the vast First style study and the only Third style fragment separated studies, due to the differences in number as well as in excavation context. I was hoping to study fragments from the Pompeian and Post-pompeian periods, and this possibility came when the first two studies were already defined. It was not either clear, until much later, if fragments from all periods represented could be examined at the Opificio or not. Therefore, the division made at the beginning has remained.

The study started with an ocular investigation combined with measuring and identification of the stucco and plaster layers. All information was noted on registers. Drawings of the fragments were made in scale 1:1, and used for sample location diagrams. Colour slide photographs were made showing the decorated surface. In some cases additional photos of the back side, or the profile, of the fragments were made. Then, samples of stucco and paint, were removed for analysis of the composition of plaster, stucco, pigments and binders, and brought to the scientific laboratory at the Opificio delle Pietre Dure in Florence, where the chemical-technical investigations were performed by Dr. Archangelo Moles, Dr. Giancarlo Lanterna and Dr. Carlo Lalli. The present investigation was made in concordance with Dr. Gaetano Messineo and Dr. Matilde Carrara, Soprintendenza Archeologica di Roma, XX circoscrizione, and with the support of the Swedish Institute for Classical Studies in Rome.

[7] Meyer Graft, 1997, p. 318.

Case Study 4a:

Torre di Prima Porta
First style decorations

The Torre di Prima Porta

The excavation site, Torre di Prima Porta, is named after the Medieval tower on a hill at close, c. 200 m, distance to the Villa of Livia. Under the tower, and in its immediate surroundings, there are remains from the Archaic period, during the 9th century BC, as well as such of Etruscan and Roman origin. A complex of subterranean rooms have been excavated, some still preserving their original stucco on the walls.[8] Among these rooms, partially carved in the rock and partially constructed of tufa blocks, are spaces identified as cisterns. These rooms are accessible through an open doorway, followed by a gallery and successive stairs leading to the vaulted cisterns.

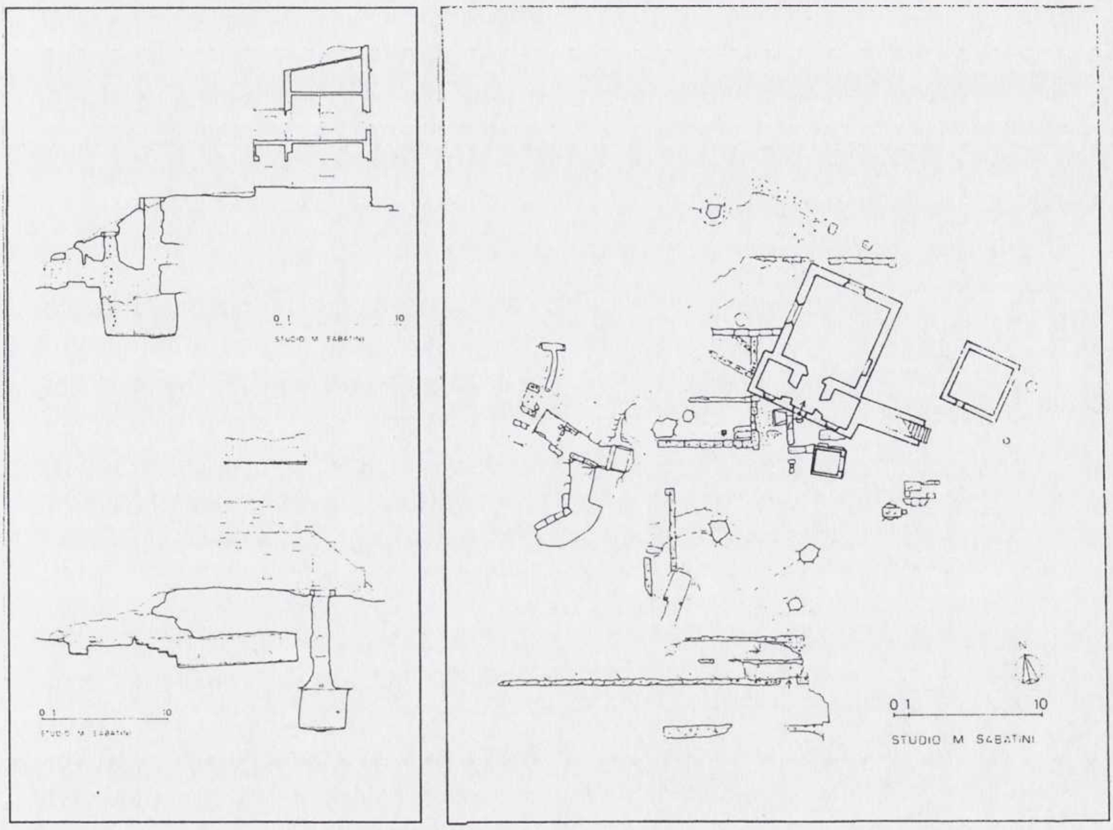


Fig. 54. Torre di Prima Porta.
To the left: Plan over the site. *To the right*: Map of the excavation site. After Messineo, 1989.

[8] Messineo, 1986, p. 725.

Objects from the Archaic period until the late Empire, have been excavated at specific locations, specified and described by Messineo.[9] There seem to have been various periods of building activities, with successive structural changes within the original building, e.g. in the Hellenistic period, and finally during the middle of the 1st century BC. Some finds, such as the identical structure of tufa blocks, and similarities between mosaic pavements, indicate a possible integration of the site with the nearby Villa of Livia. These buildings were, during the Augustan period separated by the Via Flaminia.[10] Finally, the Medieval tower was erected, upon part of the Roman building.

The First style fragments, investigated in this study, derive from the *cisterna meridionale*, situated east of the tower. In the same context two portraits of terracotta were found at the interior of the cave. One of the portraits, representing a bearded man, is dated to the Late Republic. The other portrait, with remains of polychromy, is the head of a woman, and dated to the late Hellenistic period.

In the upper layers, fragments of wall paintings were found, all made in the First style, and datable to between the 2nd and 1st centuries BC. It is known that this style appeared during the Hellenistic period in Greece, and successively was adapted throughout the Hellenistic world. Roman First style decorations are supposed to date from between c. 200-70 BC. The fragments were at the time of excavation recorded as belonging to four specific groups, A, B, C or D, with differences within the groups registered as 1, 2, 3 etc., published by Messineo 1989-90.

The Pompeian First style

The Pompeian First style decoration is dateable to the Hellenistic and the Republican periods. [11] Decorations of this style may be defined as painted stucco reliefs, rather than paintings. These decorations usually were imitations of marble, often made in a fanciful and not necessarily naturalistic manner, but could represent a vast selection of colours.[12] Many-coloured panels were often alternating with such of a monochrome hue. The panels appear in relief, delimited by flat and depressed borders, and were built up by various layers of stucco. An incised line was frequently delimiting one panel from the next.

The fragments investigated

Twenty-four First style fragments have been investigated. The fragments were chosen according to the principle, that they should be representative examples of commonly found colours, decorations and profiles. All fragments, except two, were chosen as *not previously* having been conserved and thereby contaminated by modern conservation materials. The previously treated fragments were

---

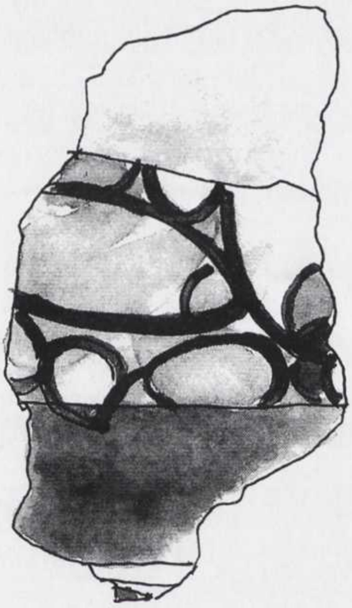
[9] Messineo, 1986, 1989-90, 1991.

[10] Messineo, 1986, p. 732.

[11] Barbet, 1985, p. 12; Clarke, 1991, p. .39.

[12] Borda, 1958, p. 5; Mau, 1908, p. 39.

included in the study due to their decoration, which was well preserved. Full size drawings of these fragments were made, and their stucco and plaster layers were measured, but thereafter excluded from further investigations. The decoration very much resembles one in the Hellenistic Palace at Pergamon, documented by Wiegand. All fragments were excavated in 1985 at the Torre di Prima Porta.



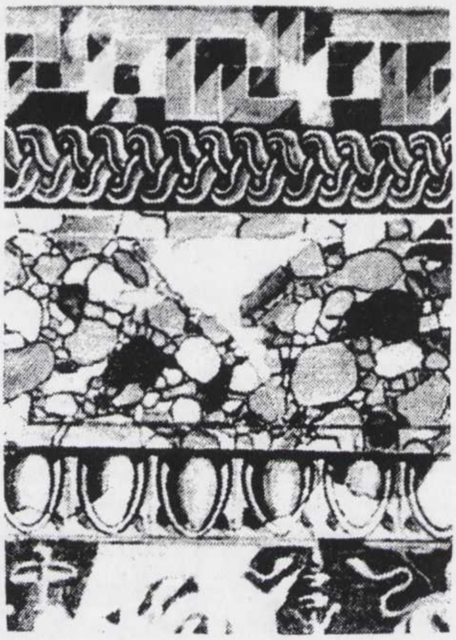


Fig. 55. *To the left*: Fragment from Prima Porta. *To the right*: Wall decoration from the Palace at Pergamon. After Baldassare.

The investigation

The surface and thickness of all fragments were initially measured, and then cleaned with demonised water and a sponge, or a soft nylon brush. Hard deposits were removed with a scalpel. At this point, it was discovered, that three "false marble" fragments had been treated with a surface coating, since they were water repellent. After cleaning, the stucco layers were measured and drawings were made, representing the fragments in natural size. Finally the grain size of sand, and of some glassy particles in the layers were noted. In some cases the marble particles in the stucco were measured as well. Generally the marble was present as particles of dust and not in grains, and marble dust was not measured. The visual investigation was made without a microscope, which means that further layers may be identified if viewed under a microscope.

It is well known that most Roman murals were painted *al fresco*, at least as far as the first layer is concerned. Those pigments consequently were protected by the skin of calcium carbonate, which was formed during the drying process. Successive colours, monochrome areas or decorations, were applied when the surface either had started drying, or was already dry, and a binder consequently had to be added to the paint, in order to permit adhesion to the surface. These binders are not fully known, and recent research has revealed that various binders were used by the Romans.[13]

When cleaning, it became obvious that the painting techniques were two, i.e. the paintings had either been made *al fresco* or *a secco*. The colours applied *al fresco* were well integrated with the surface, and did not dissolve, or soften, during the cleaning process, and therefore did not present any problems at cleaning. Colours applied *a secco* had the tendency to soften or dissolve, and in many cases the surface deposits were harder, than was the paint. After testing, and when needed, applications of ammonium carbonate in paper pulp, or Viscor, a gel adapted for cleaning of mural paintings and marble, were made in order to remove remaining surface deposits.

Testing

Tests were made to study *if* and *how* the surface of two fragments, the blue TPP 426405 (77) and the yellow TPP 426462B (137B) reacted to deionized water, Viscor and ammonium carbonate, i.e. if one substance would be more suitable than another, for softening the hard deposits. Testing was performed by the application of each substance with cotton, folded on sticks, and identified as I, II and III. After 5 minutes, each spot was softly rubbed with respective cotton stick. Finally the surface was cleaned with deionized water.

TPP 426405 (77): Deionized water dissolved some colour, ammonium carbonate less colour, and Viscor, dissolved no colour at all.
TPP 426462B (137B): Deionized water dissolved no colour, ammonium carbonate, and Viscor, dissolved hardly any colour at all.

Results

The stucco, generally was containing white and brilliant components, and also some with a crystalline appearance. The layers were mostly two, upon which a distinct and shell-like surface layer could be distinguished. This last layer was hard and smooth and with the thickness of about 1mm. Whether this was a specific layer, or just the well compacted part of the upper stucco layer, is not possible to say, at this moment. This shell-like structure is, however, apparently due to smoothing and compacting of the surface. Since such a shell appears on every fragment, it will not be specifically mentioned, when the layers are described. It was always there, as a characteristic of the preparations.

[13] Andersen, 1985, p. 114; Barbet, 1998, p. 105; Clarke, 1991, pp. 45-46; Ling, 1991, p. 103.

In the group of 10 (8+2) "false marble" fragments, the stucco layer was generally 4-5 mm, and the plaster layer underneath as well. Among these fragments, seven had a plastic profile, and three were flat. One of the flat fragments, had two distinct stucco layers, all the others just one. The remaining fragments show similar results, the upper stucco layer 3-5 mm and the lower layer 4-6 mm, if there was a profile. In case the fragment was flat there was no lower layer. In one case, there were three stucco layers.

Most fragments contained remains of plaster, only four did not. It is, of course, not possible to say anything about the original thickness of the plaster, or about the number of mortar layers, since there are only some remains, and no limitations at two levels. In two cases, there were two distinct plaster layers, in all other cases just one.

a) eighteen fragments had 2 distinct stucco layers, one fragment had 3 layers, and the remaining eight had 1 stucco layer. Four of these eight fragments had no remains of plaster, and those, consequently, may have had an additional stucco layer.
b) all fragments had a shell-like surface, in addition constituting the paint layer.
c) all fragments had an *upper layer*, made of a fine and homogeneous stucco, with the grain size of less than 2 mm Ø.
d) most fragments had a fine grained *second stucco layer*, made as the stucco described above, with the inclusion of larger grains, c. 2-3 mm Ø.
e) One fragment had a fine grained stucco of the kind first described, but with inclusions of 3-5 mm Ø size.
f) All stucco layers obviously contained lime, fine sand and marble dust. In some cases there were inclusions of other materials, such as minimal glassy, or glassy black particles and possible travertine.
g) All plaster layers contained lime, and fine sand, and, generally (22 cases), glassy black articles. In some cases there were some inclusions glass-like particles, and of some red and brown particles as well.

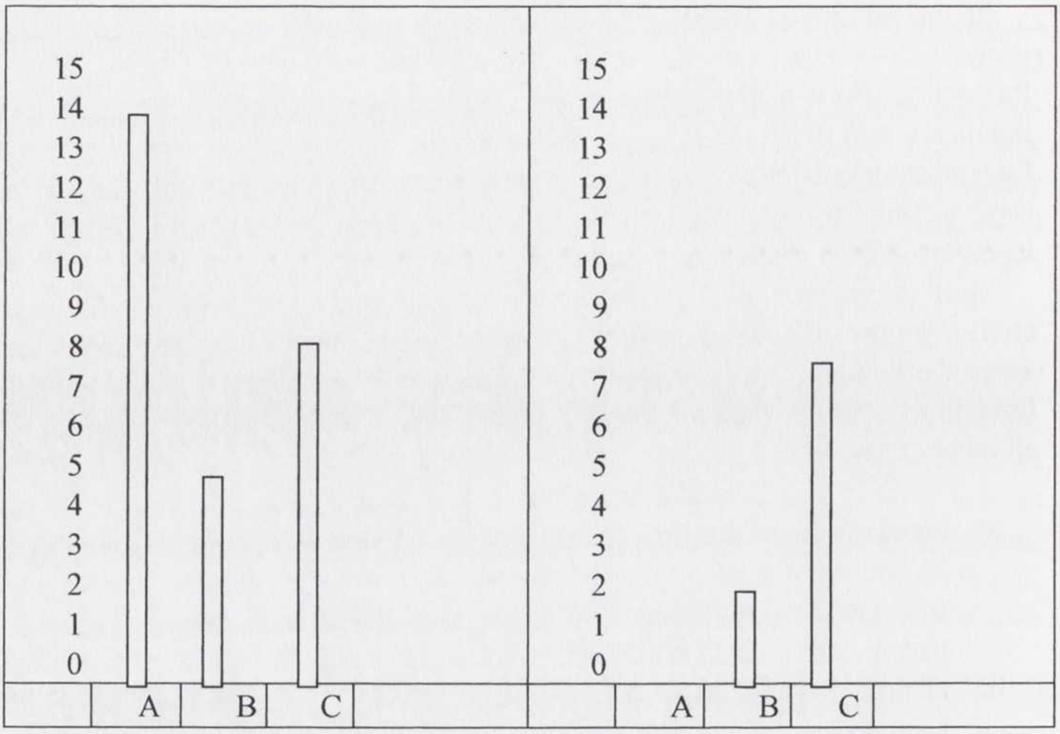


Fig. 56. Stucco layers.
To the left. The measures of grain sizes, of all fragment investigated. *To the right*. The grain sizes of the "false marble" fragments.

A = 1 layer, with the grain sizes of less than 2 millimetre.
B = 2 layers, with grain sizes of less than 2 mm (the upper layer), and 2-3 mm (the second layer).
C = 2 layers, with grain sizes of less than 2 mm (the upper layer), and 3-5 mm (the second layer).

Conclusions

The number of mortar and plaster layers cannot be determined, due to the non existence of fragments, containing all those layers. The layer immediately before the stucco, i.e. the last plaster layer, mostly is composed of lime and fine grained sand, generally with the inclusion of glassy black particles (obsidian?) and sometimes with the inclusion glassy particles (quartz?) and of larger grained sand. The sand grains were mainly rounded, while the glassy particles had distinct edges. Preliminary results from the material analyses performed at Opificio, did not reveal any presence of quartz, the glassy particles instead proved to be alabaster. Other inclusions in the lime/sand plaster were marble and travertine.

The stucco layers were generally two, the upper of a finer grain-quality than the lower, and in addition there was always the compacted and shell-like, 1 mm thick upper layer, often constituting the paint layer *al fresco*. Analyses of the stucco, made at the Opificio, show, that alabaster dust was frequently used for these preparations. The inclusion of this brilliant, and very costly material, explains the glittery appearance of the surfaces, and also the brilliance of the colours.

The materials used for plaster and stucco were of highest possible quality for these First style decorations. This was not quite expected, since the original hypothesis was that the painting preparations from the Augustan period might have been made of materials of the better quality. Most surprising was that alabaster-dust was used for these early decorations, a practice assumed to have been invented a little later, during the Augustan period. Consequently, the use of costly materials and high-class workmanship, were not inventions of the Augustan period, but rather a tradition inherited from craftsmen during the Republic, or maybe even earlier. Therefore, Vitruvius, when describing the materials for wall-preparations, based his recommendations on the actual knowledge of the craftsmen during his life-time.

Roughly half of the samples seem to have been painted *al fresco*. In a few cases, the painting technique could not be distinguished, due to weathering of the surface. Most fragments had additional paint layers, which clearly indicates that the paint was applied on a drying or dry surface. In some cases, there were indications of some ancient surface application, since the paint appeared to have a greasy consistency. Pigments used, binders and possible surface protective may be determined in future analysis of the samples. A preliminary result from the Opificio, reveals that beeswax had been applied on some fragments.

Cleaning and removal of incrustations on surfaces painted *al fresco* are not a great problem, since the pigments are well integrated to the surface, and thereby protected. Such cleaning may be done with applications of deionized water, ammonium carbonate, or Viscor, followed by cleaning with deionized water and a soft brush. Remaining incrustations are mechanically removed with a scalpel. There is a definite difficulty in cleaning mural fragments, if there are hard surface incrustations, and if the paint layers are applied *a secco*, since the incrustations are harder than the paint. By softening the incrustations, the paint softens too, or becomes less attached to the surface, and is, therefore, easily removed. Incrustations may partially be removed by deionized water and a scalpel without harming the paint. By identification of the binders it would be possible to choose a cleaning method adapted for each kind of paint, which would dissolve the incrustations but not the paint.

The results from the analyses of pigments and binders are presented in appendix IV.

Case Study 4b:

Villa of Livia at Prima Porta, Atrium
Third style decorations

The Roman context

It has been assumed that the excavated building was the country estate of Livia recorded in ancient sources by e.g. Pliny and Suetonius. According to Pliny, it happened at one occasion that Livia, at the time she was engaged to Octavian, " *... while she was seated an eagle, passing in the sky, dropped into her lap a hen of remarkable whiteness, without hurting it; she regarded it with wonder, but undismayed, and there was a further miracle: it was holding in its peak a laurel branch bearing its berries. So the augurs ordered that the bird and any chickens it produced should be preserved and that the laurel branch should be planted in the ground and guarded with religious care. This was done at the country mansion of the Caesars standing on the banks of the river Tiber about nine miles out on the Flaminian road; the house is consequently called The Poultry (Ad gallinas), and the laurel grove so begun has thriven in a marvellous way. Afterwards the Emperor when going in a triumph held a laurel branch from the original tree in his hand and wore a wreath of its foliage on his head, and subsequently every one of the ruling Caesars did the same.*"[1] Suetonius tells a similar story, and is adding that "*It was also their constant custom to plant others on the same spot, immediately after a triumph; and it was observed that, a little before the death of each prince, the tree which had been set by him died away. But in the last year of Nero, the whole plantation of laurels perished to the very roots, and the hens all died.*"[2]

The mansion owned by Livia was situated close to the ancient Via Flaminia at about nine miles from Rome, a road constructed already in 223 or 222 BC, and repaired by Augustus in 27 BC, when also most of the bridges were restored.[3] At Prima Porta there are remains of the ancient cross-roads of Via Flaminia and Via Salaria, indicating that the villa was built in a strategic position.

Based on the ancient descriptions mentioned above, the site was thought to be localised at the village of Prima Porta, and only in the middle of last century the villa was actually identified. This led to the discovery in 1863 of the cuirass statue of Augustus, now in the Vatican Museum, and of the famous garden paintings, now in the Museo Nazionale Romano. These beautiful decorations, painted in a subterranean room, give the impression of a paradise garden and at the same time provide a lot of information about plants and birds.[4]

---

[1] Plinius, NH, XV, 135-137.

[2] Suetonius, Galba, I.

[3] Messineo, 1991, p. 2.

[4] Gabriel, 1955, pp. 10-16.

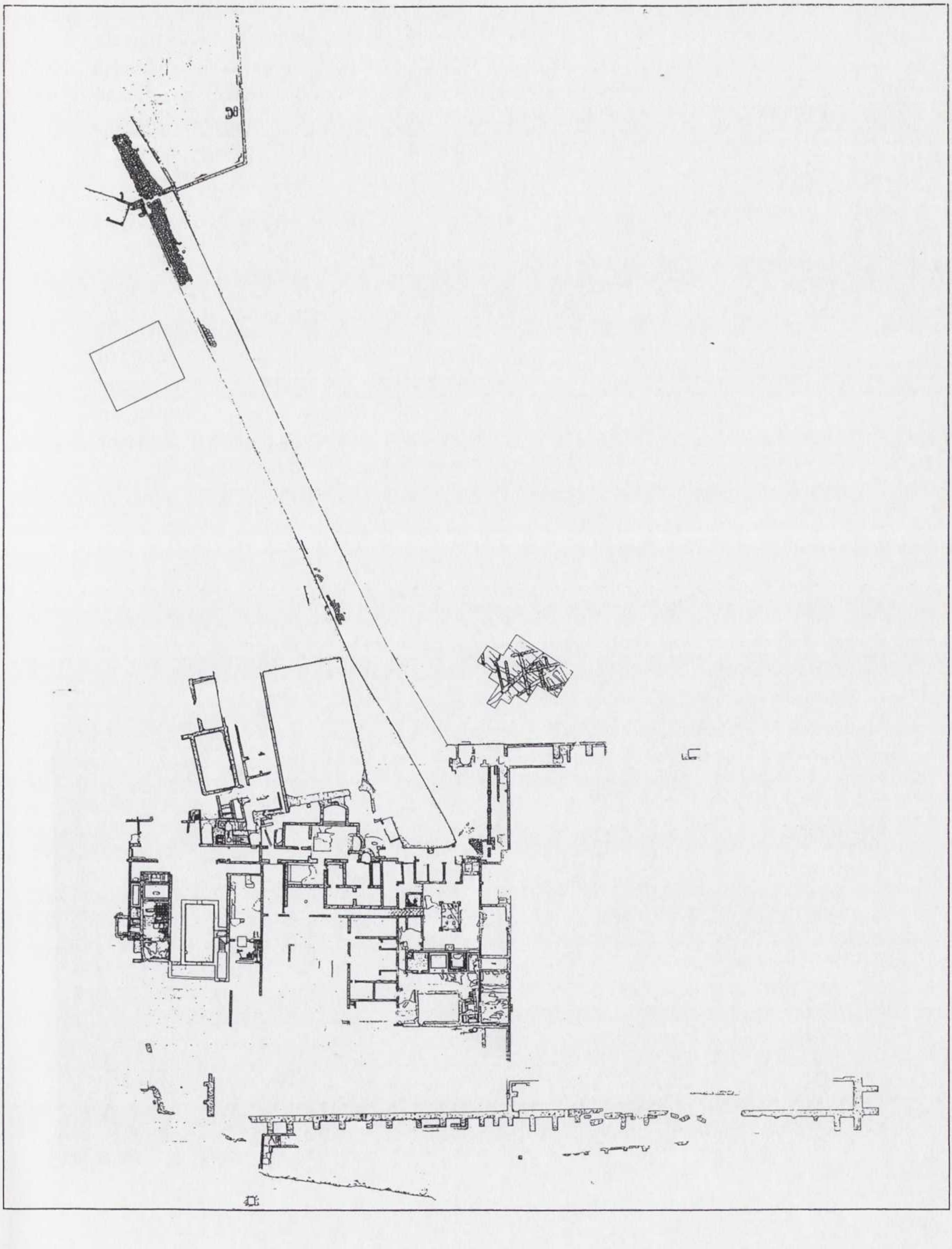


Fig. 56. Plan of the Villa of Livia. After Messineo, 1989.

Excavations

Recent excavations at the villa have resulted in the unearthing of various objects, paintings and fragments of paintings from the Augustan period and later. Except for the remains of masonry and wall decorations, several floors with mosaics or in *opus sectile* have been found. These are dated to the Republic, the Augustan and the Antonine periods.[5] In this study only a large fragment from the atrium is studied. A narrow Third Style fragment from the same space is still *in situ*.

The fragments of wall painting

Remains of a an elegant decoration, mainly in yellow and red on a black background, are situated close to a concrete foundation in the atrium. The foundation might have been the base for the famous statue of Augustus, found at an undefined spot at the villa. The wall decoration was made on a smooth and shiny surface, upon which the painted decoration appears slightly in relief. In areas where the decoration is weathered, the black monochrome underlying layer is showing, indicating that the painting was made in a mixed technique.

Fig. 57. From the atrium at the Villa of Livia. The mural fragment still *in situ*. Detail.

[5] Dr. Peter Liljenstolpe, head of the Swedish excavations at Prima Porta. Lecture at the site, October 3, 1998.

The fragment of the atrium decoration was kept in the laboratory of the Soprintendenza at Malborghetto after excavation. The fragment, measuring 225 x 117 mm, had not been cleaned nor conserved with modern conservation materials and, therefore, was regarded to be appropriate to observe and to use for material analysis. The results may perhaps in future be compared to material analysis from part of the painting still *in situ*, not yet been excavated. At the visual observation, some samples were removed. Documentation was made by photography and drawings in scale 1:1 and registered on a conservation schedule. The samples were kept in plastic containers for future analysis.

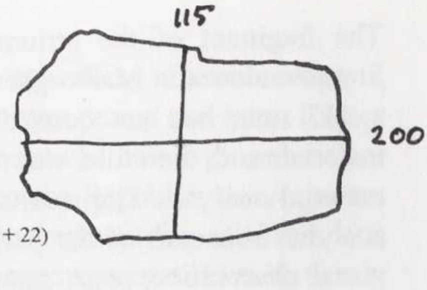
At a second occasion, the plaster and stucco layers were measured. In the period between, the fragment had been exposed to conservation treatments, consisting in consolidation of the plaster layers, which were enclosed by then in Paraloid B72. Some samples of particle inclusions in the stucco were removed although they probably preserve some application of Paraloid at one surface.

Results

The fragment originally was part of a wall composed by several plaster and stucco layers just as described by Vitruvius. Visual observation reveal that five or six layers of plaster and stucco were applied. Preliminary chemical-technical analyses of the plaster revealed that alabaster dust as well as marble dust had been used for the plaster, confirming that the material quality of this decoration is excellent.

Comparing the composition of this fragment and the First style fragments mentioned in Case study 4a, there is a difference, principally noted in the numbers of layers. The lustre and smoothness of this fragment is outstanding.

Fragment no VLA (1)



Provenance: Prima Porta, Villa of Livia
Location: Atrium, room 43
Excavation date: 1997
Object: Fragment of wall decoration
Subject: Third style (1st century, c. 20-15 BC)
Measures, mm: Surface: 200 x 115; stucco: 17 (2+4+5+4+2) plaster: 45 (23 + 22)
Photos: Colour slides.
Bibliography: Not published.

Description
Fragment of a wall decoration. On a black monochrome preparation appears an elegant floral motif in red and yellow. The fragment was part of the atrium wall decoration, partially still *in situ*.

State of preservation
The stucco is hard and solid, and the painted surface seems stable too. It is partially covered with surface deposits.

Investigations
Some samples were removed with the objective of determining the pigments and binders used. The samples were removed with a pointed scalpel and disposed in plastic sample containers. It was difficult to take cross-section samples due to the very hard and compact surface, into which the black colour was completely integrated. The red paint was well affixed. The yellow colour, also extremely hard, seemed to have been made upon a white application slightly in relief. At one spot, an area of paint lifted, and this is the only large sample collected. Samples in powder form were taken, and also this were difficult to remove. The fragment was not cleaned before sampling, just part of the surface dirt was removed with the scalpel.

Cross-sections
VL.I. Black paint layer at the extreme right side.
VL.II. Red paint layer at the right upper edge.
VL.III. Yellow paint layer from central decoration.
VL.IV. Yellow paint layer from the lower left edge.

Powder
VL.1. Black paint layer.
VL.2. Red paint layer.
VL.3. Yellow paint layer.
VL.4. Yellow paint layer.

Additional samples
These were removed from the plaster at a second investigation of the fragment. Paraloid B72 will probably be traced upon one side of the particles.

VLA: A, alabaster?	Analyses revealed the presence of only calcite (alabaster).
VLA: C, carbon?	Analyses revealed silicates and nitrates, indication of carbon.
VLA: M, marble?	Analyses revealed only calcite (marble or alabaster).
VLA: T, travertine?	Analysis revealed silicates, quartz, (probable travertine) nitrates (inquniation).
VLA: Q, quartz?	Analyses revealed only calcite, i.e. marble. (No quartz).

Further observations
Except for the visual inspection and measuring of the layers and particles included in the plaster and stucco, no further investigations were made. The fragment was not cleaned. It was quite obvious that at least the yellow colour was applied after the black surface had dried. The applications of plaster and stucco was made according to the description of Vitruvius, and it seemed to have been made in six or seven layers.

Chemical-technical investigation at the Opificio

VLA I.	No visible paint layer.
VLA II.	Two layers. 1: remains of stucco preparation. 2: paint layer with red pigment, probable cinnabar. Intense red fluorescence.
VLA III.	No visible paint layer.
VLA IV.	Three layers. 1: preparation with only calcium carbonate. 2: yellow paint layer. 3: another yellow paint layer, with intense yellow fluorescence.
VLA 1.	Only stucco.
VLA 2.	Calcite and aragonite and minor quantities of silicates (red ochre).
VLA 3.	Calcite, silicates (yellow ochre) and an organic substance.
VLA 4.	Calcite, silicates and an organic substance (acrylic polymer).

Conclusions

The plaster preparation was made in several layers, the upper layer containing alabaster dust. Pigments identified were cinnabar, yellow ochre and carbon black. There were no traces of wax. The fragment had been treated with a surface protective.

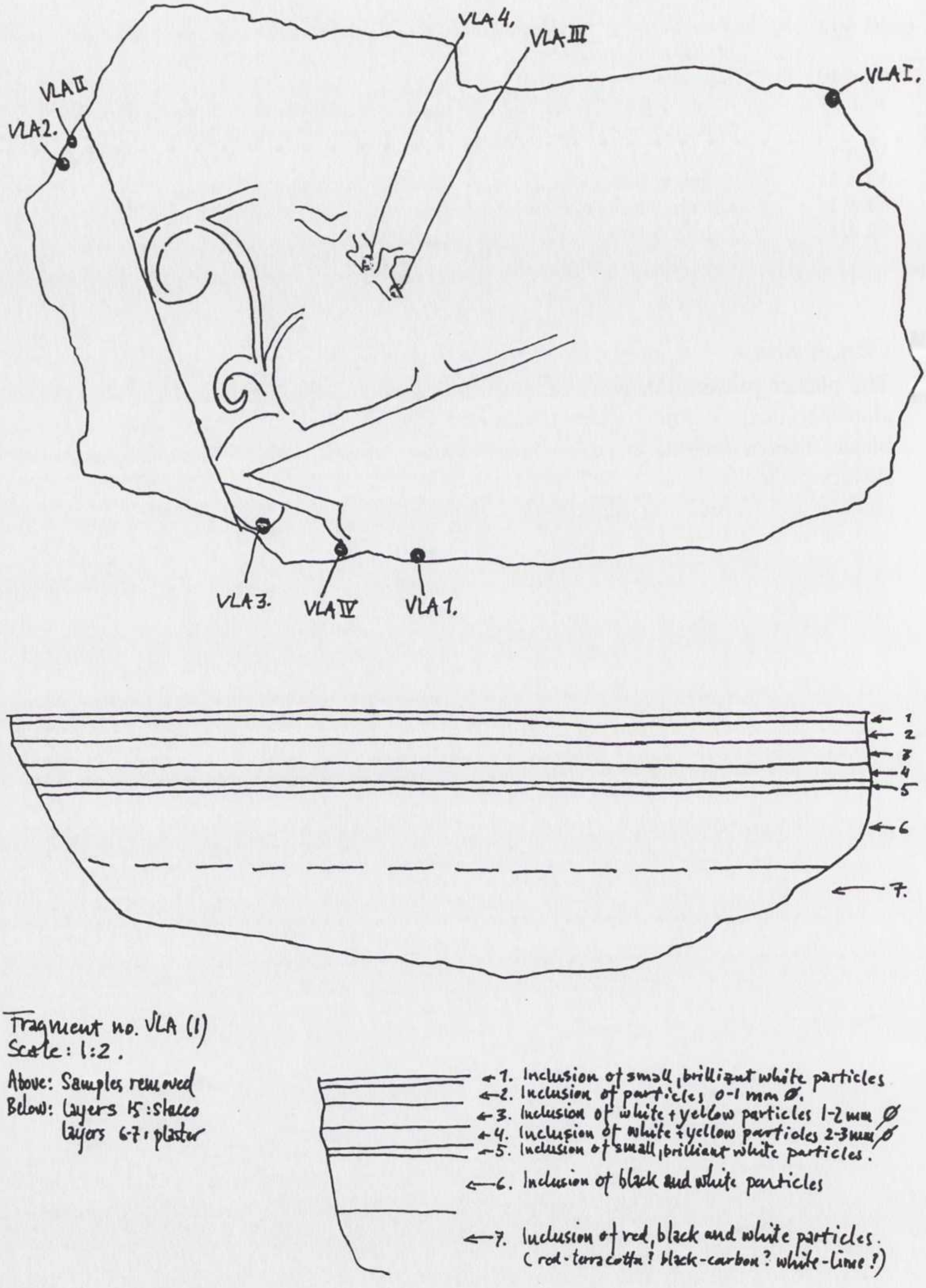


Fig. 58. The fragment investigated and the positions of the sampling areas. Scale1:2.

Case Study 4 c:

Villa of Livia at Prima Porta With decorations dated from the Republican to the Late Roman periods

The present case study is an investigation of fragments of Roman wall paintings representing First and Third style decorations and Post-pompeian decorations, covering the period from between the Republic and Augustan to the Antonine and Severan periods.

The First style, also known as the incrustation style, mainly consisted of painted imitations of marble and precious stones, made on stucco relief walls. The tradition of decorating walls with imitations of estimated stones, was a heritage from the Hellenistic world, with the intention of resembling the Hellenistic Palaces, such as the palace at Pergamon. It has been assumed that these decorations were introduced in Italy about 200 BC, a result of the Roman war campaigns through which the Classical Greek and Hellenistic culture became familiar to the Romans. About 80 BC, a new style appeared, the so called architectonic style. The material stone was the motif in the first style. Crowded, illusive painted architecture, with landscape views in the openings, was the motif in the Second style. During the Augustan period, c. 30 BC – AD 14, there was a transition from the Second to the Third style, or the Egyptizising style. To Augustus, figuring himself as the *princeps*, the first citizen, it was important to appear equal to the Hellenistic kings, but at the same time to show respect for the severe traditions of the ancient Roman families. The style which took form during his reign, was flat, elegant and linear, often showing floral decorations and motifs inspired from Egypt. The motifs of the Third style were made to be decorations painted on the wall, and not to appear as any illusion of something else. Painted small-size landscapes often were included, and appeared as *pinakes* on the wall. At the end of the Claudian and during the Neronian period the Third was succeeded by the Fourth style, an eclectic style in which elements from the previous styles reappear, but with a pure decorative intention, often repeated in patterns. The Fourth style was not succeeded by any new style, but the established decorative scheme and the pictorial elements continued to be used, with variations, throughout the Roman period and later. The paintings made after AD 79 are called Post-pompeian, marking the end of the city but not the end of the style.

The Post-pompeian period is not uniform, various sub-periods are known, such as the Hadrianic period, when there was a classisistic revival. Very little has been published about art and architecture from after Hadrian. Since the following period is not well documented, it is difficult to understand whether a decoration in a private house is from e.g. the Antonine or the Severan period. Therefore, masonry often is used for dating. The decorative scheme of the Post-pompeian style continued to be used also in the early Christian catacombs, and traditional pagan motifs were transformed into Christian vocabulary. Since the Post-pompeian style spans over a long period, observable changes must be assumed to exist. In this study, concerning fragments and not paintings, any attempt of exact dating (within the various styles) has been avoided, since there is not evidence enough for making stylistic determinations. The argument in this case study is, that there were not only stylistic changes but also variations in the material composition, and that these factors have to be regarded as parts of the same whole.

Results

Ten First style fragments, seven from the Augustan period, nine from the Antonine, and nineteen Post-pompeian fragments were investigated, according to the system described above. All written facts are presented in Appendix V, but, photos and full size drawings are excluded, only with the objective of limiting the number of pages. Each fragment has been documented as is shown in Case study 4b.

So far may be stated that the First and Third style fragments were made of highest class material and were of excellent craftsmanship. Also those dated to the Antonine period were carefully made, while those from the later Roman period were more simply executed. Alabaster dust in the stucco was determined until the later period, when the stucco layers were thinner and less shiny. The variety of pigments used were similar throughout the period.

mm	A	B	C	D	E
15		x			
14					
13		x			
12		x			
11		xxxx		x	
10					
9	xxx		xx	x	xx
8			x		x
7	x		x		x
6	xxx		x		x
5	x		xx	xxxx	xx
4	x		x	x	xxx
3				x	x
2					xx
1					
0					

Fig. 54. The registered thickness of the stucco layers.

A = the Republican period, First style fragments
B = the Augustan period, Third style fragments
C = the Antonine period, Post-pompeian fragments
D = the Severan period and later, Post-pompeian fragments from Room 14A
E = the Severan period and later, Post-pompeian fragments from Room 14B
X = one fragment

Discussion - Case studies a, b, and c

The results from the investigation at the Opificio show that the materials used at Prima Porta for plaster and stucco during the Republican, Augustan and Antonine periods were of the highest possible quality. It was a surprise, though, that alabaster-dust was used for the First style decorations, a practice assumed to have been of a later date. Consequently, the use of costly materials and a high-class workmanship, were not inventions of the Augustan period, but rather a tradition inherited from craftsmen during the Republic, or maybe even earlier. Therefore, Vitruvius, when describing the materials and methods for wall-preparations, based his recommendations on the actual knowledge of the craftsmen during his life-time. Also the fragments dated to the Antonine period were made of high-class materials, while the late Roman wall preparations were of inferior quality.

The number of layers were more on the Third style fragment than on any other, indicating that such a careful preparation was made in important rooms like the atrium, while fewer layers were applied in general. The compacted, hard and shell-like upper surface was a common characteristic for all fragments, even though the smoothness and lustre was extreme on the Third style fragments, and almost as brilliant on those from the First style.

The thickness of the stucco layers increased from the First to the Third style and then gradually decreased. Fragments from the Republic roughly have a 5-6 or a 9 -11 mm stucco layer and those from the Augustan period generally have a 11-12 mm layer. The atrium fragment had the exceptional thickness of 17 mm. During the Antonine period the layer generally was 5-6 mm and during the Severan and later periods only 4-5 mm. The measures registered in Case studies 4 a are shown in fig. 55.

11	xxxxx
10	xx
9	x
8	x
7	xx
6	xxxx
5	xxxxxxx
4	xxx
3	xx
2	
1	
0	

Fig. 55. The stucco layers registered on First style fragments in Case study 4a.

x = one fragment

All fragments from the Villa of Livia have a well known find context. Main part of the fragments origin from decorations in private rooms, except one fragment from the Augustan and five from the Antonine period, which were excavated at the atrium, and consequently made to be seen by the public. No fragments derive from any kind of service room. The original context of the fragments found in the cistern at Torre di Prima Porta is not known. The very high class quality of the fragments makes believe that also these origin from a decoration in a public room, but not from a simple space.

The method of observing the material composition and measuring the layers and grains, has proved to be useful. In most cases the impressions from the ocular inspection were verified by those achieved at the chemical-technical analyses. The white or yellowish glassy particles which could not be identified at the beginning, now are known to be crystals of alabaster.

The ocular inspection revealed that the monochrome layers were made *al fresco*, since the pigments were integrated with the surface. In cases when there was a decoration, this had been made when the stucco had dried. The binder, or binders, have not been identified.

The pigments used did not vary through this period, but the same colours, mainly earth pigments, were used. Egyptian blue and cinnabar were found on fragments from all centuries, except from the late Roman period. Whether or not these pigments were represented on the Post-pompeian fragments or not, could not be analysed, since the author brought back those fragments to Rome before samples had been taken.

Red hues were mainly identified as red ochres, secondarily as cinnabar.

Pink hues either contained red ochres or cinnabar.

Brown hues were obtained either by

a) mixing pigments, such as red ochre or cinnabar with carbon black, sometimes with the addition of yellow ochre.

b) by the successive application of two colours, e.g. a layer of red ochre covered with a layer of carbon black or vice versa.

Violet hues contained the same pigments as the brown hues.

Green hues generally consisted of a green earth (Terra verde) or Egyptian blue mixed with a yellow ochre or a green earth.

Blue hues generally was obtained with a mixture of Egyptian blue and carbon black. Only in one case exclusively Egyptian blue was identified in the sample (fragment VLA 43 A from the Antonine period). Occasionally there were two separate layers either of carbon black, yellow ochre, terra verde or cinnabar covered by Egyptian blue.

Yellow hues mainly were yellow ochres. In one case an organic yellow was identified (fragment 44A from the Antonine period). Sometimes a layer perceived as a yellow colour was a red layer with a very small amount of pigment grains.

White hues consisted of the white preparation with sparse inclusions of pigments.

Grey hues consisted of the white preparation and sparse inclusions of pigments.

Black hues consisted of carbon black, sometimes with the addition of an earth pigment.

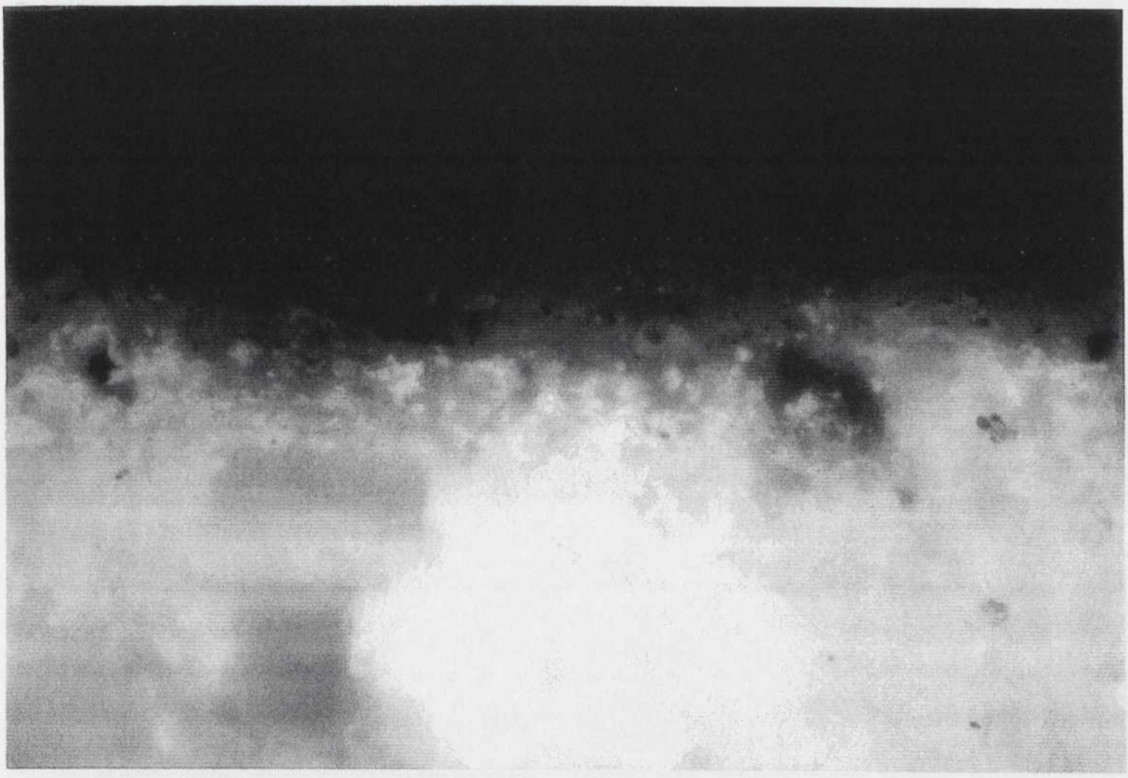


Fig. 59. Fragment 44 A from the Antonine period. Optical microscopy. The grains of red ochre and of carbon are clearly visible in the upper, cinnabar red layer, as well as in the half transparent layer of beeswax below. Some grains of a yellow ochre are dispersed in the sample. Calcite crystals may be observed in the preparation. Photos: Opificio.
Above: The sample photographed in diffusion light.
Below: The sample photographed in UV-light.

Some organic material was observed on stratigraphic investigations of sections with optical microscopy. Such material generally occurred on cinnabar coloured fragments, and was found on samples from the Augustan and Antonine periods. SEM and FTIR investigations of one such sample (VL 44A, from the Antonine period) revealed the presence of beeswax or saponified beeswax.

The material stability of these fragments was good, and they could be handled without any necessity of a consolidation treatment. On the other hand, many fragments presented thick and hard incrustations, which were very difficult to remove. The Late Roman, Post-pompeian fragments which were removed from the wall in connection to this study, were very easily cleaned with a soft brush, since cleaning was made before the salts had crystallised and the incrustations had become hard.

As long as there was only one paint layer, made *al fresco*, the removal of hard incrustations was less problematic than on the additional paint layers. Fresco-painted areas could be cleaned with deionized water, ammonium carbonate in paper poultice, or Viscor, softening the incrustations without causing any additional problems on the surfaces. The removal of hard deposits on areas painted differently, caused great problems, since the incrustations sometimes were harder than was the paint. Consequently, if the binder of such paint could be identified, it might be possible to choose a cleaning method adapted for each kind of paint, dissolving the incrustations but not the paint.

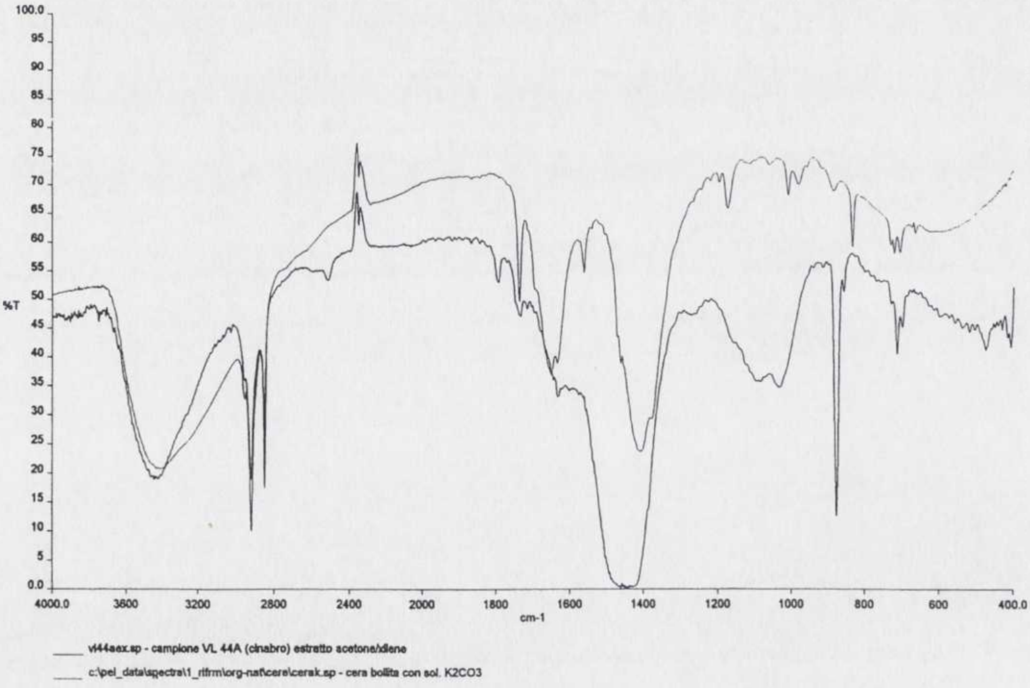


Fig. 60. Fragment VL 44 A. FTIR photospectrometry. The upper spectrum shows cinnabar extracted with acetone/xilene and the lower shows the spectrum of a reference sample of beeswax boiled in K_2CO_3.

Case Study 5:

Villa San Michele at Anacapri

The Villa San Michele at Anacapri on the island of Capri is situated on a high cliff with an extraordinary view of the Bay of Naples. This house was created by Dr. Axel Munthe, who as a young man fell in love with the island of Capri, and in particular the site where he constructed his home. The book he wrote on this subject immediately became a best-seller, and it still is.[1] The house is situated in a beautiful garden, where many marble objects are exposed, such as columns, sarcophagi and statues, mainly from the Roman period.[2] Water is flowing in small canals, the colours of flowers and bushes glow in the sunshine or in the shadow below great trees. There are pergolas and open places, in fact it is a garden offering many sensations, not unlike the *horti* of the Roman period. The garden at San Michele and the building reflect the personal taste of Axel Munthe as well as the general taste of the epoch, i.e. the beginning of the 20th century.

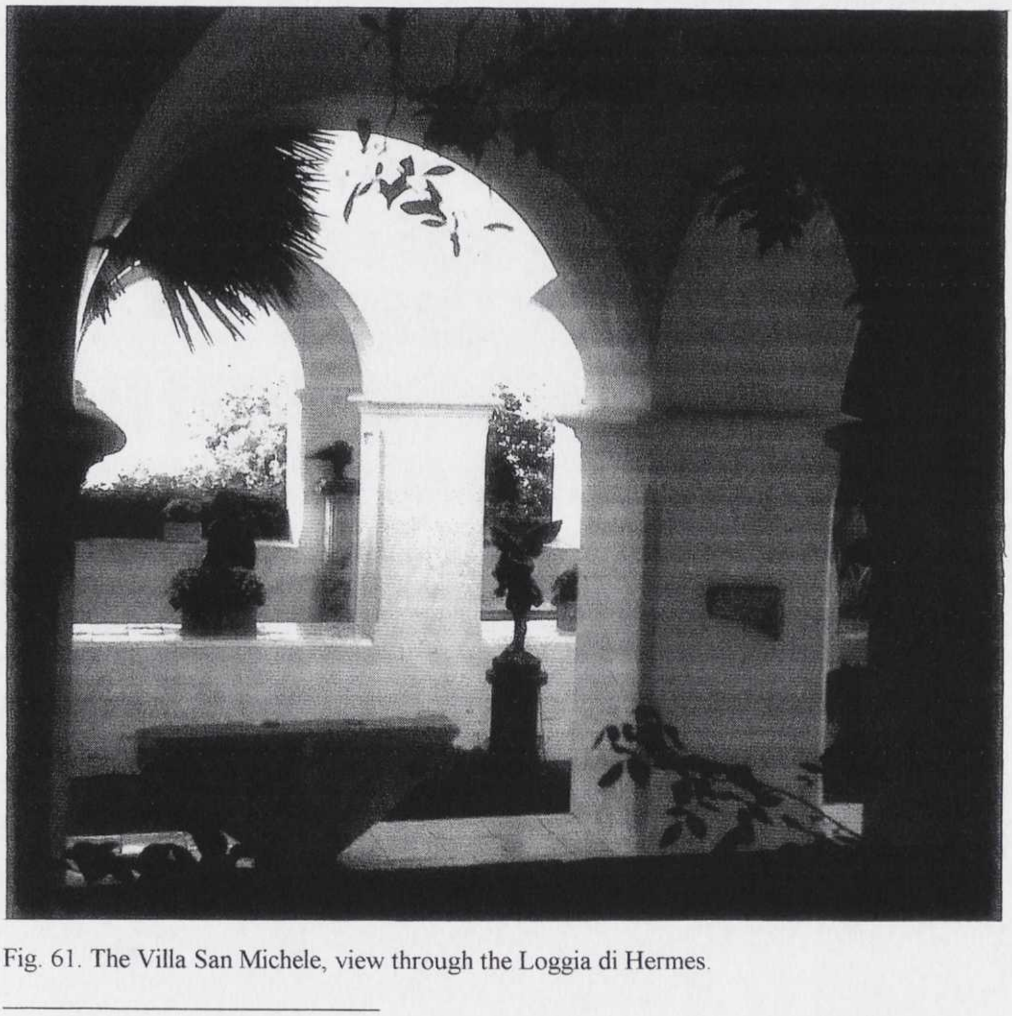


Fig. 61. The Villa San Michele, view through the Loggia di Hermes.

[1] The story of San Michele, first edition published in England in 1929.

[2] Andrén, 1957; Andrén, 1962; Oliv, 1957; Kleiner, 1977; Ministero per i Beni culturali ed ambientali, Napoli e Caserta, 1997; Pavese and Thomasson, 1997; Thylander, 1964.

These marble objects, surrounded by vegetation in a subtropic climate, are exposed to various kinds of deterioration, caused by the conditions of this environment. The objects are more or less covered by biomass, such as lichens and fungi. To some extent such growth underline the atmosphere of the garden, illustrating the passage of time. On the other hand, too much invasion of lichens and moss make a garden look abandoned, and even more important, damages the works of art by corroding the material. Many cracks in the marble occur, caused by the expansion of corroded iron nails, another problem caused by humidity. In this case study, only aspects related with marble decay caused by biomass and conservation issues connected to such problems are presented.

Pollen and spores are always present in the air causing biological pollution. These easily form layers on rough surfaces, and unless these layers are wiped or washed off at intervals, they will form the basis of higher forms of life, such as lichens, fungi and moss.[3] The lichen is a symbiotic compound between algae and fungi. The algae produces organic substances through photo-synthesis, while the fungi acts like a shield over the alga, protecting it from sunshine and reducing the variations of humidity. Form and colour of the lichen depend on its combination of alga and fungus. A number of chemical compounds such as salts and organic acids can be formed in the lichen cell. Such acids sometimes have strong colours like red, yellow or brown. Due to the nature of lichens, these are not harmless, but have the potential to penetrate marble surfaces, disintegrate marble crystals and discolour the stone.[4]

The stone conservation project at the Villa San Michele was planned by its director Ann Marie Kjellander and this author. To start with, an overview of the general situation was made, and the state of preservation of all marble, limestone and terra cotta objects, indoors as well as outdoors, was registered. The degree of deterioration was listed between 0 and 3, 0 being no observable decay and 3 being a case of emergency. Based on these results, a conservation plan was made. At this phase it was decided to try to form a didactic conservation project, involving the Institute of Conservation at Göteborg University, offering practical conservation experience to students studying conservation of stone in 1998. In addition, it was regarded important to invite representatives from Italian conservation authorities such as ICR, as well as professional conservators representing corporations such as CBC in Rome, making possible some exchanges of experiences. Consequently, when the project started some weekend seminars on various subjects were realised.

The present project was carried out in springtime of 1998 and 1999. It was initiated with the main objective of cleaning and consolidating some of the most deteriorated works of art, in order to save the material from escalating decay. The basic idea was to use as harmless materials as possible, and always starting with the mildest method possible. Consequently, work started with the removal of dust and earth, performed with soft brushes. Work progressed with cleaning

---

[3] Tiano, 1991, pp. 56-57.

[4] Tiano, 1991, pp. 58, 63.

with water, followed by water and the traditional Swedish cleaning compound "såpa", made of extracts from the pine tree. If necessary, more effective substances and methods were used, e.g. ammonium carbonate conveyed by paper pulp. The working progress and the decisions made for each object were documented in specially prepared conservation forms illustrated by drawings and photos, made for each object.

During the initial period, conservation interventions were concentrated in the Loggia di Hermes. This way it was easy to supervise the students and to control the working progress, compared to having students working over a vast area. The loggia was chosen also for esthetical reasons, since it seemed more appropriate to upgrade the appearance of one ambient rather than to clean single objects in different locations. During the second period, conservation interventions were made on selected objects in the garden, in the atrium and in the loggia. The programme was carried out with the intentions formulated at the start. Some new materials were tested, e.g. biocides. Such a treatment had been suggested by Dr. Rosalia Varoli Piazza and the conservator Lidia Rissotto from ICR in Rome, since biocide treatment had proved to be effective during similar circumstances.[5] The antialgal effect of some biocides on stone has been studied by Tiano.[6]

It must be stated that the author as well as the students, reacted very strongly against the use of biocides, but agreed to make some testing. The reason was that a few statues and portraits of marble either were covered with, or strongly discoloured by lichens. The surface of these objects was corroded and sugaring, and cleaning had to be delicately made. Therefore, one of these statues was selected for an initial test series. Some detergents and one biocide were applied on small areas at the base of the statue.[7] Our experience of biocide treatment is, however, that such an application may, in some controlled circumstances, be the most delicate way of removing lichens on corroded surfaces. After cleaning, the next question was, if and how to make a surface coating on the statue. Since a protective coating is irreversible, and has to be compatible with the material coated, it was decided to test a few materials for coating, and study the results before applying any material on the statue.

Comparative material tests were made on a marble slab and later placed on the ground in the garden to be exposed to the same environmental aggressions as the works of art. The surface protectives (RC 80, Wacker 290, Silo 111, and saponified beeswax i.e. Punic wax, made by the author) were applied. Directly after application, it was noted that Silo 111 was easily applied and that the protective film was very thin, smooth and did not change the colour of the marble. RC 80 and Wacker 290 added a yellowish hue on the stone, and the layers were not completely smooth but slightly uneven. The Punic wax was applied on the last sector of the stone, and when the surface had dried, it was heated with a hairdryer, and then polished with a rag. This surface became

---

[5] Information given at the seminar on Capri, June 1998.

[6] Tiano, 1979, pp. 252-260.

[7] The conservation report is presented in appendix V.

smooth and received a silky lustre. The surface became slightly darker than it was before the wax application.

Fifteen months later, the slab was inspected. It was covered by fallen leafs and earth. The loose particles were brushed off, and the slab was carefully studied. The film of Silo 111 was still practically invisible, and there were no signs of any decay. The sector with an application of RC 80 had become dotty, and had deteriorated more than any of the other materials tested. The surface treated with Wacker 290 appeared uneven and the protective had partially worn off. The Punic wax had become slightly darker, and a complete removal of the surface deposits was not possible to make with a soft brush. The remaining deposits were, however, easily removed with a humid rag. After this initial ageing period, the surfaces of Silo 111, as well as Punic wax consequently were undamaged. After inspection the marble slab was replaced on the ground, and the intention is to control the ageing progress at intervals, before one of the substances will be chosen for coating the Roman statue.

Fig. 62. The Etruscan sphinx. A white marble statue completely covered with lichens. Villa San Michele, Anacapri.

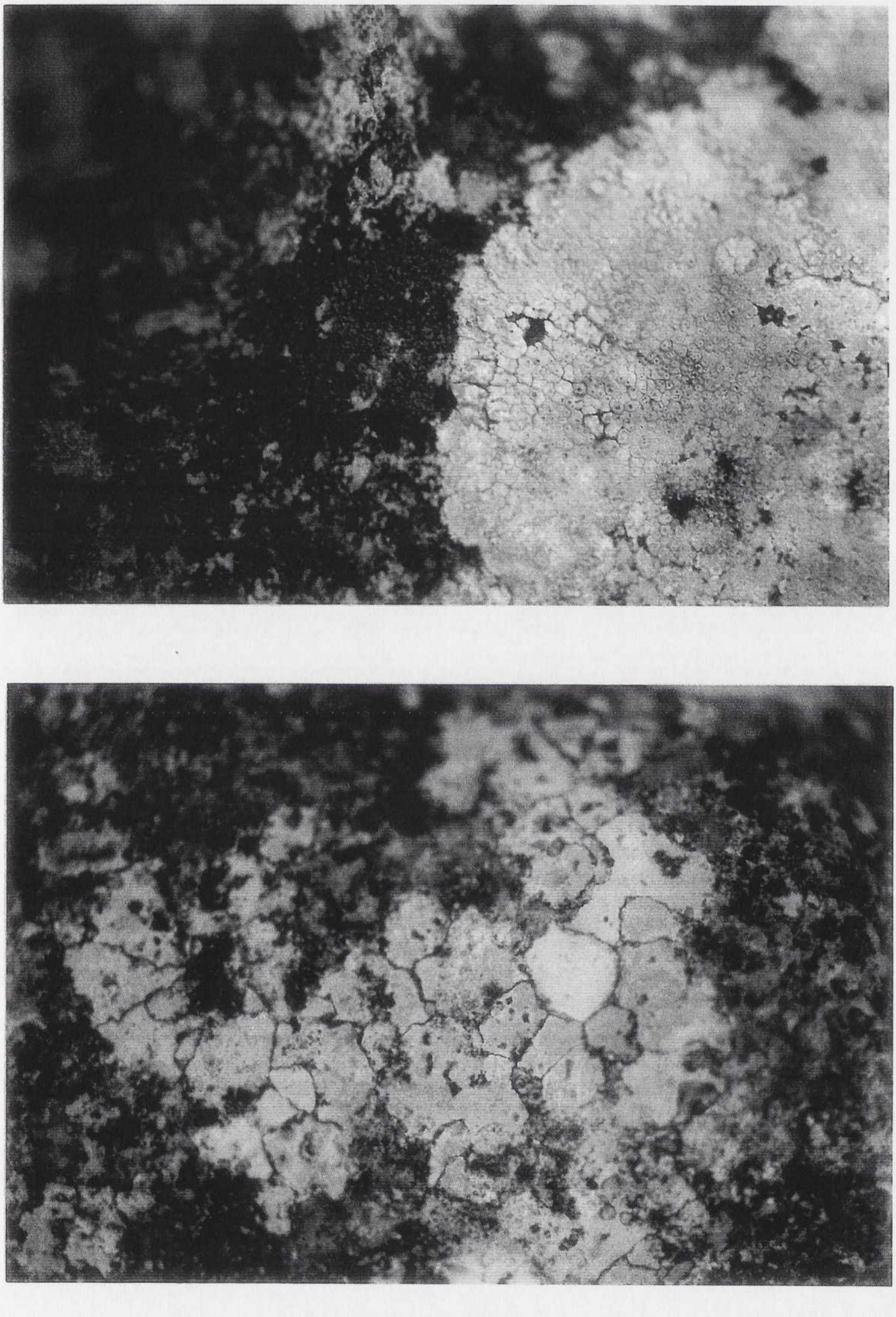


Fig. 63. Various kinds of lichens, covering the Etruscan sphinx.

Discussion

Works of art in open air environment such as at Villa San Michele, are exposed to biological aggressions. These are not harmless but contribute to gradual deterioration. On the other hand, the charm of a milieu such as the San Michele garden, depends on its combination of art and vegetation, becoming a work of art in itself, and has to be respected as such. To a certain degree, decay or ageing, such as biological growth has to be accepted. On other kinds of objects such as portraits, statues and figural reliefs, it is important to remove continuously the lichens etc., in order to save these works of art for the future. The main reason for giving some works of art a particular care, is that details which have been carefully worked, generally also are the first to deterioration. Stone carving causes micro-cracks in between the crystals, and therefore fine-worked areas are easily subject to decay. Figural motifs must also be considered in their respect of representing a person or as narrating an event, a message which tends to become dissipated if the surface is covered by deposits or partially lost.

Conservation interventions cannot be carried through always in the same manner, but must be considered at each occasion. It is also of vital importance that the objectives of conservation interventions are explicitly formulated and that work is then carried out according to these principles.

In October 2000, the conservation interventions performed during 1998 and 1999 were inspected, and the general impression was that the substance used for cleaning was not crucial for the long-term result, but of major importance was that cleaning had been carefully made. This means that objects cleaned with "såpa" were still equally clean as those cleaned with e.g. ammonium carbonate. No changes, expected or unexpected, could be noted. Therefore, cleaning should be performed with methods as harmless as possible. After cleaning, regular maintenance measures at intervals normally should be sufficient.

The issue of surface coating and what material/materials to use, is still an unsolved question, which may be considered when the substances on the marble slab have been ageing another year or two.

Case Study 6:

Experiments on encaustic painting

During the period between 1995 and 1997 the author was making some series of experiments, with the main objective to test and evaluate the qualities of different wax-paints, different supports, and the interaction between these factors. In addition I tried to make Punic wax as described by Pliny, or, Punic wax as described by Pliny and interpreted by various scholars. In addition, a wax tempera diluted with turpentine was tested, in order to see if there would be any significant difference between this wax mixture and the others tested. The mixture was made of the same components as the *cera colla*, used by artists during the Renaissance. The first series of experiments were made in summer 1995 and different wax paints were created and tested on panels, measuring 30 x 60 cm, having had applications of various preparations. The paints were

a) natural beeswax which was melted and pigmented,
b) paint of saponified wax, i.e. *Punic wax*,
c) the same Punic wax as a surface coating on a lime-based paint, and
d) beeswax solved in turpentine, *wax-tempera*.[1]

Each of the different paints were applied to panels prepared with

1) lime plaster,
2) lime-marbledust plaster, i.e. *marmorino*,
3) a commercial Portland cement and lime mixture, *KC-plaster*, and
4) a commercial gesso product, *alltek*.

a)

b)

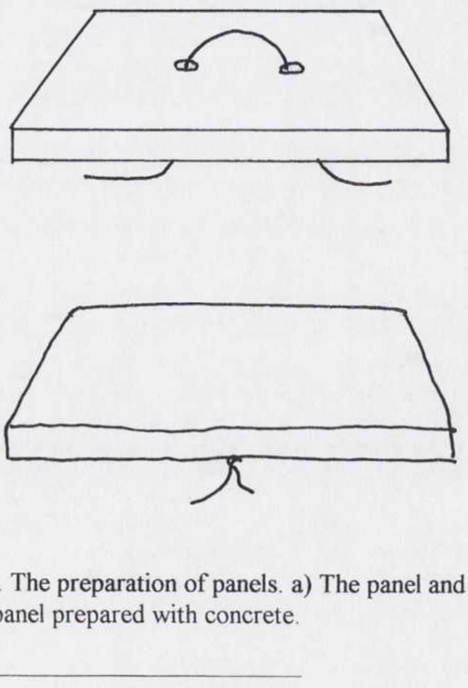


Fig. 64. The preparation of panels. a) The panel and the wire, used to tie the panel to the stand, b) the panel prepared with concrete.

[1] The emulsion was called "wax-tempera" by Inganni (1979), a term which was used also in the test series.

The objective was to test if one of the four paints was better suited for mural painting than the others, and if the preparation had any influence on the material stability of the rather large size panels prepared. A double set of test panels was made and half of the samples were placed outdoors, completely unprotected from climatic changes. The other half were kept in a simple barn, thus protected from rain, snow and wind, but not from changes in humidity and temperature.

The sets of panels were disposed in stands, designed for this occasion. The stands in open air were placed against a wall in south-west position, leaning against the wall, to make them as much disposed to climatic changes as possible, with the intention of making them age rapidly. These panels consequently were exposed to direct sunshine, rain, and winds containing salt and fine sand from the nearby seaside, as well as frost, snow and ice in the winter. They were remaining in this position for more than four years.[2] During the first two years the samples were regularly inspected, and later observed just occasionally. After two years exposure to outside environment, much of the paint layers had disappeared, but it was still possible to see the patterns engraved and the colours originally used on all panels, with exception for the paintings on the commercial gesso panels, which just lasted some months, and fell off together with the preparation during the first winter.

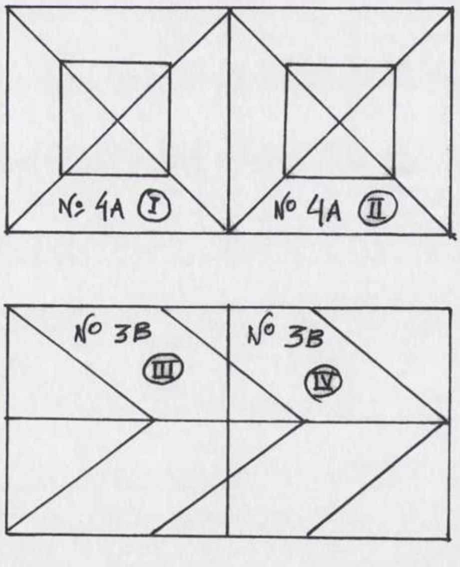


Fig. 65. The patterns on the panels.
Above: No. 4A I and 4A II. (Recipe no. 4 = wax-tempera. A = outdoors. I = Lime-plaster, unheated and unpolished paint. II = Lime-plaster, heated and polished paint).
Below: No. 3B III and 3B IV. (Recipe no. 3 = Punic wax on lime-painting. B = indoors. III = KC-plaster, unheated and unpolished paint. IV = KC-plaster, heated and polished paint).

[2] In December 2000, when this was written, the panels still were remaining in the stands.

The panels disposed in the barn have not changed in these five years. In this initial phase, the objective was to study how wax reacted on different supports, and to see if there was any correlation between support and wax-paint. The tests were recorded and are available in complete form in a working paper at ICUG presented in 1996, "Encaustic painting; a case study of encaustic painting techniques on different mural groundings" as well as, slightly reduced, in my Ph. Lic. dissertation in 1997.[3] A brief summary of the test results is presented below.

As mentioned above, the panels prepared with the commercial gesso, *alltek*, did not last through the first winter. This was not a surprise, since the product was not intended for outdoor use. The manufacturer has a different product available, which is especially intended for open air environments. All panels prepared with this gesso, and kept in the barn, have remained unaltered, just as the panels with other preparations. A couple of panels fell on the floor at one occasion, after two years, when the stands were moved from one side of the barn to another. The fall resulted in minor breakages at the edges, a damage which has not led to further decay. The only material change which may be noted is, that the application of natural beeswax, melted and un-pigmented, has become somewhat darker, while the pigmented parts do not seem to have changed. Since there is no visible material decay, all paints and preparations must be considered as equally resistant, during the circumstances presented above.

In December 2000 most of the panels kept outdoors distinctively show the patterns engraved, and they have some remains of colour. Consequently all preparations have been adequate, and some of the paint applications promising, although none is good enough for commercial use at the present stage. The plaster resulting to be the better for these circumstances are lime-plaster, i.e. showing less decay, or being almost completely materially intact.[4] The paint most promising is Punic wax paint and Punic wax applied on lime-based paint, i.e. those applications appearing as being most intact, having most remains of colour. The better combination of materials was Punic wax on lime-plaster preparation (2A I and II), followed by un-pigmented Punic wax applied on a decoration made with lime-based paint on KC-plaster (3A III and IV).

In the next series of experiments, performed in summer 1996, different kinds of saponified wax, or Punic wax, were tested on a new set of panels. The panels used were rather large-sized, measuring 60 x 120 cm. These were prepared either with lime plaster or with lime-marbledust plaster, *marmorino*, since those preparations had, after one year, proved to be most durable in the study made previously. These preparations were also considered as particularly interesting, due to the fact that they were generally adapted for Roman mural preparations. In this case interest was focused upon different paint mixtures, such as saponified wax with the addition of an animal glue, a resin, lime or oil. The same saponified wax was divided into portions, and into each portion one of the substances mentioned was added. The objective was to test applicability, aesthetic appearance and, in a longer perspective of time, the durability.

---

3 The experiments are presented in the Ph. Lic thesis at Göteborg University 1997 *Encaustic painting and ganosis*.

4 The evaluation of these results were made November 20, 1999.

In addition, two large-size panels were divided into 32 square fields and the possible saturation of pigments in the paint was tested, beginning with a small addition of pigment until gradually reaching a stage, considered as ultimate saturation, i.e. when the paint almost was too dry to apply on any preparation. Various natural earth pigments were used on one panel, and some artificial, i.e. chemically produced pigments were used on the other. This resulted in one panel of ochre-red-brown-green appearance and the other representing white-blue-black colours. The resistance against some kinds "normal" kinds of mechanical damage and scrawling were tested on another large-size panel. When the damages had been made, some methods for cleaning and repair were tested. A final test series was performed with applications of the same paints on gypsum board, on request of the architects following this part of the project, since gypsum boards are frequently used in modern building construction. The combination of any of the wax paints and the gypsum board was unsatisfactory, primarily due to aesthetic reasons, and later for reasons of material stability. The great problem was, that an adhesive tape of different material, and specifically made to close the minimal space between boards connected to each other, was glued to the edges of the boards. The disparate structural appearances could not be hidden with any of the paints tested, and diversity between gypsum board and adhesive tape remained obvious. None of the paints tested was opaque, but more or less transparent. Applications of paint were made in between one five layers, and tested on any supportive material. All applications and results were registered, and the results were published in 1997.[5]

The final accomplishment of this third phase material testing, was the performance of a mural painting. This was made with the objective to test one of the Punic wax mixtures on a full scale. The painting was made as an integrate part of the project, in collaboration with White arkitekter in Göteborg, and the telephone company Ericsson, Ericsson ETX, at Mölndal close to Göteborg. The project was economically supported by Ericsson and Forskningsstiftelsen for Samhällsplanering, Byggnadsplanering och Projektering, the latter contributing economically also to the first two series of experiments mentioned above.

A wall in the entrance to one of the commercial buildings of the Ericsson company was chosen. The environment in this entrance is exposed to specific problems, due to the flow of warm air, separating the outdoor and indoor climates. The difference in temperature and humidity is, during winter, quite extreme. Another factor to consider before painting, was the constant passage of persons and materials through this rather narrow room. The wall chosen for decoration was made of a creamy white concrete, and the motif was painted directly on this material. The paint applied was a Punic wax mixture containing Venezian turpentine, even though a mixture containing lime could have been selected just as well. The decoration was made in February - March 1997, and at an inspection two years later it was still completely intact. Grey dirt on some areas were noted, and this dust was removed with a dry cloth.

---

[5] The experiments are presented in the publication by Forskningsstiftelsen för Samhällsplanering, Byggnadsplanering och Projektering 1997, *Enkaustik*.

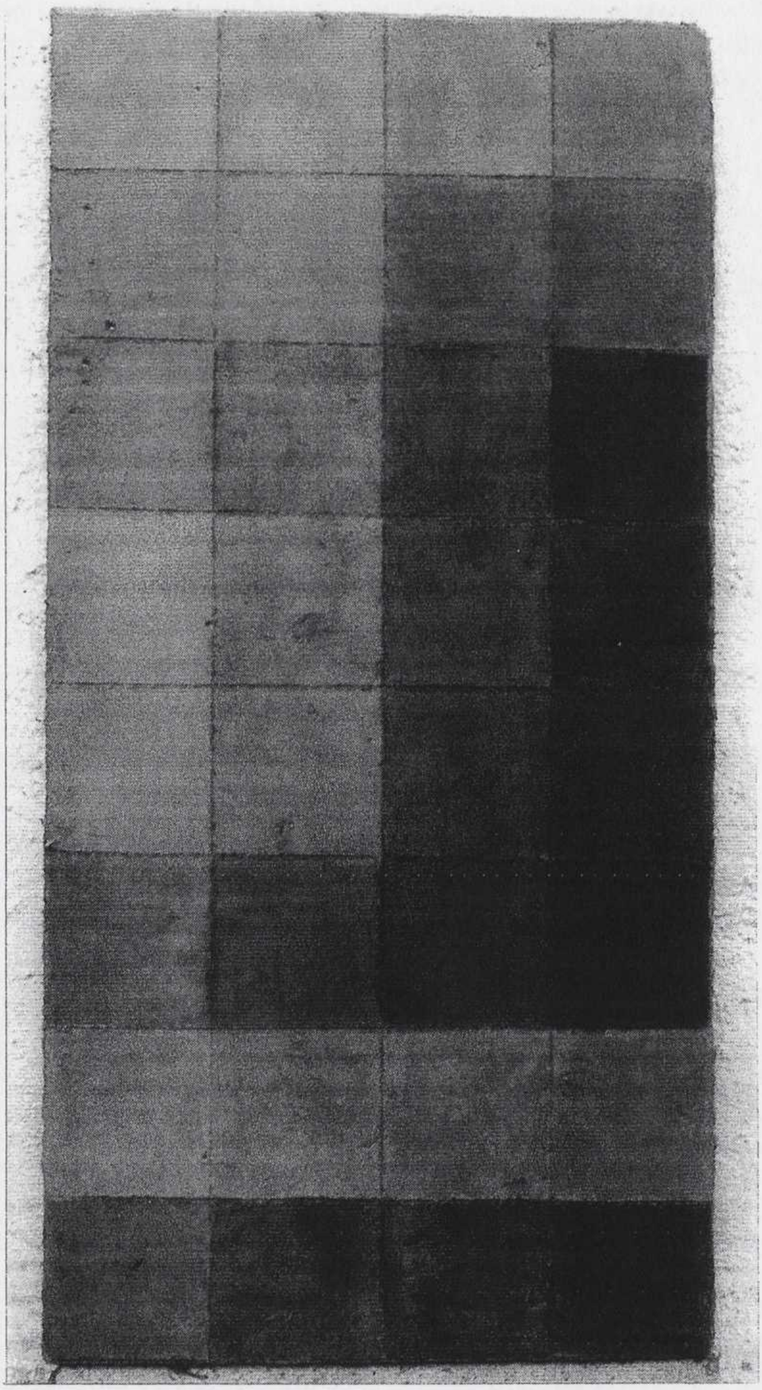


Fig. 66. Panel STD VII. Earth pigments and carbon black mixed in Punic wax and applied on a lime plaster test panel. Each colour has been applied on four areas, the area to the left containing just a little pigment, those towards the right successively more.
From the top: Yellow ochre, raw Terra di Siena, burned Terra di Siena, raw Terra, burned Terra, burned Umbra, terra verde, carbon black.

A description of the project is included in the publication "Enkaustik; experiment med Puniskt vax", 1997.

Samples were later removed from some of the earlier test-panels, and brought to the Scientific Laboratory at Opificio delle Pietre Dure in Florence, in order to make a comparative test between these samples and those taken from ancient materials of some Fayum portraits. One of the samples, containing saponified beeswax and lime, presented a spectrum similar to that of some samples from the Fayum portraits. That specific substance will therefore be further investigated in the future.

In addition, all the emulsions or substances described above, were used in some additional tests, and applied on wood and paper, just to see if and how they could be applied for artistic purposes on other materials than plastered walls, but no systematic registration of the results was made. In one unregistered test series, the capacity of different mixtures to penetrate through a thick, hand-made paper was observed, and photographed. The penetration capacity varied very much between the different mixtures. The same emulsions were also tested on wet lime-plaster, in the *al fresco* technique, with excellent result. These tests are planned to be re-made, registered and evaluated.

Finally, this emulsion, with the addition of some oil, was used as a surface coating on a white marble sculpture, placed in a garden in the south of Sweden. The statue had been exposed in the garden for some years, and its unprotected surface was covered with biological growth. The sculpture was cleaned with soap-water and a soft brush, followed by careful washing with clean water. When the surface had dried, an application of saponified wax was made. As soon as this application was dry, the surface was heated with a hair-dryer, making the wax "sweating". Later the surface was rubbed with a clean cloth. The pedestal, on which the sculpture was standing, was just cleaned and left with its surface un-coated. This was done in springtime 1997, and two years and a half later, in the end of November 1999, the marble surface still was rather clean, especially in confront to the un-treated basis.

Pliny indicated *natron* for making Punic wax, and this double salt was described by Schiavi as significant in her experiments on Punic wax.[6] In December 1998 I had the opportunity to collect such salt at Wadi Natrun in the Libyan desert north-west of Cairo in Egypt. The salt was tested, but the result was disappointing, since it did not make a paint possible to spread. When the salt was examined at the laboratory of Opificio it resulted to be contaminated as an effect of air pollution. Consequently such salt is chemically not anymore the salt described by Plinius, and it therefore can not be used for the experiments planned, but has to be substituted by other chemicals.

---

[6] Elena Schiavi, *Il sale della terra*.

Discussion

At this point it is too early, and not possible to make a statement about the long-term qualities of the various types of beeswax tested. Neither is it possible to determine which is the better paint, or if one of the Punic waxes tested is equal to that of used in Antiquity. So far may be stated that the wax mixtures used on the preparations in the experiments first performed, and still kept indoors, have remained in equally good state of preservation during five years, while all panels kept in open-air environment have suffered great damage, and the paint is almost entirely lost.

The varieties of Punic wax on large panels have remained unaltered when applied on stucco or plaster. The pre-fabricated gypsum panels are all destroyed, since the gypsum did not resist the humidity in the barn, and gradually became deformed and partially covered with mould. The wall-painting made at Ericsson still remains intact, and there has not been any need of re-treating the marble statue with Punic wax. Seen from the practical, and the esthetical, point of view, the various emulsions of Punic wax which were tested, were comparatively similar, and were easily applied.

Chemical-technical analyses showed that one of these mixtures, containing an addition of lime, was of similar composition as samples of Punic wax from ancient Fayum portraits.

Fig. 67. Various test panels during work, exposed in the barn.

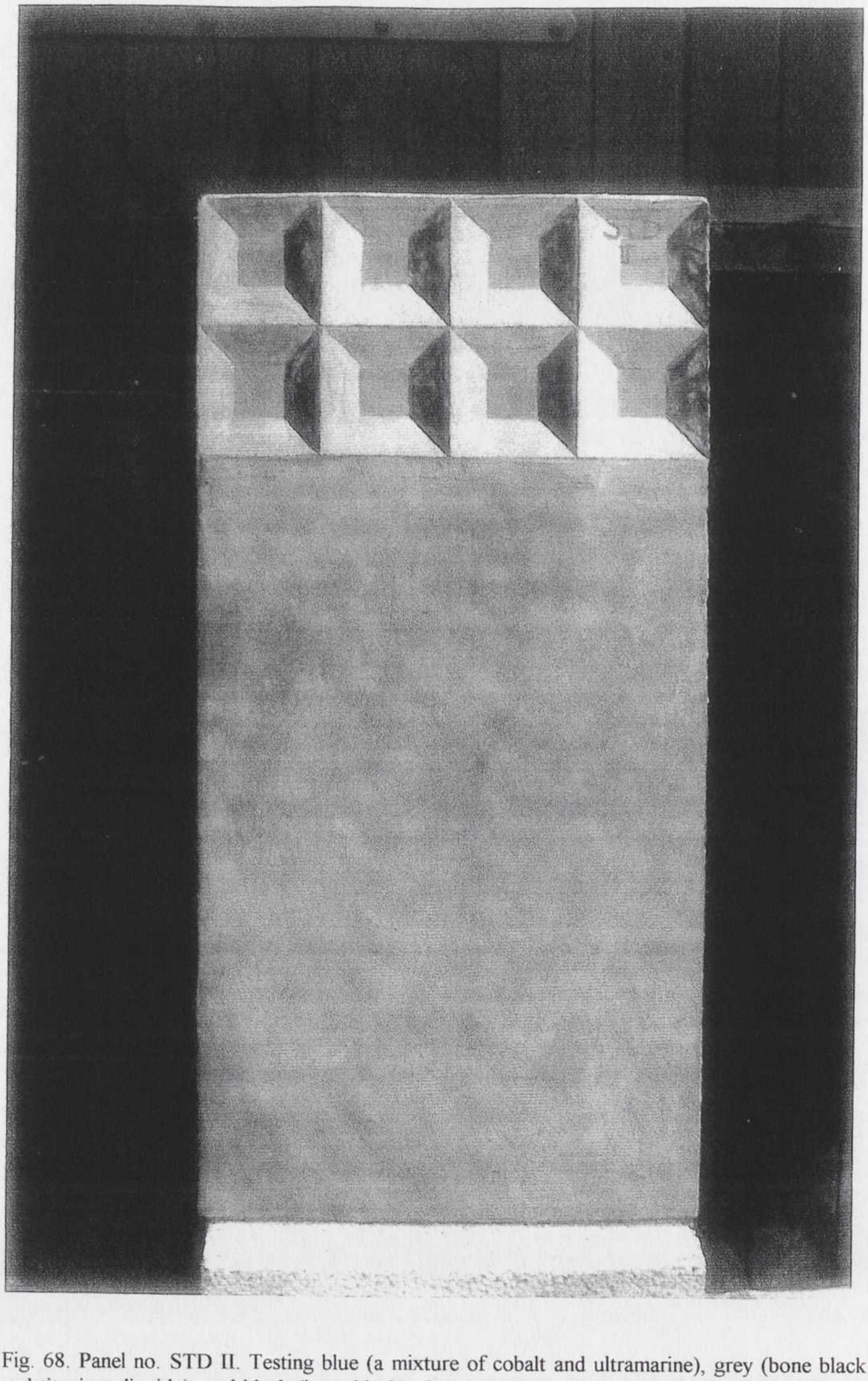


Fig. 68. Panel no. STD II. Testing blue (a mixture of cobalt and ultramarine), grey (bone black and titanium dioxide), and black (bone black) pigments. The paint was applied in three different layers with the objective to create a combination of a geometric decoration, with a large monochrome area resembling the sky.

DISCUSSION AND COMPREHENSIVE CONCLUSIONS

The present study initiated as a reaction on the misuse of some cancerogeneous and toxic materials in conservation. Such a reaction could inevitably only lead to the question – did any materials exist, acceptable in modern conservation, which might substitute harmful chemicals? When searching for an answer, there is an immediate choice of either looking backward or forward for a relevant solution. My choice was to study the past, with the objective of understanding what was used before the introduction of modern detergents, consolidants, surface coatings and adhesives. These issues, combined with my interest for beeswax, as a paint, a modelling material and a coating, have remained the basis for the following studies.

Terminology and the cultural context

To begin with, it was important to understand what was intended during Antiquity with the terms *encausto* and *ganosis*, mentioned by Pliny and Vitruvius, since these terms and concepts are surrounded by unclarities in recent as well as in historic and ancient literature. It was of vital importance to eliminate unclarities and misapprehensions, in order to make possible to find a logic explanation of terms and concepts, applicable in the real world and not only in written terms.

The term *encausto* initially indicated that paint, or wax, was heated and "burned in", thereby to some extent penetrating the surface of the supporting material. This original meaning seems to have been lost already during Antiquity, since Pliny uses the term for three methods, and "burning in" i.e. final heating, is adaptable just for two of these methods. If used for "the first method" mentioned by Pliny, heating would melt the paint and ruin the painting. The common factor therefore was beeswax, not final heating. *Encausto*, consequently, was not used strictly according to its original meaning of "heating" during the Roman period, but rather indicated "wax-painting". Also nowadays encaustic is used synonymously with wax-painting. There have been attempts to combine *wax-painting* with *encausto* in the original sense – i.e. "burning in", and the results of such a combination must by necessity be disastrous, if applied on a decorative painting and not on a uniformly coloured area. Wax, pigmented and melted, was also used for filling the lines of engraved decorations on ivory. To heat the surface of such decorations would be favourable, since the melted wax would fill the lines perfectly. Beeswax, chemically transformed into Punic wax, by boiling in water with natron or some other adequate salt, was used for painting ships, for painting portraits, and maybe for large size decorations. Punic wax also was used for surface coating on marble, i.e. *ganosis*. Final heating was part of the *ganosis* process. To sum up, inconsistencies in terminology appear to be a linguistic problem, but existing unclarities are rather caused by lacking understanding of the paintings techniques. The present state may have been the result of continuing quotations of literary passages, and without a complete understanding of the content.

The next research issue was be able to establish whether or not *encausto* and *ganosis* actually were part of the artistic tradition in the Mediterranean area, i.e. in real life, and not only appearing as quoted concepts in literature. The present study confirms that *encausto* and *ganosis* were commonly known methods for painting and surface coating. These methods were mentioned in ancient Greek and Roman literary sources roughly from the 4th century BC and throughout the Hellenistic-Roman period. The latest of ancient notes known on encaustic are from the Middle Ages, and, as known, beeswax was used for surface coating on statues during Renaissance and later. In fact, the tradition of coating with wax never really seized to exist. There is, as far as these facts are concerned, no discrepancy between ancient literary sources and evidences from archaeological finds, and this is also confirmed by chemical-technical analyses of samples from ancient materials.

Encaustic painting and *ganosis* consequently were part of the artistic tradition in Graeco-Roman society. Encaustic was used for painting and *ganosis* was a method of surface coating.

The next issue was to understand how and when these methods were used during Antiquity, and to explain their use within the cultural context. To begin with, it was important to find evidences, i.e. objects representing encaustic and *ganosis*. For reasons of availability, focus for some time, was set at encaustic painting.

The so called Fayum portraits are examples of encaustic paintings from the Roman period. Some of these traditionally were called encaustic and others were considered to be tempera paintings. Lately it has been suggested that some were made with Punic wax. The investigation of materials used for Fayum portraits in Nationalmuseum has revealed that natural, i.e. raw, beeswax as well as saponified beeswax were used for such paints. Raw beeswax was used for paintings which generally are defined as encaustic, i.e. wax-paintings where the glossy paint has been thickly applied and the surface appears in relief. Saponified beeswax was identified on portraits which had characteristics of encaustic as well as of tempera paintings, i.e. there was a combination of paint appearing in relief and paint applied in brush-strokes. Saponified beeswax has also been detected on portraits presumed to be tempera-paintings. The later group of portraits had a smooth surface, the paint apparently applied with a brush, and no details appeared in relief. Consequently, this group may be considered as wax-tempera paintings. None of the presumed tempera paintings in Nationalmuseum was a traditional tempera with egg or glue as a binder, but all contained saponified beeswax, i.e. Punic wax. This does not exclude that other mummy portraits may have been painted with some traditional tempera.

Consequently, the first and the third techniques mentioned by Pliny, have been carefully studied. The second technique, used for engravings, has been studied as well, but since no objects have been available for material analyses, such have not been performed. This was not a painting method, but a method exclusively used for engraved decorations on bone, ivory and maybe other hard materials. Therefore, the second method has not been of specific importance in this study, since painting and surface coating was the main issue.

Punic wax was used for surface coating on Roman murals and on marble statues. The tradition of coating wall decorations with Punic wax has been described by Plinius and Vitruvius, and analyses of samples from Roman wall decorations have proved to contain Punic wax. It is however, not clear if such coatings were made on entire surfaces or just on areas painted with specifique pigments. Results of material analyses show that such applications were made on red pigments, above all on cinnabar.

It has not been possible within this study, also to consider the paints used for polychrome statuary, since that would have been an issue of too vast extension in this context. According to ancient literary sources, statues were painted, and *ganosis* was the method of protecting the colours as well as the marble from a rapid decay. The Roman concept *circumlitio* refers to painted statues, coated to obtain a protective shield. There is no reason for assuming that *ganosis* was not part of the sculptural tradition, since statements concerning painting and surface protection on murals have been confirmed. In addition, depicted painted statues appear on Roman wall paintings. The issue is, however worth to study in depth.

Materials and techniques studied are represented in Roman art. As a consequence, it was necessary to understand the Roman culture. The influence from Greek and Etruscan culture were the basis for the development of Roman art, but a mental ground existed, which permitted the Romans to adopt these signs from more developed cultures, and transform them into Roman. By gaining some comprehension of Roman mentality, it was possible to understand the repetitions of motifs in art, observable in the Fayum portraits, in wall decorations and in plastic art. It further was obvious that some objects within a "type" or a group of similar motifs of high artistic value, while other appeared to have been rapidly made or by a less skilled craftsman. Such differences in appearance and material can be noted throughout the Imperial period, and may be useful indications of the status of the commissioner and of the period.

The investigation of Roman murals at Prima Porta shows, that the quality of the material used, as well as of the craftsmanship, were absolutely outstanding during the Republican, the Augustan and the Antonine periods, after which it was a general decline. The preparations, previously extremely thick and well made, became much thinner and more or less of the same standard as fresco preparations from the Renaissance periods and later. Preparations and painted decorations from the Republican period, i.e. First style decorations, were made as one unity, imitating marbles, by using first class materials. Decorations of this kind were made to last, to be assigned from one generation to those of the future. During the Augustan period, there was a peak of perfection as far as the surfaces of the wall paintings, and the number of layers are concerned. The materials adapted were equal to those of the Republican period. The brilliance of the surfaces seem to have been of particular importance. The materials used during the Antonine period were of the same standard as those of the previous periods, but the lustre of the surfaces were less elaborated than during the Augustan period.

Decorations from the Post-pompeian period are of a radically inferior quality, materially as well as technically. The only constant is the pigments adapted in painting, which appear to have been the same throughout the period. The only exception is cinnabar, frequently used in the earlier periods but in this investigation, not identified in murals made after the Antonine period. The results of the investigation of fragments of wall paintings at San Lorenzo in Lucina confirm that the material and technical quality was of superior class during the earlier period than later, also in this urban context.

Analyses of samples taken at Prima Porta as well as at San Lorenzo revealed that beeswax had been used to coat decorations made with cinnabar, confirming that the description, and recommendation by Vitruvius was a common practice. At present it seems that such coating was made on cinnabar decorations only, but it can not be excluded that coatings were sometimes applied to protect some walls.

Ancient and modern materials in conservation

Knowledge about materials and the competence of using them are skills which traditionally have been transmitted from one generation to the next, by working together. Ready-made materials did not exist until modern times, and consequently, the materials used in earlier workshops had to be manufactured by the craftsmen, who therefore were aware of their constituents and knew how to manipulate them when necessary.

Materials used in modern schools and workshops have mainly become substituted by chemicals provided by the industry. Conservation materials provided by the chemical industry are ready-made, easy to use and "chemically correct", i.e. tested and approved by chemists. The conservator, therefore, does not have to "know" the material he/she is working with, but rather learn an appropriate way of using it. Ancient materials and methods tend to be deserted and forgotten, in favour of modern substitutes.

Some popular, modern chemicals contain toxic or cancerogene components. A mask or other special equipment is often required, but seldom used, since conservation is a slow and time-consuming labour, and uncomfortable equipment consequently is avoided by the conservators. Not only the persons working in conservation are in contact with such materials, but it also affects the nearby surrounding, the air, ground and water. If the sewage system or the ground close to a building under restoration was to be examined, the result might be alarming.

Great quantities of unhealthy conservation materials are constantly used, and adequate protective measures are often not made. Considering the present situation and the effects of such toxic materials on persons and environment, the conservator has to make a choice of standpoint, and either consciously accept to work with these industrial products or to avoid them, completely or as far as possible. One way is to try to substitute cancerogeneous and toxic materials with more harmless products. Research for alternative materials, compatible with man as well as art objects, has been going on for years, and still is a great challenge for the future.

While waiting for safe materials and appropriate methods to use them, there is no alternative but to use methods and materials available. Even materials regarded as unhealthy but effective occasionally have to be used, under controlled circumstances. Most important is to break the trend of using such products unquestionably.

Beeswax is one of the many traditional materials which might be used again in conservation. It is a stable material and it does not change much with time. It is a good water-repellent, but allows the supporting material to "breath", i.e. it does not entirely close the pores of the supporting material, but allows humidity within the material to evaporate. Like any other material it has its disadvantages.

Experiments have been made by this author in order to reconstruct the ancient compound Punic wax. Various mixtures have been tested as paint on murals and, on a limited scale, as a surface coating on marble. A positive quality is the silky lustre, which is never hard and uniform, but pleasant. One disadvantage of the product is that the supporting material becomes slightly darker than before. This possibly may be used as a positive characteristic, in case a white marble object has turned too white by cleaning. An application of Punic wax might give the surface a pleasant hue, combined with protecting it from renewed deterioration. The question is rather whether or not to accept a product which changes the hue of the object. At present it seems as if this change appears immediately after application, but that there are not successive changes in colour. This kind of transformation is not specific for Punic wax, but can be observed also on modern coatings such as Paraloid B72, a product which is internationally used.

A second disadvantage with Punic wax is that the surface becomes slightly sticky, and consequently allows surface deposits such as dust and biological pollution to remain on the surface. A surface treated with Punic wax, heated and rubbed, is, however, easy to clean, and the deposits do not seem to become firmly attached to the object.

Still it is not possible to predict the long-term results, since the first attempt by the author of coating marble was made only five years ago. The second test was made in this situation roughly sixteen months ago, which is a very short perspective. Applications were made on fragments of Roman wall paintings in autumn 1999, and the results so far are satisfactory. Although there are some negative aspects, Punic wax, at this moment, seems to be a good surface coating for marble and wall paintings. It is neither harmful to human health nor to environment. How this compound, in a longer perspective, reacts with marble, lime and pigments in polluted environments, is still not possible to evaluate.

Ethics and guidelines in conservation

There are no conservation products which are perfect, and which respond to all demands which have been formulated, or are wanted. Therefore, each conservator has to make a personal choice of which product to use. There are general guidelines to follow, but at the end, the conservator has to stand up for a personal choice.

International agreements in conservation are of basic importance and constitute the operating frames. These theoretical guidelines are beautifully formulated but often do not constitute the basis of work in practice. Consequently, there is a problem, consisting of the gap between those high ideals and the actions taken in real life. As a consequence, theories are supplying the content for conservation programmes and reports, but considering the field of conservation as a whole, actions taken in practice often are made for strictly practical and economical reasons. It is impossible for a conservator to survive as a business manager, if not considering economical aspects. Therefore, relatively efficient methods are preferred to slow methods. Methods described and approved in technical literature tend to become continuously repeated, and there is little time for testing or searching for alternative methods. Except when the conservator participates in conservation projects, such "luxury" can be afforded.

Maybe the problems exist because conservation guidelines are theoretic constructions aimed at solving practical problems. Furthermore, these guidelines are formulated by intellectuals, experts in various fields connected to conservation, often employed by institutions, i.e. having the advantage of a regular salary and a secure position. It is not only natural, but also an obligation, to suggest or to strive for optimal conditions in conservation. The conservator, on the other hand, often has to struggle to survive on the market, including to compete with building contractors for large conservation commissions.

Conservation nowadays has become a word of honour, occasionally misused by the possibilities of making money in the conservation business, now attractive to great contractors and to industry. Conservation methods used by contractors by nature are very different from interventions made by professional conservators. The problem is, that the term *conservation* only indicates the action taken of conserving i.e. preserving something from decay or destruction. Seen in that perspective, also the building contractor aims at conservation. Conservation is in this context understood as a conscious act of preservation, performed by professionally trained conservators. Such conservation consists of securing the material stability, but also in respecting the material as such, its aesthetic appearance and the cultural values connected to the object. Securing the material stability is connected to good craftsmanship, which includes the knowledge about suitable materials possible to use in each singular case. Respecting the material as such, means that transformations of the original material, should not be made unless absolutely necessary.

There is a contrast between craftsmanship and industrial effectiveness. Conservation with traditional methods is a time-consuming activity, controlled by man, and modern industrial methods used by contractors. The later are efficient, sometimes aggressive, and hard to control. Cleaning which may be done in a day by a machine, may take a week for person. If economical and time aspects are regarded as more important than the professional conservation of the object, the seriously working conservator may easily be excluded from any building or other large size project. It has to be seriously contemplated *how* to conserve, i.e. when a professional conservator should be in charge and when a contracting firm might be accepted.

The professional conservator

During the last decades, there have been profound changes in the attitudes concerning the field of conservation. Such changes occur as well in professional education as in the field of research and development of conservation materials and techniques. Conservation as a professional scholarly education is relatively new. Just some generation ago, conservation was performed by skilled craftsmen. The conservation or restoration of e.g. a gilded frame, was performed by the gilder, who was also a frame-maker, often professionally trained since childhood. The craftsmanship acquired by such studies, tends to be different to that of a school-educated conservator. While the prior has a deep knowledge of materials and techniques, often including secrets of the studio, inherited and used since generations, the modern conservator starts with theoretical studies which later are applied in conservation interventions. The school-educated conservator has, on the other hand, been trained in understanding not only the chemical reactions between chemicals used, but also how to use modern techniques for analyses, as well as to plan and carry out conservation interventions according to international standards. The lack of practical experience is an disadvantage for a period of time, since a good result is not only a question of knowing what to do, but also how to do it.

Craftsmanship is of vital importance for the result of any conservation intervention, and consequently the conservator not only has to be a good craftsman, but should in addition, have an artistic capacity and a sense of aesthetics, as far as the final touch is concerned. Not in the sense of inventing, but to be able to make an intervention which is aesthetically integrated with the object restored. Equally important, at least for a recently educated conservator is, to be able to respond to the demands of the modern market, i.e. to be aware of international agreements and standards in conservation and documentation, and to know how to use modern technology. A well established traditional conservator or conservators studio may probably rely on an established circle of customers, but many recently educated conservators must find their position at the market, and fight for it, independently if the person is directed towards working in a museum or a national board of heritage, at archaeological excavations, in a private studio, in collaboration with some building contractor, counting on international projects or maybe on material research.

Since nobody can be the expert of everything, it might be wise to join in co-operatives, having the advantage of mutual support. In a group of professionals with different capacities, the total knowledge becomes broadened, and consequently increases the commercial power of the members. In a co-operative or project group, the members have the advantage of occasional collaborations and joint competitions for large-sized conservation projects, thereby approaching the field of the building contractors. There is also the possibility of creating interesting conservation and research projects within the European community. Independently of the professional conditions, it is of vital importance for the conservator being responsible of cultural heritage, to be aware of results in recent research.

Encaustic in modern building construction

The Punic wax reconstructed by this author has proved to be useful as a protective on modern sculpture, made of marble as well as of bronze. In addition, the substance, with the addition of pigments, has been tested for a wall decoration on concrete. At present the results are satisfactory, the painting has not deteriorated during the four years since it was made. Since this is a relatively short time, it still is not possible to predict the long-term outcome of the experiment.

Punic wax was also tested on traditional supports such as lime-plaster and marmorino-plaster, as well as on modern materials such as industrially manufactured gypsum panels, frequently used in construction. The result on traditional materials was very good. When tested on the gypsum panels, the result was negative, since the joints between the edges were not possible to hide, due to the relative transparency of the paint. If the joins could be made in similar structure and material as the panels, this problem would be solved.

Punic wax in these test series were either applied with a brush or with a roller. The appearance of the surface became quite different depending on the application method adapted. It takes more skill to paint with a brush, since the brushstrokes remain visible and the colour varies. When application is made with a roller, the colour becomes uniform. Independently on method of application, the surfaces could be heated and polished with a rag, thereby gaining a specific lustre.

SUMMARY

Issues regarding ethics in conservation, including the personal responsibility of the conservator as a professional form the basis in this study. Out of this fundament, four issues have been developed; *conservation*, *material technology and materials*, *terminology*, and *art history*. *Conservation* comprises the history of conservation, conservation terminology, and guidelines in conservation, i.e., the professional fundament. *Material technology and materials* is a study of some ancient painting techniques and the materials used. The double objective of such an investigation is to be aware of materials and techniques used in Antiquity, and to study the possibility of their use nowadays, in conservation or in modern construction. Related to ancient materials are issues of ancient and modern *terminology*. *History of art*, in this case signifies that some aspects of Roman culture has been studied, since most objects important for this study belong to the Roman context. The aspects presented above are briefly described, followed by practical aspects, applications of theories in real life situations, and the evaluation of such combinations, presented in form of *case studies*.

Traditional and modern conservation methods, in particular beeswax as a paint and a protective are at focus. The characteristics of natural beeswax have been studied, but also its potential when used in combination with other materials. Therefore, some supportive materials, such as Roman lime plaster and preparations on wood have been regarded. Ancient materials based on beeswax have been studied with the objective of understanding whether or not such materials might be accepted in modern conservation.

The reasons for starting this kind of a study needs to be explained. In this case it was a combination of indignation and curiosity. Indignation caused by the discovery of the use of dangerous products in conservation, in quantity and frequency. Curiosity expressed as searching for explanations and alternatives.

The existence of unhealthy materials was not a novelty to me when entering conservation studies, but the massive use of strongly smelling solvents, adhesives and paints was quite a chock. Dangerous materials for a painter mainly are solvents such as turpentine or white spirit. Turpentine is hardly used anymore, and white spirit may be substituted with solvents based on e.g. extract of lemon. The stone carver sometimes needs an adhesive and uses it occasionally. The conservator on the other hand, uses varnishes for surface coatings on stone and ceramics, thinner as a solvent for enamels, epoxy resins as adhesives and also to reconstruct missing parts. The list could be made very long of dangerous materials which are constantly used. Maybe the situation has changed, but this was the situation some five or ten years ago. Enamels and their solvents are probably not used for reconstruction of decorations on faience and ceramics anymore, since there are excellent substitutes. But, remembering a class of students working with these materials, remembering the odours and remembering the headache or indisposition at lunchtime and at the end of the day, still fills me with discomfort. Remembering two young women, one a student and the other a stone conservator, who had to interrupt their pregnancies

due to foetus malformations, possibly caused by conservation materials, still make me convinced about my repudiation from dangerous products.

What materials could possibly substitute modern chemicals? For various reasons my interest was focused on beeswax. The first contact with this kind of material was to use it melted and pigmented, as a paint. Next was to add colour to the wax and shape it into leaves in an old fruit decoration which had partly collapsed, and to reconstruct the fingers of a votive figure. Beeswax solved in white spirit was used as a coating on gilding and painted panels. The lustre of the surfaces became very sophisticated.

Beeswax could obviously be used in other ways as well, one of these called *encausto* and another *ganosis*. Part of this study consists in searching for the original meaning of those terms, and to understand the methods of application during Antiquity. Some existing inconsistencies in terminology contributed to making this a diffuse and time-consuming project. The somewhat unclear descriptions of Pliny and of the more precise notes on *ganosis* made by Vitruvius, were confronted to technology in real life. Finally it became possible to suggest interpretations of these materials and the methods connected.

Some causes of existing unclarities connected to encaustic may be explained by a literary apprehension and interpretation of the Plinian texts by later scholars. When describing the three methods of encaustic painting he mentions a) painting with wax, b) painting on ivory with a *cestrum* and c) a method of painting ships by using wax paint, melted with fire and applied with a brush. At first a) he mentions the paint i.e. the material, then b) he mentions a technique, i.e. the supporting material and the operating tool, and finally c) he mentions a supporting material, a paint and a tool. By analysing what Pliny wrote about these paints, the tools and the methods, and confronting it to what is actually happening in a real life situation, it becomes possible to reconstruct these techniques. Comparing this information with such given by Vitruvius and other ancient writers, and also to other passages by Pliny, conclusions on the subject may be either confirmed or rejected. Finally there is the possibility of searching for evidences of ancient objects which may represent the three methods of encaustic painting.

The first method (a), painting with wax was, according to Pliny, one of the two ancient methods of encaustic. Painting with melted wax signifies that the paint has to be hot, i.e. fluid, and consequently preferably applied with a tool resistant to heat. Such a tool, *cauterium*, is spoon-like and was during Antiquity made of bronze. It could be used to pour the paint and for modelling the surface. Examples of paintings made in this manner, are some of the Fayum portraits, which were made with coloured beeswax. The traces of tools used for modelling the paint are evident. The second method (b) was used for engraved decorations on ivory. In order to perfectly fill the thin engraved lines, wax ought to be hot and fluid. Excesses of paint may easily be scraped off as soon as the paint has set. Examples of antique engraved decorations with coloured lines do exist, but it has not been possible for this author neither to analyse the kind of bone nor the paint. The third method (c) has been subject to many speculations. In a number of studies the question of hot (Punic) wax has been at focus, while this author has chosen to focus at a paint possible to spread with a brush. That seems originally to have been the innovation, which allowed painting on large areas, such as on a ship.

Punic wax was a chemically transformed beeswax. By a complex series of boiling and drying, i.e. cleaning and bleaching, this product finally was used for coatings on marble and on wall decorations. Consequently the substance must have been possible to spread, or craftsmen would have preferred other materials for surface protection. Punic wax would, in that case, not have been described as an adequate protective.

Encausto originally meant "burned in" i.e. that the paint or the protective was heated and consequently "burned" into the supportive material. Already Pliny did not apply the term strictly according to the terminological meaning, but used it in a more general manner for wax painting as well as for applications of wax coatings on painted surfaces. In one passage, Pliny mentions that waxes were stained with some colours containing delicate pigments such as *purpurissum* and *caeruleum*, in cases these were applied on wet lime, i.e. for wall decorations. Vitruvius describes the same process, and continues by stating that "this process is called ganosis by the Greek".

Punic wax, or saponified wax, may be defined as a link between *encausto* and *ganosis*. It was used for painting on wood and for surface coating. According to Pliny it was used for coating weapons (leather and metal) and, in addition, for medical purposes. Punic wax applied with brushes and resembling tempera has been identified on paintings. Wax has been identified in samples from Roman wall paintings, enclosing the pigments. Consequently, the encaustic techniques as well as Punic wax have been identified as part of ancient material tradition.

Some ancient techniques become transformed during the passage of time, other seize to have importance and become forgotten. Beeswax has been used by sculptors as a coating on marble and bronze until recently, when modern chemicals have substituted many traditional materials. Encaustic was abandoned as a painting technique already during Antiquity, mainly substituted by tempera and oil paint for small size paintings. Some artists have, at intervals, tried to reconstruct encaustic, e.g. Leonardo da Vinci during the Renaissance, Arnold Böcklin during the 19th century, and Jasper Johns who made some encaustic paintings in the 1950s. Beeswax in various forms has been, and still is, used as a material for artistic purposes.

Beeswax is an ideal modelling material, since it becomes malleable at roughly the temperature of 38°, i.e. by the contact with human hands. It has a low melting point, generally at about 64° but oxidation with the atmospherical oxygen may increase the hardness and raise the melting point considerably, to almost the double. Beeswax has excellent qualities of impermeability to atmospheric moisture, and a surface coated with wax is repelling most solvents. Natural beeswax is virtually insoluble in water, unless saponified. Saponification is achieved by boiling the beeswax in water with a salt, e.g. soda or potash. *Natron* was, according to Pliny, used as the saponifying agent during Antiquity. *Natron* is an impure double salt, with desiccation qualities, which has been collected in salt lakes in the Egyptian deserts since the Pharaonic era. It was, among other, used in the mummification process, for cleaning, for the production of glass and as one ingredient in incense.

Beeswax is a stable material, and does not change much with time. Beeswax used during Antiquity still is of the same chemical composition, and in addition, much the same as beeswax produced nowadays. Just as natural beeswax is not changing much with time, saponified wax or Punic wax, also remains stable, both maintain their original characteristics. The products consequently are easily recognised in chemical-technical analyses, but their presence can not be used as a means for dating the object.

Beeswax was used as a paint, Punic wax was principally used as a coating on marble and on walls. Roman wall paintings are known to have a specific lustre. Whether such a lustre was due to an application of e.g. a wax, or if it was due to the preparation of the plaster and stucco, has been a subject of disagreements. Since Pliny and Vitruvius mention the application of Punic wax on painted walls, at least on some colours, the preparation and painting of Roman murals make part of the materials studied in this dissertation.

Roman wall preparations from the Republican to the Antonine periods, are extremely well made. Vitruvius recommends as many as six applications of lime plaster and marble dust plaster (stucco) on the rough layer. Preparations reflecting such description have been found, and seem to have been common during the Republic and the Augustan periods, at least in houses of wealthy families. Plaster preparations dated to these periods often show lucid stucco layers of one centimetre or more. Lustre was achieved by compacting the layers, smoothing and polishing them. The combination of highest class materials and excellent craftsmanship contribute to the lustre of these walls. Applications of wax were made during Antiquity, since beeswax or saponified beeswax have been identified on samples examined. Whether such applications were made upon large areas or just on specific colours, is not possible to say from the results within this study. Cinnabar seems, however, to have been coated with Punic wax, just as proposed by Vitruvius.

Ancient techniques connected to beeswax have been examined and are described in this study. The issue is to understand whether or not such materials might be accepted in modern conservation.

Materials in conservation have dramatically changed during roughly the past fifty years. During the same period, conservation as a profession and as an academic discipline has undergone radical development. The academic structure has permitted the penetration of science into this field of traditional craftsmanship. Chemistry has overthrown traditions, laboratory tests and scientific research have substituted manipulations and variations of traditional technology. The voice of a scientist speaks louder than that of a craftsman. Chemical formulas and chemical reactions have seemed to be more reliable than results from experience, especially since craftsmen cannot prove their results in figures.

Conservation is relatively young as a professional activity. In ancient times, conservation was made either by artists or craftsmen. A skilled stone-carver or a sculptor made repairs or reconstructions on marble statuary, a painter made necessary infills and reconstructions on paintings. Repairing objects in the household was often within the domain of its owner, or elsewise by a craftsman. Preservation of heritage such as public properties were, and still are, attended to by an architect in charge. Cultural heritage such as statues, altars and paintings were restored in studios specialised in specific materials or art forms, i.e. the frame-maker and gilder also restored ancient wooden objects such as an altar screen or a candelabrum. The stone-carver created his own statues, but also worked with repairs or reconstructions of details on works of art within his speciality, i.e. he had a personal relation with material as well as with form. Although commissions are still given to artists and specialised craftsmen, major part of conservation of cultural heritage in western countries is nowadays performed by professional conservators. National education systems are slowly developing into systems of international standards, i.e. western standards. Although some attention lately has been given to other cultural traditions, western standards are dominating, accepted by western scholars as a superior phase.

Prefabricated industrial products have, to a great extent taken over, and traditional materials and techniques have been largely abandoned also in conservation. Maybe this was necessary during a period when conservators fought for conservation to be recognised and respected as an academic profession. At present it might be wiser to combine traditional experiences with modern achievements, and to make conscious selections among all possibilities available. The professional conservators nowadays have great possibilities of choices, in materials and techniques, but also in the field of profession and how to work, i.e. whether to be employed or a free-lancer, working in a museum or with short-time, national or international projects, being part of a co-operation team etc. Maybe any conservator nowadays has to reflect upon the professional situation not only once but many times, and again and again make choices. The necessity of being able to consciously make choices among all kinds of conservation materials available, is of vital importance. Being aware of, and understanding, the cultural context of those objects which are exposed to conservation interventions is a vital factor for making adequate decisions, and necessary for achieving appropriate results.

During the formation period of conservation as an academic discipline, traditional craftsmanship was undermined and a new kind of conservator appeared, maybe not as competent in crafts, but well aware of scholarly historic research, chemical reactions, analytical methods, methods in documentation, computer processing, international agreements, legal rights, etc. International agreements and guidelines in conservation have the double effect of providing rules and strategies for management of cultural heritage, and also providing the personal or collective power to have an influence on national and international boards of heritage, museums etc., but also on the academic level, making possible to create strategies and developments in education. It is important to study the development of national and international organisations in conservation, since being aware of the past makes possible to individuate progresses in the future.

Issues concerning conservation principles and agreements are important and constitute the basis for actions taken in real life. Some statements, constantly repeated, and their actual application in practice, have been studied. These statements comprise e.g. that, at any conservation intervention, as little as possible should be done, and that the original material should be respected. Additional materials have to be reversible, or they should be compatible with the material of the object restored. Statements such as these are by nature, possible to interpret, and to react to, in many ways. It seems logical that additional materials should be reversible, i.e. that a reconstructed area should be possible to remove. But on the other hand, it is commonly accepted that such a removal often is combined with the risk of loosing some more of the original material. In other cases, reversibility is not requested, e.g. when consolidating a material in severe decay. In such a situation, reversibility is the quality least requested.

The object of art and its material should be respected, but is it respected if impregnated with substances which, strictly speaking, are not compatible with the original material? Silicates are commonly used for the impregnation of lime stone and marble. According to the principle of compatibility, silicate should be used for only stone containing silicate, and not for lime stone. Anybody within the field of conservation, however, accepts to use silicate as a consolidant for marble.

As little as possible should be done, but who is deciding what is as little as possible? There are different ways of understanding, and when one person only recommends a maintenance intervention, another may accept cleaning, consolidation, infills and reintegration of colours. There are many possible ways to interpret several official statements of the conservation organisations. There is a similar lack of clarity in the term conservation. It is possible to understand any procedure connected to preservation. The conceptions behind some terms important in conservation are presented in this study.

Ancient materials, used during the Roman era, have been at focus in this dissertation. Consequently the Roman cultural context has been regarded as well. Roman wall paintings, Fayum portraits, and polychrome statuary, are the three modalities of Roman art which have been studied, as bearers of a material and a mental tradition. The material aspect has been presented above, the context will be described below.

The tradition of decorating plastered walls, was a heritage of the Hellenistic civilisation. Stucco decorations painted to resemble costly marbles have been found throughout the Hellenistic world. These decorations, imitating marble-coated walls, reflect a mode set at the Palace of Mausollos in Halicarnassos in the middle of the 4th century BC. Decorations of this kind appear in Italy during the 2nd century BC, generally called the First Pompeian style. The decorative system, i.e. the manner of dividing the wall into an upper, a middle and a lower zone, also was a heritage of the Graeco-Hellenistic tradition. With exception of some gradual or temporary changes in proportions between the constants, the system as such remained rather unaltered throughout the Roman period, and continued in the Early Christian and later Western traditions.

The Roman house was decorated according to some principles, which seem to have been followed and repeated throughout the period. Some reasons for the acceptance of strict rules in building and decorating, may be explained by the hierarchic structure of Roman society and the traditional life of a Roman citizen. The *domus* of a Roman family was not only a private home, but also the office of the head of the family *pater familias* and the place of daily receiving of clients. The doors towards the street were wide open during daytime, and anyone passing by could see not only the owner and his clients, but also had a clear view through the official part of house towards its interior, and somewhat more private quarters. Generally the view from the street-side comprised the *fauces*, *atrium*, *tablinum* and the *peristyle* garden, all decorated to impress the visitors and to illustrate the social status of the owner. Public parts of the house consequently were richly decorated with wall paintings, stuccoed ceilings, reliefs and pillars. There were also statues and fountains, and of particular importance, the family shrine, the *lararium*, exposed to be seen by all who visited the family. The floors in public rooms were made of mosaics or *opus sectile*, while those in the service quarters were often made of terra cotta tiles, laid in a pattern called *opus spicatum* or fish bone. Wall decorations in service rooms were simple, often monochrome white, or painted in a simple black-and-white pattern.

The Roman house consequently was a place of official duties, built and decorated to manifest the political and economical power of its owner. The materials used for public areas were chosen to underline such impressions, and the technical quality of decorations made for public spaces show that good craftsmanship was connected to the use of high class materials. Observations of plaster layers and material analyses may be useful at archaeological excavations and documentation of Roman houses, since such methods contribute to the identification of their periods of construction as well as of the status of their space. Expensive pigments such as cinnabar were used only in rooms of receivement, while lime and earth colours dominate simple rooms and houses of less wealthy families.

It seems to have been important for the Romans to decorate their houses according to established schemes. Some motifs were regarded to be appropriate for spaces such as dining rooms and rooms of receivement, while motifs chosen for libraries and peristyles had other qualities. Repetition of popular motifs is a characteristic of Roman art, and there are endless variations of some popular themes. The motifs principally origin from Greek mythology, but famous characters of Greek civilisation, such as philosophers and athletes also had their given places within the Roman decorative scheme. Copies of famous statues and paintings may appear in the same context as Greek originals, indicating that the question of original or copy was not as important as the issue of *decor*, i.e. the suitability within a given ambience.

Even though commonly acknowledged rules were followed in the decoration of spaces, Roman culture was not completely static, but there were gradual changes. Changes within wall decoration are defined according to the system of August Mau, who recognised the so called Four Pompeian styles.

The First style, mentioned above, consisted of stucco relief decorations, painted to resemble various existing types of marble, often combined with brightly coloured fields. In the Second style, also called the architectonic style, architectural settings were painted on the walls, sometimes combined with real elements such as cornices and columns, thereby transforming the flat surface into fantastic constructions. Views of gardens and landscapes often occur in illusive openings. The Third style occurred during the Augustan period, and may be described as a classisistic style with some influences from Egyptian art and its landscape, and society. During this period the wall becomes a flat surface with elegant decorations. The central field generally was decorated with a figural motif. The Fourth style is often defined as an eclectic style, since motifs from each of the previous styles appear, although modified to create a new kind of harmonious unit. Typical of this style are the filigree patterns, framing the sections of the walls. The Fourth style is known from roughly the period of Claudius and Nero, and the eruption of Vesuvius in AD 79, marks its end. Decorations made later are referred to as Post-Pompeian paintings.

Fayum portraits is a comprehensive term indicating Roman portraits painted in Egypt roughly between AD 17 and 250-75. Early portraits are dated to the reign of Tiberius, but there is no final date commonly agreed upon. In recent research it has been assumed that the tradition ended during the second part of the 3rd century AD. The portraits were named after the district Fayum, an oasis situated in the Libyan desert south of Cairo. At the end of the 19th and beginning of the 20th centuries a vast number of mummies were found during excavations in the Fayum area, and later on at other sites along the River Nile and in Northern Egypt. Some mummies had a portrait affixed over its face, sometimes painted in a naturalistic style, sometimes in a stylised manner. Repetitions concerning features, hair fashions and expressions are obvious, and also such which may be used to identify the artist or the workshop. Due to the evident desire of the depicted to resemble leading persons within the Roman aristocracy, it has been possible to date most portraits within limited periods of time.

The Fayum portraits were painted with encaustic or with tempera. Some are unmistakingly encaustic paintings since the wax paint is appearing slightly in relief. Other portraits are definitely tempera paintings, since they have the specific characteristics of that medium, such as a dry surface where the single brush-strokes can be individuated. There are two sub-groups of portraits which resemble both encaustic and tempera paintings. One of these contains portraits painted with wax-paint in a mixed technique. On such surfaces the paint partly appears in relief, shaped with a hard tool, and partly was applied with a brush, which leads to the suspicion that Punic wax may have been used. The other group consists of portraits painted with a lucid paint, flatly applied and with visible brush-strokes just where lines were desired. These traditionally have been regarded as tempera paintings, but at least occasionally were painted with saponified wax, i.e. Punic wax.

According to ancient literary sources, Punic wax was used for coating painted statues. Such a procedure was the traditional way of giving statues the final shield of protection. Painted statues in wall decorations remain as evidences of such a tradition, as well as remaining statues with more or less discernible traces of polychromy. Research on the subject has in this study been limited to the literary level, since there has been no opportunity of taking samples from relevant works of art for chemical-technical examination.

Case studies

In order to confront theories and real life situations, some issues were studied in depth. Each case study is connected to some important aspect of conservation, observations of materials, and of cultural aspects connected to the situation studied.

In *Case Study 1*, the relation between important guidelines in conservation, internationally agreed, and the actual situation in real life are studied. The materials are plasters and pigments, the cultural context is a graffiti decorated Renaissance building in Viterbo in Italy. Being a cultural and educational programme planned as a Raphael project financed by the European Community, one would expect it to be carried out according to strict standards. Within this three-nation collaboration, the Swedish group working in practice at Viterbo for one week in 1998, consisted of conservation students from ICUG. Their compit was described as documentation and material observations leading to suggestions on conservation techniques and materials. The Swedish participants made a general overview of the facade registering the different kinds of damages which were noted, also searching for possible reasons of decay. Full size tentative reconstructions of the graffito decorations were made on plastic films in raking light, and samples for material analyses of plaster and pigments were taken from relevant areas. Based on the results of analyses result, final decisions regarding conservation materials should be made. During the field week in Viterbo, the Swedish group had daily meetings with the Italian participants, i.e. the architect id charge and the project secretary, and regular meetings with the constructor, the art historians, and representatives of the local government. Ethics in conservation, methods and materials were discussed, leading to an agreement on how to proceed. In addition, on request, the Swedish group presented a proposal for the possible future use of the building.

The samples of plaster and pigments were brought to ICUG for analyses, and the results which should be available before conservation started, were not available until 1999, when conservation of the facade was already terminated. Neither were the results requested, indicating that conservation of the facade was carried through according to another programme. The theoretical part, i.e. the phase of planning and formulating a strategy and a final goal, was made perfectly according to academic demands. There were interdisciplinary debates and different opinions on conservation materials, on how to proceed and if and how to test materials which might be used. Disappointing was, on the other hand, that the material analyses, which should have been the basis for conservation interventions were never asked for, and that information about the interventions which actually were made, never reached the Swedish group of conservators. Therefore it is not possible to make a conclusion regarding the conservation programme, but only regarding the discrepancy between theory and practice.

Case Study 2 regards planning and realisation of a material investigation, the materials were beeswax, pigments and preparations, and the cultural context Fayum portraits in Nationalmuseum in Stockholm, i.e. portraits from Roman Egypt in a museum collection. The first contacts between this author and representatives for the museum were taken in autumn 1996 and in autumn 1997 the material study started as a collaboration together with the department of conservation at Nationalmuseum, and the Opificio delle Pietre Dure in Florence. This study was carefully planned. To begin with the aims of the investigation were defined, and a strategy laid out, not only for observation of materials but also including suggestions on future conservation and maintenance. At first information was collected to make possible a selection of portraits for a further study in depth. Each portrait in the collection was verbally described on register sheets and various kinds of deterioration observed were documented on plastic sheets placed upon large-size photos of the portraits. Finally, some portraits were selected for a material investigation. Samples were taken in concordance with the Opificio, and later brought to Florence for chemical-technical analyses.

Binders, pigments and preparations were at focus in this study. One issue was to find out if it was possible to make certain statements about whether a paint was encaustic, Punic wax or tempera, by observations based on paint and preparations and the combination of these. The scientific investigation at Opificio was carried through and in 1998 the results were available. Based on these it was possible to confirm some assumptions, but there were also some unexpected results. The results are presented in the publications *Fayum portraits* and *Mumieporträtt*, both published in 2000. One aim of this material study was to understand the technology of ancient materials, thereby providing information which contribute to consciously performed actions in conservation. During the last year, all portraits in the collection have been brought to the conservation studio, where necessary conservation interventions have been made, and a permanent, more suitable way of mounting and presenting the portraits is planned. A final result of this investigation was the presentation of the portraits, when these were exposed in two cabinets in Nationalmuseum in 2000.

Case Study 3 concerns documentation of archaeological material and conservation interventions performed for a planned didactic exhibition of the fragments at the church San Lorenzo in Lucina in central Rome. The materials plaster, pigments and binders, and the cultural context, Roman art as represented by fragments of wall paintings in an *insula* building of Campo Marzo. The project was carried out in1999, mainly in collaboration with Dr. Olof Brandt, who led the archaeological excavations at San Lorenzo in Lucina, providing the material investigated in this study. At a later phase, in 2000, this study was extended and included in a larger scale research project at the Swedish Institute for Classical Studies in Rome.

Visual observations, including measuring of plaster layers and grain sizes, descriptions of pigments and paint layers were made. Decisions had to be made regarding conservation methods in order to make possible any exhibition of the fragments. Documentation was carefully made and conservation interventions registered. As part of the project, all discussions leading to interventions or any kind of further steps, were presented in the report. According to the initial plan, material investigations should be performed at ICUG, but a complete set of results was for various reasons never available, mainly due to the scientifically inadequate situation connected to analytical equipment. Some questions regarding pigments were resolved at ICUG and others at The Swedish National Heritage Board, and finally at the Opificio. Plans regarding the exhibition of the archaeological finds were made in collaboration with Dr. Brandt and the architect Mats Fahlander, later including the archaeologist Leif-Eric Vaag. Final decisions regarding the exhibition hall are planned to be made in 2001.

All parts of this collaboration project worked out satisfactorily, except for the scientific material analyses, which were not carried out according to the plan, but was fragmentarily resolved. Consequently, a functional working plan and collaboration between competent professionals is necessary for success, but also, technological equipment for carrying out the plans.

Case Studies 4 a, b and c, relate a collaboration project between different disciplines related to some institutes, materials studied are plaster, pigments and binder, and the context is Roman buildings at Prima Porta outside Rome. Institutes involved were Soprintendenza Archaeologica di Roma, Opificio delle Pietre Dure in Florenze and supporting this author, the Swedish Institute of Classical studies in Rome.

Fragments of wall paintings from the Republican to the Post-Pompeian periods were studied. Plaster layers and grain sizes were measured and general observations on plaster, paint layers and pigments were noted. Relevant samples were brought to Florence, and chemical-technical analyses were performed at the Opificio. The hypothesis was, that visual observations might reveal changes in materials and techniques which might be correlated with a specific time during this period, supposing that there was a progress at the beginning of the period and a decline at the end. This environment probably was in the possession of the Imperial family and not of a family belonging to the lower classes, indicating that materials and techniques used might be expected to be the very best, considering economical aspects. Cultural aspects connected to the function of the Roman house as an official space, were also taken into consideration, since one might expect that the *princeps* had to visually manifest his power and supremacy.

Visual observations of the material made it clear that the material quality and technology were extremely high already during the Republic, as visualised in the First style fragments. Fragments from the Augustan period likewise, except that these were even thicker and more smoothly polished. A technological decline during the later Roman period was observed. Results from the chemical-technical investigation at Opificio confirmed these observations, and proved that the technical and material decline at Prima Porta started after the Antonine period. Until then, alabaster grains was used in the stucco preparation, which in addition, was very thick. During the later period, the stucco consisted of lime and marble dust, or just lime. Pigments were mainly earth pigments, constantly used throughout the period. Cinnabar was not found on fragments from the later period. Binder generally was lime, but occasionally also some organic matter was found. Beeswax or Punic wax was identified in samples with cinnabar pigment. To conclude, this collaboration smoothly progressed, and the results were presented in due time. These will be useful for future observations on Roman wall paintings.

Case Study 5 was a didactic conservation project, the principal materials studied were traditional and modern products for conservation of stone. The cultural context was an old house at Anacapri on the island of Capri, partially rebuilt and partially constructed by Dr. Axel Munthe during the middle of the 20th century, and containing a vast collection of Roman art and crafts. Many marble and terracotta objects at the Villa San Michele, were in great need of various conservation interventions. Considering the situation, and searching for a positive solution, it was decided to form a didactic programme, co-involving ICUG and students studying the conservation of stone. Before the programme was initiated in May 1998, a plan had been formulated by this author, including aims and objectives of the project. The programme was approved by the director at Villa San Michele and by ICUG.

One principal objective was to give the possibility to Swedish students to work with materials from the Roman period, in that way broadening their personal experiences of ancient art and culture. Another objective was to provide that they had the opportunity of meeting Italian professionals connected to conservation and art history, having the possibility of asking and of discussing experiences. An important objective was to initiate a conservation programme to preserve this Swedish heritage of Roman art in Italy, intended to lead to the formulation of a regular maintenance plan. One of the main principles was to use simple methods, and to avoid substances which might be harmful for human health and environment. The results in theory as well as in practice have been most satisfactory and sometimes overwhelming. One preliminary conclusion is that careful cleaning of a deteriorated object is of vital importance for the result. The project was carried out in 1998 and 1999, and is planned to proceed in 2001, after a temporary break for evaluation of the results.

Case Study 6, consists of studies and experiments concerning wax painting and reconstruction of Punic wax. The materials included were natural beeswax and compounds of beeswax, various plasters and preparations. The cultural context was to reconstruct Roman tradition and to try to combine traditional materials and modern products. Experiments were carried out during the period between 1995 and 1997, starting with applications of various wax-paints on some plaster preparations. At the next phase, focus was set at the reconstruction of ancient Punic wax, and the application of substances on plaster preparations and modern building materials. Reconstructed Punic wax was also tested as a surface coating on marble and bronze. Finally, a full scale wall decoration was made at Ericsson ETX at Mölndal outside Göteborg, as a collaboration together with White Architects and Ericsson. Evaluation of the experiments have been made at intervals, and are still going on.

Many important experiences were made during the period of these studies. Some are strictly related to the subjects investigated and others are related to collaboration situations. The overall experience is, that there is a discrepancy between theoretic constructions and the situation actually observed in real life situations. This becomes particularly obvious in the field of conservation, since guidelines are formulated for actions planned to be performed. Theoretical guidelines in conservation should be respected, but often are not. The reason for such discrepancy generally may be referred to a lack of adequate equipment, a lack of skilled specialists or a lack of time, all reasons related to economy. Ethics in conservation are at a high level and, if economy allowed, should probably be followed as a standard procedure. One recommendation in conservation, often repeated, is the necessity of collaboration in groups of specialists. Such co-operations are one of the most important experiences made during this period of study. Participating in project means contributing to obtaining results which have been previously agreed upon. In a well functioning project group it also means having the advantage of learning from other professionals striving towards the same goal. In cases when all participants within a project group do not collaborate as intended, or the results do not correlate with the intentions formulated at the beginning, there is probably a hidden economic reason to discover. Economic issues as well as conservation issues should be taken care of professionally. When large contributions are made for conservation projects, the results should be checked by a competent member of the board. Professionally performed conservation has to be adequately paid, and public offices at least, should choose the better offer, not the cheapest. Conservators should not offer their services for an unprofessionally low price, underbidding each other, etc.

The conservator has a personal responsibility when choosing between products and techniques. An absolutely perfect method or material does not exist, and consequently, at present the choice must be between more or less imperfect possibilities. There is a constant research for better products and methods, and by being aware of positive and negative factors of a product, it becomes possible to develop and perfect it. And making as little as possible, is a good recommendation.

Punic wax is one ancient product which may be a functional alternative in conservation. It is harmless for human health and environment, factors which should not be neglected when conserving cultural heritage.

ABBREVIATIONS

AIC	The Code of Ethics of the American Institute for Conservation of Historic and Artistic Works
CC	The International Committee for Conservation (within ICOM)
CNR	Centro Nazionale delle Ricerche
EDS	Elementary Diffraction Spectroscopy
FTIR	Fourier Transform Infrared Spectroscopy
ICCROM	The International Centre for the Study of the Preservation and Restoration of Cultural Property
ICOM	The International Council of Museums
ICOMOS	The International Council of Monuments and Sites
ICR	Istituto Centrale per il Restauro
ICUG	Institute of Conservation, at Göteborg University
IIC	The International Committee for Conservation of Historic and Artistic works
NKF	Nordiska Konservatorsförbundet
NKF-S	Nordiska Konservatorsförbundet, the Swedish section
SEM	Scanning Electron Microscopy
UNESCO	United Nations Educational, Scientific and Cultural Organization

SOURCES NOT PUBLISHED

Aleby, Stig, chemist. Personal communication, Göteborg 1997.
Cavalieri, Marina, conservation technician. Personal communication, Rome 1998.
Danesi, Alessandro, conservator. Personal communication, Rome 1999.
Iskander, Nasser, conservator. Personal communication, Cairo 1997.
Karlsson, Lars, PhD. Lecture at the Forum in Rome 1998.
Liljenstolpe, Peter, PhD. Lecture at Prima Porta 1998.
Lindberg, Bo Ossian, PhD. Personal communication, Göteborg 1997.
Massa, Sandro, scientist. Personal communication Rome 1998.
Meyer-Graft, Reinhard, conservator. Personal communication, Naples 1998.
Mols, Stepan T.A.M, PhD. Personal communication, Rome 1998.
Paparatti, Elio, architect, conservator. Personal communication, Rome 1998.
Silvestri, Silvia, art historian. Personal communication, Rome 1998.
Staub Gierow, Margareta, PhD. Personal communication, Pompeii 2000.
Vodret, Antonello, architect. Personal communication, Rome 1998.
von Matern, Göran, artist. Personal communication, Stockholm 1998.

BIBLIOGRAPHY

ALBERTI, Leon Battista, (1996) Om målarkonsten. Stockholm.

ALDRED, Cyril, (1994) Egyptian art. London. ISBN 0-500-20380-3.

ALEBY, S., FISCHMEISTER, I and IYENGAR, B.T.R. (1971) "The infrared spectra and polymorphism of long chain esters: IV. Some esters from tetradecanol, hexadecanol, octadecanol, eicosanol, docosanol and dodecanonic, tetradecanonic, hexacanonic, octadecanonic and eicosanonic acid". In: *Lipids*, pp. 421-425, vol. 6, no. 6.

ALESSANDRI, Marina and ALESSANDRI, Angelo (1992). La pulitura delle pietre. In: *La pulitura, il consolidamento e la protezione della pietra: problemi applicativi*. Pisa.

ALDOVRANDI, Alfredo, MATTEINI, Mauro, MOLES, Archangelo, SANTAMARIA, Ulderico and VIGLIANO, Giuseppina, (1996) "Indagini scientifiche per lo studio delle superfici marmoree dell´"Apollo e Dafne" di Gian Lorenzo Bernini". In: *OPD Restauro*, no 8, pp. 9-29.

ALETTI, Ezio, (1951) La tecnica della pittura greca e romana e l´encausto. Roma.

1948, Lo stile di Ludio e l´impressionismo ellenistico romano. Roma, L´Airone.

ALEXOUPOLOU-AGORANOU, Athina, KALLIGA, Alexandra-Eleni, KANAKARI Urania and PASHALIS, Vassilios, (1997) "Pigment analysis and documentation of two funerary portraits which belong to the collection of the Benaki Museum". In: *Portraits and masks*, pp. 88-95.

AMBIENTE, CITTÀ E MUSEO. Gabriella Lippi, Nardini Editore, Fiesole 1995. ISBN 88-404-4038-0.

ANCIENT FACES: mummy portraits from Roman Egypt. Susan Walker & Morris Bierbrier, ed. London, British Museum Press, 1997. ISBN 0714119059.

ANDERSEN, Flemming Gorm, (1985) "Pompeian painting - some practical aspects". In: *Analecta romana*, XIV, pp. 113-128. Roma, "L´Erma" di Bretschneider. ISBN 88-7062-587-7.

ANDERSSON, Tord, (1961) "Traditional surface treatment of natural stones: an introduction". In: *Proceedings of the 2nd International conference held in Seville, Spain, 14-16 May 1961*.

1994. Konservering - ideologi för bevarande. In: *Kulturminnesvård*, 4.

ANDRÉN, Arvid, (1957) Den antika konsten i San Michele. In: *Boken om Axel Munthe, Capri och San Michele*, pp. 350-378. Allhems Förlag, Malmö.

(1962) Classical antiquities of the Villa San Michele. In: *Opuscula Romana*, V. Lund.

(1975) Capri. Från stenåldern till turiståldern. Lund, Svenska humanistiska förbundet. ISBN 9185158038.

ANTICHE STANZE: un quartiere di Roma imperiale nella zona di Termini. Museo Nazionale Romano, Terme Diocleziano, Roma dicembre 1996 - giugno 1997. Milano, Mondadori 1996.

ANTONSSON, Oscar, (1958) Antik konst - en konstbok från Nationalmuseum. Stockholm, Ehlins.

APPELBAUM, Barbara, (1987) "Criteria for treatment: Reversibility". In: *Journal of the American Institute for Conservation*, 2, pp. 65-74.

ART AND ETERNITY: the Nefertari wall paintings conservation project 1986-1992. Miguel Angel Corzo & Mahasti Afshar, ed. New York, J. Paul Getty Trust, 1993.

ARTISTS´ PIGMENTS. A handbook of their history and characteristics, vol. 1. Robert F. Feller, ed. Oxford University Press 1986. ISBN 0-89468-086-2.

ARTISTS´ PIGMENTS. A handbook of their history and characteristics, vol. 2. Ashok Roy, ed. Oxford University Press 1993. ISBN 0-89468-189-9.

ASHLEY-SMITH, Jonathan, ed. (1996). Science for conservators, vol.2. Cleaning. London & New York.

ASHMOLE, Bernard, (1972) Architect and sculptor in Classical Greece. London, Phaidon. ISBN 0-7148-1551-9.

ASPELIN, Kurt & LUNDBERG, Bengt A., ed. (1976) Tecken och tydning. Stockholm, Pan/Norstedts. ISBN 91-1-764011-3.

AUGENBLICKE: Mumienporträts und Egyptische Grabkunst aus römischer Zeit. (Katalog von der ausstellung in der Schirn Kunsthalle Frankfurt 30. januar bis 11. april 1999). Klaus Parlasca & Hellmut Seemann, ed. München 1999, Klinkhardt und Biermann. ISBN 3781404234.

AUGUSTI, Selim, (1967) I colori pompeiani. Roma, De Luca.

(1961) "Restauro e conservazione della pittura romana". In: *Atti del congresso di archeologia classica, Vol. 1*, pp. 159-162.

(1950) "Sulla tecnica della pittura pompeiana". In: *Bollettino d'Arte*, 3, pp. 189-191.

BAGLIONI, Piero, DEI, Luigi, PIQUÉ, Francesca, SARTI, Giuseppe and FERRONI, Enzo, (1997) "New autogenous lime-based grouts used in the conservation of lime-based wall paintings". In: *Studies in Conservation*, 42, pp. 43-54.

BAGNALL, R.S., (1993) Egypt in late antiquity. New Jersey .
(1997) "The Fayum and its people". In: *Ancient faces*, pp. 17-20.
BAILOR, Denis, (1996) "Colour mechanisms of the eye". In: *Colour: Art and Science*, pp. 103-126. Cambridge.
BALDASSARE, Ida, (1985) "Pittura parietale e mosaico pavimentale dal IV al II sec. a.C.". In: *Ricerche di pittura ellenistica*, pp. 203-214. Roma.
BALDINI, Umberto, (1988) Teoria del restauro e unitá di metodologia. Volume primo. Firenze, Nardini Editore.
(1989) Teoria del restauro e unitá di metodologia. Volume secondo. Firenze, Nardini Editore.
BANDINI, Giovanna, (1996) "Il restauro degli affrschi e dei mosaici di Piazza dei Cincuecento tra passato e presente. Appunti di lavoro". In: *Antiche stanze*, pp. 211-216.
BANDINI, Giovanna, FALCUCCI, Claudio, and SCIUTI, Sebastiano, (1996) "Analisi non distruttivi dei pigmenti di dipinti murali". In: *Antiche stanze*, pp. 220-224.
BARBET, Alix, (1981) "Les bordures ajourées dans le IV style de Pompei. Essay de typologie". In: *Mefra*, 93, pp. 917-920.
(1985) La peinture murale Romaine: les styles décoratifs pompéiens. Paris, Picard. ISBN 2708401165.
(1988) "La tecnica pittorica". In: *romana pictvra*. pp. 103-111.
BAROV, Zdranko, (1990) "Removal of inorganic deposits from Egyptian painted wooden objects". In: *Cleaning, retouching and coatings*. London.
BARTHES, Roland, (1995) "Semiotik och kulturkritik". In: Kulturstudier, pp. 70-91. Lund.
BARTMAN, Elizabeth, (1994) "Sculptural collecting and display in the private realm". In: *Roman art in the private sphere*, pp. 71-88.
(1999) Portraits of Livia: imaging the Imperial woman in Augustan Rome. Cambridge University Press. ISBN 0-521-58394-2.
BEARAT, Hamdallah, (1993) "Analyses mineralogiques sur les peintures alterees de la Villa gallo-romaine de Vallon". In: *Revue d'Archéométrie*, 17, pp. 65-74.
(1997) "Les pigments verts en peinture murale romaine: bilan analytiqe". In: *Roman wall painting*, pp. 269-286.
(1997) "Quell est la gamme exacte des pigments romains? Confrontations des résultats d´analyse avec les textes de Vitruve et de Pline". In: *Roman wall painting*, pp. 11-34.
BEARD, Mary, (1995) "Imaginary *horti*: or up the garden path". In: *Horti romani*, pp. 23-32.
BERGER, Ernst, (1904) Die Maltechnik des Altertums nach den quellen, Funden, chemischen Analysen und eigenen Versuchen. München.
BETTINI, Claudio and VILLA, Alberto, (1981) "Descriptions of a method for cleaning tombstones". In: *The conservation of stone*. Preprints of the contribution to the International symposium, Bologna 27-30 October 1981.
BIANCHI, Robert Steven, (1995) "The mummy as a medium". In: *Archaeology*, x pp. 23-24.
BIANCHI BANDINELLI, Rannuccio, (1980) La pittura antica. Roma, Editori Riuniti.
BIERBRIER, Morris, (1997) "The discovery of the mummy portraits". In: *Ancient faces*, pp. 23-24.
BLOMÉ, Börje, (1977) Kyrkokonservering i teori och praxis: den italienska restaureringsdoktrinen och dess tillämpning vid tre svenska kyrkor 1966-1977. Göteborg, Konstvetenskapliga institutionen.
(1991) "Venedigdokumentet 1964, dess betydelse och tillämpning i Sverige". In: *Kulturmiljövård* 1, pp. 3-6.
BLOMÉ, Börje, HOLST, Anna, LÖWE, Arthur & ÅKERLUND, Bengt, (1972) Låt Stå! Om bevarande av stadsmiljön. Lund, Berlingska tryckeriet. ISBN 91-37-05097-4.
BOATWRIGHT, Mary T., (1995) "Luxuriant gardens and extravagant women: the *horti* of Rome between the Republic and Empire". In: *Horti romani*, pp. 71-82.
BOËTHIUS, Axel, (1960) The Golden House of Nero: some aspects of Roman architecture. Ann Arbor, University of Michigan Press.
BOËTHIUS, Axel & WARD PERKINS, John B., (1970) Etruscan and Roman architecture. Harmondsworth, Middlesex, Penguin Books.
BOLOGNA, Ferdinando, (1993) "La riscoperta di Ercolano e Pompei nella cultura artistica del Settecento europeo". In: *Riscoprire Pompei*, pp. 102-115.
BOMFORD, David, (1996) "The history of colour in art". In: *Colour: Art and Science*, pp. 7-30. Cambridge.
BÒNA, István, (1997) "Restoration and scientific examination of large Roman frescoes from Brigeto". In: *Roman wall painting*, pp. 307-315.

BORDA, Maurizio, (1958) La pittura romana. Milano, Società Editrice Libraria.

BORDIGNON, Celso, (2000). Caratteri e dinamica della tecnica pittorica nelle catacombe di Roma. Caxias do Sul/Roma.

BORG, Barbara, (1995) "Problems in the dating of the mummy portraits". In: *The mysterious mummy portraits. Faces from Ancient Egypt*, pp. 229-235.

(1996) Mumienporträts. Chronologie und kultureller Kontext. Mainz, von Zabern. ISBN 3805317425.

(1998) "Der zierlichste Anblick der Welt..." Ägyptische Porträtmumien. Mainz am Rein, von Zabern. ISBN 3805322631.

BORRELLI, Licia Vlad, (1980) "Le pitture e la tecnica della conservazione". In: *Pompei 1748-1980*, pp. 81-85.

BOULANGER, Robert, (1965) La péinture égyptienne et l'Orient ancien. Lausanne, Editions Rencontre.

BRAGANTINI, Irene, (1980) "Tra il III e il IV stile: ipotesi per l'identificazione di una fase della pittura pompeiana". In: *Pompei 1748-1900*, pp. 106-117.

BRAGANTINI, Irene and BADONI, Franca, (1985) "Il quadro pompeiano nel suo contesto decorativo". In: *Richerche di pittura ellenistica*, pp. 257-267.

BRALIA, A., MATTEINI, Mauro, MOLES, Archangelo and SABATINI, G., (1989) "La sintesi degli ossalati di calcio nella interpretazione delle patine presenti sui marmi esposti all'aperto. Risultati preliminari". In: *Atti del convegno, Milani 25-25 ottobre 1989*, pp. 75-84.

BRANDI, Cesare, (1952) "Il restauro del opera d'arte secondo l'istanza della storicità". In: *Bollettino dell'Istituto Centrale del Restauro*, 12, pp. 115-119.

(1953) "Il restauro dell'opera d'arte secondo l'istanza della storicità". In: *Bollettino dell'Istituto Centrale del Restauro*, 13, pp. 3-8.

(1977) Teoria del restauro. Quarta edizione. Torino, Einaudi.

BRION, Marcel, (1961) Pompeji och Herculaneum. Stockholm.

BRISING, Harald, (1911) Antik konst i Nationalmuseum i urval och beskrifning av Harald Brising. Stockholm, Cederquists grafiska aktiebolag.

BRUNNSÅKER, Sture, (1971) The tyrant slayers of Kritios and Nesiotes. Stockholm, Acta Instituti Atheniensis Regni Sueciae. ISBN 91-85086-00-2.

BRUNO, Vincent J., (1977) Form and colour in Greek painting. New York, WW Norton. ISBN 0-393-04445-9.

BRÖNNERSTAD, Britt Marie, (1994) Om mumier och mumifiering. Stockholm, Rubicon.

BUGINI, R., FOLLI, L. and ROSSI, F., (1995) "Stone materials from a Roman Republican temple, Brescia (Northern Italy)". In: *Conservation, preservation and restoration - traditions, trends and techniques*, pp. 191-196. Hyderabad.

BÜLL, Reinhard, (1963) Vom Wachs. Hoechster beitrage zur kenntnis der Wachse. Band 1, Beitrag 7/1. Frankfurt.

CAGIANO de AZEVEDO, Michelangelo, (1949) "Il restauro degli affreschi della Casa di Livia". In: *Bollettino d'Arte*, 2, pp. 145-149.

(1952) "Conservazione e restauro presso i greci e romani". In: *Bullettino del Istituto Centrale del Restauro*, n.9-10, pp. 53-60.

(1952) "Encausto e encausticatura nella pittura murale romana". In: *Bollettino dell'Istituto Centrale del Restauro*, 12, pp. 199-202.

(1953) "La sala dipinta della Livia a Prima Porta". In: *Bollettino dell'Istituto Centrale del Restauro*, 13, pp. 11-46.

(1961) "Techniche della pittura parietale antica". In: *Atti del congresso di archeologia classica,* Vol. 1, pp. 145-153.

CAIRA LUMETTI, Rossana, "Italian culture and Swedish culture in the eighteenth century". Unpublished paper presented at "*Il Settecento Romano*", at Istituto Svedese di Studi Classici a Roma, 21-23 Settembre 1998.

CAMPANELLA, Rosella Grassi & POSITANO, Mauro Tomassetti, (1996) "Il restauro degli affreschii e dei mosaici di Piazza dei Cinquecento tra passato e presente". In: *Antiche stanze*, pp. 211-219

CANTILENA, Renata, (1992) "La conservazione ed il restauro dei dipinti pompeiani, tra Settecento ed Ottocento". In: *Alla ricerca di Iside*, pp. 105-110.

CANTARELLA, Eva and Jacobelli, Luciana (1999). Un giorno a Pompeii. Vita quotidiana, cultura, società. Electa, Napoli. ISBN 88-435-8749-8.

CAPPONI, Gisella, (1998). Materiali per l'aggiornamento nel restauro: materiali lapidei. ICR, Roma.

CARTER, John, (1989) "Civic and other buildings". In: *Roman public buildings*, pp. 31-65.

CASAZZA, Ornella, (1989) Il restauro pittorico nell´unitá di metodologia. Firenze, Nardini Editore. ISBN 88-404-4002-X.

CASOLI, Antonella, PALLA, Gerardo and TAVLARIDIS, Jorgos, (1998) "Gas-chromatography/mass-spectrometry of works of art: characterization of binding media in post-Byzantine icons". In: *Studies in Conservation*, 43, pp. 150-158.

CENNINI, Cennino, (1948) Boken om målarkonsten. Stockholm.

CHARBONNEAUX, Jean, (1993) "La scultura". In: *La Grecia classica*, pp. 99-226.

CINTI, Paola and GAMMINO, Nicolò Mario, (1992) "L´intervento del restauro". In: *Alla ricerca di Iside*, pp. 115-122.

(1993) S. Carlino alle quattro fontane. Il restauro della facciata. Note di cantiere. Roma, CTR.

CITTÀ INQUINATA: i monumenti. Armando Montanari & Pietro Petraroia, ed. Roma, Istituto Poligrafico e Zecca dello Stato, Libreria dello Stato, 1989.

CLARKE, John R., (1991) The houses of Roman Italy 100 BC - AD 250: ritual, space and decoration. Berkeley, University of California Press. ISBN 0520072677.

(1994) "The decor of House of Jupiter and Ganymede at Ostia Antica: private residence turned gay hotel?" In: *Roman art in the private sphere*, pp. 89-104.

CLAVIR, Miriam, (1998) "The social and historic construction of professional values in conservation". In: *Studies in Conservation*, 43, pp. 1-8.

CLEANING, RETOUCHING AND COATINGS. ed. London 1990.

COLES, John, (1995) "The site record and publication". In: *Conservation on archaeological excavations*, pp. 59-72.

COLINART, Sylvie, AUBERT, Marie-France and CORTOPASSI, Roberta, (1988) "Peinture à l´encaustique: un portrait du Fayoum". In: *Techne*, no 7, pp. 45-48.

CONSERVATION IN ANCIENT EGYPTIAN COLLECTIONS. Carol Brown, Fiona Macalister, Margot Wright, ed. London, Archetype Publications 1995. ISBN 1873132 808.

CONSERVATION OF ANCIENT EGYPTIAN MATERIALS. ed. London 1988.

CONSERVATION ON ARCHEOLOGICAL EXCAVATIONS, with particular reference to the Mediterranean area. Stanley Price, ed. Rome, ICCROM 1995. ISBN 9290771305.

CORBEIL, Marie-Claude, OLESON, John Peter & FOOTE, Rebecca, (1966) "Characterization of pigments used on Roman and Abbasid Frescoes in Jordan" Preprint to the 11th Triennal Meeting in Edinburgh, 1-6 September 1996. ICOM.

CORBEIL, Marie-Claude and HELWIG, K., (1995) "An occurrance of pararealgar as an original or altered artists´ pigment". In: *Studies in Conservation*, 40, pp. 133-138.

CORCORAN, Lorelei, H., (1992) "A cult function for the so-called Faijum mummy portraits?" In: *Life in a multicultural society. Egypt from Cambyses to Constantine and beyond*, pp. 57-62.

(1995) Portrait mummies from Roman Egypt (I-IV centuries AD.) Oriental Institute of the University of Chicago. ISBN 0918986990.

CORZO, M.A., STULIC, Dusan, DOEHNE, Eric and WALLERT, Arie, (1997) "Scientific analysis of a Fayum portrait by the Getty Conservation Institute". In: *Portraits and masks*, pp.81-87.

COSTANZI COBAU, Andreina, (1993) "In situ consolidation of a Roman fresco near Ein Yael, Jerusalem". In: *ICOM Committe for Conservation*, pp. 536-540.

CURTIUS, Ludwig, (1929) Die Wandmalerei Pompejis: eine einführung in ihr Verständnis. Leipzig, E. A. Seemann.

D´AMBRA, Eve, (1998) Art and identity in the Roman world. London, Everyman Art Library. ISBN 0297824066.

DA VINCI, Leonardo, (1990) Trattato della pittura. Catania.

DE ANGELIS D´OSSAT, Guglielmo, (1982) Guida allo studio metodico dei monumenti e delle loro cause di deterioramento. Rome, ICCROM.

DELLA CORTE, Matteo (1954). Case ed abitanit di Pompei. 2nd edition. "L´Erma" di Bretschneider, Roma.

DEL MONTE, Marco and SABBIONI, Christina, (1987) "A study of the patina called "scialbatura" on Roman marbles". In: *Studies in Conservation*, Vol. 32, pp. 114-121.

DE SIMONE, Antonio, (1993) "Archeologia e scienza". In: *Riscoprire Pompei*, pp. 86-101.

DE VOS, Mariette, (1980) "La bottega di pittori di Via di Castricio". In: *Pompei 1748-1980*, pp. 119-130.

DE VOS, Mariette, and MARTIN, Archer, (1985) "La pittura ellenistica a Pompei in decorazioni scomparse documentate da uno studio dell´architetto russo A.A. Parland". In: *Ricerche di pittura ellenistica*, pp. 269-278.

DINSMORE, Jennifer and HOWARD, Helen, (1988) "The treatment of an Eighteenth Dynasty wall painting fragment at the British Museum". In: *Conservation of Ancient Egyptian Materials*, pp. 61-69. London.

DOXIADIS, Euphrosyne, (1995) The mysterious Fayum Portraits: faces from Ancient Egypt. London, Thames & Hudson. ISBN 0500237131.

(1997) "Technique". In: *Ancient faces*, pp. 23-24.

DWYER, Eugene, (1994) "The Pompeian atrium house in theory and in practice". In: *Roman art in the private sphere*, pp. 25-48.

EDMAN, Victor, (1994) Tidlösheten återupprättad. Studier i restaureringskonstens teori och historia. Stockholm.

EHRHARDT, Wolfgang, (1987) Stilgeschichtlische Untersuchungen an Römischer Wandmalereien von späten Republik bis zur Zeit Neros. Mainz am Rhein, Verlag Philipp von Zabern. ISBN 3-8053-0919-8.

(1988) Häuser in Pompeji; Casa del Orso (VII 2, 44-48). München, Hirner Verlag. ISBN 3-7774-4870-2.

ELLIS, Simon P., (1994) "Power, architecture and decor: how the late Roman aristocrat appeared to his guest". In: *Roman art in the private sphere*, pp. 117-134.

ELLIS HANSON, Ann, (1992) "Egyptians, Greeks, Romans, Arabes, and Ioudaioi, in the first century AD. Tax archive from Philadelphia: P. Mich. inv. 880 recto and P. Princ. III 152 revised". In: *Life in a multicultural society. Egypt from Cambyses to Constantine and beyond*, pp. 133-146. Chicago.

ELSNER, Jaš, (1998) Imperial Rome and Christian triumph. Oxford & New York, Oxford Unviersity Press. ISBN 0-19-284201-3.

ELSTON, Maya, (1995) "Technology and conservation of a polychrome wooden sarcophagus". In: *Conservation in Ancient Egyptian Collections*, pp. 13-22.

EMMENEGGER, Oskar, (1984) "Polychromie auf Stein". In: *Natursteinkonservierung*, pp. 181-185. München.

ERRICO, Maria, (1985) "La "moda" di decorare le facciate a Roma: origini del fenomeno, iconografia e tecniche esecutive". In: *Bollettino d'Arte*, 70, pp. 57-59.

ESCHEBACH, Hans and ESCHEBACH, Liselotte (1995). Pompeji. Böhlen verlag, Köln, Weimar, Wien. ISBN 3-412-11594-0.

FEILDEN, Bernard, (1982) Conservation of historic buildings: technical studies in the arts, archeology and architecture. London, Butterworths. ISBN 0-408-10782-0.

FEILDEN, Bernard and JOKILEHTO, Jukka, (1993) Management guidelines for world cultural heritage sites. Rome, ICCROM. ISBN 92-9077-108-9.

FELLER, Robert L., (1994) "Aspects of chemical research in conservation: the deterioration process". In: *Journal of the American Institute for Consevation*, 2, pp. 91-99.

FERRETTI, Marco, (1993) Scientific investigations of works of art. Roma.

FERRONI, Enzo, (1999). Il contributo delle scienze chimiche per la conoscenza e la conservazione preventiva. In: *OPD Restauro*, 11, pp.97-102.

FORBES, Robert James, (1965) Studies in ancient technology. Leiden, E. J. Brill. Second rev. edition.

FORCELLINO, Antonio, (1988) "Intonaci e coloriture nel cinquecento e seicento: vocazioni espressive e tecniche esecutive". In: *Bollettino d'Arte*, 47, pp. 125-132.

FORD, Bruce, MACLEOD, Ian and HAYDOCK, Phil, (1994) "Rock art pigments from Kimberly region of Western Australia: identification of the minerals and conversion mechanisms". In: *Studies in Conservation*, Vol 39, Nr 1, pp. 57-69.

FRECCERO, Agneta, (1996). Enkaustik. Experiment med puniskt vax. Forskningsstiftelsen för Samhällsplanering, Byggnadsplanering och Projektering, Göteborg. ISSN 0348-9418.

(1997) Wax painting, encausto and ganosis. Ancient Painting techniques with wax as a binding medium and methods for surface coating. Institute of Conservation, Göteborg. ISSN 11-3303.

(2000) Mumieporträtt. Stockholm. ISBN 91-7100-629-X.

(2000) Fayum portraits. Documentation and scientific analyses of mummy portraits belonging to Nationalmuseum in Stockholm. Göteborg. ISBN 91-7346-382-5.

FRENZ, Hans G., (1985) Römische Grabreliefs in Mittel- und Süditalien. Roma, G. Bretschneider. ISBN 8885007953.

(1999) "Bemerkungen zu den Datierungsmöglichkeiten und zur individuellen Ähnlichkeit bei Mumienporträts". In: *Augenblicke*, pp. 71-73.

FRINTA, Mojmir S., (1963) "The use of wax for appliqué relief brocade on wooden statuary". In: *Studies in Conservation*, Vol. 8, pp. 136-149.

GABRIEL, Mabel M., (1955) Livia's garden room at Prima Porta. New York University Press.
GALLO, Anna, (1988) "Le pitture rappresentanti Arianna abbandonata in ambiente pompeiana". In: *Rivista di Studi Pompeiani*, II, pp. 57-80.
GATES, Glenn, (1995) "A note on the artist's pigment aureolin". In: *Studies in Conservation*, 40, pp. 201-206.
GATTO, Ludovico, (1988) "Il colore dell'architettura romana". In: *Bollettino d'Arte*, 47, pp. 103-104.
GEORGE, Beate, (1977) "Ein Mumienporträt im Medelhavsmuseet". In: *Bulletin 12*, pp. 45-47. Stockholm.
GEORGE, Beate and PETERSON, Hans, (1982) "Egypten". In: *Medelhavsmuseet. En introduktion*, pp. 9-116. Stockholm.
GIANNINI, Cristina, (1992) Lessico del restauro. Firenze, Nardini Editore. ISBN 88-404-4018-6.
GIEROW STAUB, Margareta, (1998) "Copie di affreschi romani nel Museo Nazionale di Stoccolma". Unpublished paper presented at "Il Settecento Romano", at Istituto Svedese di Studi Classici a Roma, 21-23 Settembre 1998.
(1994) La casa del Granduca (VII 4,56) Casa dei capitelli figurati (VII 4,57). Häuser in Pompeji, Band 7. München, Hirmer Verlag. ISBN 3-7774-5860-0.
GILLARD, R.D., HARDMAN, Susan, THOMAS, R.G. and WATKINSON, David, (1994) "The detection of dyes by FTIR microscopy". In: *Studies in conservation*, 39, pp. 186-192.
GNOLI, Raniero, (1989) "Repertorio". In: *Marmi antichi*, pp. 131-301.
GOODMAN, Martin, (1997) The Roman world 44 BC - AD 180. London & New York, Routledge. ISBN 0415049695.
GRANT, Michael, (1973) The Roman Forum. London, Weinfeld & Nicolson. ISBN 029700199X
GRATZIU, G. and MELUCCO VACCARO, Alessandra, (1989) "Le pellicole ad ossalati: origine e significato nella conservazione delle opere d'arte". In: *Atti del convegno, Milano 25-26 ottobre 1989*, pp. 182-193.
GREEN, Lorna, (1995) "Recent analysis of pigments from Ancient Egyptian artefacts". In: *Conservation in Ancient Egyptian Collections*, pp.85-92.
GUIDOBALDI, Federico, LAURENZI TABASSO, Marisa and MECUCCI, Constantino, (1984) "Monumenti in marmo di epoca imperiale a Roma: indagini sui residui di trattamenti superficiali". In: *Bollettino d'Arte*, 24, pp. 121-134.
HAMBERG, Per Gustaf, (1945) Studies in Roman Imperial art: with special reference to the state reliefs of the second century. Uppsala, Almqvist & Wiksell.
HANSEN, Fenge and JENSEN, Ole Ingulf, (1991) Farvekemi. Uorganiske pigmenter. København, G. E. C. Gad. ISBN 87-12-01864-3.
HARLEY, Cate, (1993) "A note on the crystal growth on the surface of a wax artifact". In: *Studies in Conservation*, 38, pp. 63-66.
HERODOTOS, (1920) Historia. Translated in Swedish by Claes Lindskog. Stockholm.
HILLYER, Lynda, (1984) "The conservation of a group of painted mummy cloths from Roman Egypt". In: *Studies in Conservation*, 29, pp. 1-9.
HIGGINS, Reynold, (1985) Minoan and Mycenaen art. London.
HOFENK-DE GRAAFF, Judith, (1974) "A simple method for the identification of indigo". In: *Studies in Conservation*, 19, pp. 54-55.
HOPPE, Thomas, (1991) "Eine kleine Geschichte über Enkaustik. Zu den Auseinandersetzungen mit Wachsmalverfahren in der deutschsprachigen kunsttechnischen Literatur". In: *Zeitschrift für Kunsttechnologie und Konservierung*, Jahrgang 5, pp. 263-288.
HORIE, C.V., (1987) Materials for conservation. Organic consolidants, adhesives and coatings. Butterworths.
HORTI ROMANI: atti del convegno internazionale, Roma 4-6 maggio 1995. Maddalena Cima & Eugenio La Rocca, ed. Roma, "L'ERMA" di Bretschneider, 1998. ISBN 8882650219.
HÄFNER, Klaus, (1997) "Experiments on reconstruction of the Roman wall painting technique". In: *Roman wall painting*, pp. 143-152.
IACOPI, Irene, (1997) La decorazione pittorica dell'Aula Isiaca. Milano, Electa. ISBN 8843563297.
(1999) Domus Aurea. Milano, Electa. ISBN 88-435-7174-5.
INGANNI, Domenico, (1979) Stuckatörens hemligheter. Borås.
(1982) Skulptörens hantverk. Borås.
INNÉMEE, Karel and PARANDOWSKA, Eva, (1995) Report on the research and conservation of the paintings in the church of Al-Adra in Deir al-Sourian. Cairo.

INNÉMEE, Karel, JENNER, K.D and van ROMPAY, L., (1997) Report on the research and conservation of the paintings in the church of Al-Adra in Deir-al-Sourian season 1996. Cairo.

ISAGER, Jacob, (1978) Plinius: Malerkunsten og terrakottakunsten. Odense.

(1991) Pliny on art and society: the elder Pliny's chapters on the history of art. Odense University Press. ISBN 87-7492-794-9.

JAESCHKE, Richard, (1997) "Mechanical cleaning and the conservation of portraits from the Petrie Museum of Egyptian archaeology". In: *Portraits and masks*, pp. 96-100.

JAESCHKE, Richard and JAESCHKE, Helena, (1988) "Early conservation Techniques in the Petrie Museum". In: *Conservation of Ancient Egyptian Materials*, pp. 17-25.

JAMES, Harry, (1988) "Painting techniques on stone and wood". In: *Conservation of Ancient Egyptian Materials*, pp. 55-61.

JASHEMSKI, Wilhelmina, (1979). The gardens of Pompeii, Herculaneum and the villas destroyed by Vesuvius. Vol. 1. ISBN 0-89241-096-5.

(1993). The gardens of Pompeii, Herculaneum and the villas destroyed by Vesuvius. Appendices. Vol. 2. ISBN 0-89241-125-2.

JENSEN, Ole Ingulf, (1996) Optical identification of pigments. Microscopical determination of pigments in conservation. Theory and method. Göteborg.

JOHNSON, Colin, GILL, Anna, MILLER, Eric and HIGNETT, Karin, (1997) "Aspects of consolidation". In: *Portraits and masks*, pp. 100-107.

JOHNSON, Colin, HEAD, Kerry and GREEN, Lorna, (1995) "The conservation of a polychrome Egyptian coffin". In: *Studies in Conservation*, Vol 40, pp. 73-81.

JOKILEHTO, Jukka, (1986) A history of architectural conservation. Vol. I-III. York.

(1997) "Il problema della reintegrazione". In: *La reintegrazione nel restauro dell'antico*, pp. 47-56. Roma .

KELLUM, Barbara, (1993) "Sculptural programs and propaganda in Augustan Rome: the temple of Apollo on the Palatine". In: *Roman art in context*, pp. 75-83.

KIRBY, Jo and WHITE, Raymond, (1996) "The identification of red lake pigment dyestuff and discussion of their use". In: *National Gallery Technical Bulletine*, vol.17, pp. 56-80.

KJELLBERG, Ernst, (1932) Grekisk och romersk konst. Stockholm, Bonniers.

KJELLBERG, Ernst and SÄFLUND, Gösta, (1968) Greek and Roman art 3000 BC to AD 550. London.

(1978) Grekisk och romersk konst. Stockholm. ISBN 91-0-042743-8.

KLEINER, Diana E.E., (1992) Roman sculpture. New Haven & London, Yale University Press. ISBN 0-300-04631-6.

(1993) "The great friezes of the Ara Pacis Augustae". In: *Roman art in context*, pp. 27-52.

(1997) Roman group portraiture: the funerary reliefs of the Late Republic and early Empire. New York, Garland. ISBN 0824027035.

KOCH, Guntram and SICHTERMANN, Hellmut, (1982) Römische Sarkophage. München, Beck. ISBN 3-406-08709-4.

KORRES, Manolis, (1997) "Restoration and reconstruction in antiquity". In: *La integrazione nel restauro dell'antico*, pp. 197-206. Roma.

KÜHN, Hermann, (1960) "Detection and identification of waxes, including Punic wax, by infrared spectrography". In: *Studies in Conservation*, Vol.5, pp. 71-79.

KÅRING, Göran, (1992) När medeltidens sol gått ned. Debatten om byggnadsvård i England, Frankrike och Tyskland 1815-1914. Stockholm, Kungl. Vitterhets Historie och Antikvitets Akademien. ISBN 91-7402-235-0.

LAGERQVIST, Bosse, (1996) The conservation information system. Photogrammetry as a base for designing documentation in conservation and cultural resources management. Göteborg, Acta Universitatis Gothoburgensis. ISBN 9173463027.

LA GRECIA CLASSICA. Milano 1993.

LALLI, Carlo, (1990) "Inquinamento atmosferico: danni alle opere d'arte". In: *Kermes*, no 8, pp. 10-17.

(1999). Analisi sratigrafiche su campioni in sezioni lucide e sezioni sottili. In: *OPD Restauro*, 11, pp. 207-216.

LAMB, T. and BOURRIAU, J., (1995) Colour. Art and science. Cambridge.

LANGE, Bente, (1993) Roms farver. København, Kunstakademiets forlag, Erkitektskolen. ISBN 87-983668-9-0.

LANTERNA, Giancarlo, (1999). L'uso del SEM nella scienza della conservazione. In: *OPD Restauro*, 11, pp. 39-58.

LA ROCCA, Eugenio, (1985) "L'affresco medio-repubblicano dell'Esquilino come riflesso dell'arte "rappresentativa" e come espressione di mobilità sociale". In: *Ricerche di pittura ellenistica*, pp. 161-191.

(1998) "Artisti Rodii negli *horti* romani". In: *Horti romani*, pp. 203-273.

LAURIE, A.P., (1910) Greek and Roman methods of painting: some comments on the statements made by Pliny and Vitruvius about wall and panel painting. Cambridge University Press.

LAURENZI TABASSO, Marisa & MARABELLI, Maurizio, (1989) "Colonna Antonina: inquinamento atmosferico e stato di conservazione". In: *Città inquinata, i monumenti*, pp.119-130.

LAURENZI TABASSO, Marisa & SANTAMARIA, U., (1985) "Consolidant and protective effects on products on Lecce limestone". In: *Proceedings. Vth International congress on deterioration and consolidation of stone*, Lausanne 1985, pp. 697-707.

LAZZARINI, Lorenzo & LAURENZI TABASSO, Marisa, (1986) Il restauro della pietra. Padova, CEDAM. ISBN 8813159587.

LEACH, Eleanor Winsor, (1993) "Patrons, painters and patterns: the anonymity of Romano-Campanian painting and the transition from the second to the third style". In: *Roman art in context*, pp. 133-160.

LEANDER TOUATI, Anne-Marie, (1993) "Endymions gåta". In: *Kongl. Museum*. Rum för ideal och bildning, pp. 71-79. Stockholm.

(1998) Ancient sculpures in the Royal Museum. The eighteenth century collection. Stockholm, Svenska Institutet i Rom. ISBN 9171005676.

LEWIS, Naphtali, (1983) Life in Egypt under Roman rule. Oxford, Clarendon Press.

LIFE IN A MULTICULTURAL SOCIETY. Egypt from Cambyses to Constantine and beyond. Janet H. Johnson, ed. Chicago, Oriental Institute of the University, 1992. ISBN 0918986842.

LINDQVIST, Oliver, MANGIO, Regina, OLSSON, Lars E. and ROSVALL, Jan, (1989) "Uno studio sul deterioramento della pietra: la fontana della Cattedrale a Göteborg". In: *Città inquinata*, pp. 287-304.

LING, Roger, (1991) Roman painting. Cambridge University Press. ISBN 0521306140.

(1997) The insula of the Menander at Pompeii. Vol.1. The structures. Oxford, Clarendon Press. ISBN 0-19-813409-6.

(1999) Stuccowork and painting in Roman Italy. Norfolk, Galliards. (Variorum Collected Studies Series CS649). ISBN 08-86078-9.

LONGAIR, Malcolm, (1996) "Light and colour". In: *Colour: Art and Science*, pp. 65-102.

LUCAS, Alfred, (1962) Ancient Egyptian materials and industries. London, Arnold.

LUGN, Pehr, (1922) Ausgewählte Denkmäler aus egyptische Sammlungen in Schweden. Leipzig.

LYONS, John, (1996) "Colour in language". In: *Colour: Art and Science*, pp. 194-224.

LÖFVENDAHL, Runo, (1991) "Weathering of stone". In: *Air pollution and the Swedish heritage* 1988-1991, pp. 15-20. Stockholm.

MACDONALD, William, L., (1986) The architecture of the Roman Empire. Vol.II. An urban upraisal. New Haven & London, Yale University Press. ISBN 0300028180.

MAIURI, Amedeo, (1931) Pompei. I nuovi scavi e la Villa dei Misteri. Roma.

Pompei, Ercolano a Stabia. Le città sepolte dal Vesuvio. Novara.

MANSUELLI, Guido, (1964) The art of Etruria and early Rome. Holland.

1979. Arte Romana. Pittura - arti minori. Roma, Jouvence. ISBN L5000.

MANZELLI, Valentino, (1994) La policromia nella statuaria greca arcaica. Roma, "L'ERMA" di Bretschneider. ISBN 88-7062-854-X.

MARCONI, Paolo, (1984) "Recenti polemiche sul restauro architettonico: ripristino architettonico o conservazione decadente?" In: *Ricerche di storia dell'arte*, 24, pp. 5-14.

(1984) Arte e cultura della manutenzione dei monumenti. Roma.

(1988) "Raccomandazioni per il restauro delle coloriture delle architture romane e post-rinascimentali". In: *Bollettino dell'Arte*, 47, pp. 105-108.

(1997) "Problemi metodologici e di linguaggio architettonico". In: *La reintegrazione nel restauro dell'antico*, pp. 81-85. Roma.

MARMI ANTICHI. Gabriele Borghini, ed. Ministero per i beni culturali e ambientali, Istituto Centrale per il catalogo e la documentazione. Roma, De Luca 1989. ISBN 88-7813-265-9.

MARTA, Roberto, (1986) Architettura romana. Tecniche costruttive e forme architettoniche del mondo romano. Roma, Edizione Kappa.

MARTIN, Roland, (1993) "La scultura". In: *La Grecia classica*, pp. 97-226.

MARTIN-PATINO, M.T., PARRA, E., GAYO, M.D., MADRUGA, f. & SAAVEDRA, J., (1994) "Artificial paint or patina on the sandstone of the Ramos Gate at the Catedral Nueva in Salamanca, Spain". In: *Studies in Conservation*, 39, pp. 241-249.

MARVIN, Miranda, (1993) "Copying in Roman sculpture: the replica series". In: *Roman art in context*, pp. 161-188.

MASSA, Sandro and PARIBENE, Marcello, (1982) "Il deperimento delle opere d´arte: cause, evoluzione, possibilità di valutazione quantitative". In: *Bollettino d'Arte*, 16, pp. 11-18.

MASSCHELEIN-KLEINER, Liliane, (1995) Ancient binding media, varnisches and adhesives. Roma, ICCROM. ISBN 9290771194.

MASSCHELEIN-KLEINER, Liliane and HEYLEN, JB., (1968) "Analyse des laques rouges ancienne". In: *Studies in Conservation*, 13, pp. 49-86.

MATTEINI, Mauro, (1999). Gli ossalati artificiali nella conservazione dei dipinti murali e dei manufatti lapidei di natura calcarea. In: *OPD Restauro*, 11, pp. 30-38.

MATTEINI, Mauro and MOLES, Archangelo. (1986) "Le patine ad ossalato di calcio sui manufatti in marmo". In: *OPD Restauro del marmo / opere e problemi - opus libri*, pp. 66-73.

(1979) "A preliminary investigation of the unusual technique of Leonardo´s mural "The last supper". In: *Studies in Conservation*, 24, pp. 125-133.

MATTEINI, Mauro and NEPOTI, Maria Rosa, (1999). La spettroscopia di assorbimento in infrarosso nell´indagine sulle opere d´arte. In: *OPD Restauro*, 11, pp. 217-225.

MATTEOLI, Ugo and PASETTI, Adolfo, (1986) "Consolidamento, aggregazione e protezione: il restauro dei manufatti in marmo". In: *OPD Restauro del marmo / opere e problemi - opus libri*, pp. 59-64.

MATTUSCH, Carol C., (1998) "A school, a style or many workshops?" In: *Regional schools in hellenistic sculpture*, pp. 149-156.

MAU, August, (1908) Pompei in Leben und Kunst. Leipzig.

MAYER, Ralph, (1981) The artist´s handbook of materials and techniques. New York, Viking Press. ISBN 0571143318.

MELUCCO VACCARO, Alessandra, (1967) "La policromia nell´architettura e nella plastica antica". In: *Bollettino del Istituto Centrale del Restauro*, pp. 19-32.

(1986) "La legge speciale per Roma: attività di manutenzione e restauro dei monumenti marmorei: nota introduttiva". In: *Bollettino dell'Arte*, 35-36, pp. 179.

(1989) Archeologia e restauro: tradizione e attualità. Milano , Il Saggiatore. ISBN 88-04-31087-1.

MESSINEO, Gaetano, (1986) "La collina della Torre". In: *Bullettino della Commissione Archeologica Comunale di Roma*, 1986/2, pp. 721-732.

(1990) "Prima Porta. La collina della Torre". In: *Bullettino della Commissione Archeologica Comunale di Roma*, 1989-90, pp. 246-255.

(1991) La Via Flaminia: da Porta del Popolo a Malborghetto. Roma, Quasar. ISBN 8871400399.

MEYER-GRAFT, Reinhard and EHRHARDT, Wolfgang, (1997) "Untersuchung der Putzträger und der Malereien in der *Casa delle Nozze d'argento* in Pompeji und präsentation der Ergebnisse aus der sicht des Restaurators und des Archäologen". In: *Roman wall painting*, pp.317-327.

MILLAR, Fergus, (1967) The Roman Empire and its neighbours. London, Weidenfeld & Nicolson. ISBN 68110739.

MILLS, John Stuart and WHITE, Raymond, (1975) "The identification of paint media from the analysis of their sterol composition - a critical view". In: *Studies in Conservation*, 20, pp. 176-182.

(1987) The organic chemistry of Museum objects. Butterworths.

MOLLON, John, (1996) "Seeing colour". In: *Colour: Art and Science*, pp.127-150.

MONTET, Pierre, (1970) Dagligt liv i Ægypten. Köpenhamn.

MOORMAN, Eric M., (1988) La pittura parietale romana come fonte di conoscenza per la scultura antica. Maasricht.

(1998) "La pittura romana fra costruzione architettonica e arte figurativa". In: *romana pictvua*, pp. 14-32.

MORA, Paolo, (1967) "Proposte sulla tecnica della pittura murale romana". In: *Bollettino del Istituto Centrale del Restauro*, pp. 63-84.

(1996) "Conservation of excavated intonaco, stucco and mosaics". In: *Conservation on archaeological excavations*, pp. 91-100.

MORA, Laura, MORA, Paolo, TORRACA, Giorgio and BONITO, Virginia Ann, (1986) "A coordinated methodology for the treatment and study of the peristyle garden wall of the House of Menander, Pompeii". In: *Case studies in the conservation of stone and wall paintings*, pp. 38-43.

MORENO, Maria Antonia, DE LUXÁN, Maria Pilar and DORREGO, Fernando, (1997) "The conservation and scientific investigatins of the wall paintings in the Roman thermes, Campo Valdés, Gijón, Spain". In: *Roman wall painting*, pp. 297-306.

MUNTHE, Axel (1953) Boken on San Michele. Malmö.

MURRELL, Vernon J., (1971) "Some aspects of the conservation of wax models". In: *Studies in Conservation*, Vol. 16, pp. 95-109.

NARDI, Roberto, (1986) "Conservation of the arch of Septimus Severus: work in progress". In: *Case studies in the conservatuion of stone and wall paintings*, preprints of the contribution to the Bologna congress, 21-26 September 1986.

NODELMAN, Sheldon, (1993) "How to read a Roman portrait postscript". In: *Roman art in context*, pp. 10-25.

NONFARMALE, Ottorino, (1981) "A method of consolidation and restoration for decayed sandstones". In: *The conservation of stone. Preprints of the contributions to the international symposium, Bologna 27-30 October 1981*, pp. 401-410.

NORDBLADH, Jarl and ROSVALL, Jan, (1975) "Documentation as part of the research process. Some considerations actualized by the application of photogrammetric measuring techniques in history of culture". In: *Norvegian Archaeological Review*, 8:1, 1975, pp. 54-62.

NORMAN, Mark, (1988) "Early conservation techniques and Ashmolean". In: *Conservation of Ancient Egyptian materials*, pp.7-17.

OLIV, Josef, (1957) Axel Munthes liv och verk. In: *Boken om Axel Munthe, Capri och San Michele*. Allhems, Förlag, Malmö.

ORTOLANI, Giorgio, (1989) "Lavorazione di pietre e marmi nel mondo antico". In: *Marmi antichi*, pp. 18-42.

PAGANO, Mario, (X) "Metodologia dei restauri borbonici a Pompei ed Ercolano". In: *Rivista di studi Pompeiani*, 1991-92, pp. 169-191.

(1994) "Una legge ritrovata: Il progetto di legge per il riordinamento del R. Museo di Napoli e degli scavi di antichità del 1848 e il ruolo di G. Fiorilli". In: *Il Museo Borbonico nel 1848*, pp. 351-414.

PALAZZI, Sergio, (1997) Analisi chimica per l'arte e il restauro. Fiesole, Nardini Editore. ISBN 88-404-4042-9.

PAOLETTI, D. & SCHIRRIPA SPAGNOLI, G., (1995) "The potential of portable TV holography for examining frescoes *in situ*". In: *Studies in Conservation*, 40, pp.127-132.

PANICHI, Roberto, (1977) I principi della pittura figurativa nelle testimonianze degli artisti e degli scrittori antichi. Pisa.

PARIS, Rita, (1998) "Le testimonianze pittoriche a Roma". In: *romana pictvra*, pp.73-84.

PARLASCA, Klaus, (1966) Mumienporträts und verwandte Denkmäler. Wiesbaden, Steiner.

(1969) Ritratti di mummie, vol I. In: *Repertorio d'arte dell'Egitto greco-romano*, serie B. Roma, "L'ERMA" di Bretschneider. ISBN 8870628108.

(1977) Ritratti di mummie, vol II. In: *Repertorio d'arte dell'Egitto greco-romano*, serie B. Roma, "L'ERMA" di Bretschneider. ISBN 8870628108.

(1980) Ritratti Di mummie, vol III. In: *Repertorio d'arte dell'Egitto greco-romano*, serie B. Roma, "L'ERMA" di Bretschneider. ISBN 8870628108.

(1997) "Mummy portraits: Old and new problems". In: *Portraits and masks*, pp. 127-130.

(1999) "Bedeutung und Problematik der Mumienporträts und ihr kulturelles Umfeld". In: *Augenblicke*, pp. 23-48.

PAVESE, Monica and THOMASSON, Bengt E. ((1997) A survey of Greek and Latin inscriptions on stone in Swedish collections. Stockholm.

PENSABENE, Patrizio, (1989) "Amministrazione dei marmi e sistema distributivo nel mondo romano". In: *Marmi antichi*, pp. 43-53.

PETRIE, W. M. Flinders (1886) Naukratis, part 1., 1884-5). London, Trübner & Co.

(1898) Deshasheh. London, Gilbert and Rivington.

(1911) Roman portraits and Memphis IV. London, School of archaeology in Egypt.

(1912) The Hawara portfolio, paintings of the Roman age. London, School of archaeology in Egypt.

(1913) Tarkhan I and Memphis V. London, School of archaeology in Egypt.

PETRONIUS (1966) Satyricon. Faber Förlag, Stockholm. ISBN 91-7842-194-2.

PILCH, Jennifer and WHITE, Raymond, (1995) "The application of FTIR-microscopy to the analysis of paint binders in easel painting". In: *National Gallery Technical Bulletin*, vol 16, pp. 73-84.

PIVA, Gino, (1964) Manuale pratico di tecnica pittorica. Milano.
(1966) L´arte del restauro. Milano.
PLINIUS, Naturalis Historia. Translated in Italian by Ferri, Silvio. *Plinio il Vecchio*. Roma 1956.
Naturalis Historia. Translated in English by H. Rackham, M.A. Cambridge 1952. (1st. edition 1945).
POHL, Ingrid, (1983) Ostia, Roms hamnstad. Göteborg, Paul Åström. ISBN 91-86098-12-8.
POLLITT, J. J., (1966) The art of Rome c.753 B.C. - A. D. 337: sources and documents. Englewood Cliffs, Prentice Hall. ISBN 0-521-27365-X.
POMPEI 1748 - 1980: i tempi della documentazione: Foro Romano, Curia Senatus, luglio - settembre 1981, Pompei Antiquarium. Istituto Centrale del catalogo e della documentazione & Soprintendenza Archeologica delle regione di Napoli e Caserta & Soprintendenza Archeologica di Roma. 1981.
PORTRAITS AND MASKS: burial customs in Roman Egypt. Morris Bierbrier, ed. London, British Museum Press, 1997. ISBN 0714119040.
POULSEN, Erik, (1978) "Kunsten i Pompeji". In: *Lousiana revy*, pp. 24-28.
POULSEN, Vagn, (1949) Fidias. Stockholm, Norstedts.
PRICE, Clifford, (1987) "The consolidation of limestone using a lime poultice and limewater". In: *Natursteinkonservierung*, pp. München.
PRICE, C.A., (1996) Stone conservation. An overview of current research. USA.
PREUSSER, Frank, (1985) "A preliminary report on the possibility of using bleached beeswax to improve the resolubility of picture varnishes based on polycyclohexanones". In: *Studies in Conservation*, 30, pp. 143-144.
First report on analyses of samples. (Tomb of Nefertari). Unpublished report, Getty Conservation Institute.
RAFT, Karen, (1985) "A preliminary report on the possibility of using bleached beeswax to improve the resolubility of picture varnishes based on polycyclohexanones". In: *Studies in Conservation*, 30, pp. 143-144.
RAMER, Brian, (1979) "The technology, examination and conservation of the Fayum portraits in the Petrie Museum". In: *Studies in conservation*, 24, pp. 1-13.
REGIONAL SCHOOLS IN HELLENISTIC SCULPTURE. Proceedings of an international conference held at the American School of Classical Studies in Athens, March 15-17, 1996. Oxford, Oxbow. ISBN 1900188457.
REIFSNYDER, Joan Marie, (1996) "A note on a traditional technique of varnish application for paintings on panel". In: *Studies in conservation*, Vo 41. nr. 2, pp. 120-122.
REUTERSWÄRD, Patrik, (1966) Studien zur polykromie der plastik, Griechenland und Rom: untersuchungen über die Farbwirkung der Marmor-und Bronzeskulpturen. Stockholm, Svenska Bokförlaget.
RICHTER, Gisela M.A., (1928) "Were the nude parts in Greek sculpture painted?" In: *Metropolitan Museum Studies*, Vol.1, 1928-29, pp. 25-31.
(1948) Roman portraits. New York, The Metropolitan Museum of Arts.
(1955) Ancient Italy. A study of the interrelations of its people as shown in their arts. Ann Arbor, University of Michigan Press.
RICKERBY, Stephen, (1993) "Original painting techniques and materials used in the tomb of Nefertari". In: *Art and eternity*, pp. 43-54.
RICERCHE DI PITTURA ELLENISTICA. Letture e interpretazione della produzione pittorica dal IV secolo a.C. all´ellenismo. Edizione Quasar, Roma. 1985. ISBN 0885020666.
RISCOPRIRE POMPEI. Museo Capitolini, Palazzo dei Conservatori, 13 bnovembre 1993 - 12 febbraio 1994. Roma, "L´ERMA" di Bretschneider, 1993. ISBN 80-7062-844-2.
ROBERTS, Paul C., (1999) "Suche im Sand. Der archäologische Kontext der englischen Entdeckung von Mumienporträts im Fayum am Ende des neunzehnten und Beginn des zwanzigsten Jahrhunderts". In: *Augenblicke*, pp. 49-70.
ROMANA PICTURA: la pittura romana dalle origine all´età bizantina. Angela Donati, ed. Milano, Electa 1998.
ROMAN ART IN CONTEXT: an anthology. Eve D´Ambra, ed. Englewood Cliffs, N.J. Prentice Hall 1993. ISBN 0137818084.
ROMAN ART IN THE PRIVATE SPHERE: new perspectives on the architecture and decor of the domus, villa and insula. Elaine K. Gazda, ed. Ann Arbor, University of Michigan Press, 1991.
ROMAN CRAFTS. Donald Strong & David Brown, ed. London, Duckworth, 1976. ISBN 0-7156-0781-2.

ROMAN PUBLIC BUILDINGS. Ian M. Barton, ed. Exeter Studies in History, 1989. ISBN 0859892395.
ROMAN WALL PAINTING: materials, techniques, analyses and conservation. Proceedings of the International workshops, Fribourgh 7-9 March 1996. Hamdallah Béarat, ed. Fribourgh, Institute of Mineralogy and Petrography, 1997. ISBN 2970013207.
ROSA, Leone Augusto, (1949) La pittura romana. Milano.
ROSENBERG, Silvia, (1997) "Pigments and fresco fragments from Herod's palace at Jeriko". In: *Roman wall painting*, pp. 63-74.
ROSVALL, Jan, (1972) "An attempt at a framework for visual analysis of rock art". In: *Acts of the International symposium on rock art*. Lectures at Hankø 1972, pp. 211-224.
ROSVALL, Jan, ENGELBREKTSSON, Nanne, LAGERQVIST, Bosse and VAN GIGCH, John P., (1995) "International perspectives on strategic planning for research and education in conservation". Paper presented at Convegno internazionale di studi "Giovanni Secco Suardo. La cultura del restauro tra tutela e conservazione dell'opere d'arte. Bergamo 9-11 March 1995.
ROSVALL, Jan and LAGERQVIST, Bosse, (1992) "Techniques of restoration: urban development and conservation - an unsolvable conflict?" Special report presented at the 7th European Symposium of Historic towns organized by the Standing Conference of Local and Regional Authorities of Councel of Europe, Istanbul 16-18 September 1992.
ROY, Gillian, (1997) "The conservation of the portraits and associated antiquities". In: *Ancient faces*, pp. 25-28.
RYDBERG, Victor, (1891) "Porträttfynden i Faijum". In: *Nordisk tidskrift för vetenskap, konst och industri*, no. 4, 1891, pp. 1-13.
SACK, Suzanne and STOLOW, Nathan, (1978) "A microclimate for a Fayum Portrait". In: *Studies in Conservation*, 23, pp. 47-57.
SALVETTI, Carla, (1998) "Il colore dell'anticità". In: *romana pictvra*, pp. 85-92.
SANNUCCI, P., (1961) Tecnica di esecuzione e dei distacchi degli affreschi di età Romana. Milano.
SCAGLIARINI CORLÀITA, Daniela, (1998) "La pittura parietale nelle *domus* e nelle *villae* del territorio Vesuviana". In: *romana pictvura*, pp. 57-64.
SCHEFOLD, Karl, (1962) Vergessenes Pompeji. Bern.
SCHIAVI, Elena, (1961) Il sale della terra. Milano, Hoepli.
(1961) "Ritrovamenti della tecnica pittorica dell'encausto". In: *Atti del congresso di archeologia classica*, Vol.1, pp. 155-158.
SCRIATTOLI, Andrea, (1988) Viterbo nei suoi monumenti. Viterbo.
SEAR, Frank. (1988) Roman architecture. London, Routledge. ISBN 0-415-200093-8.
SEAWARD, and GIACOBINI, (1989) "Oxalate incrustation by the lichen Dirina Massiliensis forma Soriedato, and its role in the deterioration of works of art". In: *Le pellicole ad ossalati: origine e significato nella conservazione delle opere d'arte*, Atti del convegno, Milano 25-26 ottobre 1989.
SECCO-SUARDO, Giovanni, (1927) Il restauratore dei dipinti. Milano.
SILVESTRI, Silvia.
Studio, restauro e valorizzazione dalla decorazione superficiale. Progetto Palazzo Calabresi. Unpublished project paper. Viterbo 1998.
SKYDSGAARD, Jens Erik, (1982) Pompeji: en romersk landsortsstad. Uddevalla, Zinderman. ISBN 91-528-0384-8.
SMITH, R.R.R., (1998) "Hellenistic sculpture under the Roman Empire: Fischermen and satyrs at Aphrodisias". In: *Regional schools in Hellenistic sculpture*, pp. 253-259.
SPEIDEL, Michael P., (1999) "Bildnisse römscher Officiere aus dem Fayum". In: *Augenblicke*, pp. 87-88.
STAJKOWSKI, Alexandra, (1997) "Untersuchung, Konservierung und reapplikation eines Wandmalerei-fragments". In: *Roman wall painting*, pp. 289-295.
STANIFORTH, Sarah, (1985) "Retouching and colour matching: the restorer and metamerism". In: *Studies in conservation*, Vol.30, pp. 101-111.
STEMMER, Klaus (1992) Häuser in Pompeji; Casa del Ara massima (VI 16, 15-17). München, Hirner Verlag. ISBN 3-7774-5820-1.
STROCKA, V.M., (1980) "Case di Pompei. Un programma di documentazione archaeologica dell'istituto Archaeologico Germanico di Berlino". In: *Pompei 1748-1980*, pp. 88-93.
(1984) Häuser in Pompeji; casa del Principe di Napoli (VI 15, 7-8). Tübingen, Verlag Ernst Wasmuth. ISBN 3-8030-1032-2.
(1991) Häuser in Pompeji; Casa del Labirinto (VI 8-10). München, Hirner Verlag. ISBN 3-7774-5130-4.

STRONG, Donald, (1976) Roman art. Harmondsworth, Middlesex, Penguin Books. ISBN 0140560394.

STULIK, Dusan, PORTA, Eduardo and PALET, Antoni, (1993) "Analyses of pigments, binding media, and varnishes". In: *Art and eternity*, pp. 55-66.

SUETONIUS, Gaius S. Tranquillus, De vita Caesarum. The lives of the Caesars. Translated in English by John C. Rolfe. London 1960. (First edited in 1913).

De Vita Caesarum. The lives of the twelve Caesars. Transllated in English by Alexander Thomson. London 1893.

TALAMO, Emilia, (1998) "Gli horti di Sallustio a Porta Collina". In: *Horti romani*, pp. 113-169.

TAYLOR, G.W., (1983) "Detection and identification of dyes on Anglo-Scandinavian textiles". In: *Studies in conservation*, 28, pp. 153-160.

TAYLOR, John, (1997) "Before the portraits: Burial practices in Pharaonic Egypt". In: *Ancient faces*, pp. 9-13.

TEUTONICO, Jeanne Marie, (1988) A laboratory manual for architectural conservators. Roma.

THOMASSON, Bengt E., (1983) Qualis vetus Roma fuit. Antika texter till Roms byggnadshistoria. Göteborg.

THIEM, Gunther and Christel, (1964) Toskanische fassadendekorationen in Sgraffito und Fresko, 14. bis 17. jahrhundert. München, F. Bruckmann.

THYLANDER, Hilding (1964) Inscriptions Latines de San Michele d´Axel Munthe. In: *Opuscula Romana*, V. Lund.

TIANO, Piero, (1979) "Antialgal effect of some chemicals on exposed stoneworks". In: *Deterioramento e conservazione della pietra*. Atti del 3° congresso internazionale, Venezia 24-27 ottobre 1979.

(1991) "Problemi biologici nella conservazione del patrimonio culturale". In: *Kermes*, no.10, pp. 56-73.

TORRACCA, Giorgio, (1986) "Momenti nella storia della conservazione del marmo. Metodi e attitudine in varie epoche". In: *OPD Restauro del marmo / opere e problemi - opus libri*, pp. 32-45.

(1988) Porous building materials. Materials science for architectural conservation. Roma. ISBN 92-9077-029-5.

(1989) "Il volto della città". In: *Città inquinata, i monumenti*, pp. 33-42.

URBANI, Giovanni, (1982) "La scienza e l´arte della conservazione". In: *Bollettino d'Arte*, 16, pp. 7-10.

(1984) "Scienza e teoria del restauro: Una riflessione filosofica sul tema delle contraddizioni tra conservazione e ripristino". In: *Bollettino dell'Arte*, 24, pp. 15-17.

VAN GIGCH, John P., (1991) System design modeling and metamodeling. New York, Plenum. ISBN 0-306-43740-6.

VARONE, Antonio, (2000). Pompei, i misteri di una città sepolta. Storia e segreti di un luogo in cui la vita si è fermata duemila anni fa. Newton and Compton, Roma. ISBN 88-8289-397-9.

VARONE, Antonio and BEARAT, Hamdallah, (1997) "Pittori romani al lavoro. Materiali, stumenti, tecniche: evidenze archeologiche e dati analitici di un recente scavo pompeiano lungo via dell´Abbondanza (Reg. IX ins.12)". In: *Roman wall painting*, pp. 199-214.

VILLARD, François, (1993) "Pittura e ceramica". In: *La Grecia classica*, pp. 227-333.

VITRUVIUS, De architectura. Translated in Italian by Ferri, Silvio. *Vitruvio. De architectura*. Roma 1960.

De architectura. Translated in Swedish by Dalgren, Birgitta. *Vitruvius. Om arkitektur*. Stockholm 1989.

VON GRAEVE, Volkmar, (1985) "Marmorbilder aus Herculaneum und Pompeji". In: *Ricerche di pittura ellenistica*, pp. 227-256.

(1985) "Le stele di Demetrias". In: *Ricerche di pittura ellenistica*, pp. 197-198.

VON GRAEVE, Volkmar and PREUSSER, Frank, (1981) "Zur Technik griechischer Malerei auf der Marmor". In: *Jahrbuch des Deutschen Archäologischen Instituts*, band 96, pp. 120-156.

VON HELAND, Madeleine, (1963) Grekisk och romersk antik. Stockholm.

WALKER, Susan, (1991) Roman art. London, The Trustees of the British Museum by British Museum Press. ISBN 0714120766.

(1997) "Mummy portraits and Roman portraiture". In: *Ancient faces*, pp. 14-16.

(1999) "Porträts auf Leichentüchern aus Antinoopolis. Einige Anmerkungen zu Kleidung und Datierung". In: *Augenblicke*, pp. 74-78.

WALLACE HADRILL, Andrew, (1994) Houses and society in Pompeii and Herculaneum. Princeton, New Jersey University Press. ISBN 0691069875.

(1995) Horti and hellenization. In: *Horti Romani*, pp. 1-12. Roma.

WALLERT, Arie, (1979) "Unusual pigments on a Greek marble basin". In: *Studies in Conservation*, 24, pp.1-13.
WALLERT, Arie and ELSTON, Maya, (1997) "Fragments of Roman wall painting in the J. Paul Getty Museum: a preliminary technical investigation". In: *Roman wall painting*, pp. 93-104.
WARD PERKINS, John B., (1970) Etruscan and Roman architecture. Harmondsworth, Middlesex.
WATKINS, Sarah, (1988) In: *Conservation of Ancient Egyptian materials*, pp.
WATKINSON, David and BROWN, Jonathan, (1995) "The conservation of the polychrome wooden sarcophagus of Praise Mut". In: *Conservation in Ancient Egyptian Collections*, pp. 37-47.
WELLS, Colin, (1984) The Roman Empire. Glasgow. ISBN 0006862527.
WHEELER, Mortimer, (1969) Roman art and architecture. New York.
WHITE, Raymond, (1978) "The application of gas chromatography to the identification of waxes". In: *Studies in Conservation*, Vol. 23, pp.57-68.
WILKS, Helen, (1996) Science for conservators, vol.2, cleaning. London and New York, The Conservation Unit of the Museums & Galleries Commission. ISBN 0-415-07165-8.
WITTGENSTEIN, Ludwig, (1996) Anmärkningar om färger. Stockholm.
WOLDERING, Irmgard, (1962) Egyptens konst. Malmö.
WOLTERS, Wolfgang, (1988) "Cosa chiede lo storico ad un restauro". In: *Bollettino d'Arte*, 47, pp. 19-21.
WOMEN'S SOCIETY IN GREEK AND ROMAN EGYPT. Jane Rowlandson, ed. Cambridge 1998.
ZANARDI, Bruno, (1982) "Il restauro tra teoria, scienza e prassi". In: *Bollettino d'Arte*, 16, pp. 19-21.
ZANDER, Giuseppe, (1993) Scritti sul restauro dei monumenti architettonici. Roma.
ZANKER, Paul, (1988) The power of images in the age of Augustus. Ann Arbor, University of Michigan Press. ISBN 0-472-10101-3.
(1998) Pompeii. Public and private life. London & Cambridge, Ma., Harvard University Press. ISBN 0674689674.
ZEVI, Fausto, (1980) "La storia degli scavi e della documentazione". In: *Pompei 1748-1980*, pp. 11-21.
ØRSTED, Peter (2000). Gaius Julius Caesar. Politik och moral i det romerska imperiet. Bokförlaget Nya Doxa, Falun. ISBN 91-578-0344-7.

APPENDICES

APPENDIX I

Ancient literary sources

The original passages included in this study, consist mainly of rather lengthy descriptions of the encaustic techniques and of preparation for mural painting, often referred to in publications concerning ancient Greek and Roman art. In most cases, only fragments of the original text are presented, often only one sentence. It is rather unsatisfactory not to know the context from which a quoted line has been brought, and therefore some important passages are presented in this part. The objective, is to make it possible to understand the original lines in their context, examining if some valid information is, or is not, lost when a line is presented separately. Some interest will also be given to different ways in which the original texts have been interpreted historically, since various translations and interpretations are available. The intention is not to present a complete survey on this matter, but rather to take note of these texts, since they are important issues regarding *encausto*.

The Latin text by Pliny presented in this study comes from "Plinio il Vecchio" by Silvio Ferri, who presents a Latin manuscript together with a translation into Italian. The same parts of the Plinian texts have been confronted with the translations into German, presented by Ernst Berger and the translation into English presented by A.P. Laurie,[1] who both refer to the edition of Pliny's Natural History, edited by Carl Mayhoff in 1899. Berger refers to the same edition, when discussing the specific problem regarding Plinius XXXV, 149. In some cases comparisons have been made between Italian and English translations. The English translation of the passages, quoted from Vitruvius' De Architectura, are from Laurie, who used the late edition by Rose from 1899.[2] This version has partly been compared to the same passage of the Italian translation by Aletti, and also to the text presented by Mora.[3]

[1] Ferri, 1960; Berger, 1904; Laurie, 1910.

[2] Laurie, 1910, pp. 72-77.

[3] Aletti, 1951, pp. 55-56; Mora, 1967, pp. 73-84.

PLINIUS, NH XXXV, 149

Encausto pingendi duo fuere antiquitus genera, cera et in ebore cestro, id est vericulo, donec classes pingi coepere. Hoc tertium accessit resolutis igni ceris penicillo utendi, quae pictura navibus nec sole nec sale ventisque corrumpitur.

"In ancient times there were two methods of encaustic painting, with wax and on ivory with the cestrum, that is with a sharp pointed tool, until it became the custom to paint ships of war. Then the third method was added, that of melting the wax colours with fire and laying them on with a brush. This kind of painting applied to ships is not injured by sun, wind or salt water."

Comments

Berger, is adding the word *genus* in the second phrase, which becomes "Hoc tertium *genus* accessit...", and he adds the word *only* into the translation "...there were *only* two methods...". The versions by Ferri and Laurie do not include the word *genus*. There is also a difference in the spelling of *ventisque* (Ferri) and *ventisve* (Berger and Laurie). It must be pointed out that Pliny mentions all three techniques as encaustic. Consequently it seems that the term encausto, already during Antiquity, had lost its original significance and was used as synonymous to wax-painting.

PLINIUS, NH XXXV, 122

Ceris pingere ac picturam inurere quis primus excogitaverit, non constat. Quidam Aristides inventum putant postea consummatum a Praxitele, sed aliquanto vetustiores encaustae picturae exstitere, ut Polignoti et Nicanoris ac Mnasilai Pariorum. Elasippus quoque Aeginae picturae suae inscripsit ξνεκαεν quod profecto non fecisset nisi encaustica inventa.

"It is not agreed who first thought of painting with wax colours and making a picture by heat. Some think the art was invented by Aristides and afterwards brought to perfection by Praxiteles. But there are in existence encaustic pictures of a date somewhat earlier than theirs, such as those by Polygnotos, and by the Parians Nicanor and Mnesilaus. Elasippus also wrote on his pictures at Aegina ξνεκαεν, which he certainly would not have done unless encaustic painting had been invented."

Comments

In this passage great difference occurs in the texts by Laurie and Ferri respectively. Laurie´s translation "...painting with wax colours and making a picture by heat...", is in Ferri´s version "...painting with wax and passing over it with fire..." (dipingere cioè a cera passandovi sopra il fuoco). In Ferri´s version it is stressed that heat was the principal force for making the wax-painting, while Ferri suggests that heat was used after the painting was made, i.e. as a secondary act. Heat is mentioned by Vitruvius as the final treatment in the *ganosis* process, and was intended for melting the thin wax layer and make it form a smooth and uniform surface.

PLINIUS, NH, XXXV 49

Ex omnibus coloribus cretulam amant udoque illini recusant purpurissum, Indicum, caeruleum, Melinum, auripigmentum, Appianum, cerussa. Cerae tinguntur iisdem his coloribus ad eas picturas, quae inuruntur, alieno parietibus genere, sed classibus familiari, iam vero et onerariiis navibus, quoniam et pericula expingimus, ne quis miretur et rogos pingi, iuvatque pugnaturos ad mortem aut certe caedem speciose vehi.

"Of all the colours those which love chalk ground and refuse to be laid on a damp surface are purpurissum, indigo, caeruleum, Melian white, orpiment, Appianum, and white lead. Waxes are stained with these same colours for painting in encaustic, a kind of painting unsuitable for walls, but commonly used for ships of war, and now also for merchant ships. Since we paint even those vehicles of danger, no one should be surprised if we also paint our funeral piles, and like to have gladiators conveyed in splendid carriages to death or at least to carnage."

Comments

In this passage there are differences in the Latin texts by Berger and Ferri respectively. The version chosen in this text is by Ferri. *illini* by Ferri is *inlini* by Berger; *tinguntur* by Ferri is *tinguuntur* by Berger; *iisdem* by Ferri is *isdem* by Berger.

The interpretation of what Pliny wrote differs somewhat. Where Laurie states that encausto is "unsuitable for walls", Ferri says it is "...a technique little used for wall-paintings...", (è una tecnica poco usata nelle pitture parietali). Since this statement refers to the third method of encaustic painting, i.e. with Punic wax, it was not intended as a description of a method unsuitable for walls, since the pigments mentioned at the beginning were coated with Punic wax on wall-paintings, and that is also what is stated in this passage.

PLINIUS, NH XXXIII, 40

Inlito solis atque lunae contactus inimicus. Remedium, ut parieti siccato cera Punica cum oleo liquefacta candens setis inducatur iterumque admotis gallae carbonibus inuratur ad sudorem usque, postea candelis subigatur ac deinde linteis puris, sicut et marmora nitescunt.

"When laid on, the exposure to sun and moon is harmful. The remedy is: When the wall is dry spread on it with a brush melted Punic wax mixed with oil and glowing hot, and again heat to sweating point by placing gall-apples near it, afterwards rub it with candles and then with clean linen cloths as marble is made to shine."

Comments

This description of the *ganosis* process can be compared to the one made by Vitruvius on the same subject, which is presented next.

VITRUVIUS, De architectura VII, 9, 3

At si qui subtilior fuerit et voluerit expolitionem miniaceam suum colorem retinere, cum paries expolitus et aridus fuerit, ceram ponticam igni liquefactum paulo oleo temperatam saeta inducat, deinde postea carbonibus in ferreo vase compositis eam ceram a proximo cum pariete calefaciundo sudare cogat, atque ut peraequetur deinde tunc candela lintesque puris subigat, uti signa marmorea nuda curantur Haec autem ξνεκαεν graece dicitur. Ita obstans cerae pontiaque lorica non patitur nec lunae splendorem nec solis radios lambendo eripere ex his politionibus colorem.

"But a more discerning person, who wishes his vermilion decoration to keep its colour, should, when the wall is well polished and dry, lay on with a stiff brush Pontic wax melted in the fire and tempered with a little oil, then bringing an iron pan of glowing coals near to the wall, he must heat both it and the wall and make the wax sweat, and thereafter, to make the surface even, he must rub it with a candle and clean linen cloths, as nude marble statues are treated. This process is called ganosis by the Greeks. The coat of Pontic wax being in front does not allow the play of the sun´s rays or the sheen of the moon to take away the colour from such decorations."

Comments

The text and translation presented above is by Laurie. In this version Punic wax is translated Pontic wax, *ceram ponticam*, from the Pontic area, i.e. south of Rome. Aletti writes Punic wax, *cerae punicae*, i.e. from the Punic territory. It seems that in earlier editions of Vitruvius the term used was *punicam*, a word substituted by the words *pumicam* or *pomicam* in later editions. The process, however, was the same.

VITRUVIUS, De architectura VII, 3.

Coronis explicatis, parietes quam asperrime trullissentur; postea autem supra trullissatione subarescente, deformentur directiones harenati, uti longitudines ad regulam et ad lineam, altitudines ad perpendiculum, anguli ad normam respondentes exigantur. Namque sic emendata tectoriorum in picturis erit species. Subarescente, iterum et tertio inducator. Ita cum fundatior erit ex harenato directura, eo firmior erit ad vetutastem soliditas tectorii. Cum ab harena praeter trullisationem non minus tribus coriis fuerit deformatum, tunc e marmore graneo directiones sunt subigendae, dum ita materies temperetur uti cum subigatur non haereat ad rutrum, sed purum ferrum e mortario liberetur. Graneo inductu et inarescente, alterum corium mediocre dirigatur. Id cum subactum fuerit et bene fricatum, subtilus inducatur. Ita cum tribus coriis harenae, et item marmoris solidati parietes fuerint, neque rimas neque aliud vitium in se recipere poterunt. Sed et liaculorum subactionibus fundata soliditate marmorisque candore firmo levigata, coloribus cum politionibus inductis nitidos experiment splendores.

Colores autem, udo tectorio cum diligenter sunt inducti, ideo non remittunt sed sunt perpetuo permanentes, quod calx in fornacibus excocto liquore facta raritatibus evanida, ieiunitate coacto corripit in se quae res forte contigerunt, mixtionibusque ex aliis potestatibus conlatis seminibus seu principiis una solidescendo, in quibuscumque membris est formata cum fit arida redigitur uti sui generis proprias videatur habere qualitates. Itaque tectoria quae recte sunt facta necue vetustatibus fiunt horrida, neque cum extergentur remittunt colores, nisi si parum diligenter et in arido fuerint inductu. Cum ergo ita in parietibus facta fuerint uti supra scriptum est, et firmitatem et splendorem et ad vetustatem permanentem virtutem poterunt habere. Cum vero unum corium harenae et unum minuti marmoris erit inductum, tenuitas eius minus valendo faciliter rumpitur nec splendorem politionibus propter imbecillitatem crassitudinis proprium obtenebit. Quaemadmodum enim speculum argentum tenui lamella ductum incertas et sine viribus habet remissiones splendoris, qoud autem e solida temperatura fuerit factum, recipiens in se firmis viribus politionem fulgentes in aspectu certasque considerantibus imagines reddit, sic tectoria quae ex tenui sunt ducta materia non modo sunt rimosa, sed etiam celeriter evanescunt, quae autem fundata harenationis et marmoris soliditate sunt crassitudine spissa, cum sunt politionibus crebris subacta, non modo sunt nitentia, sed etiam imagines expressas aspicientibus ex eo opere remittunt. Graecorum vero tectores non solum his rationibus utendo faciunt opera firma, sed etiam mortario conlocato, calce et harena ibi confusa, decuria hominum inducta, ligneis vectibus pisunt materiam, et ita ad certamen subacta tunc utundur. Itaque veteribus parietibus nonnulli crustas excidentes pro abacis utundur, ipsaque tectoria abacorum et specolorum divisionibus circa se prominentes habent expressiones.

"When the cornices are finished, the walls are to be trowelled as roughly as possible, and thereafter, when the trowelling is somewhat dry, over it the directions of the sand-mortar are to be so traced out, that in length it must be true by the rule, in height by the plumbline, and the angles by the square. For thus the surface of the plaster will be faultless for pictures. When this (first coat) is slightly dry, a second is to be laid on, and then a third. The firmer and sounder the lying on of the sand-mortar, the more solid and durable will the plasterwork be. When besides the trowelling not less than three coats of sand have been set out, applications of marble-dust are to be used. This stuff is to be so tempered that in the spreading it does not stick to the trowel, but the iron comes out of the mortar clean. A coat of marble dust having been laid on and getting dry, another rather thin coat is to be applied. When this has been beaten and well rubbed, another still finer is to be put on. Thus with three coats of sand and as many of marble, the walls are so firm that they cannot crack or become defective in any way. And moreover, solidity being secured by rubbing with planes, and smoothness from the hardness and sheen of the marble, the walls will give out with great brilliance colours applied with polishing. For colours when they are carefully laid on damp plaster, do not get loose, but are forever permanent, for this reason, that the lime, losing all its moisture in the kiln, is so dry and porous that it readily imbibes whatever chances to touch it, and solidification taking place from the mixtures of the various potentialities whose elements or first principles are brought together, the resulting substance of whatever it is composed, when it becomes dry, is such that it seems to have special qualities peculiar to itself. Thus plaster-work which is well executed neither becomes rough from age nor when it is washed does it give up the colours unless they have been laid on carelessly and on a dry surface. If, therefore, plaster-work on walls is carried out as above described, it will be firm, lustrous and very durable. But when only one coat of sand and one of marble dust are used, its thinness renders it liable to be easily broken, nor can it take on a proper brilliance from the polishing owing to its lack of substance. For just as a silver mirror when made from a thin plate gives back a wavering and uncertain image, but if made from a plate of solid temper takes on a high polish and reflects to the spectators bright and faultless images, so plastering, when its substance is thin, is not only full of cracks but also quickly decays, while that which is firmly compacted of sand-mortar and marble, when it has been rubbed with many polishing, is not only glistering but also clearly reflects to the spectators the images falling on it. Greek plasterers, indeed, use not only the above methods to make their work firm, but also putting the lime and sand together in a mortar, they have it thoroughly pounded with wooden staves by a number of men, and use it after it is so prepared. Hence from their old walls people can cut out slabs and use them as panels, and those plaster slabs so cut out for panels and mirrors have fillets in reliefs round them."

Comments

In the seventh book of De architectura, Vitruvius is describing the way of making concrete floors, the preparation of lime, the plastering of arches and cornices and then he proceeds with the description of how to prepare the walls. This part is quoted by any author who is concerned with the matters of Greek and Roman painting and architecture. The Vitruvian text quoted by Aletti, seems to be the earlier edition of Rose, while Laurie refers to the second one. Obvious differences can be noticed. The original Latin script differs to some extent and such differences in the first part of the document have been indicated. *Line number* refers to the number of the line in the quoted Latin text.

Line	*Aletti:*	*Laurie:*
2	ut longitudines	uti longitudines
5	ac tertio	et tertio
4	ita quo fundatior	ita cum fundatior
6	cum ab arena non minus tribus	Cum ab harena praeter trullissationem non minus tribus
7	marmoreo grano	marmore graneo
8	subigutur	subigatur
9	mediocrius	mediocre
11	potetunt	poterunt
11	baculorum	liaculorum
11	fundatae	fundata
12	soliditates	soliditate
12	laevigatae	levigata

Mora presents a Latin text that mainly is equal to that of Aletti. These two authors use the same word *baculorum*, "beaters" which is somewhat different to *liaculorum*, smoothing planes. The tool intended is, however, the same, the plasterer´s trowel.

As can be noted there are some differences in the Latin text in this passage, a fact indicating that variations occur in the transcriptions, which inevitably lead to differences in interpretations. Since not only one single original Latin script exists, but many, it is necessary to make a choice of which one to rely on, or to quote. There are, of course, many more translations to study, if the objective would be to make an in-depth linguistic study, which however has not been the intention of this limited study. As mentioned before, the objective rather is to point out some reasons for existing obscurities.

APPENDIX II

Case Study 3: San Lorenzo in Lucina

Inventory

Characteristics of the fragments investigated

At the beginning of this investigation, all fragments within each stratigraphical unit were counted and briefly described.

Fragments from level 44
2 pieces. 1 white monochrome, 1 white with a red (ochre) stripe.
The stucco layers are 10-12 mm, with a 2mm ultimate layer.

Fragments from level 80
135 pieces. 19 monochrome bright red (cinnabar?), 44 bright red (cinnabar?) with remains of decoration in yellow, brown and/or violet. 15 yellow (ochre). 3 yellow/red decorated. 1 black and 1 blue piece. 1 red with two black and one yellow stripe. 1 white with green decoration. 1 violet/white. The rest are white. The stucco layers are between 5-12mm, + 1mm. The average thickness is about 10mm.

Fragments from level 82
14 pieces. 3 red ochre, 3 red-brown, 5 yellow ochre, 1 grey all monochrome. 1 red-brown with decoration. 1 fragment with no paint layer, but with the application of a clay-like material. 1 fragment with a figural (?) motif. The stucco layers are between 2-5 mm, the average thickness is about 3mm.

Fragments from level 83
9 pieces. 1 yellow with red (fig?), and 2 yellow with black (fig?) decoration. 2 red ochre and 4 monochrome white. The stucco layers are between 10-12 + 2 mm.

Fragments from level 84
22 pieces. 20 white monochrome. 1 red ochre. 1 red with a dark red stripe. The stucco layers are between 10-12 mm + paint layer.

Fragments from level 87
67 pieces. 39 dark red with white dots, some of them with black stripe (?) decoration. 9 monochrome white and 17 white with dots of red or red stripe decoration. 1 monochrome yellow (ochre) 1 yellow/red. The paint layers are between 4-8mm +1mm. The average thickness is about 4mm. A few fragments have just a 2mm stucco layer + paint layer.

Fragments from level 88/49
104 pieces. 15 white with violet decoration. 4 yellow (ochre). 9 yellow with red decoration. 1 white with grey stripe. 4 red (ochre) and 1 bright red. 1 fragment with a clay-like application on the surface. The rest are monochrome white or white with the addition of some other colour. The stucco layers are roughly 10 mm + 1mm, or there is a 2-3mm stucco layer + paint layer. The average thickness of is about 4mm.

Find no. 9
US1. White with red decoration. The stucco layer is 2+1mm. This fragment is found outside the stratigraphy.

Reassembly of fragments

The following fragments successively were glued together. Paraloid B72 applied with a brush on one fragmentary surface was used as a glue. Fragments marked 80:x and xx are too small to be numbered.

80:12, 80:22.	cinnabar, yellow, violet
80:31, 80:35, 80:37, 80:38, 80:41, 80:65.	cinnabar, yellow, violet
80:21, 80:105, 80:113, 80:165, 80:x.	cinnabar, yellow, violet
80:11, 80:50, 80:72, 80:xx.	cinnabar, yellow, violet
80:95, 80:134.	dark violet
82:1, 83:1, 83:6.	yellow, red, grey.
83:1, 83:9	yellow, black
87:1, 87:2, 87:3.	white, red decoration
87:4, 87:49, 87:55, 87:64.	dark red, white, black stripe.
87:25, 87:29, 87:30, 87:31.	dark red, white, red, white
87:38, 87:63.	dark red, black stripe
87:46, 87:50, 87:52, 87:54, 87:56, 87:61, 87:62.	dark red, white dots
88:33, 88:34, 88:35.	yellow, red decoration
88:59, 88:85.	red, pink

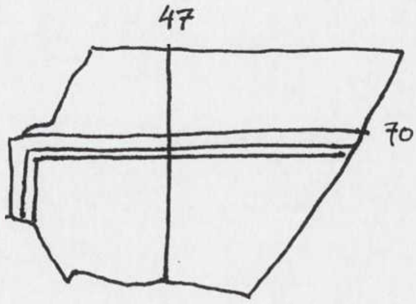
APPENDIX III

Case Study 4a:
Torre di Prima Porta
First Style Decorations

Inventory

The mural fragments from the Torre di Prima Porta were studied and described. All known written relevant information related with the excavation and registration of the fragments were noted. The observations of plaster layers, colours and decorations were noted. Full scale drawings were made, and at the upper right corner of each inventory form, a sketch of the fragment was drawn, indicating its measures in mm. With the objective of delimiting the number of pages, only the written documentation and the drawings which there is space enough to insert on the same page, are presented in this appendix. The cleaning methods are described, and so are applications of any surface coating tested. Samples were taken for plaster analyses at the Opificio in Florence, where most of the samples were investigated by FTIR. Some samples were not analysed, since the composition of the plaster was almost identical during the period investigated. In a few cases, the pigments were identified as well.

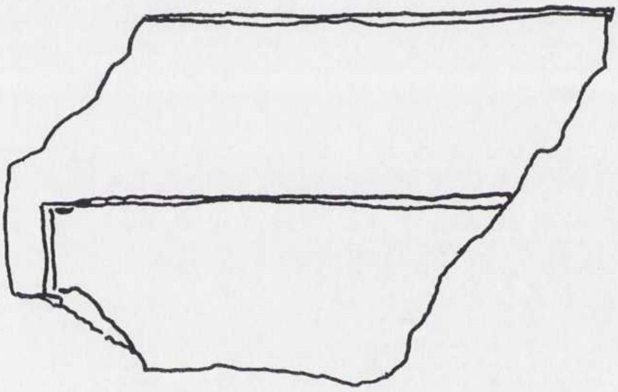
Fragment TPP 426376B (48B)

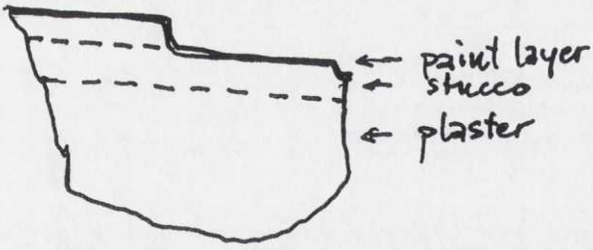


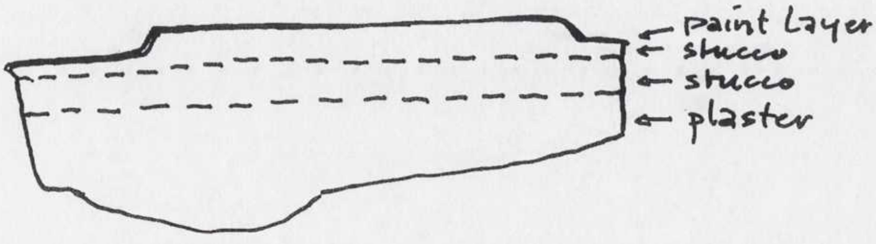
Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 1985
Object: Stucco panel with profile, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: Surface: 70 x 47; stucco: 11 (5+5+1); plaster: 12
Photos: Colour slide.

Description
Stucco panel with a depression forming a flat parametric border. An incised line at the edge of larger the border indicates the division between two panels. One corner of the inner panel is preserved on this fragment. Traces of a red decoration may be observed upon the pale yellow surface. There are two main stucco layers, and a distinct ultimate layer, yellow, thin and shell-like. The plaster is made of lime and fine and coarse-grained sand, consisting mainly of sand grains and glassy black particles smaller than 1mm Ø and with inclusions of 2-4 and sparse grains of 3-4mm Ø.

State of preservation
The stucco is hard and solid and the paint layer seems likewise. The fragment is sandy and there are hard superficial incrustations. The fragment was previously cleaned and may have been treated with Paraloid B72.

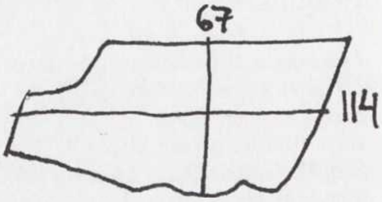






Scale 1:1

Fragment TPP 426376C (48C)



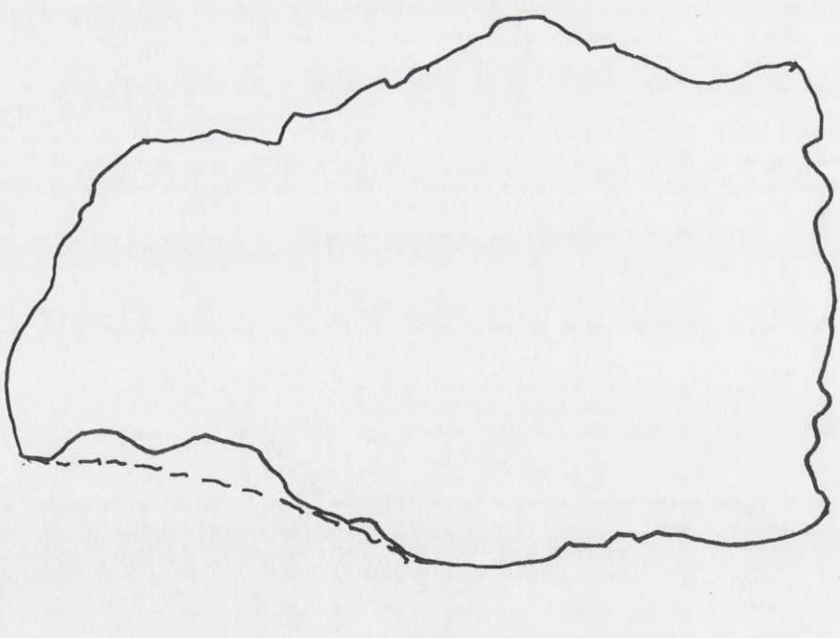
Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 1985
Object: Stucco panel, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: Surface: 67 x 114; stucco: 6 (5+1); plaster: 30
Photos: Colour slides, before cleaning; after cleaning.

Description
Stucco panel which must have been part of the inner part of a panel, since there are no traces of any border. Traces of a red decoration may be observed upon the pale pink surface. There are two main stucco layers in addition to the ultimate thin and shell-like layer which is quite distinct. The plaster consists of lime and rather coarse-grained sand, 1-2 mm Ø, with the inclusion of grains of larger size, 3-4 mm Ø, and with a few grains of glassy black particles.

State of preservation
The stucco is hard and solid and the paint layer too. The surface is covered with very hard incrustations.

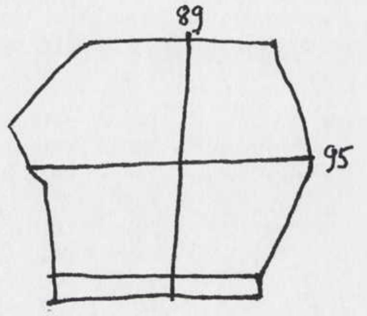
Interventions
Initial cleaning was made with deionized water, but since the result was poor due to the hard incrustations, other methods were tested. An 30 minute application of Viscor gave some result, and a 30 minute application of ammonium carbonate at the other side of the surface also gave some result, but not good enough. Another 2 hour application of ammonium carbonate in paper pulp solved some of the crusts. It was then decided to make an application of ammonium carbonate in paper pulp for 12 hours. A final 2 hours application was made, and then the fragment was carefully washed with deionized water. There are still some limited remains of incrustations.

Further observations
The red paint appears slightly in relief on the pale pink ground layer, indicating that it was probably applied *a secco*.



Scale 1:1

Fragment TPP 426377 (49)

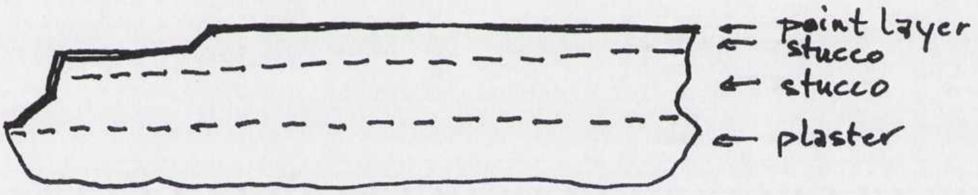


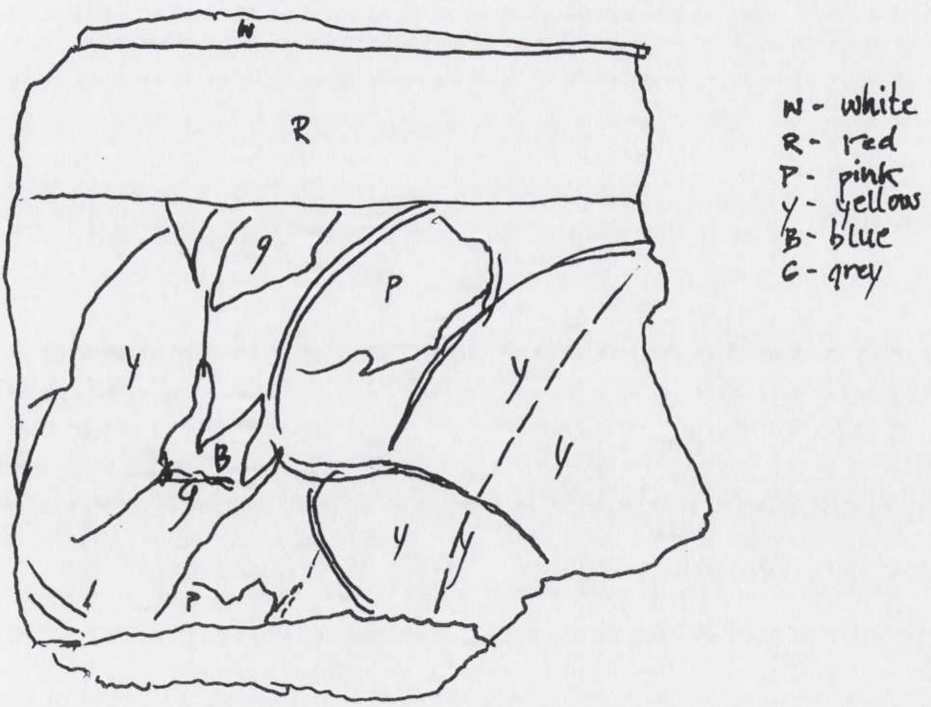
Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 1985
Object: Stucco panel with profile, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: Surface: 890 x 950; stucco: 11 (7+4); plaster: 8
Photo: Colour slide.

Description
Stucco panel with a depressed parametric flat border. A multi-colour decoration imitating marble has been made upon a creamy white ground colour. The dotted pattern has been outlined with the same red colour as was used for the monochrome border. A further depression consisting in an incised line and revealing the white stucco, indicates the division between two panels. The stuccoing has been made in 2, maybe 3 layers, the ultimate smoothed and compacted, and successively used as base for the decoration. The plaster contains rather coarse-grained sand and glassy black particles, most of 1-2 mm Ø and less 3-4 mm Ø. This is one of 8 fragments belonging to the same group.

State of preservation
This fragment has been cleaned and treated with Paraloid B72. It will not be used for any sampling, since it is contaminated by modern conservation materials.

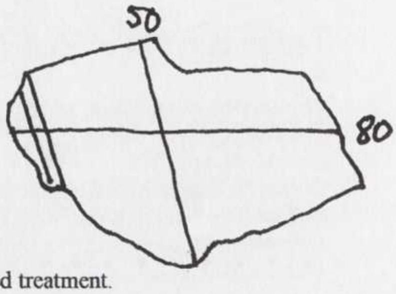
Further observations
The fragment has a clearly visible decoration and will therefore be used for comparative studies regarding style and pattern. On this fragment the decoration has been made on a light-coloured base.





Scale 1:1

Fragment TTP 426378 (50)



Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 1985
Object: Stucco panel with profile, wall decoration.
Subject: 1st style (2nd - 1st century BC)
Measures, mm: Surface: 80 x 50; stucco: 11 (1+5+5); plaster: 10
Photos: Colour slide, before cleaning; after cleaning; profile; after terminated treatment.

Description
Fragment of a stucco panel with a depressed, flat parametric border, delimited by a further depression indicating the division line between two panels. The border is painted in monochrome red. The line incised reveals the white stucco and seems to have been drawn between two red borders, since there is an exceedingly small remain of red colour at the very end of the fragment. On the upper part of the flat surface a dotted decoration outlined with a brown colour was made. The dots appear in pale colours such as yellow, two pink colours, green, and red. The upper stucco layer is all white, while that below show minor inclusions of very small size black grains. The plaster is made of a rather coarse lime-sand mixture, most grains and glassy black particles being 1-2 mm Ø or less and the larger being 3-5 mm Ø. This is one of 8 fragments from the same group.

State of preservation
The stucco and plaster layers are stable. Remaining decoration is clearly visible and the colours seem stable. The fragment is covered with incrustations.

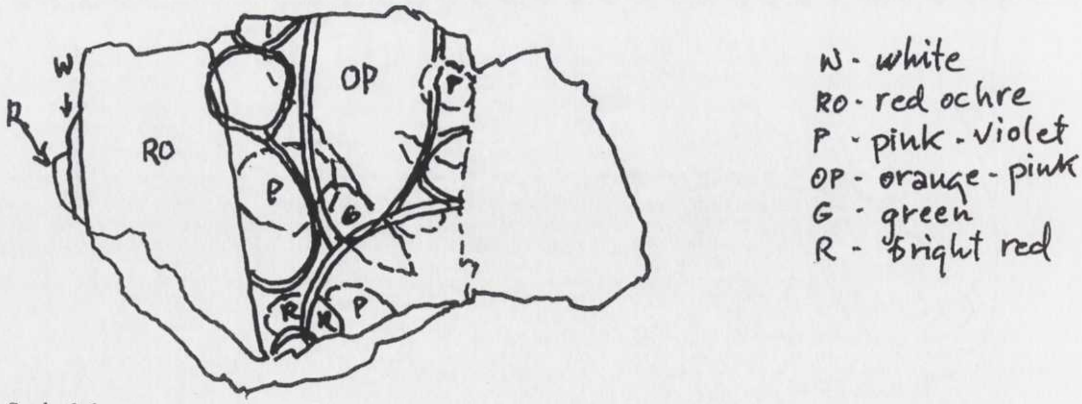
Interventions
Cleaning of the surface was made with deionized water and a soft sponge, while a soft nylon brush was used for the sides and the backside of the fragment. A few hard deposits were removed with a scalpel. A 5 minute application of Viscor, followed by cleaning with a soft brush and deionized water made the surface satisfactory clean. Saponified wax was applied as surface protective. After treatment the surface was rubbed with a cloth. Samples were removed to determine pigments and binder, the composition of stucco and plaster, and to observe the plaster under a microscope.

Samples

TPP 426378 (50)	I. From the green earth (?) paint layer.
TPP 426378 (50)	II. From the pink paint layer, with the addition of some white.

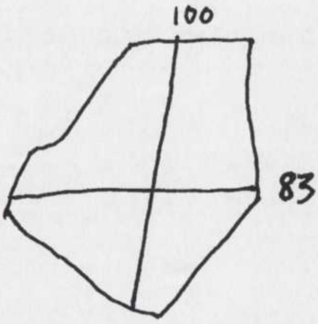
Chemical-technical investigation made at Opificio
Calcite crystals (alabaster) were observed. The red pigment was kaolin (bolo).

Further observations
When cleaning the surface there seemed to be traces of some greasy surface layer, of which a possible existence will probably be noted at examination of the orange-pink sample. The green paint layer also appeared to be greasy, and the colour had definitely been applied a secco, since it was completely situated upon the surface and was easily removed. The bright red paint layer was well attached, but also seemed to have had an application of a greasy material. The remaining colours were well attached and the samples were not easily removed.



Scale 1:1

Fragment TPP 426379 (51)

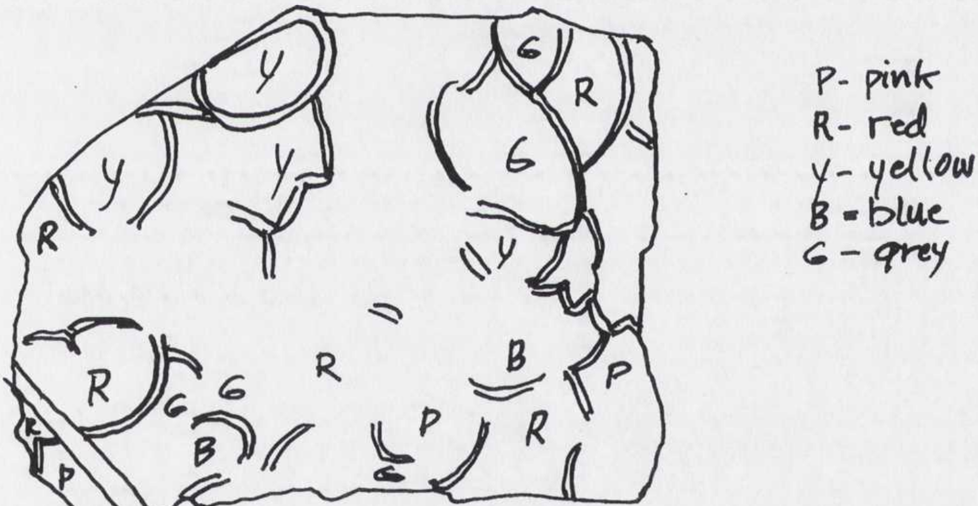


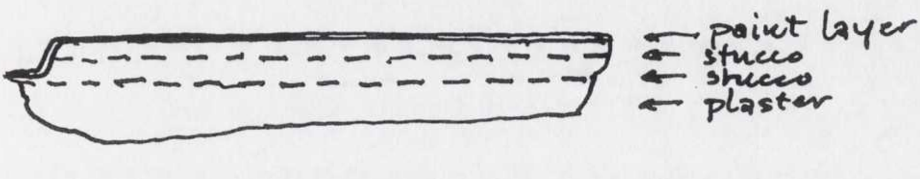
Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 1985
Object: Stucco panel, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: Surface: 100 x 83; stucco: 7 (3+4); plaster: 5
Photos: Colour slide.

Description:
Stucco panel which may derive from a corner or the end of a wall, since the plaster at one end of the fragment is slightly turned upwards, and the smooth and straight edge of the plaster and stucco indicate that some kind of firm delimitation originally existed. The multi-coloured dotted decoration was outlined with a dark brown colour, and painted on a red basis. Colours which appear are bright red, yellow, pink, blue and grey. The stucco partially has a pinkish appearance. It was applied in two layers. The plaster consists of lime and sand, mainly 1-2 mm Ø and with inclusions of glassy black particles and sand with grain size of 3-4 mm Ø. This is one of 8 fragments from the same group.

State of preservation
This fragment has been cleaned and treated with Paraloid B72, and consequently will not be used for further material investigations.

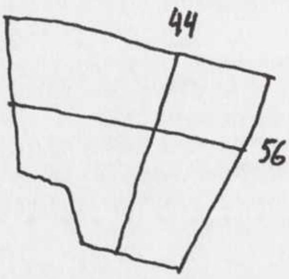
Further observations
The fragment will be used for comparative studies. On this like the other Paraloid-treated fragments the decorative pattern is clearly distinguished.





Scale 1:1

Fragment TPP 426380 (52)



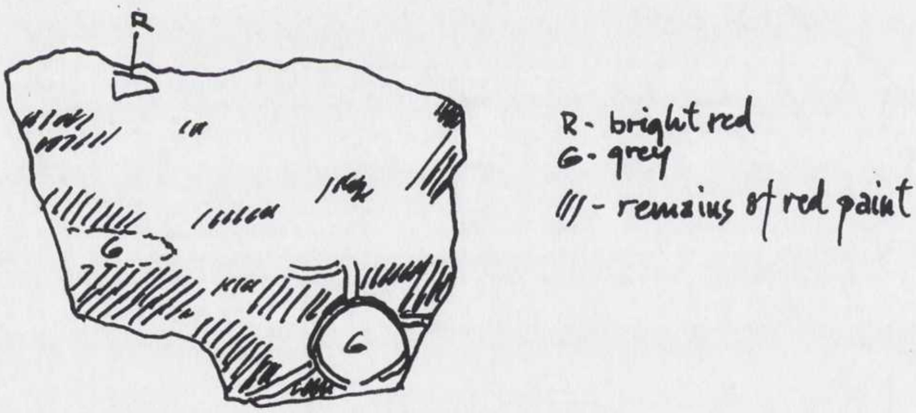
Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 1985
Object: Stucco panel, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: Surface: 56 x 44; stucco: 10 (1+4+5) ; plaster: 5
Photos: Colour slide, before cleaning.

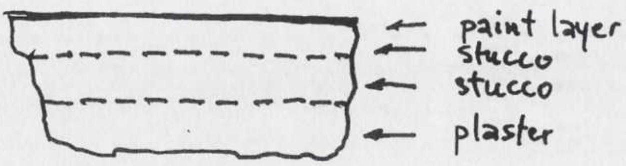
Description
The fragment consists of a central part of a panel, thereby not presenting any relief border. Remains of a red colour reveals that this was originally the ground colour, upon which the decoration was made in a spot-pattern with brown outlining. Remains of additional colours are red and grey. The stucco layers are two plus the final layer, hard, thin and shell-like. The plaster consists of lime with the addition of fine sand and glassy black particles of c. 1-2 mm Ø and with inclusion of coarse-grained sand, 3-5 mm Ø. This is one of 8 fragments from the same group.

State of preservation
The plaster and stucco layers are hard and the painted surface is very weathered.

Interventions
Cleaning revealed that this fragment must have been treated with some material, since it was water resistant. It is therefore suggested that Paraloid B72 was applied also on this fragment even though in minor quantities. Material analyses will therefore not be made.

Further observations
In order to study if the stucco was pink in interior as well as exterior a small surface area was removed at one side, and it was then discovered that the stucco was white about 1mm below the surface. This indicates that the stucco either was discoloured by a pigment or by a surface protective.

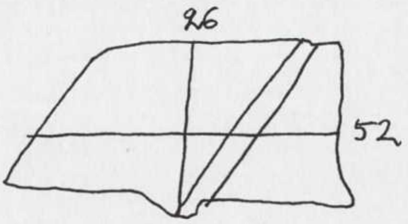




Scale 1:1

Fragment TPP 426381 (53)

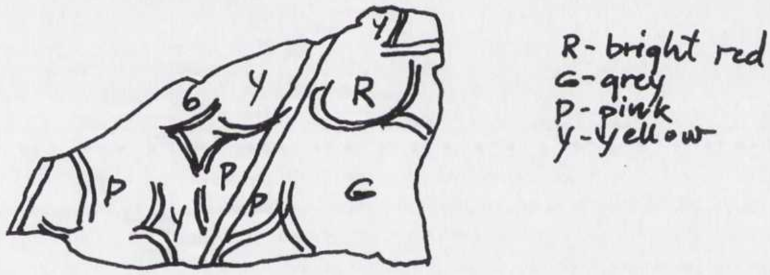
Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 1985
Object: Stucco panel with profile, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: Surface: 26 x 52; stucco: 10 (1+4+5) ; plaster: 0
Photos: Colour slide, before cleaning.

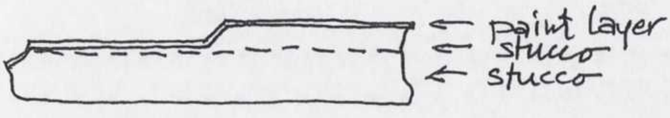


Description
The fragment with a flat parametric border. A multicoloured dotted decoration imitating marble was outlined with a brown colour and covers the surface. The ground colour is red and additional colours are bright red and yellow. The stucco layers are two, both slightly pink and the lower level presenting sparse inclusions of minimal dark grains. This is one of 8 fragments from the same group.

State of preservation
The plaster and stucco layers are hard and the painted surface seems solid.

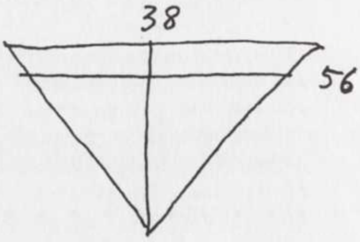
Interventions
Cleaning revealed that this fragment must have been treated with some material, since it was water resistant. It is therefore indicated that Paraloid B72 had previously been applied on this fragment even though in minor quantities. Material analyses will therefore not be made.





Scale 1:1

Fragment TPP 426381B (53B)

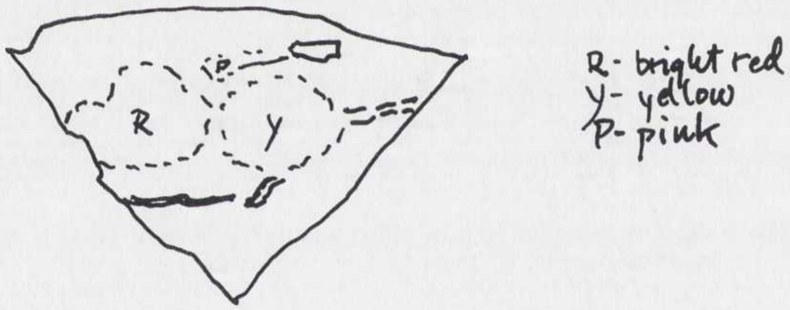


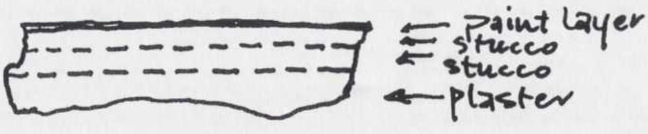
Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 1985
Object: Stucco panel, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: Surface: 56 x 38; stucco: 6 (1+2+3) ; plaster: 3
Photos: Colour slide, before cleaning; after cleaning.

Description
The fragment which must have been a central part of a panel, since there are no signs of any border. A multi-coloured spot-pattern in red, green and yellow with brown outlining covers the surface. The stucco layers are two, and in addition there is a thin distinct final layer. The plaster consists of lime with the addition of fine sand and glassy black particles, with grains generally less than 1 mm Ø. This fragment is similar to the group of 8 fragments registered and was therefore given the above identification number.

State of preservation
The plaster and stucco layers are hard and the painted surface is covered with deposits.

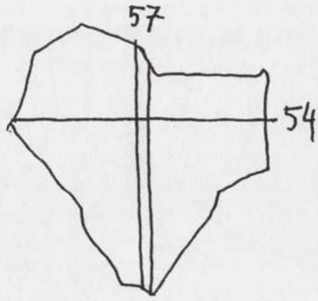
Interventions
The colours are not integrated with the lime-surface, indicating that paint had been applied *a secco*. A 20 minute application of Viscor was made and then the surface was gently cleaned with deionized water and a soft nylon brush. Some deposits were removed with a scalpel.





Scale 1:1

Fragment TPP 426381C (53C)



Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 1985
Object: Stucco panel with profile, wall decoration
Subject: 1st style (2nd -1st century BC)
Measures, mm: Surface: 57 x 54; stucco: 5 (1+4); plaster: 6
Photos: Colour slide, before cleaning; after cleaning

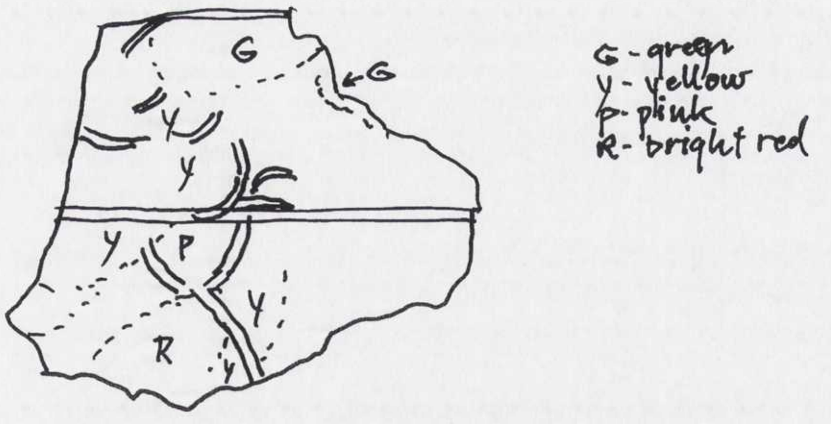
Description
Stucco fragment with a parametric depression forming a flat border. The border is delimited by a further incised line, in which the fragment was broken. The multi-colour spotted decoration in pale colours was outlined with a dark brown colour and painted on a white basis. Additional colours are pink, green and yellow. There are two distinctive stucco layers, the upper all white and the lower containing small size dark particles. The plaster is homogeneous with sand grains and glassy black particles generally less than 1 mm Ø and a few grains between 1-2 mm Ø. This fragment was not scheduled, but since it is very similar to the 8 fragment group before, it was given the present inventory number.

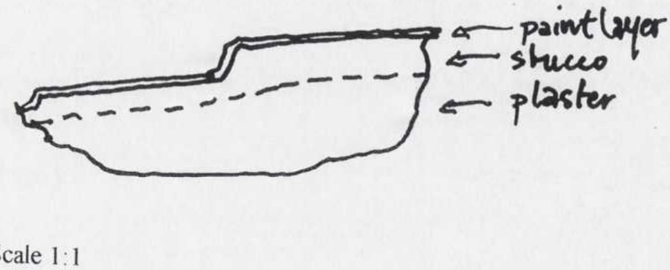
State of preservation
The stucco layer is solid and hard and the paint layer seems stable too. The surface is covered with deposits.

Interventions
A 20 minute application of Viscor was made and followed by cleaning with deionized water and a soft nylon brush, with a satisfactory result. The paint appear slightly in relief on the surface and were probably applied *a secco*. A sample from the plaster was removed for chemical and microscopical analysis.

Samples
TPP 426381C (53C) I. Plaster

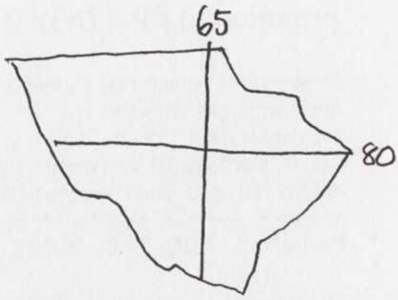
Chemical-technical investigation made at Opificio
Calcite crystals (alabaster) were identified.





Scale 1:1

Fragment TPP 426385 (58)



Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 1985
Object: Stucco panel with profile, wall decoration
Subject: 1st style (2nd-1st century BC)
Measures, mm: Surface: 65 x 80; stucco: 4 (2+2); plaster: 8
Photos: Colour slide, before cleaning; after cleaning.

Description

Stucco panel with a depressed, flat parametric border. The panel is monochrome white with traces of spots in green and yellow, outlined with a brown colour. The border is green, with brown outlines, forming a monochrome green spotted paint layer. There are not enough remains of paint to verify if the fragment was originally fully decorated or if paint was applied just to specific areas. A small green dot at the upper edge and a red line at the lower right side may however indicate that the fragment originally was painted over its entire surface. The stucco appears in 2 separate layers, the upper compacted and forming a hard rather smooth shell, upon which the decoration was made, and the underlying containing exceedingly small glassy black particles. The plaster layer contains lime and fine sand with grains generally less than 1 mm Ø and a few inclusions of larger sized, ca 2-3 mm Ø.

State of preservation

The fragment presents incrustations on parts of the surface. The remains of paint seem fairly stable.

Interventions

Materials used for cleaning was deionized water and paper pulp. For the surface a soft sponge was used and for the sides and backside of the fragment a soft nylon brush was employed. A scalpel was used for removal of hard deposits. Deionized water in paper pulp was applied and left to dry completely, in order to draw salts out of the fragment. Samples were removed for analysis of pigment, binder, stucco and plaster. Finally a 5 minute application of Viscor was made, followed by cleaning with deionized water and a soft brush, which gave a satisfactory result.

Samples

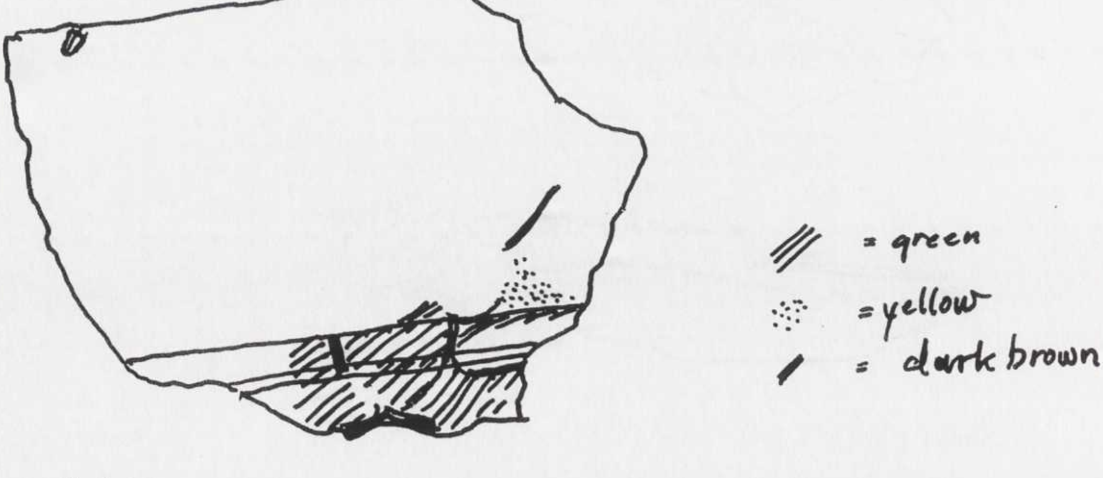
TPP 426385 (58) I. The green paint and white stucco

Chemical-technical investigation made at Opificio

Calcite, quartz and kaolin (*bolo*) were identified.

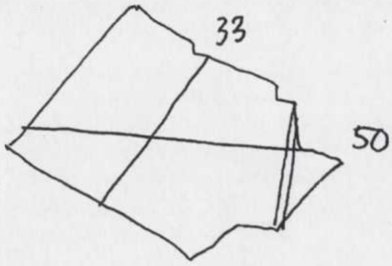
Further observations

The green colour was easily removed, and had probably been applied *a secco*, which makes it interesting to see if the binder may be determined.



Scale 1:1

Fragment TPP 426396B (70B)



Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 1985
Object: Stucco panel with profile, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: surface: 50 x 33; stucco: 8 (3+5); plaster: 0
Photos: Colour slide, before cleaning; after completed treatment.

Description
Stucco panel with a depressed flat parametric border. The upper level of the panel is painted in monochrome dark yellow and the border is white. The surface is very smooth and lustrous. There are three distinctive stucco layers. The upper has been compacted and has a shell-like appearance. The plaster was made of lime and sand with the inclusion of glassy and glassy black particles, the grain size being mainly 2-3 mm Ø and below and with the inclusion of some grains of 2-3 mm Ø.

State of preservation
The fragment appears solid and the surface seems stable. There are some areas of surface incrustations.

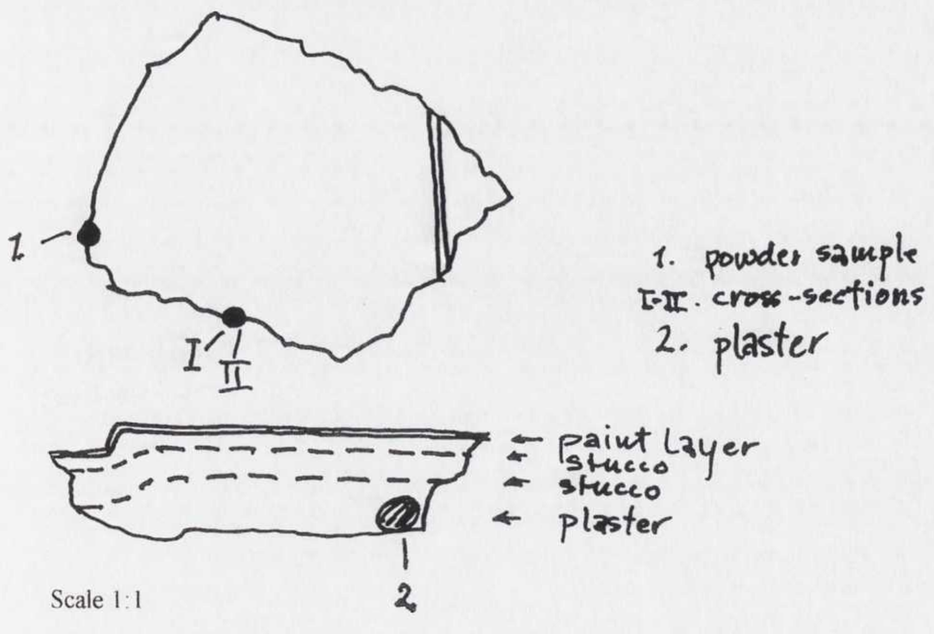
Interventions
Cleaning of the surface was made with deionized water and a soft sponge. Just a small part of the incrustations were removed since they were very hard and adherent to the surface. Deionized water in paper pulp was applied for a few hours, but the incrustations did not soften by this treatment. Since cleaning was mainly done in order to remove samples for material analyses, further applications with chemicals such as ammonium carbonate were not made. All softer deposits were removed and samples were removed for analysis of pigment and binder, stucco and plaster. A 2 hour application of ammonium carbonate in paper pulp was made and followed by cleaning with deionized water and a soft brush. An application of deionized water in paper pulp was applied on the painted surface and left until it was completely dry, with the object to draw out the salts from the fragment. There were still differences in surface appearance, probably due to an ancient surface treatment, which formed a darker film on some parts of the surface. A thin application of saponified wax was applied in order to restore the brilliance on the parts of the surface which had become dull. The wax was heated after application and later smoothed with a dry cloth.

Samples

TPP 426396B (70B)	I.	All layers
TPP 426396B (70B)	II.	All layers, including stucco

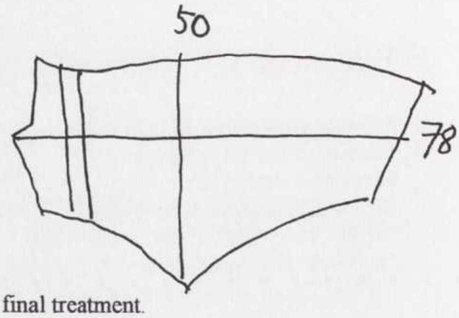
Chemical-technical investigation made at Opificio
Calcite crystals (alabaster) were found in samples I and II.

Further observations
The painted surface was very hard, indicating a fresco painting. It was possible to remove paint due to the relative thickness of the layer. The plaster is very hard.



Scale 1:1

Fragment TPP 426405 (77)



Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 19
Object: Stucco panel with profile, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: Surface: 78 x 50; stucco: 6 (1+2+3); plaster: 16-21
Photos: Colour slide, before cleaning; after cleaning; test photo; after final treatment.

Description
Narrow light blue stucco panel with a parametric depression forming a flat border on one side and on the opposite side the blue panel is delimited by a white depressed line. The stucco layers are white and the plaster was made of lime and rather fine grained sand, mainly consisting of sand grains and glassy black particles less than 1 mm Ø and with inclusions of grains being of 2-3 mm Ø.

State of preservation
The stucco is hard and solid and the paint layer also seems stable.

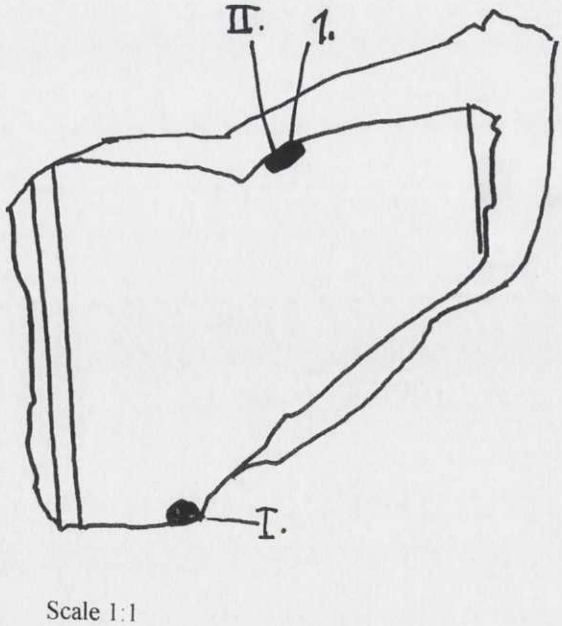
Interventions
Materials used for cleaning was deionized water and paper pulp. For the surface a soft sponge was used and for the sides and backside of the fragment a soft nylon brush was employed. A scalpel was employed for removal of some hard deposits. Deionized water in paper pulp was applied and left to dry completely, in order to draw salts out of the fragment. Samples were taken with the object to study the blue pigment and the binder. Additional samples were taken with the object to investigate the stucco and plaster. Further cleaning materials (deionized water, Viscor and ammonium carbonate) for removal of the remaining deposits, were tested and Viscor proved to be the better agent in this case. A 5 minute application of Viscor was made and followed by cleaning with a soft brush and deionized water, which gave a satisfactory result.

Samples

TPP 426405 (77)	I.	The blue pigment and all layers
TPP 426405 (77)	II.	All layers, stucco

Chemical-technical investigation made at Opificio
Calcite crystals, quartz, and nitrates were identified. The blue pigment was Egyptian blue.

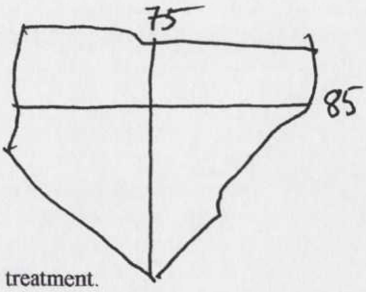
Further observations
The paint layer was very hard and integrated with the surface, which probably is painted *al fresco*. The incrustations are not very dense but hard. Some were removed, but it was decided to let a thin film of deposits remain upon the surface. Very hard plaster.



1. Powder sample
I-II Cross-sections
2. Plaster

Scale 1:1

Fragment TPP 426462B (137B)



Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 1985
Object: Stucco panel with profile, wall decoration
Subject: 1st style (2nd - 1st century BC).
Measures, mm: Surface: 85 x 75; stucco: 9 (1+3+4); plaster: 6
Photos: Colour slide, before cleaning; after cleaning; test photos; after final treatment.

Description
Stucco fragment with a depressed flat parametric border, which is followed by a further depression consisting of an incised line, delimiting the space between two panels. The surface is monochrome bright yellow, except for the incised line which appears white with very small remains of a light green colour. Three stucco layers are clearly visible, including the final shell-like layer on which the yellow painting was made. The plaster was made of lime and a rather fine-grained sand, mainly consisting of sand grains and glassy black particles less than 1 mm Ø and with inclusions of 2-3 mm Ø grains.

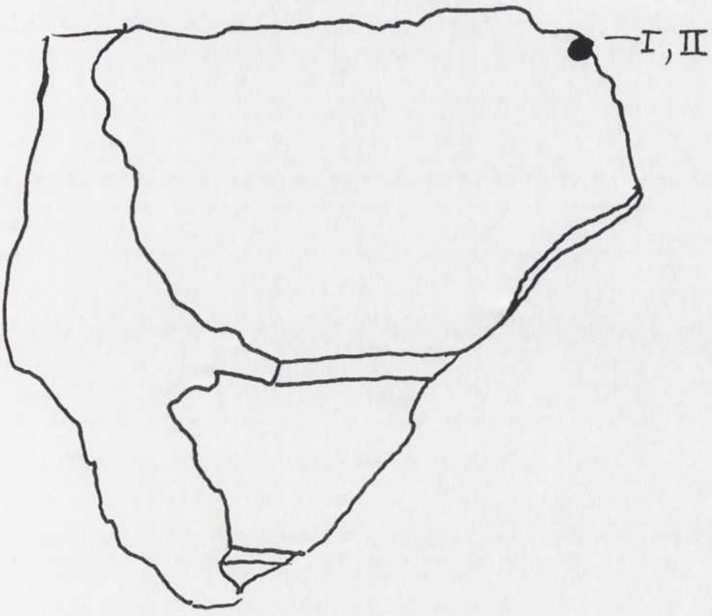
State of preservation
The material of the fragment is solid, and the painted surface is smooth and rather lustrous.

Interventions
Materials used for cleaning was deionized water and paper pulp. For the surface a soft sponge was used and for the sides and backside of the fragment a soft nylon brush was employed. A scalpel was used for removal of hard surface deposits. Deionized water in paper pulp was applied and left to dry completely, in order to draw salts out of the fragment. Samples were taken with the object to study the yellow pigment and the binder. Cleaning tests were made with the object to find out how different cleaning materials affected the surface, using water, Viscor and ammonium carbonate, and ammonium carbonate proved to be the better agent for this surface. Therefore a 5 minute application of ammonium carbonate in paper pulp was made, followed by cleaning with a soft brush and deionized water.

Samples
TPP 426462B (137B) I, II. All levels.

Chemical-technical investigation made at Opificio
Calcite crystals (alabaster) were identified in samples I and II.

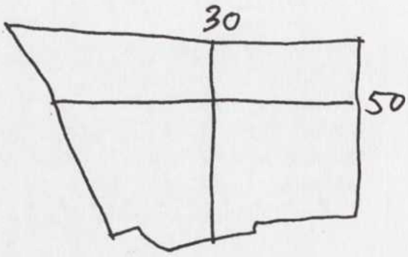
Further observations
While removing some incrustations it seemed as if an almost invisible, thin film was present upon the surface. This had a soft, greasy character, and some material was removed for analyses. The paint layer was hard. This may indicate that some material had been applied to the surface, as a protective.



I. Cross-section
II. Cross-section

Scale 1:1

Fragment TPP 426467B (142 B)



Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 1985
Object: Stucco panel, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: Surface: 50 x 30; stucco: 5 (1+4); plaster: 4
Photos: Colour slide, before cleaning; profile; after cleaning.

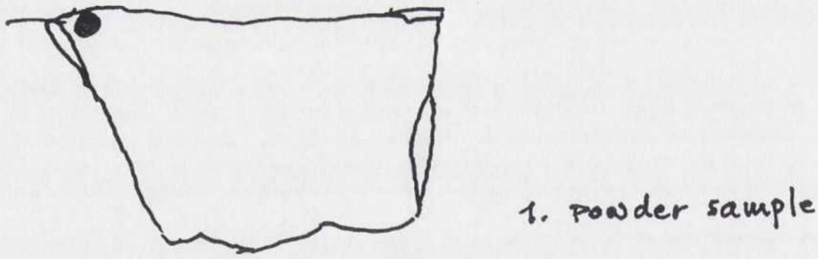
Description
This stucco fragment must be from the central part of a panel, since there is no border. A violet paint layer was applied on the white basis. Two distinct layers stucco of a slightly pinkish hue may be distinguished. The upper layer has a shell-like appearance. The plaster was made of lime and fine sand, mainly consisting of sand grains and glassy black particles less than 1 mm Ø.

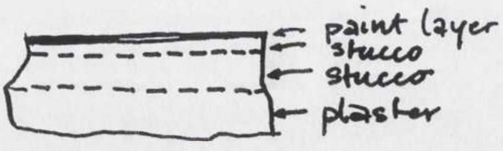
State of preservation
The stucco is hard and solid. The violet colour is weathered and partially washed off. There are some surface deposits.

Interventions
Cleaning was made with deionized water and a soft sponge. For the sides and backside of the fragment a soft nylon brush was used. Surface deposits were easily disposed of. One sample was taken for analysis of the violet pigment and the binder.

Samples
TPP 426467B (142B) I. Violet paint layer.

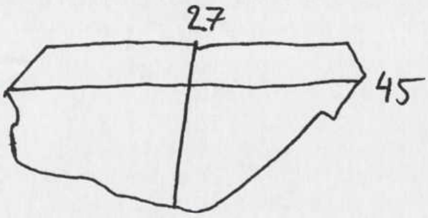
Further observations
Just one cross-section sample was removed to study the pigment, binder and stucco.





Scale 1:1

Fragment TPP 426474B (148B)



Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 1985
Object: Stucco panel, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: surface: 45 x27; stucco: 7 (2+5); plaster: 6
Photos: Colour slide, before cleaning; profile; after cleaning.

Description
This stucco fragment must be from the central part of a panel, since there is no border. A light green monochrome paint layer has been applied to the white stucco. The lower stucco layer contains very fine sand or marble dust, and the plaster layer consists of lime, fine sand and glassy black particles, the grain size mainly less than 1 mm Ø.

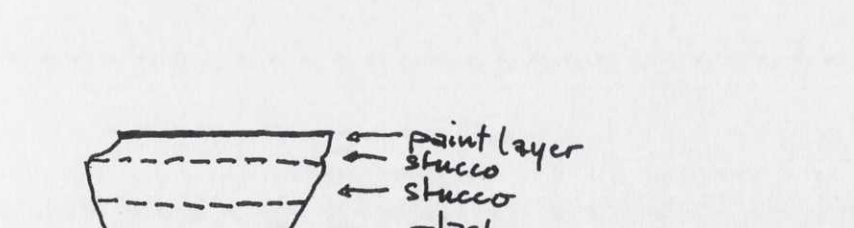
State of preservation
The stucco is hard and solid, but the paint layer is very weathered and not much of it remains.

Interventions
Materials used for cleaning was deionized water and paper pulp. For the surface a soft sponge was used and for the sides and backside of the fragment a soft nylon brush was employed. Deionized water in paper pulp was applied and left to dry completely, in order to draw salts out of the fragment. Samples were taken with the object to study the green pigment and the binder.

Samples
TPP 426474B (148B) I. All levels

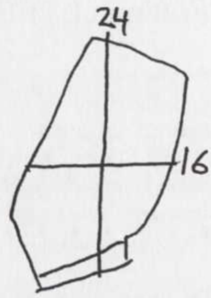
Chemical-technical investigation made at Opificio
Calcite crystals (alabaster), quartz and silicates were identified in sample I. The yellow pigment was a yellow ochre.

Further observations
The paint layer was rather soft and partially thick and consequently the samples were easily removed with the scalpel. This may indicate that the layer is not applied *al fresco*, but on a *secco* ground. In that case another binder may possibly be determined.



Scale 1:1

Fragment TPP 426476A (150A)



Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 1985
Object: Stucco panel, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: surface: 16 x 24; stucco: 5 (1+2+2); plaster: 0
Photos: Colour slide, before cleaning; after cleaning.

Description
Stucco fragment from the edge of a panel. One side of the fragment has a straight, white-coloured side, which may be indicating that this is the upper level of a panel. The paint layer is bright blue. There are distinct stucco layers and no remains of plaster.

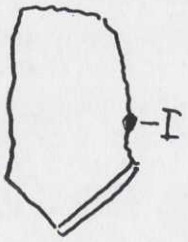
State of preservation
The fragment is hard and the painted surface stable but covered with deposits.

Interventions
Cleaning was made by a 5 minute application of Viscor, and then the surface was cleaned with deionized water and a soft brush. One sample was removed for analysis of pigment and binder.

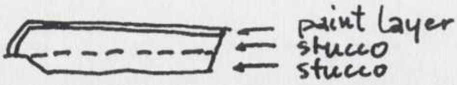
Samples
TPP 426476A (150A) I. The blue pigment and all layers.

Chemical-technical investigation made at Opificio
Calcite crystals (alabaster) were identified.

Further observations
The blue paint layer was probably applied *al fresco*.

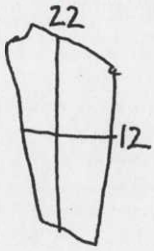


I. Cross-section



Scale 1:1

Fragment TPP 426476B (150B)



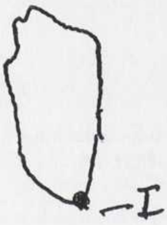
Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 1985
Object: Stucco panel, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: Surface: 12 x 22; stucco: 4 (1+3); plaster: 0
Photos: Colour slide, before cleaning; after cleaning.

Description
Stucco fragment which may have been at the centre of a wall, since there are no signs of a border. The paint layer is pale green. There are two distinct stucco layers, the lower with inclusions of exceedingly small black particles.

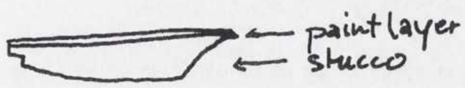
State of preservation
The fragment is solid and the paint layer too. One sample was removed for analysis of pigment and binder.

Samples
TPP 426476B (150B) I. The bright green pigment and all layers.

Chemical-technical investigation made at Opificio
Calcite crystals (alabaster) were identified.

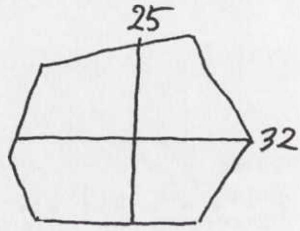


I. Cross-section



Scale 1:1

Fragment TPP 426477B (151B)



Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 1985
Object: Stucco panel, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: surface: 32 x 25; stucco: 5 (1+4); plaster: 10
Photos: Colour slide, before cleaning; profile; after cleaning.

Description
Stucco fragment which may have been at the end of a wall, since one side of the fragment is flat and appears to have been in contact with a delimiting surface. The paint layer is dark red and partially smooth. There are two distinct stucco layers, the upper one is thin and of a red hue, and the other layer is white. The plaster was made of lime, fine sand and glassy black particles, the grains being mainly less than 1 mm Ø.

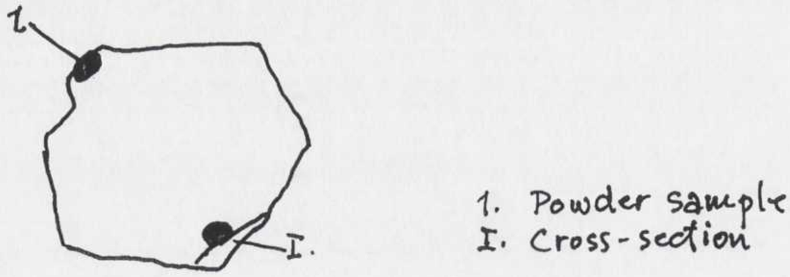
State of preservation
The stucco is solid, and the red paint layer seems stable too. There are incrustations on the surface.

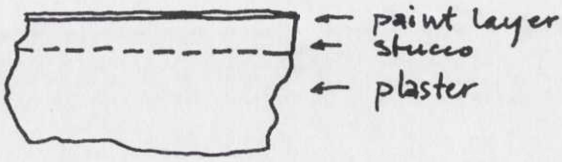
Interventions
Cleaning was made with deionized water and a soft sponge. The plaster was cleaned with a soft nylon brush. Samples were taken to study the pigment and binder. Deionized water in paper pulp was applied to the surface and left to dry, in order to draw out the salts from the fragment. Finally a 5 minute application of Viscor was made for removal of the remaining deposits followed by cleaning with deionized water and a soft brush. Saponified wax was applied as surface protective. After treatment the surface was rubbed with a cloth.

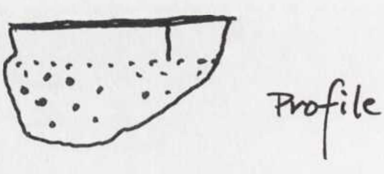
Samples
TPP 426477B (151B) I. The red pigment and all layers.

Chemical-technical investigation made at Opificio
Calcite crystals (alabaster) and silicates (hematite) were identified.

Further observations
The rather thick paint layer was hard and well adhered to the surface, which indicates a fresco-painting. The samples were easily removed due to the relative thickness of the layer. Most incrustations were removed. The application of Viscor softened and partially dissolved the paint layer.

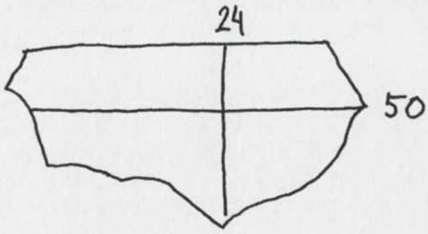






Scale 1:1

Fragment TPP 426486B (160B)



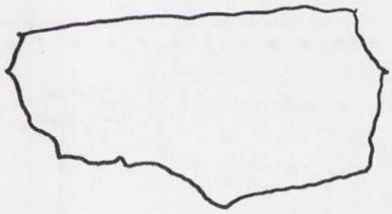
Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 1985
Object: Stucco panel, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: Surface: 50 x 24; stucco: 5 (1+4); plaster: 3
Photos: Colour slide, before cleaning; profile; after cleaning.

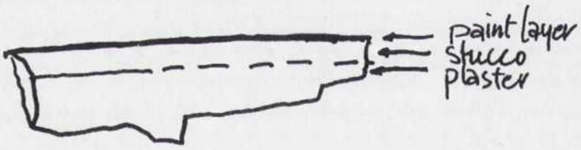
Description
This stucco fragment must be from the central part of a panel, since there is no border. A violet monochrome paint layer was applied on the white stucco. There are two distinct stucco layers, maybe followed by a final layer which was compacted and appears to be shell-like. At the back side of the fragment are impressions from the underlying structure. The two plaster layers are white and the plaster was made of lime, fine sand and glassy black particles, mainly less than 1 mm Ø. The fragment belongs to a group of 38.

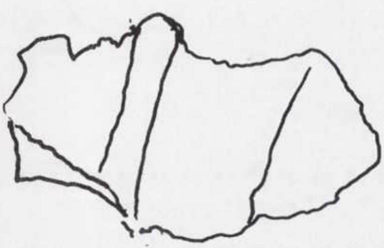
State of preservation
The stucco is hard and solid. The paint layer seems stable too. Some areas are presenting surface deposits.

Interventions
Cleaning of the fragment was made with deionized water and a soft sponge. For the sides and the backside a soft nylon brush was used. Surface deposits were easily removed. A single white incrustation on the surface was left, since it probably causes less harm to the surface than its removal does.

Further observations
The pigment of this fragment and that of no 426486c are identical and therefore no sampling was made. The paint layer of this fragment however is almost completely intact. That was the reason for choosing the other fragment for sampling.



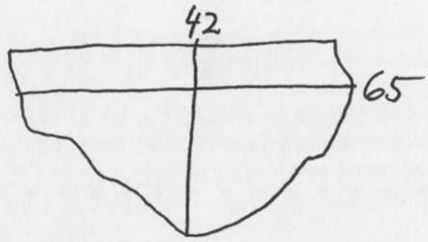




← Impressions on the backside

Scale 1:1

Fragment TPP 426486C (160C)



Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 1985
Object: Stucco panel, wall decoration
Subject: 1st Style (2nd - 1st century BC)
Measures, mm: surface: 65 x 42; stucco: 4 (1+3); plaster: 5
Photos: Colour slide, before cleaning.

Description:
This stucco fragment must be from the central part of a panel, since there is no border. A violet monochrome paint layer was applied to the white stucco. The upper stucco layer appears as a shell-like thin layer, about 1 mm. This may either be a separate layer or the surface of the compacted upper part of the upper of the two distinctive layers. The plaster was made of lime, fine sand, glassy and glassy black particles, the grains being less than 1 mm Ø. There are signs impressed from the structure underneath the plaster layer.

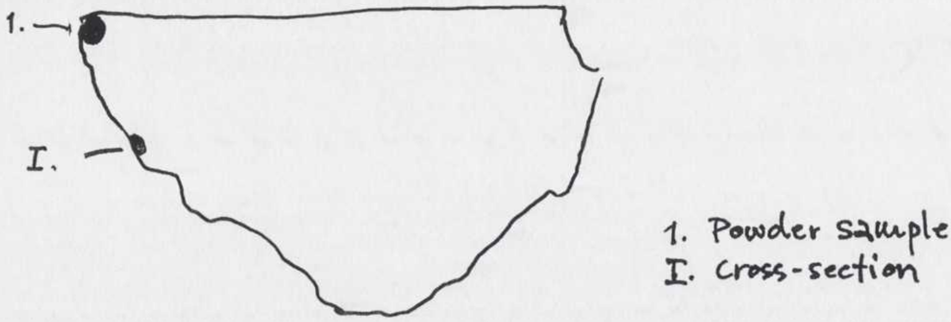
State of preservation
The stucco is hard and solid. The violet paint layer is partially weathered, and there are some areas of incrustations.

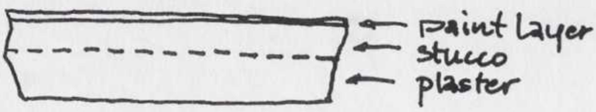
Interventions
Cleaning of the surface was made with deionized water and a soft sponge. A scalpel was used for the removal of hard deposits. For the sides and the backside of the fragment a soft nylon brush was used. A 10 minute application of Viscor was made for removal of remaining incrustations, and was followed by careful cleaning with deionized water and a soft brush. Samples were removed for analysis of pigment and binder. Saponified wax was applied as surface protective. After treatment the surface was rubbed with a cloth.

Samples
TPP 426486C (160C) I. All layers.

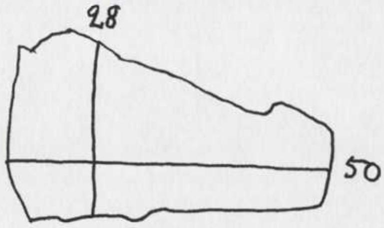
Chemical-technical investigation made at Opificio
Calcite crystals (alabaster), quartz, and silicates (hematite) were identified.

Further observations
The pigment, when wet, was not well attached to the surface. It had a greasy character and was easily removed. This may indicate that the paint was applied *a secco*, and consequently the binder is probably not lime, but a glue or gum etc.





Fragment TPP 426503 (178)



Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: 1985
Object: Stucco panel, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: Surface: 50 x 28; stucco: 3+5; plaster: 5
Photos: Colour slide, before cleaning; profile; after cleaning.

Description
This stucco fragment must be from the central part of a panel, since there is no border. A monochrome black, smooth and lustrous colour appears upon the white stucco which seems to have been made of lime and very fine sand, minor quantities of glassy particles and marble dust. The upper plaster layer was made of lime and fine sand, the lower layer with inclusions of grains of larger size, ca 1-2 mm Ø.

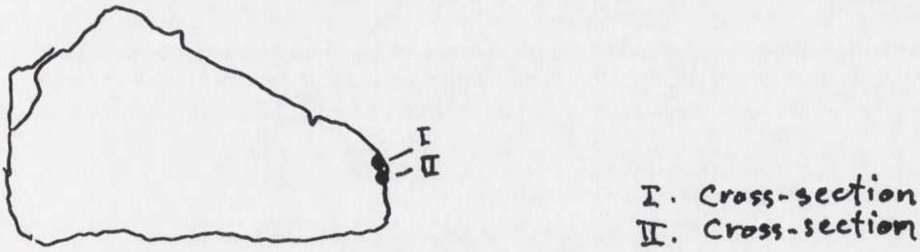
State of preservation
The stucco is hard and solid, and so is the painted surface, even though it presents some scratches.

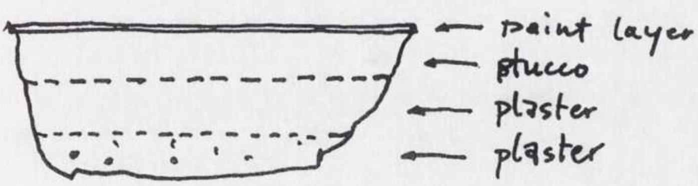
Interventions
Cleaning of the surface was made with deionized water and a soft sponge. For the sides and backside of the fragment a soft nylon brush was used. Samples were removed for analysis of pigment and binder.

Samples
TPP 426503 (178) I, II. All levels. Two samples from the same spot, in the same bottle.

Chemical-technical investigation made at Opificio
Calcite crystals (alabaster) were identified in samples I and II.

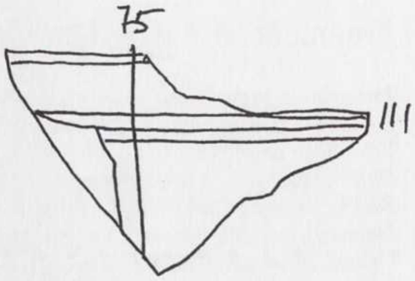
Further observations
Since the surface was so intact it seemed better to remove two cross-section samples from the hard surface than scratching off some powder, which would leave visible marks.





Scale 1:1

Fragment TTP A

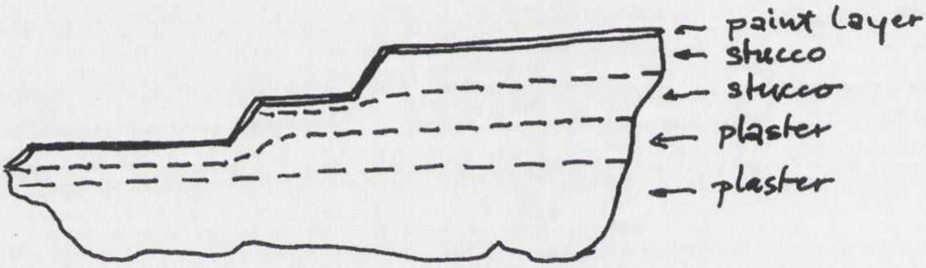


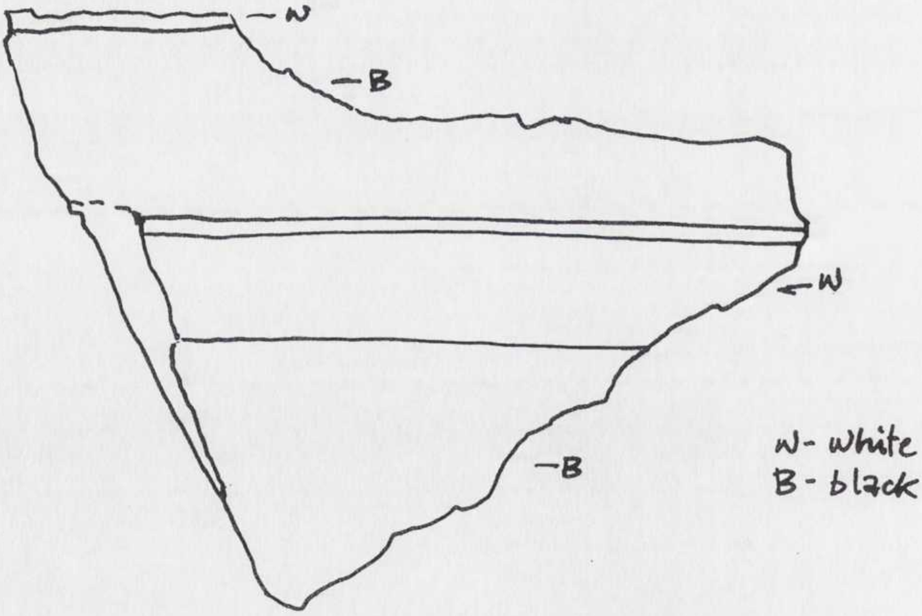
Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: Not scheduled
Object: Stucco panel with profile, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: Surface: 75 x 111; stucco: 11 (5+6); plaster: 5+6
Photos: Colour slide, before cleaning; after cleaning.

Description
Stucco panel with a parametric depression forming a flat border followed by a broad depressed border and a further depression which is the incised line between two panels. The colours are black and white. There are 3 distinct stucco layers with inclusions of rather course grained marble dust. The plaster is made of lime and homogeneously grained sand, the sand grains and glassy black particles generally less than 1 mm Ø was made of lime and rather rough grained sand, mainly consisting of grains less than 1 mm Ø.

State of preservation
The stucco is hard and solid and the paint layer is very weathered and covered with deposits.

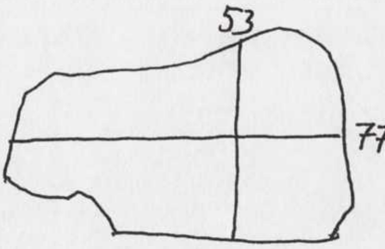
Interventions
A 1 hour application of ammonium carbonate was made in order to remove the deposits. The surface was then cleaned with deionized water and a soft brush. Saponified wax was applied as surface protective. After treatment the surface was rubbed with a cloth.





Scale 1:1

Fragment TPP B



Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: Not scheduled
Object: Stucco panel with profile, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: Surface: 77 x 53; stucco: 11 (3+4+4); plaster: 12
Photos: Colour slide, before cleaning; profile; after cleaning.

Description
Stucco panel with a parametric depression forming a flat border followed by an incised line which is the delimited area between two panels. The upper stucco layer has inclusions of fine marble dust while the lower presents a somewhat larger marble grains. The plaster was made of lime and sand with a homogeneous grain size, mainly less than 1 mm Ø but with inclusion of grains of 2-3 mm Ø. There are major quantities of glassy black particles.

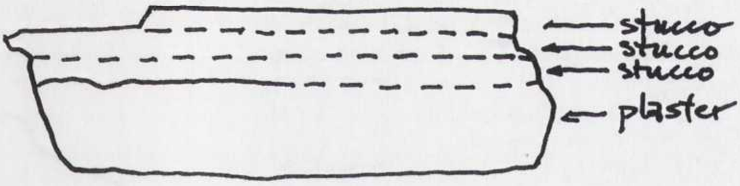
State of preservation
The stucco is hard and solid.

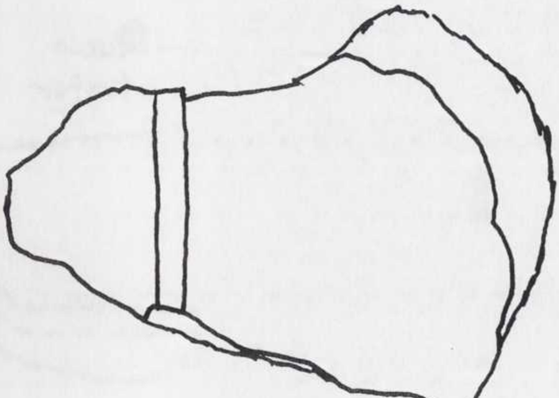
Interventions
A 2 hour application of Viscor was made in order to soften the incrustations, and then the fragment was cleaned with deionized water and a soft brush. The samples were removed after cleaning, and with the object to determine the composition of the layers.

Samples

TPP B	I. From the coarse stucco layer
TTP B	II. From the upper stucco layer
TTP B	III. From the plaster

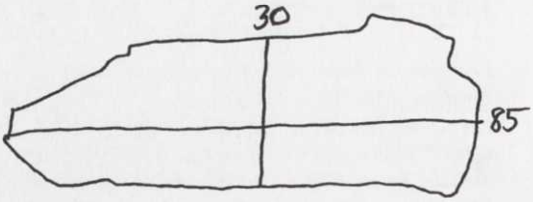
Chemical-technical investigation made at Opificio
Calcite crystals (alabaster) were identified in samples I and II.





Scale 1:1

Fragment TPP C

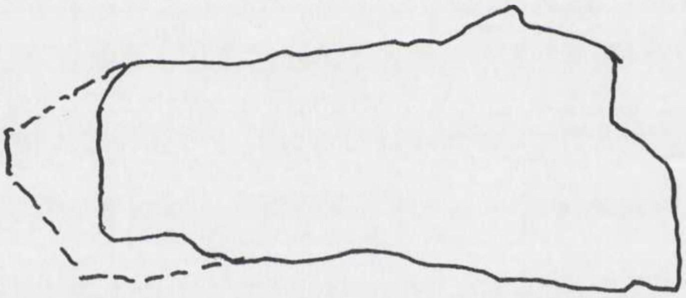


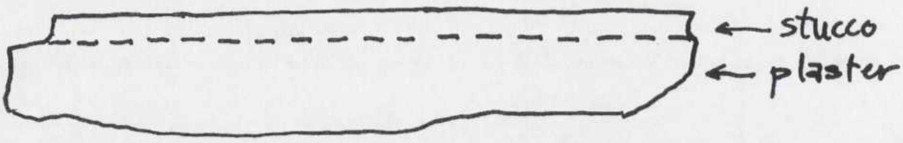
Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: Not scheduled
Object: Stucco panel, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: Surface: 85 x 30; stucco: 3; plaster: 11
Photos: Colour slide, after cleaning.

Description
The stucco fragment is flat and must have been at the central part of a panel, since there are no signs of any border. The stucco layers are white and contain marble grains, which are also visible on the white and smooth surface. The plaster was made of lime and homogeneously grained sand, mainly consisting of sand grains and glassy particles less than 1 mm Ø and with a few inclusions of red and brown grains of larger size, 4-5 mm Ø.

State of preservation
The stucco is hard and solid and the surface is covered with deposits.

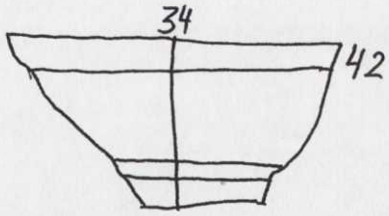
Interventions
A 2 hour application of ammonium carbonate in paper pulp was made and followed by cleaning with deionized water and a soft nylon brush. A further 10 application of Viscor was made and followed by cleaning with deionized water and a soft brush. An application of saponified wax was made on part of the surface. After treatment it was polished and then the application was removed with acetone. There are no remaining signs of the wax application on the surface.





Scale 1:1

Fragment TPP D



Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: Not scheduled
Object: Stucco profile, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: Surface: 34 x 42; stucco: 3; plaster: 5
Photos: Colour slide, before cleaning; after cleaning; test photo; after final treatment.

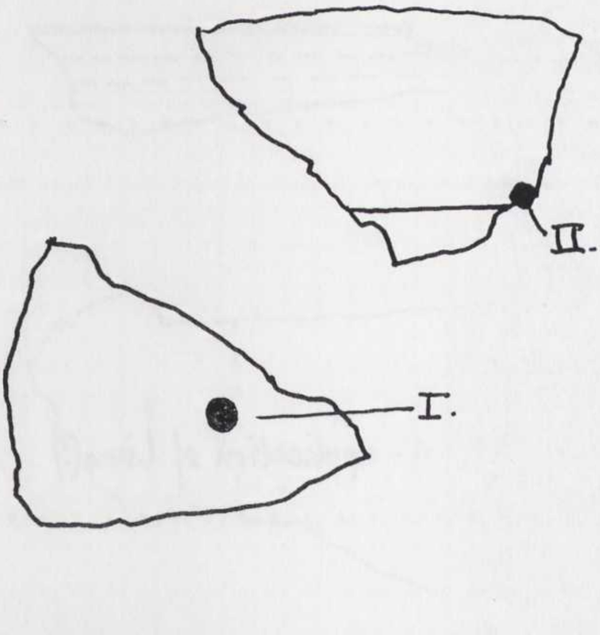
Description
This is a fragment of a stucco profile, probably deriving from a cornice. The underlying stucco contains very small size glassy black particles, and the upper layer is all white. Inclusions of grains are of a size less than 1 mm Ø.

State of preservation
The stucco is very brittle and is sanding by touch. The outer surface is rather hard. Samples were removed before cleaning, with the object to study the composition of the brittle stucco (gypsum?).

Interventions
A 2 hour application of ammonium carbonate in paper pulp was made and followed by cleaning with deionized water and a soft brush. Samples were removed for analysis of stucco and plaster.

Samples
TPP D I. Stucco from the backside (gypsum?)
TPP D II. Stucco from the surface

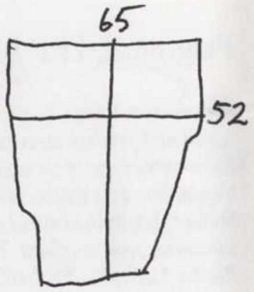
Chemical-technical investigation made at Opificio
Calcite crystals (alabaster) were identified in sample II.



I, II -cross-sections

Scale 1:1

Fragment TPP E



Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: Not scheduled
Object: Stucco profile, column cover
Subject: 1st style (2nd - 1st century BC)
Measures, mm: Surface: 52 x 65; stucco: 5; plaster: 2-5
Photos: Colour slide, before cleaning; profile; after cleaning.

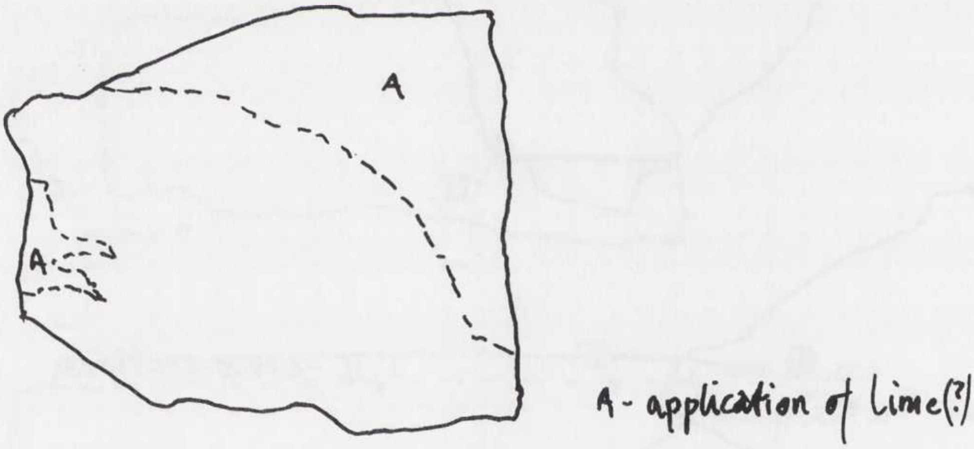
Description
This fragment was part of a stucco covering a column. The stucco layer contains roughly 1 mm Ø marble grans.

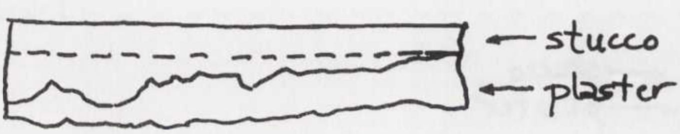
State of preservation
The stucco is hard and solid. Some light brown application of another material, maybe lime, has been made at part of the fragment.

Interventions
A 2 hour application of ammonium carbonate in paper pulp was made and followed by cleaning with deionized water and a soft brush.

Samples
TPP E I. The surface application (lime?)
TPP E II. The stucco

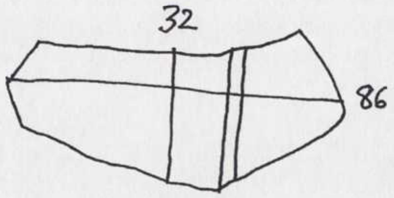
Chemical-technical investigation made at Opificio
Calcite crystals (alabaster) were identified in sample II.





Scale 1:1

Fragment TPP F

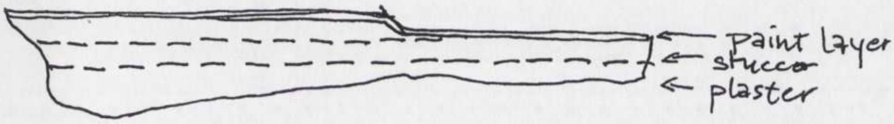


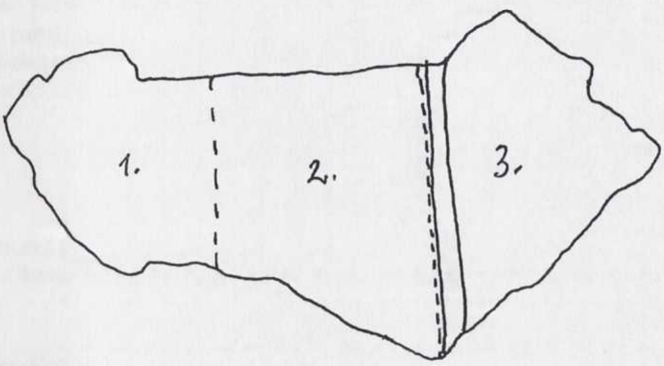
Provenance: Prima Porta, Torre di Livia
Location: Cisterna meridionale
Excavation date: Not scheduled
Object: Stucco panel with profile, wall decoration
Subject: 1st style (2nd - 1st century BC)
Measures, mm: Surface: 86 x 32; stucco: 6 (1+2+3); plaster: 3
Photos: Colour slide, before cleaning: after cleaning; after application of surface materials.

Description
Stucco fragment with a parametric flat and depressed border. The surface is black and smooth. The plaster was made of lime and homogeneously grained sand, mainly consisting of sand grains and glassy particles less than 1 mm Ø.

State of preservation
The stucco is hard and solid and the surface is covered with deposits.

Interventions
A 2 hour application of ammonium carbonate in paper pulp was made and followed by cleaning with deionized water and a soft nylon brush. The surface was divided in three parts, with the object of testing surface protectives, in order to observe possible future changes as well as the aesthetic aspect of the different areas.
Area 1: saponified wax
Area 2: no surface application
Area 3: Paraloid B72





Scale 1:1

APPENDIX IV

Case study 4c:

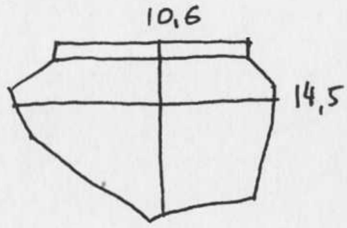
Villa of Livia at Prima Porta outside Rome
Investigation of materials used in Roman murals from the First style to the Post-Pompeian period

Inventory

First style fragments from the Republican period (200-80BC)
Third style fragments from the Augustan period (27BC-AD14)
Post-pompeian fragments from the Antonine period (AD 138-193)
Post-Pompeian fragments from the Severan period and later (AD 250-350)

TPP 426371/73

Provenance: Prima Porta, Torre di Livia.
Excavation date: 1985
Object: Stucco relief panel, wall decoration.
Subject: First style (2nd -1st century BC)
Measures: 10,6 x 14,5 cm.
Stucco: 9 mm.
Plaster: 1,6 mm.



Description

Fragment of a black stucco panel with a white depressed border. Cleaned with deionised water and a soft brush. The colour was stable.

Samples

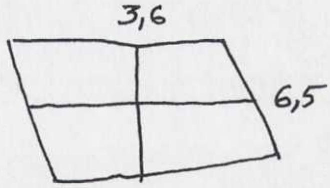
52. From the inferior layer with dark grains.
53. Large green crystal.
54. Black on preparation.
55. White on preparation.

Chemical-technical investigation made at Opificio

Optical microscopy
Sample 52: 2 paint layers. 1 - a black layer consisting of carbon. 2 – a very fine layer of bitumen. Inclusions of olivine and serpentine crystals create a sensation of green.
Sample 53: A large dark grain, surrounded by longitudinal, half-transparent olive green crystals, identified as olivine or serpentine by FTIR.
Sample 54: 2 layers. 1 - preparation with large transparent crystals. 2 - a thin application of a coating containing an organic pigment.
Sample 55: Only preparation with large alabaster crystals.
FTIR: Calcite, silicates (ochres).

TPP 426383

Provenance: Prima Porta, Torre di Livia.
Excavation date: 1985.
Object: Stucco panel, wall decoration.
Subject: First style (2nd - 1st century BC)
Measures: 3,6 x 6,5 cm.
Stucco: 9 mm.
Plaster: 5 mm.



Description

Fragment of a stucco panel with a false marble decoration. Upon the white background colour is painted decoration in yellow and pale green. Cleaned with deionised water and a soft brush. The colours were stable. (Paraloid ?)

Samples

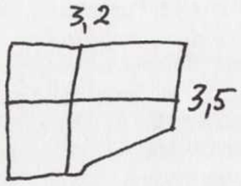
65. Brown on green on yellow, various particles.

Chemical-technical investigation made at Opificio

Optical microscopy
3 layers. 1 - irregular layer (30 μm) of *terra verde*. 2 - pinkish layer (40 μm) containing a few grains of red ochre. 3 - black and red layer containing an elevated quantity of carbon black pigment.
FTIR analysis of the green pigment: calcite, *terra verde*, kaolin, a synthetic polymer.
SEM-EDS examination of the sample shows an upper layer of red ochre with inclusions of black grains. Cinnabar grains in the preparation. The preparation contains lime with grains of feltspati, silice and traces of Ti.

TPP 426386

Provenance: Prima Porta, Torre di Livia.
Excavation: 1985
Object: Stucco panel, wall-painting.
Subject: First style (2nd - 1st century BC).
Measures: 3,2 x 3,5 cm.
Stucco: 4 mm.
Plaster: 7 mm.



Description

Fragment of a stucco panel with a false marble decoration in red upon a white preparation. Cleaned with deionised water and a soft brush. The colours were stable. (Paraloid ?)

Samples

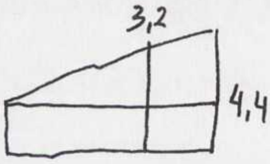
56. Pink on white.

Chemical-technical investigation made at Opificio

Optical microscopy
2 layers. 1 - preparation with large crystals. 2 - thin pink paint layer. The pink colour, was finely ground cinnabar, in which small black grains were visible.
FTIR and *microanalysis* of the red colour revealed that it was cinnabar.

TPP 426446

Provenance: Prima Porta, Torre di Livia.
Excavation: 1985.
Object: Stucco panel, wall-decoration.
Subject: First style (2nd - 1st century BC).
Measures: 3,2 x 4,4 cm.
Stucco: 5 mm.
Plaster: 7 mm.



Description

Fragment of a red stucco panel with a decoration of yellow and black borders. Cleaned with deionised water and a soft brush. The colours were stable.

Samples

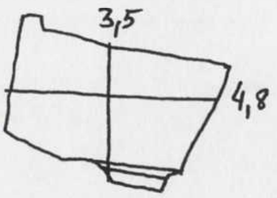
57. Black on red.
58. Red.

Chemical-technical investigation made at Opificio

Optical microscopy
Sample 57: 2 layers. 1 - preparation containing large transparent crystals. 2 - a thin black layer, visible only in UV light. Red pigments were observed in UV-light.
Sample 58: 3 layers. 1 - white preparation with large calcite crystals (alabaster). 2 - thick red layer, probably two thin layers, with red fluorescence. 3 - irregular half-transparent, greyish layer.
FTIR analysis of the red pigment: calcite, hematite, silicates.

TPP 426458

Provenance: Prima Porta, Torre di Livia.
Excavation: 1985.
Object: Stucco panel with profile, wall preparation.
Subject: First style (2nd - 1st century BC).
Measures: 3,3 x 4,8 cm.
Stucco: 6 mm.
Plaster: 2 mm.



Description

Yellow panel with a depressed black border. Cleaned with deionised water and a soft brush. The colours were stable.

Samples

59. Black.
60. Yellow.

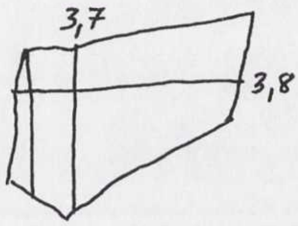
Chemical-technical investigation made at Opificio

Optical microscopy

Sample 59: 2 layers. 1 - white preparation with a pinkish fluorescence towards the surface, containing large transparent crystals. 2 - very thin, half-transparent black layer, visible only in UV-light.
Sample 60: 2 layers. 1 - preparation. 2 - a thick yellow paint layer of yellow ochre.
FTIR analysis of the yellow colour: calcite, yellow ochre, silicates.

TPP 426465

Provenance: Prima Porta, Torre di Livia.
Excavation:1985.
Object: Stucco panel with profile, wall-decoration.
Subject: First style (2nd - 1st century BC).
Measures: 3,7 x 3,8 cm.
Stucco: 6 mm.
Plaster: 3 mm.

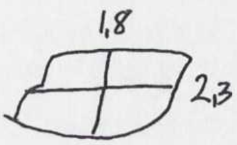


Description

Fragment of a yellow stucco panel with a depressed black border. Cleaned with deionised water and a soft brush. The colour was stable.

TPP 426474

Provenance: Prima Porta, Torre di Livia.
Excavation: 1985.
Object: Stucco panel, wall-decoration.
Subject: First style (2nd - 1st century BC).
Measures: 1,8 x 2,3 cm.
Stucco: 9 mm.
Plaster: 0.



Description

Fragment of a pale green stucco panel with no remains of plaster. Cleaned with deionised water and a soft brush. The colour was stable.

Samples

61. Green

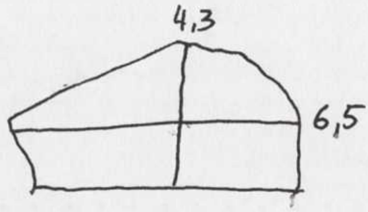
Chemical-technical investigation made at Opificio

Optical microscopy

2 layers. 1 - preparation containing large calcite crystals. 2 - irregular layer of green paint (*terra verde*) with a uniform half-transparent appearance.
FTIR analysis of the green colour: calcite, *terra verde*, a little kaolin.

TPP 426478

Provenance: Prima Porta, Torre di Livia.
Excavation: 1985.
Description: Stucco panel, wall-decoration.
Subject: First style (2nd - 1st century BC).
Measures: 4,3 x 6,5 cm
Stucco:
Plaster:



Description

Fragment of a red stucco panel. Cleaned with deionised water and a soft brush. The colour was stable.

Samples

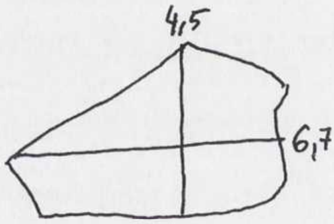
62. Red and stucco.
63. Red on pink.

Chemical-technical investigation made at Opificio

Optical microscopy of
Sample 62: 2 layers. 1 - white preparation with large calcite crystal, some with an icy white fluorescence, others pinkish or yellowish.. 2 - thick red paint layer (75µm) of red ochre with a reddish fluorescence. Uniform colour and pigment very finely ground.
FTIR analysis of the red colour: calcite, red clay (*bolo*).
Sample 63: 2 layers. 1 – paint layer, as above. 2 - greyish layer (earth ?).

TPP 426486

Provenance: Prima Porta, Torre di Livia.
Excavation: 1985.
Object: Stucco panel, wall-decoration.
Subject: First style (2nd - 1st century BC).
Measures: 4,5 x 6,7 cm.
Stucco: 7 mm
Plaster: 3 mm.



Description

Fragment of a violet stucco panel. The fragment was cleaned with deionised water and a soft brush. The colour was stable.

Samples

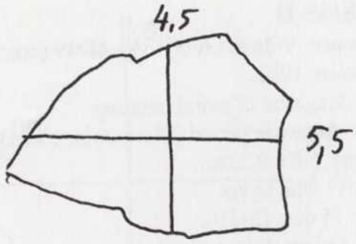
64. Violet.

Chemical-technical investigation made at Opificio

Optical microscopy
2 layers. 1 - preparation with large transparent calcite crystals (alabaster), some linear. 2 - thick red-brown layer (100 µm), containing large grains of carbon black in red ochre.
FTIR analysis of the red colour: calcite, red ochre, an organic material, not identified.

TPP 427865 B.

Provenance: Prima Porta, Torre di Livia.
Excavation: 1985.
Object: Stucco panel with profile, wall-decoration.
Subject: First style (2nd - 1st century BC).
Measures: 4,5 x 5,5 cm.
Stucco: 6 mm.
Plaster: c.15 mm.

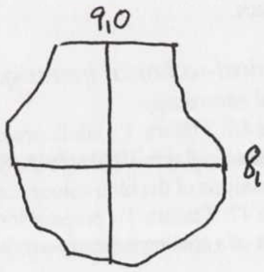


Description

Fragment of a white stucco panel with remains of red paint.
Cleaned with deionised water and a soft brush. The colours were stable.

VL 48/49 A

Provenance: Villa di Livia, room 48/49 (corridor).
Excavation: 1982.
Object: Fragment of mural painting.
Subject: Augustan period (Third style, c.15 BC-AD10).
Measures: 9 x 8,5 cm.
Stucco: 11 mm, 1 layer
Plaster: 22 mm.
Photos: Colour slide, surface.



Description

The fragment has a decoration in borders made in black, white and pale green. The stucco layer is milky white, probably containing much lime. The plaster layer is distinctly grey. One side of the fragment has a flat surface which indicates it probably derives from an opening or an angle. The fragment was cleaned with deionised water and a soft brush. Cleaned with deionised water and a soft brush. The colours were stable.

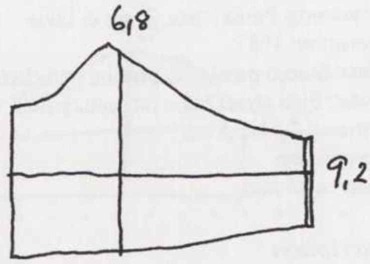
Samples

44. White on black.
45. White and blue-green on black

Chemical-technical investigation made at Opificio

Optical microscopy
Sample 44: 3 layers. 1 - remains of preparation. 2 - very thick black paint layer (400 µm), carbon black or bitumen. 3 - very thick, compact white layer (100-120µm) with intense white fluorescence.
Sample 45: 3 layers. 1 - preparation with large calcite crystals. 2 - very thick black paint layer (600 µm). 3 - thick and irregular blue paint layer (max. 100 µm). There may be two layers, since the inferior part appears to have a greenish hue. A second fragment: Preparation as above; thick and irregular black paint layer; regular and thin green layer containing terra verde; partial and fragmentary remains of a beige coating containing one blue crystal.
FTIR analysis of the green colour: calcite, terra verde. *Chemical microanalysis* revealing Fe.
FTIR analysis of the white line: calcite, silicates, an organic substance.
FTIR analysis of the black colour: calcite, carbon, a synthetic polymer.
SEM-EDS examination. The superior lime layer contains Mg, Si and Al. The preparation consists of only lime.

VL 48/49 B



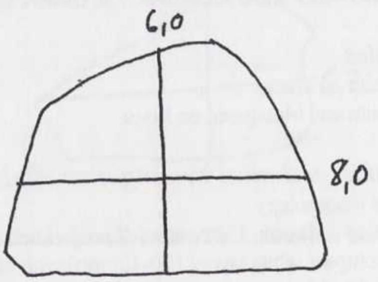
Provenance: Villa di Livia, room 48/49 (corridor).
Excavation: 1982.
Object: Fragment of mural painting.
Subject: Augustan period (Third style, c.15 BC-AD10).
Measures: 6,8 x 9,2 cm.
Stucco: 11 mm, layers.
Plaster: 15 mm. (5+10).
Photos: Colour slide, surface.

Description
The fragment has a decoration in blue-green and white on a black background. The stucco layers are milky white, and the rough plaster layer of the same colour. The fragment was situated at an angle, indicated by a flat side, and furthermore by the stucco which is slightly bent upwards, following the angle.

Samples
46. Blue on black.
47. Black.

Chemical-technical investigation made at Opificio
Optical microscopy
Sample 46: 3 layers. 1 - white preparation with transparent crystals. 2 - thick black paint layer. 3 - thick and irregular layer of blue paint similar to VL 48/49 A. The underlying half-transparent green layer was evident.
FTIR analysis of the blue colour: calcite, Egyptian blue.
Sample 47: 2 layers. 1 - preparation containing large crystals. 2 - very thick black layer, with an apparently organic pigment, remains of a coating.

VL. 48/49 C



Provenance: Villa di Livia, room 48/49 (corridor).
Excavation: 1982.
Object: Fragment of mural painting.
Subject: Augustan period (Third style, c.15 BC-AD10).
Measures: 6,0 x 8,0 cm.
Stucco: 13 mm, layers.
Plaster: 5 mm.
Photos: Colour slide, surface.

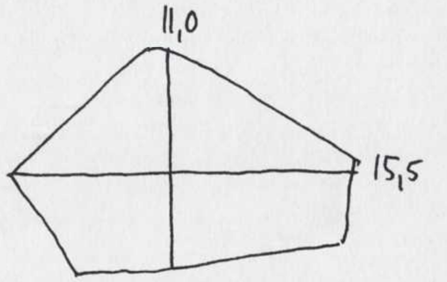
Description
The fragment has a decoration in bright red and white on a black background. The stucco consisted of more than one layer. Cleaned with deionised water and a soft brush. Colours resistant.

Sample
48. Red on black.

Chemical-technical investigation made at Opificio
Optical microscopy
5 layers. 1 - white preparation with many large calcite crystals. 2 - irregular and thick grey layer, pigmented with finely ground carbon black. 3 - thin and regular white layer (10 µm). 4 - red paint layer (25 µm), of which the lower part is yellow and the upper has an intense red colour. 5 - irregular layer of accumulated materials.
FTIR analysis of the red colour: aragonite, calcite, red ochre.
FTIR analysis of the black colour: calcite, carbon black, silicates.

VL. 48/49 D

Provenance: Villa di Livia, room 48/49 (corridor).
Excavation: 1982.
Object: Fragment of mural painting.
Subject: Augustan period (Third style, c.15 BC-AD10).
Measures: 11,0 x 15,5 cm.
Stucco: 11 mm, layers.
Plaster: 23 mm (5 + 18 mm).
Photos: Colour slide, surface.



Description

The fragment has a decoration made in red, blue and white on a black background. The stucco as well as the plaster were applied in layers. Cleaned with deionised water and a soft brush. Colours resistant.
Selected for material analyses.

Samples

49. Blue on black.
50. Red on pink.

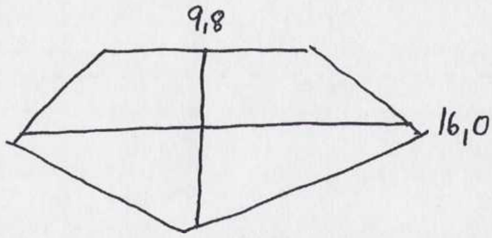
Chemical-technical investigation made at Opificio

Optical microscopy

Sample 49: 3 layers. 1 - preparation. 2 - thin pink paint layer with a light redish fluorescence, apparently finely ground cinnabar. 3 - irregular blue layer (max. 20 µm) of Egyptian blue.
FTIR analysis of the blue colour: Egyptian blue, calcite.
FTIR analysis of the red colour: calcite, aragonite, silicates, an organic substance. *Microanalysis*: cinnabar.
Sample 50: 1 layer. A thin red layer similar to the second layer of the previous sample.

VL. 48/49 E

Provenance: Villa di Livia, room 48/49 (corridor).
Excavation: 1982.
Object: Fragment of mural painting.
Subject: Augustan period (Third style, c.15 BC-AD10).
Measures: 9,8 x 16,0 cm.
Stucco: 11 mm, layers.
Plaster: 5 mm.
Photos: Colour slide, surface, plaster (cut surface).

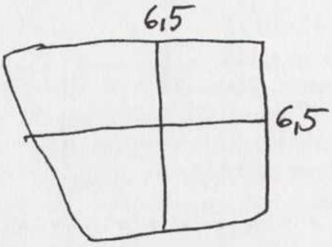


Description

The fragment has remains of red and ochre colours on a black background. The stucco was applied in layers. The plaster was fine grained. Cleaned with deionised water and a soft brush.

VL. 48

Provenance: Villa di Livia, room 48 (small garden).
Excavation: 1998.
Object: Fragment of mural painting.
Subject: Augustan period (Third style, c.15 BC-AD10).
Measures: 6,5 x 6,5 cm.
Stucco: 15 mm.
Plaster: 21 mm, layers.
Photos: Colour slide, surface.



Description

The fragment is monochrome bright red on ochre. The stucco was applied in layers. The distinctly dark grey plaster was applied in layers. Cleaned with deionised water and a soft brush. Selected for material analyses.

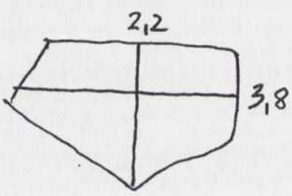
Sample

51. Red (on ochre?).

Chemical-technical investigation made at Opificio
Optical microscopy
2 lasyers. 1 - preparation without no alabaster crystals, but inclusions of organic and biological material. 2 - thin red paint layer (75 µm) based on finely ground cinnabar, with a red-violet fluorescence.
FTIR analysis of the red colour: calcite, silicates, an organic substance. *Microanalysis*: cinnabar.

VL. 11

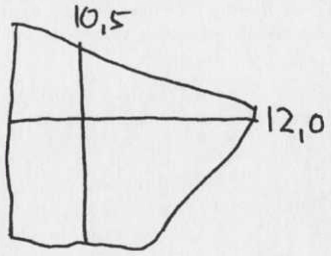
Provenance: Villa di Livia, room 11.
Excavation: 1982.
Object: Fragment of mural painting.
Subject: Augustan period (Third style, c.15 BC-AD10).
Measures: 2,2 x 3,8 cm.
Stucco: 12 mm, in layers.
Plaster: 0
Photos: Colour slide, surface.



Description

The fragment is monochrome cinnabar red. The stucco is white and contains medium sized grains of inclusions. Cleaned with deionised water and a soft brush.

VL. 44 A



Provenance: Villa di Livia, room 44.
Excavation: 1982.
Object: Fragment of a mural painting.
Subject: Antonine period (138-193).
Measures: 10,5 x 12,0 cm.
Stucco: 4 mm.
Plaster: 18mm, homogeneous.
Photos: Colour slide, surface.

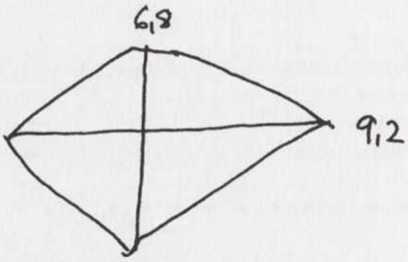
Description
The fragment has a decoration in borders, made in various shades of red, pink, ochre and brown. The plaster is homogeneous. Cleaned with deionised water and a soft brush.

Samples
32. Red and wine red and stucco.
33. Pink.
34. Ochre.
35. Brown.

Chemical-technical investigation made at Opificio
Optical microscopy
Sample 32: 3 layers. 1 - white preparation with large transparent crystals. On the upper part, irregular yellowish fluorescence. 2 - regular red paint layer (50 μm). Cinnabar with reddish fluorescence. 3 - partial and irregular white layer.
FTIR analysis of the red colour: calcite, silicates. *Microanalysis*: cinnabar.
SEM-EDS examination: The irregular white layer resulted to be calcium. It could be a saponified wax or a film of crystalline calcium carbonate. The presence of wax or saponified wax was confirmed at FTIR analysis.
Sample 33: 3 layers. 1 - white preparation with large alabaster crystals. 2 - a thick layer (70 μm) of a lemon-yellow hue with a light sand-brown fluorescence, in which red grains appear. The pigment is of organic nature. 3 - thin regular pink layer, pigmented with red ochre and cinnabar.
FTIR analysis of the yellow colour: calcite, Roman ochre (kaolin + yellow ochre).
SEM-EDS examination of the yellow area: The paint has a dark-yellow fluorescence. Presence of Fe, traces of Si, Al and a yellow organic substance of uncertain origin, probably a sap.
Sample 34: 2 layers: 1 - preparation containing large calcite crystals. 2 - regular lemon-yellow paint layer.
Sample 35: -

VL. 44 B

Provenance: Villa di Livia, room 44.
Excavation: 1982.
Object: Fragment of a mural painting.
Subject: Antonine period (138-193).
Measures: 6,8 x 9,2 cm.
Stucco: 8 mm, in layers.
Plaster: 10 mm, homogeneous.
Photos: Colour slide, surface.



Description

The fragment has a decoration made in borders of earth colours such as grey, brown and ochre.
The plaster was very white, containing much lime.

Samples

36. Ochre and beige.
37. Brown.
38. Grey.
39. Stucco.

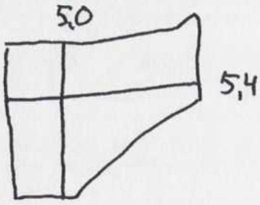
Chemical-technical investigation made at Opificio

Optical microscopy

Sample 36: 3 layers. 1 - preparation with large calcite crystals. 2 - thick light yellow layer (75 μm) pigmented with yellow ochre. Possible to distinguish in UV because of the sand-brown fluorescence. 3 - remains of a yellow layer.
FTIR analysis of the yellow colour: calcite, aragonite, yellow ochre.
Sample 37: 4 layers: 1 - preparation containing alabaster crystals. 2 - a thick layer (150 μm) containing transparent blue crystals, some cinnabar and yellow ochre. 3 - thin wine-red layer of red ochre and black grains. 4 - remains of a coating and calcium carbonate.
FTIR analysis of the red-brown colour: calcite, aragonite, ochre.
Sample 38: Identical to 37, but more diluted.
Sample 39: The stucco was of the same composition as above.

VL. 44/53

Provenance: Villa di Livia, room 44/53 (corridor).
Excavation: 1982.
Object: Fragment of mural painting.
Subject: Antonine period (138-193).
Measures: 5,0 x 5,4 cm.
Stucco: 5 mm.
Plaster: 11 mm.
Photos: Colour slide, surface.



Description

The fragment has a decoration in blue-green, red, white and brown on an ochre coloured background.
The plaster was very white, containing much lime.

Samples

40. Blue on yellow.
41. Red on white on ochre.

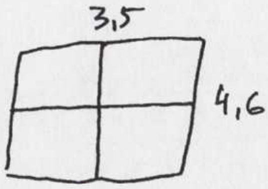
Chemical-technical investigation made at Opificio

Optical microscopy

Sample 40: 2 layers. 1 - preparation containing calcite crystals. 2 - green layer (50 μm) containing blue crystals and terra verde.
FTIR analysis of the blue colour: calcite, Egyptian blue.
Sample 41: 5 layers. 1- intensely yellow layer. 2 – thick light sand-coloured layer (75 μm). 3 – regular white layer (50 μm), with intense white fluorescence. 4 – irregular red layer (max. 50 μm), of red ochre with light brownish fluorescence. 5 – thin layer of a material with intense white fluorescence.
FTIR analysis of the yellow colour: calcite, yellow ochre.
FTIR analysis of the red colour: calcite, red ochre.

VL. 45

Provenance: Villa di Livia, room 45.
Excavation: 1982.
Object: Fragment of mural painting.
Subject: Antonine period (138-193).
Measures: 3,5 x 4,6 cm.
Stucco: 5 mm.
Plaster: 10 mm.
Photos: Colour slide, surface



Description

The fragment has a decoration in various green colours, and some brown, suggesting a garden motif. The plaster was very fine grained and contained much lime. Cleaned with deionised water and a sponge. (Previously cleaned).

Samples

42. Green.
43. Brown.

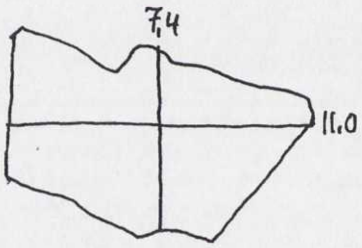
Chemical-technical investigation made at Opificio

Optical microscopy

Sample 42: 3 layers. 1 – White preparation containing large calcite crystals (alabaster). 2 – irregular green-blue layer consisting of blue crystals and grains of terra verde. 3 – remains of a coating.
FTIR analysis of the blue colour: calcite, aragonite, Egyptian blue.
Sample 43: 2 layers. 1 – white preparation. 2 – thin brown layer (25 µm), containing black, yellow and red grains, and one green crystal.

VL. 43A

Provenance: Villa di Livia, room 43 (atrium).
Excavation: 1982.
Object: Mural fragment.
Subject: Antonine period (138-193).
Measures: 7,4 x 11 cm.
Stucco: 6 mm, 2 layers.
Plaster: 5 mm. (grey) + 15 mm rough.
Photos: Colour slide, surface, plaster (cut surface in profile).



Description

Decoration in pale green and light blue on a white background. Some highlights in yellow and ochre. Cleaned with deionised water and soft brush. The dirt was easily removed. The colours were stable.

Samples

23. Green paint and stucco.
24. Blue paint and stucco.
25. Thin section, all layers.

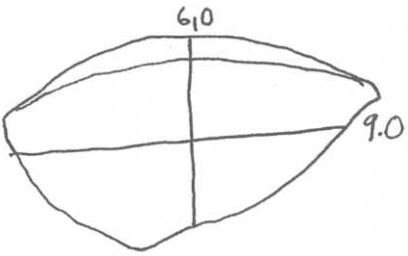
Chemical-technical investigation made at Opificio

Optical microscopy

Sample 23: 2 layers. 1 – white preparation. 2 – irregular and partial yellowish green layer, containing mainly yellow ochre some blue, red, and black grains.
Sample 24: 3 layers. 1 – white preparation containing transparent crystals. 2 - a thick layer calcium (250 µm). 3 – thick blue layer (110 µm), containing light blue crystals (Egyptian blue). Another fragment from the same sample had a third partial irregular grey coating.
Sample 25: Only stucco.

VL 43 B

Provenance: Villa di Livia, room 43 (atrium).
Excavation: 1982.
Object: Mural fragment.
Subject: Antonine period (138-193).
Measures: 6 x 9 cm.
Stucco: 7 mm, 2 layers.
Plaster: 6 mm (grey) + 12 mm (rough).
Photos: Colour slide, surface, plaster (uncut and cut surface in profile).



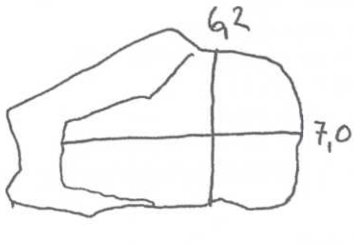
Description
Decoration in red, black and white borders.
Cleaned with deionised water and a soft brush. The dirt was easily removed. Incrustations remained. The colours were stable.

Samples
26. Blue paint and stucco.
27. Red paint and stucco.

Chemical-technical investigation made at Opificio
Optical microscopy
Sample 26. 4 layers. 1 – white preparation with a yellow and pink fluorescence, containing small calcite crystals. 2 – thick and irregular orange-yellow paint layer with a brownish fluorescence. 3 – white layer with intensely white fluorescence. 4 – thick gray layer containing grains of carbon black and large transparent blue crystals (Egyptian blue).
Sample 27: 2 layers. 1 – white preparation with yellow and pink fluorescence, containing small calcite crystals. 2 – Thick and irregular orange layer with brownish fluorescence.

VL 43 C

Provenance: Villa di Livia, room 43 (atrium).
Excavation: 1982.
Object: Mural fragment.
Subject: Antonine period (138-193).
Measures: 6,2 x 7 cm.
Stucco: 9 mm, 2 layers.
Plaster: 5 mm (grey) + 20 mm (rough).
Photos: Colour slide, surface.



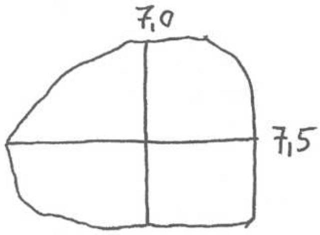
Description
Decoration in light blue, bright red, brown and ochre on a white background. Cleaned with deionised water and a soft brush. The dirt was easily removed. The colours were stable.

Samples
28. Blue paint and stucco.
29. Red paint and stucco.

Chemical-technical investigation made at Opificio
Optical microscopy
Sample 28: 3 layers. 1 – white preparation with yellow-brownish half-transparent crystals. 2 – irregular light blue paint layer (100 μm), containing some Egyptian blue. 3 –partial grey layer, containing grains of carbon black.
Sample 29: 3 layers. 1 – white preparation containing half-transparent yellow-brown crystals. 2 – irregular light blue layer (Egyptian blue). 3 - thin red layer , on basis of cinnabar, with reddish fluorescence.
FTIR analysis and *microanalysis* of the red pigment: cinnabar.

VL 43 D

Provenance: Villa di Livia, room 43 (atrium).
Excavation: 1982.
Object: Mural fragment.
Subject: Antonine period (138-193).
Measures: 7 x 7,5 cm.
Stucco: 3 mm.
Plaster: 10 mm (rough).
Photos: Colour slide, surface.



Description

Decoration in red, brown and pale blue on a white background. The surface is very deteriorated and partially worn off. The plaster was very white and contained shiny particles, maybe alabaster. Cleaned with deionised water and a soft brush. The dirt was easily removed. The colour was stable.

Sample

30. Red and blue and stucco.

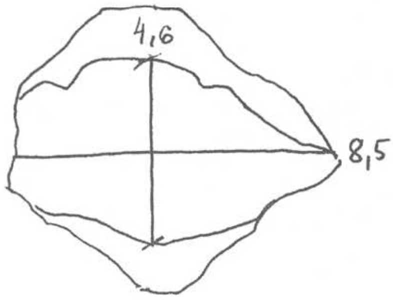
Chemical-technical investigation made at Opificio

Optical microscopy

2 layers. 1 - a greyish preparation containing large alabaster crystals and fine black grains. 2 – thin red-brown paint layer (20 μm), made of cinnabar and carbon black.
FTIR analysis of the red paint: calcite, aragonite, silicates, quartz. *Microanalysis*: cinnabar.
FTIR analysis of the brown paint: calcite, aragonite, brown earth, quartz.

VL 43 E

Provenance: Villa di Livia, room 43 (atrium).
Excavation: 1982.
Object: Mural fragment.
Subject: Antonine period (138-193).
Measures: 4,6 x 8,5 cm.
Stucco: 9 mm, 2 layers.
Plaster: 5 mm (grey) + 16 mm (rough).
Photos: Colour slide, surface.



Description

Red monochrome surface. Cleaned with deionised water and a soft brush. The dirt was easily removed. Colours stable.

Sample

31. Red and stucco.

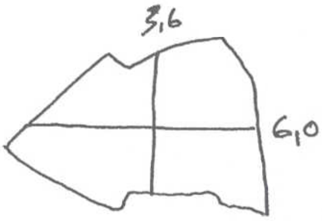
Chemical-technical investigation made at Opificio

Optical microscopy

4 layers: 1 – white preparation containing large transparent crystals, yellow dots and a few black grains. 2 – irregular brownish half-transparent layer with grey fluorescence, containing some black grains. 3 – thin red-brown paint layer (15-20 μm), containing red ochre and carbon black. 4 – partial light grey application with intense white fluorescence.
FTIR analysis of the red paint: calcite, a little aragonite, red bolus, and an organic substance.
SEM-EDS examination: Preparation made of feltspatic lime, containing calcite, silicate grains and quartz. The red layer made of red bolus and a vivid red ochre (Fe). There are large black grains of carbon. In the surface, an irregular layer containing lime.

VL. 14A I

Provenance: Villa di Livia, room 14 A.
Excavation: 27.10.99.
Object: Fragment of a plastered socle.
Subject: Late Roman (c. 250-350).
Measures: 3,6 x 6,0 cm.
Stucco: 5mm.
Plaster: 15 mm (10 + 5).
Photos: Colour slide, surface.



Description

The fragment is white with a decoration in green paint.
Cleaned with deionised water, scalpel and a soft brush. The calcareous incrustations were rather easily removed.

Sample

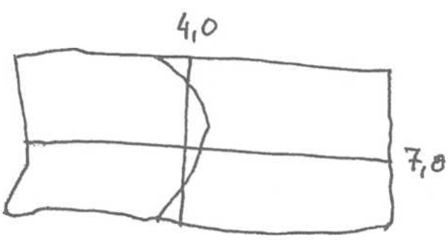
13. Green paint and stucco.

Chemical-technical investigation made at Opificio

Optical microscopy
3 layers: 1 – white preparation with few fine inclusions. 2 – paint layer (60 μm), based on *terra verde*. 3 – partial remains of a grey layer.

VL.14A II

Provenance: Villa di Livia, room 14 A.
Excavation: 27.10.99.
Object: Fragment from the stucco ceiling.
Subject: Late Roman (c. 250-350).
Measures: 4,0 x 7,0 cm.
Stucco: 5 mm.
Plaster: 30 mm (10 + 20).
Photos: Colour slide, surface, back side, profile.



Description

The fragment is dark red with a decoration in white (lime preparation). On the backside are relief marks of the canes. Cleaned with deionised water an a soft brush. The calcareous incrustations were rather easily removed. The red colour was stable.

Samples

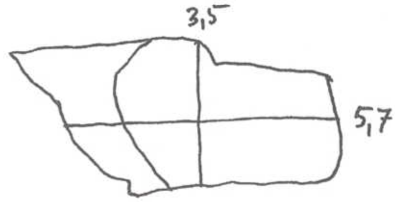
14. Red, white and stucco.

Chemical-technical investigation at Opificio

Optical microscopy
2 layers. 1 - white preparation. 2 – thin and regular red-orange paint layer (25μm).

VL. 14A III

Provenance: Villa di Livia, room 14 A.
Excavation: 27.10.99.
Object: Fragment from the stucco ceiling.
Subject: Late Roman (c. 250-350).
Measures: 3,5 x 5,7 cm.
Stucco: 5 mm.
Plaster: 21 mm.
Photos: Colour slide, surface.



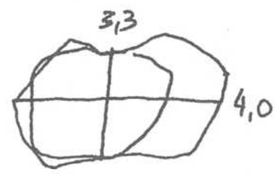
Description
The fragment is dark red and probably part of the ceiling. Cleaned with deionised water and a soft brush. The calcareous incrustations were rather easily removed. The colour is stable.

Samples
15. Dark red paint and stucco.

Chemical-technical investigation at Opificio
Optical microscopy
3 layers. 1 – preparation without inclusions. 2 – regular red-brown paint layer (40µm) with some inclusion of black grains. 3 – remains of a coating with intense white fluorescens.

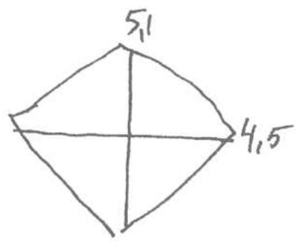
VL. 14A IV

Provenance: Villa di Livia, room 14 A.
Excavation: 27.10.99.
Object: Fragment from the stucco ceiling.
Subject: Late Roman (c. 250-350).
Measures: 3,3 x 4,0 cm.
Stucco: 5 mm.
Plaster: 15 mm.
Photos: Colour slide, surface.



Description
The dark red fragment was cleaned with deionised water and a soft brush. The calcareous incrustations were easily removed, and the colour is stable.

VL. 14A V



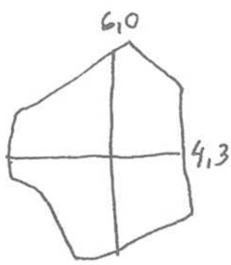
Provenance: Villa di Livia, room 14A.
Excavation: 1999.
Object: Fragment from the stucco ceiling.
Subject: Late Roman (c. 250-350).
Measures: 5,1 x 4,5 cm.
Stucco: 3 mm.
Plaster: c.10 mm.
Photos: Colour slide, surface.

Description
The fragment has a decoration in borders, painted in red, pink, white and green. Cleaned with deionised water, a scalpel and a soft brush. The colours were stable.

Samples
16. Green paint and stucco.
17. Stucco.
18. White, grey, and stucco.
19. Grey, white, pink, some red and stucco.
20. Red and stucco.

Chemical-technical investigation made at Opificio
Optical microscopy
Sample 16: 4 layers. 1 - preparation with few and fine inclusions. 2 – thin green layer (20 µm), *terra verde*. 3 – at the other end of the fragment, instead of the green layer, a thick paint layer made of a mixture of finely ground red and yellow ochres. A very thin film of this layer is partially present underneath the green layer. 4 – upon the green layer, presence of a coating.
Sample 17: only preparation.
Sample 18: 2 layers. 1 – preparation rich of inclusions, particularly grains of red ochre, but also vegetal fibres and fine grains with lemon-yellow fluorescence. 2 – remains of a white layer without crystals or inclusions.
Sample 19: 2 layers. 1 - lime preparation. 2 – paint layer (60 µm) containing very fine black, red and yellow grains. Slightly pinkish fluorescence.
Sample 20: 3 layers. 1 – white preparation. 2 – irregular red-orange paint layer with a pinkish fluorescence. 3 – remains of an application with a whitish fluorescence.

VL.14A VI



Provenance: Villa di Livia, room 14A.
Excavation: 1999.
Object: Fragment from the stucco ceiling.
Subject: Late Roman (c. 250-350).
Measures: 6,0 x 4,3 cm.
Stucco: 4 mm.
Plaster: 5 mm.
Photos: Colour slide, surface, plaster (cut surface in profile).

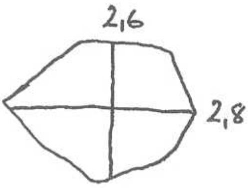
Description
The fragment probably was part of the stucco ceiling. A decoration made in borders covers the surface. The colours are ochre, black and white. Cleaned with deionised water and a soft brush. The colours were stable.

Samples
21. Brown paint and stucco.
22. Black paint and stucco.

Chemical-technical investigation made at Opificio
Optical microscopy
Sample 21: 4 layers. 1 – remains of a brown preparation containing brown vegetal fibres. 2 – thick white preparation, c. 2,5 cm, with few very fine red and yellow grains. 3 – thin red-orange paint layer. 4 – remains of a surface coating.
Sample 22: 3 layers. 1 – white preparation without calcite crystals. 2 – greyish layer containing lime and carbon black. 3 – remains of a coating or carbonated depositions.

VL. 14A VII

Provenance: Villa di Livia, room 14A.
Excavation: 1999.
Object: Fragment of mural painting.
Subject: Late Roman (c. 250-350).
Measures: 2,6 x 2,8 cm.
Stucco: 11 mm, 2 + 9.
Plaster: 0.
Photos: Colour slide, surface.

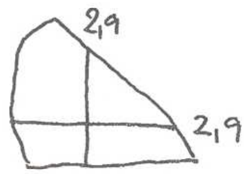


Description

The fragment has a decoration in light blue and a drawing in a red terra hue. Cleaned with deionised water and a soft brush.

VL 14B I

Provenance: Villa di Livia, room 14B (with bird decoration).
Excavation: 27.10.99.
Object: Fragment of mural painting.
Subject: Late Roman (c. 250-350).
Measures: 2,9 x 2,9 cm.
Stucco: 7 mm.
Plaster: 0.
Photos: Colour slide, surface.



Description

The red fragment was easily cleaned with deionised water and a soft brush. The red colour was not resistant.

Sample

1. Red paint and stucco.

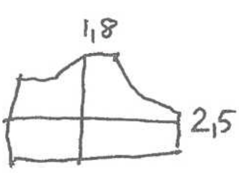
Chemical-technical investigation made at Opificio

Optical microscopy

2 layers. 1 – white preparation with yellow-brown inclusions, some of biological or organic nature. 2 – irregular orange-red layer with reddish fluorescence. Red ochre.

VL. 14B II

Provenance: Villa di Livia, room 14B (with bird decoration).
Excavation: 27.10.99.
Object: Fragment of a mural painting.
Subject: Late Roman (c. 250-350).
Measures: 1,8 x 2,5 cm.
Stucco: 9 mm.
Plaster: 0.
Photos: Colour slide, surface.

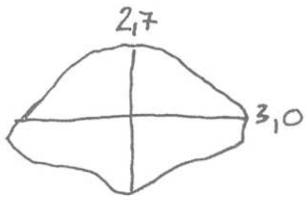


Description

The red fragment was easily cleaned with deionised water and a soft brush. The paint was stable.

VL. 14B III

Provenance: Villa di Livia, room 14B (with bird decoration).
Excavation: 27.10.99.
Object: Fragment of mural painting.
Subject: Late Roman (c. 250-350).
Measures: 2,7 x 3,0 cm.
Stucco: 2 mm.
Plaster: 7 mm.
Photos: Colour slide, surface.



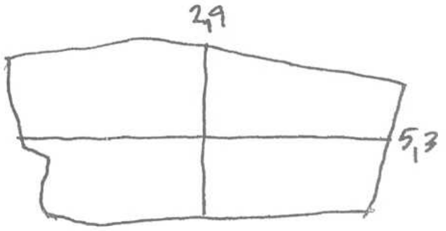
Description
The pale green fragment was easily cleaned with deionised water and a soft brush.

Sample
2. Green paint and stucco.

Chemical-technical investigation made at Opificio
Optical microscopy
2 layers. 1 – light sand-brown preparation with lots of yellow-orange inclusions of non-mineral nature. 2 – thick green paint layer (55-60 μm) with greenish fluorescence, containing half-transparent light blue crystals and grains of yellow ochre (mixture of Egyptian blue and yellow ochre).
SEM-EDS examination: Paint layer consisting of Egyptian blue and yellow ochre. At the surface there is a thin calcareous layer. Inclusions of pumice (Al, Si, Ca, K), probably a constituent of the preparation.

VL 14B IV

Provenance: Villa di Livia, room 14 B (with bird decoration).
Excavation: 27.10.99.
Object: Fragment of mural painting.
Subject: Late Roman (c. 250-350).
Measures: 2,9 x 5,9 cm.
Stucco:5 mm.
Plaster: 15 mm.
Photos: Colour slide, surface, plaster (cut surface in profile).



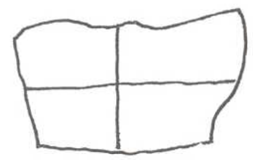
Description
The violet fragment was easily cleaned with deionised water and a soft brush.

Sample
3. Violet paint and stucco.

Chemical-technical investigation made at Opificio
Optical microscopy
2 layers. 1 – white preparation, without inclusions of calcite crystals. 2 – very thick red-brown paint layer (100 μm), on basis of red ochre and black grains (probably mineral).

VL. 14B V

Provenance: Villa di Livia, room 14 B (with bird decoration).
Excavation: 27.10.99.
Object: Fragment of stucco ceiling.
Subject: Late Roman (c. 250-350).
Measures:
Stucco:
Plaster:
Photos: Colour slide, surface, back side, profile.

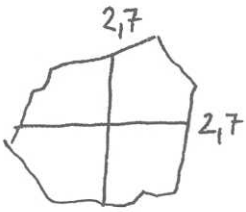


Description

The white fragment has distinct relief signs on the backside from the canes. The incrustations were several mm thick, and were removed with deionised water, a scalpel and a soft brush.

VL. 14B VI

Provenance: Villa di Livia, room 14B (with bird decoration).
Excavation: 1999.
Object: Fragment of mural painting.
Subject: Late Roman (c. 250-350).
Measures: 2,7 x 2,7 cm.
Stucco: 2 mm.
Plaster: 5 mm.
Photos: Colour slide, surface.



Description

The pale green fragment was cleaned with deionised water and a soft brush.

Sample

4. Pale green paint and stucco.

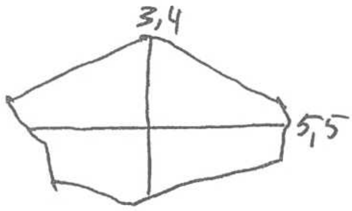
Chemical-technical investigation made at Opificio

Optical microscopy

2 layers. 1 – preparation containing large calcite crystals. 2 – irregular green layer, in some areas very thick (250 μm), with a half-transparent appearance (*terra verde*).

VL. 14B VII

Provenance: Villa di Livia, room 14B (with bird decoration).
Excavation:1999.
Object: Fragment of a mural painting.
Subject: Late Roman (c. 250-350).
Measures: 3,4 x 5,5 cm.
Stucco: 8 mm.
Plaster:
Photos: Colour slide, surface.



Description

The fragment has a border decoration made in red and green. The red lines coincides with two lines incised in the stucco. The fragment was previously cleaned.

Samples

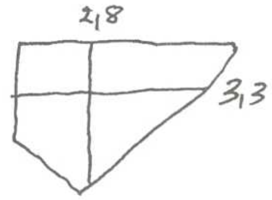
5. Red paint and stucco.
6. Green paint and stucco.

Chemical-technical investigation made at Opificio

Optical microscopy

Sample 5. 2 layers. 1 – white preparation with yellow-brown inclusions of biological or organic nature. 2 – irregular red-orange paint layer with reddish fluorescence. Red ochre.
Sample 6: 3 layers. 1 – preparation without crystals. 2 – thin layer of *terra verde*. 3 – remains of a white layer.

VL. 14B VIII



Provenance: Villa di Livia, room 14B (with bird decoration)
Excavation: 1999.
Object: Fragment of a mural painting.
Subject: Late Roman (c. 250-350).
Measures: 2,8 x 3,3 cm.
Stucco: 9 mm, 2+7.
Plaster: 19 mm.
Photos: Colour slide, surface, plaster.

Description

The fragment presents remains of a decoration made in borders. Remaining colours are pale green, green, yellow and white on a preparation of a pale earth colour. The fragment was cleaned with deionised water and a soft brush.

Samples

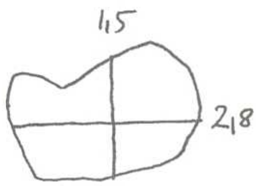
7. Green paint and stucco.
8. Yellow paint and stucco.

Chemical-technical investigation made at Opificio

Optical microscopy

Sample 7: 2 layers. Preparation with lots of yellow-orange inclusions. 2 – paint layer (50 μm) on basis of Egyptian blue.
Sample 8: preparation containing fine grains of red and brown ochre.

VL. 14B IX

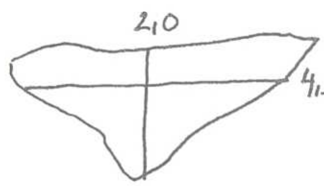


Provenance: Villa di Livia, room 14B (with bird decoration).
Excavation: 1999.
Object: Fragment of a mural decoration.
Subject: Late Roman (c. 250-350).
Measures: 1,5 x 2,8 cm.
Stucco: 5 mm.
Plaster:0.
Photos: Colour slide, surface.

Description

The fragment has a green surface. Cleaned with deionised water and a soft brush.

VL. 14B X

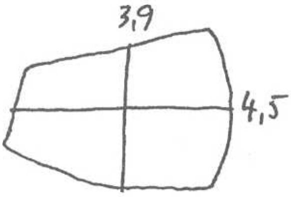


Provenance: Villa di Livia, room 14B (with bird decoration).
Excavation: 1999.
Object: Fragment of a stucco ceiling.
Subject: Late Roman (c. 250-350).
Measures: 2,0 x 4,3 cm.
Stucco: 4 mm.
Plaster: 2,5 mm (rough stucco?)
Photos: Colour slide, surface.

Description

The fragment was part of a painted ceiling. It presents borders in various red hues, in white and green. Cleaned with deionised water, a scalpel and a soft brush.

VL 14B XI



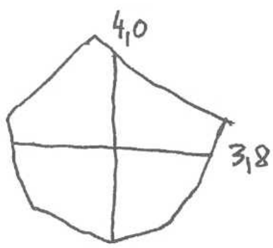
Provenance: Villa di Livia, room 14B (with bird decoration).
Excavation: 1999.
Object: Fragment of a decorated socle.
Subject: Late Roman (c. 250-350).
Measures: 3,9 x 4,5 cm.
Stucco: 4 mm.
Plaster: 16 mm.
Photos: Colour slide, surface.

Description
The dark red fragment with borders in grey and white, was part of the socle. Cleaned with deionised water, a scalpel and a soft brush.

Samples
9. Violet and stucco.
10. Grey and stucco.

Chemical-technical investigation made at Opificio
Optical microscopy
Sample 9: 2 layers. 1 – white preparation containing calcite crystals. 2 – very thick red-brown layer of red ochre and black grains.
Sample 10: 2 layers. 1 – preparation with few dark inclusions similar to mica. 2 – thin pinkish grey layer.

VL. 14B XII



Provenance: Villa di Livia, room 14B (with bird decoration).
Excavation: 1999.
Object: Fragment of the stucco ceiling.
Subject: Late Roman (c. 250-350).
Measures: 4,0 x 3,8 cm.
Stucco: 4 mm.
Plaster: 11 mm.
Photos: Colour slide, surface.

Description
The dark red fragment was part of the painted ceiling. It has remains of a decoration made in yellow and white. Cleaned with deionised water, a scalpel and a soft brush.

Samples
11. Dark red paint and stucco.
12. Yellow and white paint and stucco.

Chemical-technical investigation made at Opificio
Optical microscopy
Sample 11: 2 layers. 1 – white preparation with yellow-brown inclusions. 2 – thin and irregular red-orange paint layer.
Sample 12: 3 layers. 1 – remains of preparation without calcite crystals. 2 – thick paint layer (two applications) yellow ochre. 3 – thick half-transparent whitish coating.

APPENDIX V

Case Study 6:
Villa San Michele at Anacapri

Conservation report

Conservation Report no 9, 1999

Object: Funerary monument. Group portrait, carved in high relief.
Material: Luniense marble, a white fine crystalline marble with a slightly greyish hue, quarried at Luna close to Carrara in northern Italy.
Location: The chapel of San Michele. Inserted into the wall, to the left of the entrance.
Measures: Height: 1.71. Width, at the top: 0.46. At the bottom: 0.58. Depth: 0.22.
Provenance: Rome.
Dating: c. 13 BC – AD 5.
Bibliography: Andrén (1965), p. 135; Kleiner (1977), pp. 51, 54, 72, 74, 78, 108, 111, 114, 155, 157, 173, 193, 232. Kleiner (1993), pp. 27-52.

Description

This relief is representing a woman with her young son both shown frontally. Their movements are identical, standing in slender contrapost positions, resting on their left leg and with their right hand posed over the breast while the left arm is suspended along the body. Only their heads do not move according to the same scheme, but slightly turned away from the centre. The womans tunic is almost covering her feet, and a mantle, *pallium*, is draped around the body, with the upper edge drawn over her neck. The shape of the womans face is regular and somewhat idealised, the corners of the mouth slightly drawn upwards. The hair with a node above the forehead, combed back from the face backwards in soft waves, and collected in a knot at the back of the head, was a fashion during the Augustan period. Many portraits of Livia, the wife of Augustus, represent her with this kind of coiffure. The little boy reaches approximately to his mothers left hand. He is wearing a short tunic, which was the usual dress for young Roman boys. Over the tunic hangs a mantle, attached with a brooch on his left shoulder. A cylinder on a string, *bulla*, is hanging around his neck, identifying him as a freeborn child. The long and curly hair resembles the hairstyle on portraits of children represented on the Ara Pacis, the peace altar of Augustus. This may, according to Kleiner, be the left part of a larger portrait group, since children usually were represented between their parents. On the other hand, married couples either were looking towards each other or straigth forwards. If this had been a family group with the father standing to the right of the child, the woman would have turned her face away from her husband.

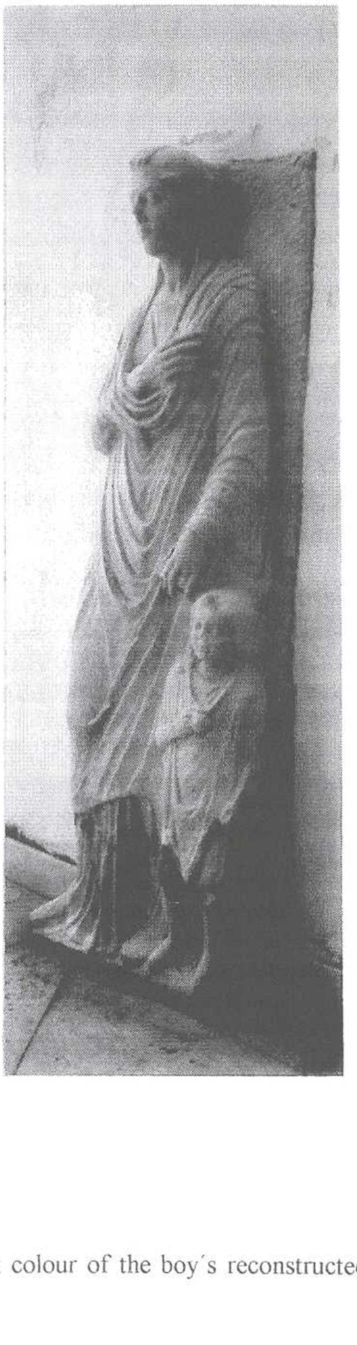
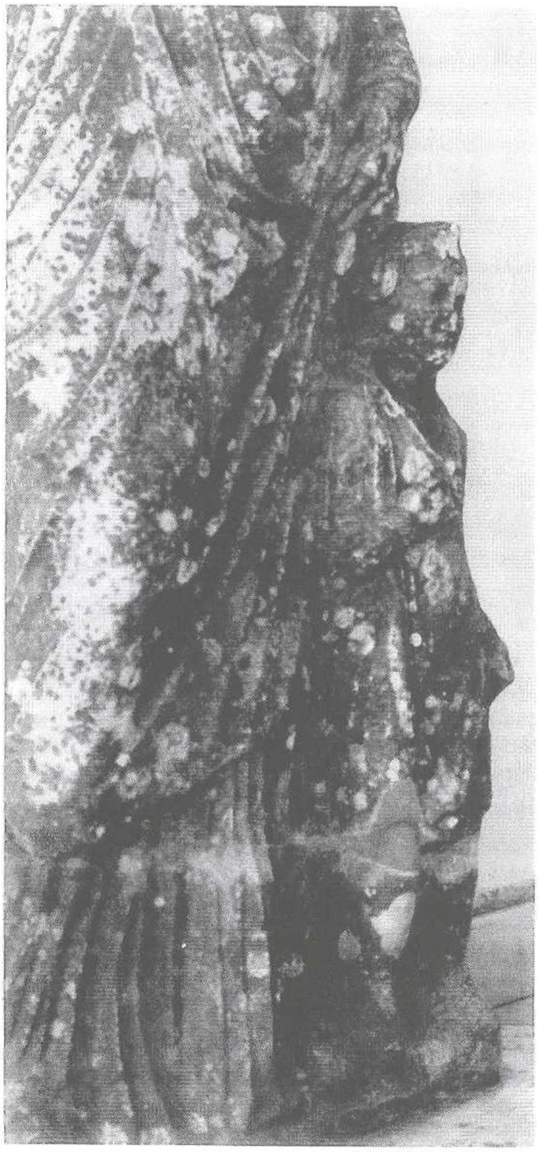


Fig. 68. Funerary group statue, Villa San Michele. After cleaning. The dark colour of the boy´s reconstructed knee appears distinctly.

Damage survey

The surface of this relief is damaged, mainly due to weathering and biomass. Lichens are covering large part of the surface. One side of the relief is more covered by lichens than the other, probably due to environmental reasons. The right side is facing a sheltered area of the garden, while the partially clean left side, faces the sea, and consequently is more exposed to wind. At the first general survey the visible marble seemed to be in a rather good condition, in spite of biomass. Some minor fissures were noted at the right side of the womans mantle, seen frontally, and at some folds. The tip of her nose is missing. The lower part of the relief was broken and mended, and there is a rather unsightly reconstruction the level of the little boys knee. A part of the marble at the lower left side of the statue is missing. There is a tendency of sugaring on finely cut details.



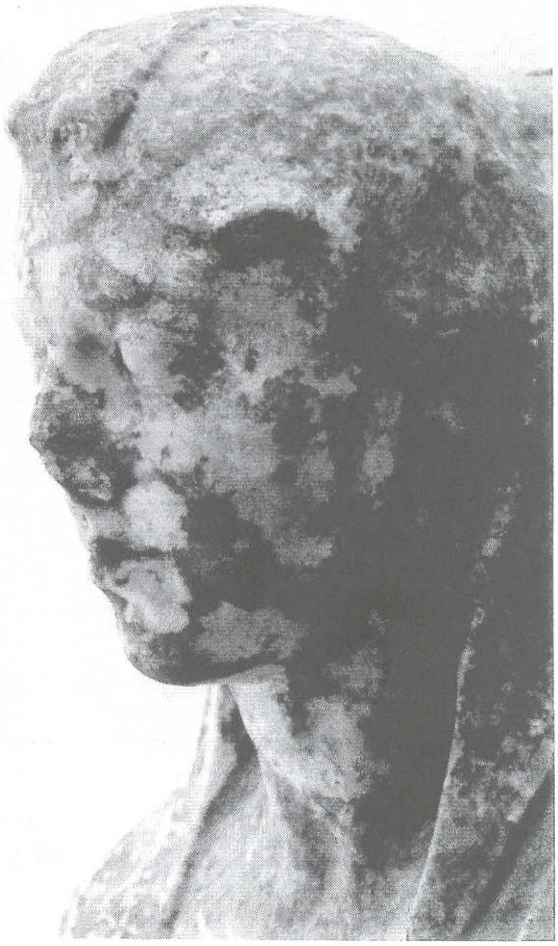


Fig. 69. *To the left*: The lower part of the statue, showing the little boy to the right. The dark-coloured reconstruction at the level of his knee appears light compared to the lichens surrounding the mending.
To the right: Lichens covering the the face of the woman.

Conservation interventions
Planning for conservation interventions started in 1998, when a general survey was made. Some cleaning tests were made at an area, roughly 15 cm long, at the base of the statue. Each test area covered 1x2 cm, with a short distance in between. The detergents såpa (c.5%), Contrad (2%) and EDTA (2%) in water were applied in paper pulp for 2 hours. Such short time applications were made for reasons of securing of not damageing the marble. A biocide, Preventol R 80 (5%) and ammonium carbonate (10%) were applied in paper pulp for 12 hours. Biocides are generally recommended to remain on the surface for weeks or months, sometimes in more than one application, and ammonium carbonate often is applied for 4-24 hours or more. Rinsing and cleaning with deionised was made afterwards with deionised water and a soft brush.
The area was photographed before and after application, and again in springtime 1999, when a control of the longer term result was made.

1999
Best result, intended as most complete removal of biomass and surface deposits, were achieved by ammonium carbonate and Preventol R 80. Additional test were made with two hour applications of a more recent biocide, Preventol OC 3082 and the detergent Ochtil. The intention was to avoid any biocide, but since this material had proved to be the better and a new variety of Preventol, not containing formaldehyde, had been introduced on the market, it was decided to try this substance. The result was not good enough. Ochtil a gel-detergent, its active constituent natrium hydroxide, was tested since it was recommended for cleaning of wall paintings. It was effective, but excluded due to its chemical composition. Finally it was decided to use ammonium carbonate in paper pulp on a larger area, and the small figure was cleaned. The application was left for 4.5 hours, with repeated controls. The result was not satisfactory. The surface became cleaner but the lichens remained. During the same day, salts were extracted from the statue by an application of folded Japanese tissue paper wet with deionised water, covering the surface until it was dry. Preventol R 80, finally was applied over night, and then removed with deionised water and a soft brush. An additional rinsing was performed after two days. The result was satisfactory, and the lichens were easily removed. In order to study the long-term effect, it was decided to inspect the result at intervals, before decisions were made regarding any application of a surface coating. In autumn 1999, the statue still looked clean but not too white.
Salt tests on the surface of the statue, following the recommendations by the Swedish National Heritage board, were made before and after conservation, and analyses made at ICUG by one of the students, Katinka Klingberg. Chlorides were noted before conservation, and were reduced to almost not notable after desalination.

2000
The statue was observed in May, and in October. The surface still was clean, and no negative effects could be noted. At the time of the last inspection, the unsightly reconstructed area was retouched with water colour, with the principal objective of reducing its dark colour. Lime, slightly pigmented with raw umbra was used to fill some fissures, in order not to permit water to penetrate, and also to avoid a new colonisation of lichens in the cavities.

Fig. 70. The statue before and after conservation.