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Reviewed Article:

Painting Bronze Age Plaster from Thebes Boeotia

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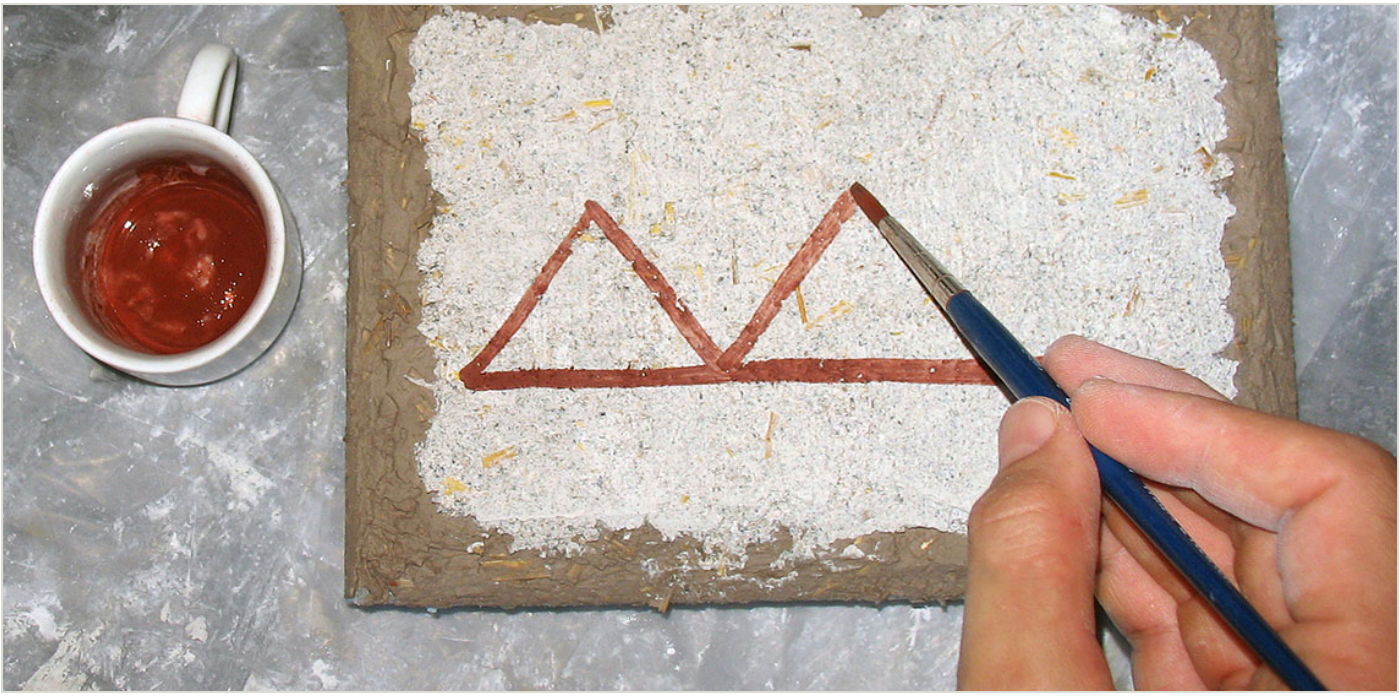

A series of experiments were conducted to study an unusual mortar mixture identified by Brysbaert (2008a) in plaster fragments found in Thebes, Boeotia (Her study of the samples mentioned in the article included investigation by X-ray diffraction, stereo, reflected light and scanning electron microscopy, laser-induced breakdown spectrometry, micro-Raman spectroscopy and macroscopic study.). The mixture was very interesting in its composition, containing unusual aggregates such as crushed seashells and bone. The techniques used in the samples are presented with reference to the sources that were consulted, the materials

used, and their preparation. During research, a small number of technical issues and details of painting were identified which were also raised in Brysbaert's original article. We have seen similar beliefs repeated elsewhere and so we took this opportunity to address them. Our experimental results show that seashells can be used as an aggregate in lime mortars. We believe that they are a good material to add alongside other aggregates. They can also be used on their own, but they produce a mixture that tends to dry faster.

> “ In our methodology, we agree with the idea that experience is needed in scientific research and believe that the experimental and experiential parts can overlap (Deady et al. 2015). Experience is necessary as a way of understanding and evaluating what is happening. One must strive to gain similar experience to that of the ancient craftsman in order to better understand his technical choices.

The premise

The author is currently studying for a PhD in experimental archaeology at the University of the Aegean. The focus of the research involves the recreation of a 4th Century B.C. wall painting (Tomb of Persephone, Vergina) using the same pigments and painting method that was used by the ancient painter. In this project, we sought to identify the painting technique used, and wanted to demonstrate the way in which the wall was painted. The technique that was used in the tomb is a variation of the *fresco* technique, which is why we examined similar methods. Our search extended forward into the 20th century and backwards into Bronze Age findings. The core methodology of the research has been outlined in Stefanakis and Vlavogilakis publication (2014). During this research phase we discovered Brysbaert's article (2008a). The recipe of the ancient mixture was very unusual in terms of the aggregate materials used to make the plaster. Although it was not part of the recipes we were preparing for, like most of the recipes collected, we resolved to try it. The main series of experiments was named "Brysbaert samples" for easy reference.

The logic

This series of experiments had an experience-oriented starting point, but they were not wholly experiential in nature, their purpose was to strengthen archaeological knowledge (Ch'ng 2009; Deady *et al.* 2015).

These experiments had as their starting point a) the need to understand why that particular mortar mixture was used, b) the need to gain experience in using an unusual mixture. The purpose of these experiments was:

1. To study the technical construction requirements and ease of construction.
2. To study the use of seashells as aggregate.

3. To understand the technology of mortars containing plant fibres.
4. To study the difference in behaviour of these mixtures in relation to normal lime mortars.
5. To study a form of ancient technology in practice.

The experiential component of this investigation lies in sections 2 through 4.

This set of experiments set out to contribute to the understanding of the practices and technology involved in such a mixture. It is hoped that this publication will enhance the understanding of lime mortar technology. We have also tried to provide some hands-on technical information on painting practice, and felt the need to explain some of technical issues that we identified in the article.

In our methodology, we agree with the idea that experience is needed in scientific research and believe that the experimental and experiential parts can overlap (Deady *et al.* 2015). Experience is necessary as a way of understanding and evaluating what is happening. One must strive to gain similar experience to that of the ancient craftsman in order to better understand his technical choices. We cannot always divorce contemporary technical know-how from ancient processes, but being informed allows for more correct assumptions and results.

Therefore, gaining experience is necessary as a means to an end. A certain level of experience is necessary to conduct the experiments, to understand the necessities of the process and how it works. It also helps to be able to know whether what is written in the bibliography is technically possible or is a misconception that has been perpetuated. To summarize, experience is necessary in order to a) formulate the correct (most relevant) working hypotheses (Schiffer *et al.* 1994, 199), b) to correctly conduct the experiment (Kelterborn 2005, 120; Paardekooper 2007, 1357; Schenck in Deady *et al* 2015) and c) to correctly interpret the procedure and its results (Hein 2009, 4; Schenck 2011, 91). The experimental archaeologist needs to learn the form of technology they are researching in order to be able to apply it correctly (Johansson 1983, 81; O'Sullivan *et al.* 2014, 216; Paardekooper 2007, 1346; Verkooijen in Deady *et al.* 2015).

In experimental archaeology the technical level of the researcher should be reported because it affects a number of factors. These include the working hypothesis, the methodological approach of the experiment, the technical level and the equipment used, as well as the way the results are interpreted (Bradley 2009, 3; Busuttil 2008-2009, 64; Hein 2009, 4; Paardekooper 2007: Carrell 1992, 7; 1346 Johansson 1983, 8). The experience of the researcher is mentioned in relation to a specific series of experiments. In terms of technical ability, the author is a painter with experience in the use of different painting styles, techniques and materials, but not wall painting. Fresco-type techniques had to be learnt for the purposes of the PhD research. Thus, the technical-skill level of the author when this series of experiments was conducted was higher than someone who had never used painting techniques, but lower than that of a seasoned fresco painter with years of working experience.

Methodology

The research was conducted on a particular experimental context, using specific equipment and a specific technical competence. The methodology we used was based on rules set by two fathers of experimental method, John Coles and Peter Reynolds. According to Coles (1966, 1) there are two main types of experiments: mimetic experiments reproducing products of man's industry and experiments using these products to determine their functionality. For Reynolds (1999, 389-393; Outram 2008, 3), archaeological experiments are divided into five categories: construction, operation and process, simulation, contingent (combining the first three) and technological innovation. Based on the categories of archaeological experiments as defined by Coles and Reynolds (Busuttil 2008-2009, 62; Coles 1966, 1; Comis 2010, 10; Outram 2008, 3; Reynolds 1999, 389-393), the experimental tests presented here included construction in dimensions related to archaeological findings, in order to study the characteristics and the use of a specific technology. They also included a study of the manufacturing process.

As required by Coles' rules for archaeological experiments (1979, 46-47), most of the materials used lime plaster, straw, and seashells, which all existed in the time period explored. In addition, the technical process employed did not exceed the technological level of the era. The experiments were carried out using modern equipment that had a similar form and function to that of the corresponding tools of antiquity (float, trowels, ceramic vessels, paintbrushes).

The only anachronous material was the extruded polystyrene (XPS), used as a base for the samples (See Figure 2). We avoided using Heraklith boards (see below) as bases for our samples because they contain cement, which might react with the mixtures we made. We also avoided using wood-based materials, because the wetting of the surface could damage them (for example; warp them). A wooden surface would also need some form of coating to protect it from the alkalinity of the lime plaster. We chose to use extruded polystyrene because it is designed to be used with mortars, it is easy to cut into size, and to scratch to create the groves needed for the mixture to grab on to; it is also very lightweight, which helps with transportation and storage. One drawback to the polystyrene is that it does not absorb water, which can cause the mixtures to dry faster than normal. This characteristic was counteracted by adding a base mortar layer that simulated a wall between the polystyrene and the painted mortar layer. Regardless of the materials used as a base, using a base mixture allowed the mixture above it to have a more typical behaviour.

In order to replicate the technique used, we resorted to descriptions of similar techniques that came from later periods. The accumulated recipes came from artists' technical manuals and descriptions of mortars analysed in archaeological or conservation derived publications. The amount of detail in both categories of descriptions can be very small, which is acceptable in terms of a bibliography-based research, but not for the practical application of this technology. That creates the need for a form of translation from what is mentioned in artist's manuals to what is actually done in practice, and a greater need to search for technical details. This also related to the particulars of the mixture. A simple mixture of thin sand and lime is easy to mix and to spread on the wall and equally easy to find detailed descriptions of , in the bibliography. In terms of straw or chaff containing mortars, the majority of descriptions we encountered mention their existence, but not the quantity used. What is also missing is the length of the pieces and their state when they were used. For example, were they used intact but chopped, or where they crushed as well?

Out of the four samples (8 mixtures) presented here, the first one (*25214 Brysbaert 1*) was based directly on the recipe identified by Brysbaert (2008a). The second one (*4314 Brysbaert 2*) was a small modification of that recipe. Sample *16314 Palmette Flower* was a supporting experiment, created to study the use of straw in mixtures. When the main series of samples was concluded, we wanted to try using seashell on its own in a mixture. We understood that it would be usable, but still needed to see the difference between seashell and sand. The last sample (*22314 Brysbaert 3*) was an extreme modification of the initial recipe.

All of the mortar layers were placed in the middle of the surface with enough space so that the lower layers can be seen. Most samples had their surface roughly floated. We did not completely smooth the surface as the same results would be obtained from a polished surface. Apart from floating, there was no other surface manipulation employed before or after painting.

All of the samples presented here were painted. The mortars used in the wall paintings Brysbaert analysed were composed for that purpose, regardless of the painting technique used. In our experience painting a mortar also influences its behaviour. Brysbaert (2008a, 2767) mentions the use of *secco* technique to paint the details in Thebes, but we did not paint over the dry mixtures, as we did not want to interfere with their surface. In all the samples discussed here we didn't make use of incised drawing or *sinopie* to prepare for the painting. Painting was done *alla prima* (in one sitting) directly on the wet surface.

As with most samples of our research, the first photograph was taken immediately after the last brushstroke or mixture placement. All samples were photographed dry two months later and again two and half years later to assess any deterioration during that period, along with the appearance of salt from the seashells, and the development of any cracks, as we did not know what to expect from mixtures containing straw or seashells. There was also another practical reason; a mixture containing river sand is dark when fresh, and becomes bright grey when dry a month later. In our experience the colour doesn't change much within the first two months. The basic difference that appears one year later is that the mortar has become a brighter grey, closer to a white hue, which makes pigments appear brighter.

Presenting the samples

Before detailing the samples, presented here in chronological order, we wish to clarify a few of the terms employed. The names of all samples of our research are in English for cataloguing and compatibility reasons. The name of each sample refers to date of its creation and the subject painted on it. In all the Brysbaert samples we used the same decorative motif, which was borrowed from Minoan iconography. The flower in *16314 Palmette Flower* was copied from the decorative frieze of the Tomb of Persephone.

In the samples, we refer to *thin*, *medium* or *thick sand size* when we describe the aggregates. We categorize the sizes of sand in the following way:

Thick sand = Ø 5 mm - 1.1 cm.

Medium to thick sand = Ø 4-5 mm.

Medium sand = Ø 4 mm.

Thin to medium sand = Ø 1-3 mm.

Thin sand = Ø up to 1/2-3/4 of a mm.

The numbers before each material refer to the amount of parts. All materials used, including the lime, were measured by volume using the same shovel. As you can see from figures 4, 6, 9, 12 and 15, we have the habit of measuring the aggregates first and then added the lime. We also used the terms *layer* and *dose* when referring to the mixtures. We differentiate them as one layer can be composed of several doses of the same mixture. For example, a dry layer of plaster that is 5 mm thick could be made from three doses that were 2 mm thick, each placed 30 minutes after the other.

The preparation of the materials used in the experiments

The execution of this series of experiments was programmed to coincide with other experiments that had similar mortars. These experiments were not central to our PhD research, so they were conducted at a later stage over a period of 4 months. It is common practice in our research that non-central samples between the normal ones -for example, while waiting for layers of mortar to settle. The materials were gathered and slowly prepared over the course of a year.

The materials

Lime plaster

In all of the samples we used lime plaster free from magnesium and gypsum as in fresco gypsum and magnesium containing plasters are traditionally forbidden. A local producer, close to the author's home, creates lime plaster using a dark marble that is abundant in the area. The plaster is usually a month old when the building material supplier obtains it. In these experiments we counted the age of the plaster based on the day we purchased it. The lime plaster used for all of the samples presented here was 6 months old. When bought, this plaster was sieved by us without being watered down, resulting in no change to the caustic properties of the material, and that it could be used in the same or the next day. If it was sieved diluted, it would be less caustic and would need time to settle. Diluted sieving also results in a more creamy material that must be left to set for almost a full year before being used.

Seashell preparation (See Figure 1)

Seashells can and have historically been used to produce lime plaster. The material itself is compatible with plaster. Brysbaert mentions seashells used both as aggregates and as sources of lime (Brysbaert 2003, 172-175; Brysbaert 2000, 35). She also mentions specifically crushed *Murex* shells used as aggregates in Bronze Age floor and wall plasters of the eastern Mediterranean (Brysbaert 2008b, 117-118; Brysbaert 2003, 172-175 - The location of plasters that contain shells as aggregates appear in; Brysbaert 2003, plate XLII). Small seashells were also found in a clay plaster studied by Shaw (2009, 142). So far we have not located further mentions of seashells used specifically for *fresco* painting. We assume that the seashells in the ancient plaster were transported to the location from either the Corinthian or the Evoikos gulf, the seas closest to the area of Thebes.

For the samples, we used the common orange-brown Mediterranean cockle (bivalve) seashell, belonging to the *Cardiidae* family (Gosse 1854, 268-272). We initially wanted to use *Murex* shells like the ones in the ancient mixtures, but in the last decade this species has become rarer on the beaches of Crete. Seashells were collected in the winter from various north-facing beaches of Chania, as in winter the winds produce strong waves that deposit them to the shore.

They were rinsed first with water to remove the sand, then with lime-water, and again immediately with clean water. We followed this process because we assumed that the ancient mixture was made with properly washed or at least rinsed shells. We did not use any chemicals in the washing process. After cleaning they were left to dry indoors, and when completely dry, they were crushed and sieved into different sizes. To crush them, we stacked them in a densely woven table cloth, closed it tightly and hit it repeatedly with a hammer. Being closely placed one on top of the other helped crush them more easily because of the accumulated pressure. Afterwards we removed the crushed shells by sieving and the process was repeated for the larger pieces.

Brysbaert mentions that in the mixture "larger fillers are present ... in the form of crushed shell fragments ... and rarely bone pieces"(Brysbaert 2008a, 2765). The grading was tripartite, following a grading system similar to that of sand (thin, medium and thick). That was done in order to be able to study their behaviour as aggregates of different sizes. The thick shards had different sizes, the largest being 5 x 4 mm, but the majority was 3 x 2 mm. Thin and medium size had the same sizes as sand. Grinding them to thin sand size also produced a quantity of creamy orange-coloured powder. Powdered shells were not used in the mixtures. The article by Brysbaert does not include the quantity of the shell fragments used. Essentially, the mixture of the first sample was partially the result of informed guessing, based on previous experience with lime mortars and the bibliography mentioned below.

Straw preparation (See Figure 2)

Plant fibres are added to plaster mixtures in order, to increase their mechanical strength, improve coherence, reduce shrinkage and to keep them wet for more time during setting (Mpeteinakis 2008, 27- 31; Daniilia *et al*. 2007, 1976; Mugnaini *et al*. 2006, 174; Daniilia *et al*. 2000, 107; Jones 1999, 153; Howard 1995, 93; Kondoglou 1993, 52-53; Zamvakellis 1985, 39; Sickels 1981; Gettens and Stout 1958). In mortars straw is used either on its own or as a part of mixtures that contain other materials. It is there but it is not prominent. The number of descriptions that present lime and straw only mixtures are fewer.

In order to gather more practical information on fibre containing mixtures, we interviewed older people in the more rural areas close to Chania ,Crete. Starting with the local café's recommendations of contributors, we asked older people as they were more likely to have experience with, or memory of, such a mixture. Many recalled that when their parents or grandparents needed straw for plastering, they collected material that had fallen in the feeding trough while the animals were eating. It was mostly in small pieces and partly damaged by chewing. The practice of leaving straw for 3 days in lime to ferment that is proposed by some authors (Dionysios of Fourna and Hetherington 1989, 14; Kondoglou 1993, 52-53) appeared strange to them. This practice theoretically serves to soften if not partially melt the straw into the plaster and probably requires lime plaster that is quite caustic. That is against the usual practice of using less caustic plaster for the final layer of a fresco painting.

Statistically speaking, lime and straw mixtures are mentioned in the bibliography that follows with a thickness ranging from a few mm to more than 2 fingers thick. The larger thickness of the layers mentioned in the recipes imply some form of compacting either before or after painting. But the practice of compacting is not always mentioned in the recipes. In compacting techniques, the surface of the mortar is condensed through pressure. According to Istudor (2008, 29, see also note 6), the durability of Byzantine frescoes is mainly due to the compacting of the plaster. According to Mpeteinakis (2008, 43) compression makes the plaster more dense. Compacting the mortar is described by different authors (Kondoglou 1993, 52-54; Mpeteinakis 2008, 31, 33, 43), but the methods they describe are different (see below).

The barley straw used in the experiments was taken from a local farmer. It was first dry cleaned by hand and then with a large brush, and afterwards chopped into pieces. It had to be dry-cleaned, so as not to damage it by soaking before use. While chopping it into smaller pieces a small quantity of black powder -probably earth or dirt- fell from the inside. The pieces of straw were sieved before being used to minimize the inclusion of that material in the mixtures. The straw used had varying lengths, ranging from 9 mm up to 3 cm. For the mixtures of lime and plant fibres we used descriptions as sources of information from later time periods (Hein *et al.* 2009, 2069; Civici *et al.* 2008, 209; Mpeteinakis 2008, 25, 27, 29, 31, 33, 39- 41, 45; Istudor 2008, 31 Table 1; Nicolaescu and Patrascu 2008, 59; Daniilia *et al*. 2007, 1976; Guasparri 2006; Mugnaini *et al*. 2006, 174; Daniilia *et al*. 2000, Howard 1995, 91- 93; Kondoglou 1993, 52-54; ; Dionysios of Fourna and Hetherington 1989, 14; 107; Zamvakellis 1985, 39; Winfield 1968, 95; Winfield 1968, 66-67; Gettens and Stout 1958, 107, 109-110; Theophilus 1847, 86, 89-90; Dionysius of Fourna *et al*. 1845, 18).

Clay Plasters

A clay (or mud) plaster, even if it contains lime, is less caustic that a lime mixture. It is therefore more suitable to lay over wooden masonry (Brysbaert 2008a, 2764). That is why these mixtures are more commonly used for backing plasters. Similarly, a straw and clay mixture is less damaging to the straw than a mixture that contains lime plaster. From our experience with clay plasters we discovered that they cause the overlapping lime mixture to dry faster, occurring even if the clay plaster is wet. The grey clay used in our first sample was offered by a local ceramicist (Vlavogilakis http://www.tetraktis-studio.gr/index_en.php). We must stress that the focus of these experiments was on the lime mixture and not in the backing mixture. We have limited experience with clay mixtures and in the scope of our research we could not expand on them. The following is a summary of the descriptions of clay plasters on which we based our research on.

For our clay mixture we based our research on a number of descriptions that came from different time periods (Shaw 2009, 142; Daniilia *et al* 2008, 2476, 2484; Lilibaki-Akamati 2007, 13; Maniatis *et al*. 2007, 141; Jones and Photos-Jones 2005, 202-203, 220, 221, table 13.4; Maravelaki-Kalaitzaki *et al*., 2005, 1579, 1582; Mantzourani 2002, 57-58; Chiotis *et al*. 2001, 329, 331; Jones 1999, 13; Doumas 1983, 145; Hood 1978, 83; Cameron *et al*. 1977, 131, 153; Profi *et al.* 1976, 34, 38).

Bone (See Figure 3)

Similarly to seashells, bone is a calcium-based aggregate that is compatible with lime plaster. The quantity of bone mentioned in the ancient plaster was small (Brysbaert 2008a, 2765). The bone that we used came from lamb. It was first boiled ,then cleaned from all meat and connecting tissue. After leaving it to dry overnight, we broke it into pieces using a similar method to that used for the seashells. We only used bone in the first sample, in pieces that were 4 mm - 1 cm long.

Recycled mortars

Brysbaert mentions the existence of added calcium in the mixture, derived from the use of recycled fragments of painted plaster (Brysbaert 2008a, 2765-2766). We know from the bibliography that mortars can and have been recycled in the past (A number of cases of the practice of recycling of fragments of frescoes in the Bronze Age appear in Brysbaert 2003, 169-170, 172-173, 175-176, plate XLII; Brysbaert, 2008b, 118). We hypothesised that the existence of pigments on the recycled plaster used in the ancient mixture did not interfere with its properties as a mortar. We know from our experiments that reused lime mortars can be added as aggregates, either on their own or as additions. We used debris and dried leftovers of mixtures as part of the mortar for plastering training (Stefanakis & Vlavogilakis 2014). Instead of using dried debris, in sample *25214 Brysbaert 1* we added medium-sized marble chips and in *4314 Brysbaert 2* we used marble dust and dried lime plaster (powdered).

The painting technique

The painting process we used was a form of "simple" *fresco* technique. By that we mean that painting was executed on a lime mixture within 30 minutes from plastering. We did not employ *secco* or any mixed techniques. The terms *al fresco* and *al secco* generally mean painting on wet and dry plaster respectively (Piovesan et al. 2011, 2635-2636; Daniilia et al. 2007, 1972; Photos-Jones 2005, 228; Mora and Philippot in Tsuji 1983, 218). For Tsuji (1983, 215-216, 220-222), *fresco* is the Italian mural technique which appeared the late thirteenth century. We differentiated between *fresco* and *buon fresco* in the sense that *buon fresco* requires a plaster mixture and the use of *giornata*[1] . Other *fresco*-type techniques such as *secco su fresco* or *lime technique* are *fresco* but they are not *buon fresco*. In addition, *buon fresco* means that the *giornata* is made up of a mixture. Lime painting has a type of *giornatta* which is done through localised and / or selective lime-washing. In general, the use of the word *buon* implies the Italian version of the technique (Photos-Jones 2005, 228).

According to Cameron *et al.* (1977, 168criterion no. 18) in *fresco* the painting period can last for several days. A lime mortar on its own can allow for a full eight hours of working time (Brysbaert 2008a, 2768), but from our experience that depends on its composition. A mixture that contains marble dust dries faster than one containing only thin river sand. The same applies to more complicated mixtures and especially those containing large amounts of brick powder. Weather is also an important factor, but is not enough to guarantee the eight working hours. The plaster in Thebes allowed the painter to work for more than eight hours (Brysbaert 2008a, 2768). In terms of the mixtures that only have seashells, we don't think that they can be painted for the full hours of a *fresco* technique, as the mixture is very dry and cannot be used for more than two hours.

According to the bibliography, in *fresco* painting pigments are mixed with water, rain water, lime water, lime milk or lime depending on the author of the definition or recipe (Piovesan et al*.* 2012, 724, 729; Piovesan et al*.* 2011, 2635-2636; Bianchin et al. 2009, 382; Mpeteinakis 2008, 27; Daniilia et al. 2007, 1972; Colaluci in Saatsoglou-Paliadeli 2006, 219 note 23; Norris 2005, 147; Photos-Jones 2005, 228; Saatsoglou-Paliadeli 2006, 215; Ajò et al. 2004, 338, table 4, 347; Cameron et al. 1977, 161 note 77; Sister Daniilia et al. 2000, 107; Kondoglou 1993, 55; Zamvakellis 1985, 40; Tsuji 1983, 218, 219 note 15; Doro Levi quoted in Cameron et al. 1977, 16; Plakotaris 1969, 118; Nordmark 1947, 51). As Cameron *et al* (1977, 161) also observed, calcium hydroxide will "contaminate" the pigments in *buon fresco* simply because they are laid on a soft wet plaster surface. The presence of even a very small quantity of lime in the pigments is unavoidable. Regardless of the water-based binder used, each brushstroke adds water to the surface, which 'awakes' the calcium in the plaster layer. We must note here that all of the above are not technically binders (the carbonation of the surface binds the pigment) but act as binders. They serve as a courier to the pigments, but it is easier to think of them as binders when working.

We need to make here a small note on the use of pigments in painting. The grain size of the pigment is important in its strength, which also depends on the pigment used. For example, yellow ochre is a softer material that cobalt blue and is easier to paint with. There are two ways of mixing a binder with any pigment, by grinding with a muller, spatula or palette knife and by stirring. The first one creates a more uniform colour, the second one a more variable one. Mixing by mulling is essentially an additional grinding of the pigment. By stirring the resulting colour contains pigment of different particle sizes. Painters that mix their own colours might alternate between the two based on the pigment used or personal preference. The difference in the method of mixing was noticed and analysed by Birkmaier et al. (1995, 121) in relation to Titian's painting *Venus and Adonis* (c.1560) in the collection of the J. Paul Getty Museum. In technical terms, some pigments -such as yellow ochre- can be properly mixed regardless of method. Others, due to their nature, require the additional grinding that accompanies mulling (for example, carbon black and Cennini's white). The binder in all the pigments used in our samples was tap water.

For the seashell-based samples we used the same pigment, Kremer Haematite 48600. Haematite was chosen because it is a very stable pigment, suitable for *fresco* and it was used in the original painting. We used the same pigment in the Brysbaert samples in order to compare its behaviour in the different mixtures. That included both the way it sets on the mortar and any change in colour tone. Although the pigment was already powdered, we used a piece of very thinly-woven muslin to sieve the quantity we used. This was a matter of personal preference and not a technical requirement of this particular pigment. In all of the Brysbaert samples the haematite was mixed with the binder by stirring.

In the supporting sample *16314 Palmette Flower* we used two pigments, Cennini's white and a carbon black. Cennini mentions two versions for the creation of white pigment from lime plaster, the full (slow method) and the quick version (Cennini, 1933 34 section LVIII).

The Cennini white we used was the quick version. In our research we have produced and used both, but have not seen much difference in their behaviour as paint or in the way they dry. We assume that in the future there might be some variation, as the full version produces a cleaner product. During painting, both behave like a semi-transparent white that is similar to zinc white in oil painting. The carbon black we used was ground charcoal from pieces of oak that had been burnt in a household fireplace. Both carbon black and Cennini's white were sieved and mixed with water by grinding.

The samples

25214 Brysbaert 1 (See Figures 4-8)

Base 1, 29/11/2013: 1 grey clay: 2.5 straw (See Figure 4). Placed by hand in one dose in one layer whose dimensions were 15.1 cm x 21.7 cm x 6 mm. As this sort of layer has edges that slope inwards to the top surface the usable surface area was only 13x19.5 cm. The surface of the layer was levelled with a dry spatula immediately after spreading. The mixture was relatively hard, a characteristic to which both straw and the clay itself contributed. The clay that was used was a little stiff. The straw was cut into various lengths varying from 1-3 cm. The mixture was stirred well, but the straw protruded at several points. The colour of the mixture was brown-grey. Apart from the clay being a little stiff, the straw needed to be cut into smaller pieces.

When it dried the mixture shrank and took a grey tint (See Figure 5). This made the pieces of straw more prominent, even though they were covered by the clay. The surface texture was rough but soft to the touch. Its texture was similar to compressed (dry) paper pulp. Cracks were visible in various parts of the surface, but the mixture adhered well to the polystyrene. Most cracks were 2 mm deep, but there were some that were deeper, reaching down to the polystyrene surface. All of the cracks were very thin.

Testing layer, 25/02/2014: 3.5 lime: 1 thin river sand: 1 medium river sand: 1 medium white marble: 1 dried lime: 1.2 straw: 2 crushed seashell: 1/6 crushed bone (See Figure 6). Placed with one dose in one layer whose dimensions were 11.5 cm x 17.5 cm x 1.5 mm (surface area 11 x 17.5 cm). The surface was compressed with a dry spatula and left to set for 1 minute. Afterwards the surface was levelled using with a dry spatula. The mixture was placed after the wetting of the surface of *base 1*. We felt that the wetting was necessary for the survival of the second mixture because the clay plaster was very dry. The water softened the surface of the *base 1 layer*, but not to the point of making it fluid.

The testing layer was placed 2 minutes after the wetting of *base 1*. The dried lime that was used was in pieces with dimensions similar to that of medium and thick sand. The straw was cut into smaller pieces than those of the base. The pieces used were 9 mm -1.5 cm long. The majority of the pieces were shorter than 5 mm. The seashells were broken into pieces that were 3-7 mm in diameter. The majority of the pieces had dimensions similar to that of fine to medium sand (2-3 mm). The bone that was used was in pieces that were 4 mm -1 cm long with a thickness of 1-4 mm. The mixture was rough and somewhat stiff. It was easily mixed, but it did not become uniform in texture. Since it felt somewhat dry, it was spread quickly on the base layer.

Pigment used: Hematite (Kremmer 48600) mixed with water.

First application:

The painting of the sample started 5 minutes after levelling because we had the impression that the mixture would dry quickly (See Figure 7). The straw pieces in the testing layer were too long for this mixture, which was evident from the pieces protruding from the surface. In areas that the straw was visible, the colour appeared closer to an orange tone, and more matte, especially in places where it was used more thickly. There was no difference in the smell of the fresh mixture with that of a simple mixture of lime and sand.

Results and conclusions:

The top mixture was white, slightly darker than a mixture of lime with thin marble (See Figure 8). The surface had a rough texture. Pieces of straw were still protruding slightly, but they were well adhered to the surface. In some areas of the surface, such as above the centre, there were some stains. We believe that the stains came from the straw, as they were limited to those areas only. The mixture of the surface was too inhomogeneous in the dimension of its constituent aggregate materials. Straw, shells and bones were used in flat pieces, and needed to be broken into smaller pieces, of a size similar to that of thin to medium sand. The straw probably needed to stay in the lime to soften and become more cooperative. The mixture had a matte texture when it dried and its surface was without cracks.

The clay plaster of *base 1* was probably wrong both as a mixture and in terms of the method used to place it. The cracks were not concentrated in a single area. This means that the fault was probably on the mixture itself. Either it did not have the correct proportions of aggregate and clay, or it was not properly mixed.

In terms of painting, the mixture felt dry but performed well. The colour did not seem to be influenced by the mixture, as it took its usual light red-brown hue when dried. When the surface dried, the brushstrokes became more visible. When the plaster mixture was wet the straw was visible under the colour in some areas. When it dried, the colour covered the straw completely. In the horizontal lines above and below the triangles the colour was passed over several times. We expected the surface to be more damaged in that area, which was not the case.

4314 Brysbaert 2 (See Figures 9-11)

Base 1, 25/02/2014: 5 lime: 4 thick quarry sand: 4 medium quarry sand: 2.5 thin quarry sand. Water was added to the mixture in a quantity that was less than 1/10th of the lime. Placed with one dose in one layer whose dimensions were 14.4 cm x 17 cm x 9 mm (surface area 14 x 16.3 cm). The surface was levelled immediately after spreading the mixture with a wet spatula. After 10 minutes the surface was roughened by dragging a wet spatula vertically on it. This created a rough surface. The layer was then allowed to dry.

Testing layer, 04/03/2014: 1 lime: 0.5 thin river sand: 0.5 dried lime powder: 1 straw: 0.5 thin white marble: 1 crushed seashell (See Figure 9). Placed with one dose in one layer whose dimensions were 12.5 cm x 15 cm x 2 mm (surface area 12 x 15 cm). The mixture was placed after the wetting of the surface of *base 1*. The surface was levelled with a wet spatula immediately after spreading. The layer was left for five minutes before use. The straw that was used was cut into small pieces, 4 mm - 1 cm long. The majority of the straw used was in thin and short pieces. The broken seashells had dimensions similar to that of medium and thin sand (Ø 1/2 -2 mm). Most pieces had the size of thin sand (Ø 1/2 -1 mm). The mortar was a little dry and rough, but more easily mixed than that of *25214 Brysbaert 1*. The dimensions of the aggregates were similar, thereby creating a more homogeneous mixture. The mortar was stained yellow from the straw. It seems that when the straw is cut into small pieces it affects the colour of the lime. There was also a strong smell coming from the mixture, which we attributed to the straw.

Pigment used: Hematite (Kremmer 48600) mixed with water.

First application:

Similar to the mixture of *291113 Brysbaert 1*, the top mixture of this sample seemed somewhat dry and it began being painted 10 minutes after spreading (See Figure 10). The first brushstrokes lifted lime from the surface (first triangle from the left). This resulted in the colour becoming lighter and the surface being carved by the brush. For this reason we left the layer for another 10 minutes before attempting to paint again.

In the second attempt to paint the surface lime was again raised by the brush (middle triangle). This time however the amount was considerably smaller. The mixture retained a lot of moisture, something to which to the levelling of the surface with a wet spatula contributed. The surface was allowed to set for another 10 minutes.

When painted again, the surface behaved like a normal sand and lime mix. The brushstrokes did not lift lime from the surface, even though we attempted to pass over the same area several times with the brush (right triangle). There was wearing of the surface on the horizontal lines. These were made by making several passes with very diluted paint in the same area. It appeared that this mixture had to be left for 30-40 minutes after spreading before it could be painted. The smell of the mixture was strong, but subsided about 20 minutes after spreading.

After 48 hours the mixture appeared to be dry and had a yellow tint. There were no cracks on the surface. The colour of the last triangle was darker than that of the rest. The majority of the surface of the mixture was flat, meaning that the brushstrokes that had dug into the wet surface had lifted very little lime. The mixture contracted while drying causing the brush marks to sink into the surface.

Results and conclusions:

The mixture became a little more yellow when it dried (See Figure 11). At the areas where the pieces of straw were closest to the surface, the mixture seemed to be a darker yellow in colour (for example on the right of the third triangle, above the date). . The surface was quite glossy, even though the texture of the mixture was not smooth, the texture of the dry surface had a satin-like gloss. In the middle of the third triangle (right triangle) and on the number 14 of the date the surface was less shiny. There were no cracks in the surface. We expected to see cracks in the areas that the surface had been affected by the brushstrokes, this did not happen. We considered this mixture very successful, but we would have preferred it without the straw. The size of the straw was appropriate to the thickness of this particular mixture.

The presence of a lime mixture as a base underneath the top layer was beneficial to the sample. In sample *25214 Brysbaert 1* the clay plaster was too dry as a base, causing the top mixture to become dry. In this sample, the plaster base retained sufficient moisture. We believe that the test mixture of *25214 Brysbaert 1* would behave better with a lime mixture as a base.

In terms of painting, it was difficult to calculate the final shade of colour. The haematite took its usual colour in the last triangle because it was not soiled. Where the colour was more watery or was passed numerous times with the brush it took part of the lime from the mixture. In the first two triangles the colour became lighter towards a creamy yellow. There the surface also maintained part of the relief created by the brushstrokes. The above means that the surface needed to be left for more time before painting.

16314 Palmette Flower (See Figures 12-14)

Base 1, 17/07/2013: 5 lime: 4 thick quarry sand: 4 medium quarry sand: 2.5 thin quarry sand. Placed with one dose in one layer whose dimensions were 14.5 cm x 14.2 cm x 9 mm (surface area 13.4 x 13.5 cm). The surface of the layer was levelled with a wet spatula immediately after spreading.

Testing layer, 03/16/2014: 1 lime: 3 straw (See Figure 12). Water was added to the mixture, in a quantity that was less than 1/20th of the lime. The straw was cut into small pieces with lengths varying from of 3 mm to 1 cm. It was not cut into smaller pieces because we expected the material to melt after three days, which did not happen. During mixing the mortar felt strange, as if trying to mix lime with a soft flat material reminiscent of cardboard strips. The lime was stained slightly towards a creamy yellow. When the straw was mixed with the lime a strong unpleasant smell emerged. The mixture was enclosed in a plastic container for three days. The vessel was closed tightly with masking tape to avoid contact with the air.

When the mixture was opened it seemed dry and relatively hard, as if it was straw pieces that had almost dried lime on them (See Figure 13). It was apparent that the straw had absorbed the moisture of the lime. This justified the need to add water, as reported in the literature. We mixed the plaster which caused it to become soft again. The colour of the mixture was a uniform bright yellow. The mixture gave off a strong smell for up to two hours after spreading it. From the start it showed that the length of the pieces of the straw was wrong. We expected it to soften or melt, instead it simply coloured the lime.

It was placed with one dose in one layer whose dimensions were 11.5 cm x 11 cm x 4 mm (surface area 10 x 10.2 cm). The mixture was placed after the wetting of the surface of *base 1*. The surface was levelled with a wet spatula five minutes after spreading. The layer was quite thick because of the straw. An attempt was made to compress the surface, but without success. The texture of the layer was quite smooth and shiny. The pieces of straw that were near the surface were visible. The layer was allowed to set for 30 minutes before the first brushstroke.

Pigments used:

a) 1 Charcoal Black (oak): 1 Cennini White Quick ver. mixed with water.

b) Charcoal Black (oak) mixed with water.

First application:

In the time that the mixture was left to set, some very small craters appeared on its surface (Fig 14). Such craters existed isolated at various points on the edges of the layer, but the highest concentration was in the upper right hand corner. These craters probably originated from air that was trapped on the surface during the spreading or the levelling of the mixture. Similarly to the other straw mixtures (*25214 Brysbaert 1* and *4314 Brysbaert 2*) several pieces of straw protruded slightly from the surface. They were, however, very well adhered to it.

When we started to paint the surface was still soft, but the colour seemed to be easily absorbed into it. Since we felt the surface had approached the golden hour, the sample was painted hastily.

Results and conclusions:

As with *4314 Brysbaert 2*, when the straw surface mixture dried it became pale yellow (See Figure 14). It appears that the size of the straw is not responsible for the colour of the plaster. While soaking in lime some colouring substance comes out of the straw and stains the plaster.

The pieces of straw that were near the surface were still visible and some of them were protruding from it. They had the same texture and gloss as the rest of the surface, probably a result of their soaking in lime. The mixture needed the straw to be more finely-cut in order to be more uniform. We also believe that the compression of the mixture the next day would be good for the layer, even if the mixture was made with thinner straw.It is possible that if water was added, the surface would be soft enough to get compacted.

No cracks appeared on the surface, which means that the thickness of the layer was correct in relation to the materials of the mixture. The ratio of the materials also seemed to be correct. We expected to see some form of damage or deterioration at the points that the craters were concentrated. Cracks or fissures did not appear anywhere of the surface. The presence of a base layer of lime plaster underneath was beneficial to the surface mixture.

The surface was glossy (satin) but the colours were more matte. It seemed that all the colours were absorbed into the surface, but their texture, especially that of Charcoal Black (oak), showed that they needed more grinding. The black colour was slightly more matte and more textured than the grey. The mixture of black and white was more successful and functioned better as paint. Even though it seemed to be uniform while it was wet, when it dried it showed slight variations in tone, especially in areas that had successive layers. The Cennini White Quick version behaved quite well. It is confirmed that it is a translucent white that is quite handy in mixing colours. A mixture of Charcoal Black (oak) and Cennini White Quick requires more grinding to use.

22314 Brysbaert 3 (See Figures 15-18)

Base 1, 19/06/2013: 1 lime: 0.5 medium pumice: 0.5 thin pumice: 2 medium white marble. Water was added to the mixture, in a quantity that was equal to about 1/20th of the lime. The mixture was placed with one dose in one layer whose dimensions were 21.4 cm x 26.7 cm x 6 mm (surface area 25.5 x 20.4 mm). The surface of the layer was levelled with a dry spatula 10 minutes after spreading. It needed more time to mix than a normal sand and lime mixture, but in the end it became homogenised. The water was added during mixing because the pumice appeared to be pulling the moisture from the lime. The layer was allowed to dry.

Base 2, 06/02/2014: 1 lime: 1 medium Egyptian quartz: 3 straw: 0.5 brick powder (See Figure 15). Placed with one dose in one layer whose dimensions were 18 cm x 23 cm x 2.5 mm (surface area 18 x 22 cm). The mixture was placed after the wetting of the surface of *base 1*. The surface of the layer was levelled with a wet spatula immediately after spreading. The straw was cut into small pieces that were 9 mm -1.5 cm long. The colour of the mixture was an intense orange, similar to that of wet brick. The mixture was tough and very difficult to mix. It also needed to be pressed more during spreading. The mixture was layered on the wet surface of *base 1*, which was not completely flat. Some of the pieces of straw protruded from the surface, which means that it needed to be cut into smaller pieces. We also feel that straw should have been used in a smaller quantity.

After 48 hours half the surface was glossy and the rest was matte (See Figure 16). When the layer dried completely, the part of it that was shiny had taken a hue towards white, while the rest of the surface was light orange (similar to that of brick powder). All this relates to both the materials used (brick powder produces matte mixtures) and with the stirring. We believe that it needed more effort to mix the materials to homogenize the plaster. The shine of the surface appears to have been influenced by the straw.

We believe that it needed to be spread on a combed surface to improve the mechanical grip of the two mortars. There was a crack in the lower right portion of the mixture. Since this was the only flaw of the surface, we believe that it originated from the way the mixture was spread on at that point.

Testing layer, 22/03/2014: 1 lime: 2.5 crushed seashell (See Figure 17). Placed with one dose in one layer whose dimensions were 13 cm x 17.2 cm x 1 mm (surface area 13 x 17 cm). The mixture was placed after wetting the surface of *base 2*. The surface of the layer was levelled immediately after spreading the mixture using a dry spatula which was pressed in all directions. The seashells were broken into pieces with dimensions similar to that of medium and fine sand size. One third of the seashell pieces used had the size of very fine sand. The materials were easily mixed, but the resulting plaster was very firm. During spreading it seemed quite dry, to which the dimension of the seashells contributed. The texture was drier than that of a mixture with medium and coarse marble. The colour of the mixture was a creamy white. Since the mixture felt dry, it was only left for 10 minutes before painting.

Pigment used: Hematite (Kremmer 48600) mixed with water at different dilutions.

First application:

The mixture was quite compact when wet, feeling quite dry with a rough texture. The surface was not dug by the brush or brushstrokes despite the different colour dilutions (See Figure 18). Based on the texture and moisture of the surface the plaster could be painted for about an hour.

Results and conclusions:

When the mixture of the surface dried it became lighter towards white, and its texture became uniformly matte. No cracks or fissures appeared. The top mortar layer (base 1) is more matte than the second layer (base 2). The colour of the testing layer dried a darker white than the mixture of the base layer. We believe the seashell mixture needed more lime. The testing layer also did not seem to have good mechanical adhesion to the base 2 layer. As a mixture it appeared to be successful, but we would prefer it to have more lime. Misled by the size of the seashells we used we made a mixture with the ratios of a mixture with thick sand. We believe that the mortar would have behaved better with a ratio of 1 part lime: 2 parts seashells. It is also possible that the mixture needed the addition of a small quantity of water. As an additive to a mixture, crushed seashells behave quite well. If they are the only aggregate used, they result in a mortar that is quite dry.

The haematite took its normal hue when it dried. On the date of the sample the colour was used more thickly. It retained its hue and did not peel off, suggesting that there was enough moisture in the mixture to hold the pigment in place.

Results and conclusions of the experiments

Seashells

We agree with Brysbaert that if seashells were used for lime making they would not be visible (Brysbaert 2008a, 2765), although this only happens if the slaking is done properly. When lime plaster is freshly slaked it must undergo sieving to clear out impurities such as small stones or pieces of unslaked material. If it is not properly sieved, then the lime will contain them.

Seashells are an adequate aggregate for mortar, but based on our experience, mostly as a medium to thin size aggregate that is part of a mixture rather than on its own. We would not be surprised if a mixture of seashell and sand is found in the future. On its own, seashell is a problematic aggregate to use. In terms of the size of the inclusions, very large fragments (> 3 mm) are more difficult to stir into a uniform mortar. In addition, trying to spread a mixture made up of flat pieces of aggregate is very difficult. If the seashells are crushed in the size of thin or thin to medium size sand, it behaves like sand. We believe that this would not happen with powdered shells, as the material would present the same problems that appear when using powder or silt-sized aggregates. These problems include more difficulty in mixing the materials, producing a mixture that is very dry, difficult to spread properly and is more likely to crack even before drying.

When mixing with lime plaster, thinly crushed seashells behave like medium to thin sharp sand. The essential difference is that the mixture appears to dry much faster, behaving similarly to fine marble dust and thinly crushed unglazed ceramic.

The fact that all of the seashell mixtures touch-dried rapidly indicates that they needed more water. This could be added to the plaster before or after it was mixed. Our own technical preference was not to add any water, as it leads to a weaker mortar. For future work, the water could come from the previous layer or mixture or by keeping the surface wet.

We can understand the logic of using these aggregates: seashells and bone are calcium-based, lime mortars are recyclable, but we would expect to see such a mixture in a different location. Mixtures with crushed seashells should be more common in a coastal area, or if there are activities producing quantities of seashell waste, such as a *murex* dye industry nearby. However, the abundance of sand and the relatively low preparation required to use it would make seashells an unusual aggregate. Even the calcination of seashells to produce lime plaster is unusual in a country that has abundant rock to use. The area where the fragments of the original wall paintings were found is near to the sea and to a lake. It would be expected that the seashells used were from species found to the area. It would be interesting to see if there are more examples of similar mortars from different periods in the area of Boeotia, because that would indicate a local practice. Otherwise, it is probably the practice of an isolated craftsman.

Educational applications

As an artist, the author is interested in the application of alternative materials and during research became more interested in recyclable materials. Apart from the archaeological -experimental or otherwise- part, crushed shells can be considered to be an adequate and interesting material to use for recyclable *fresco* applications. A lime mortar made with recycled materials can be used as an educational activity that relates to ancient painting, mortar technology and ancient forms of recycling. We believe that in areas that have large quantities of unused seashells, using them to produce plaster or as an aggregate for a mixture is an eco-friendly building solution. For example, in our time a number of oyster and fish farms operate in the area of the Cheng-Long Wetlands (Yunlin County, Taiwan). That has resulted in the accumulation of piles of oyster and clam shells (See https://artproject4wetland.wordpress.com/about/). In such an area, seashells could be used as an aggregate or as a source of lime for building or wall painting projects.

If finely ground, seashells could also be used as a pigment. Although we did not use them in that fashion, based on the powder produced from grinding, we believe that it would produce a bright creamy orange colour. We would not expect ancient painters to use such a material, as they would prefer a more stable, reliable and "clean" pigment.

Straw

The existence of a large quantity of straw can give a slight colour to the mixture, especially if it also contains a little water. This phenomenon is also mentioned in the bibliography (Kondoglou 1993, 52; Theophilus 1847, 90), but if straw is a small part of the mixture it will not affect its pigmentation. The colour of the mixture of sample *16314 Palmette Flower* appears to be more yellow because of the process used to prepare the straw.Putting the straw for three days in the plaster caused the transference of colour from it, which possibly partially continued when the mixture was painted and left to dry. It also appears that the more straw there is in the mixture, the more yellow it becomes. Logically, if the mixture identified by Brysbaert was not yellow, then straw was not prepared in the way mentioned by Kondoglou and Dionysios of Fourna, and it was not used in large quantity.

Straw produced an intense smell when mixed with the plaster, especially when it is the only aggregate. The material itself has a distinctive smell, which becomes more intense when wet. The phenomenon became more intense in the top mixture of *16314 Palmette Flower* where the straw was affected by the lime before being used. When dry, the smell disappears from the mixture. In most of the samples we presented some parts of the straw protruded from the surface, but were firmly stuck to the mixtures. That means that the straw was not in the size that it should be for these specific lime mixtures and that it was not in the state that it was supposed to be. It also means that the mixtures were neither properly mixed or nor compacted while spreading.

We agree with Brysbaert (2008a, 2766) that the choice of materials suggests knowledge of their properties. Most of the materials used in the ancient mixture are compatible with lime plaster and are quite durable. The only ones that are not durable are straw and hair. Regardless of the method used to incorporate them in a mixture, organic materials rot over time. That makes the mixture that contains them vulnerable and weak (Mpeteinakis 2008, 27). *Fresco* paintings change over time, but that is a process that takes years. We cannot rule out the possibility of new change or alteration in the future, but we would expect it more on sample *16314 Palmette Flower* than any the other samples. It is also the one that is more likely to deteriorate due to its composition.

Clay

As mentioned above, in Cameron's experiments the clay plaster had a smell that was attributed to the organic additives. In our clay mixture we have not yet detected any smell or mould, but we cannot exclude the possibility of mould appearing. In a similar fashion, we cannot exclude the possibility that perhaps there was something amiss with the materials used in Cameron's experiments. The one sample that did smell was the lime and straw mixture (*16314 Palmette Flower*), but that did not include clay.

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1 The technical term giornata comes from the Italian word giorno which means day. In fresco the term refers to space that can be painted in one day. The term can also mean the working day in general (Benton 2009, 48· Istudor 2008, 28· Conti 2007, 422· Tsuji 1983, 216· Meiss 1970, 235· Winfield 1968, 70Pozzo in Merrifield 1894, 54·). The wall painting is composed of irregular pieces of mortar that are placed one next to the other. The pieces themselves are also called giornatas. Each piece of mortar slightly covers the previous piece and is in turn covered by the next (Johnston 2011, 553· Conti 2007, 422· Tsuji 1983, 216; Meiss 1970, 16, 235· Plakotaris 1969, 120· Radel 1966, 34·Cennini 1933, 44· Armenini in Merrifield 1894, 45; Mérimée and Taylor 1839, 278-279). Every giornata is larger than the space that is to be worked that day. When the painting of the day is finished, the unpainted part of the giornata is cut and removed. These cuts are made at a) the outlines of the naked parts of the figures, b) the outlines of clothing, c) the outlines of entire figures or d) the limits of the painted part of the composition (Daniilia et al 2007, 1972· Tsuji 1983, 216· Tintori and Meiss 1964, 380· Palomino in Merrifield 1894, 74· Pozzo in Merrifield 1894, 55· Winsor and Newton 1843, 32).

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FIG 1. THE SEASHELLS THAT WE USED IN THE SAMPLES.

FIG 2. CHOPPED STRAW AND A PIECE OF POLYSTYRENE.

FIG 3. THE BONE THAT WE USED IN THE SAMPLES.

FIG 4. 25214 BRYSBAERT 1: THE MIXTURE OF THE CLAY PLASTER.

FIG 5. 25214 BRYSBAERT 1: WET AND DRY CLAY PLASTER LAYER.

FIG 6. 25214 BRYSBAERT 1: THE SEASHELL MIXTURE OF THE SURFACE.

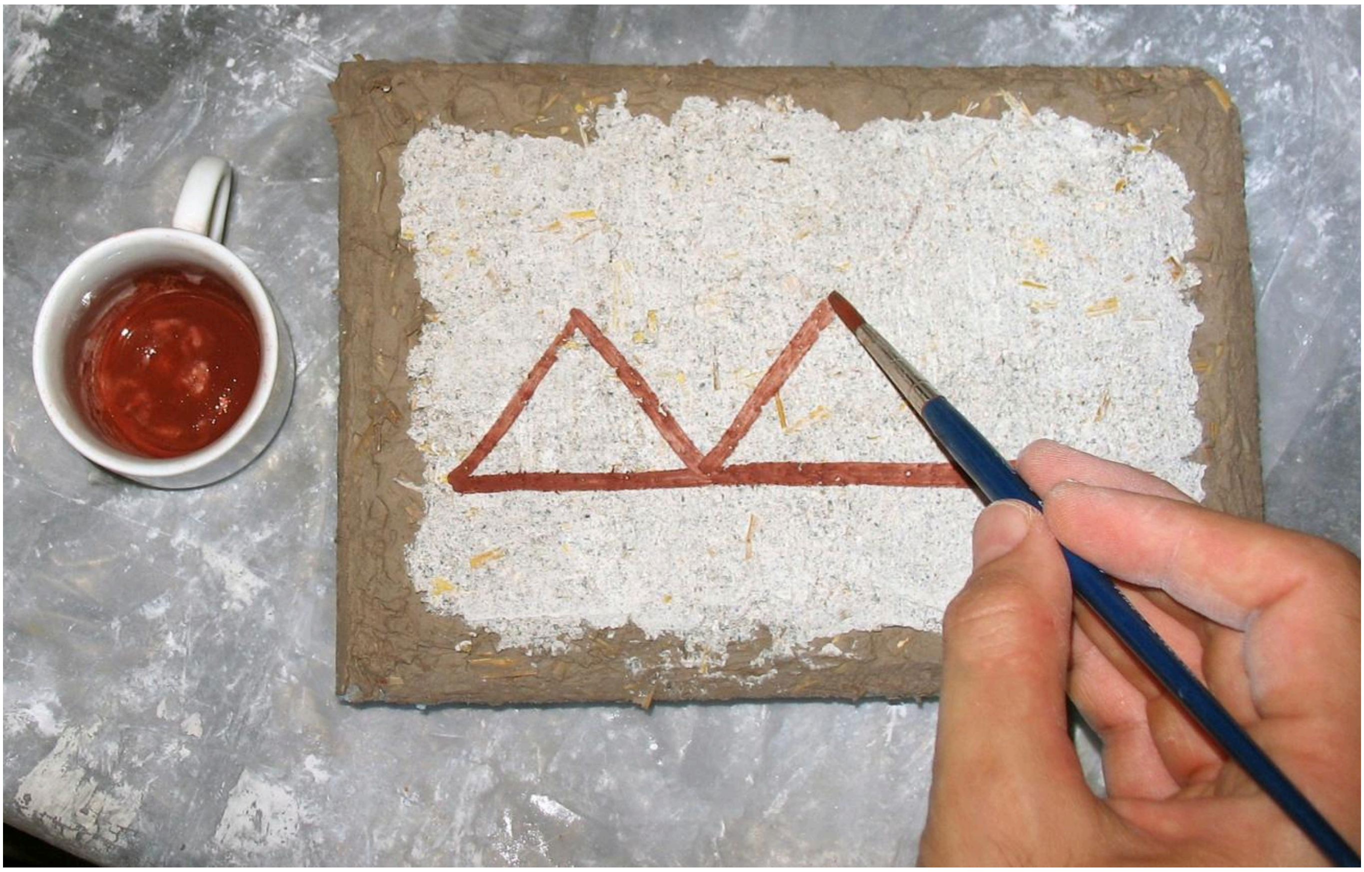

FIG 7. 25214 BRYSBAERT 1: PAINTING THE SAMPLE.

FIG 8. 25214 BRYSBAERT 1: THE FRESH (ABOVE) AND DRY (BELOW) SAMPLE.

FIG 9. 4314 BRYSBAERT 2: THE MIXTURE OF THE SURFACE.

FIG 10. 4314 BRYSBAERT 2: PAINTING THE FIRST TRIANGLES OF THE SAMPLE.

FIG 11. 4314 BRYSBAERT 2: THE FRESH (ABOVE) AND DRY (BELOW) SAMPLE.

FIG 12. 16314 PALMETTE FLOWER: THE FRESH MIXTURE OF THE STRAW AND PLASTER.

FIG 13. 16314 PALMETTE FLOWER: OPENING THE MIXTURE OF THE STRAW AND PLASTER AFTER 3 DAYS.

FIG 14. 16314 PALMETTE FLOWER: THE FRESH (LEFT) AND DRY (RIGHT) SAMPLE.

FIG 15. 22314 BRYSBAERT 3: THE MIXTURE OF BASE LAYER 2, CONTAINING EGYPTIAN QUARTZ, STRAW AND BRICK POWDER.

FIG 16. 22314 BRYSBAERT 3: ALTERATIONS DURING THE DRYING OF BASE LAYER 2.

FIG 17. 22314 BRYSBAERT 3: MIXTURE AND TESTING LAYER OF SEASHELLS AND LIME-PLASTER.

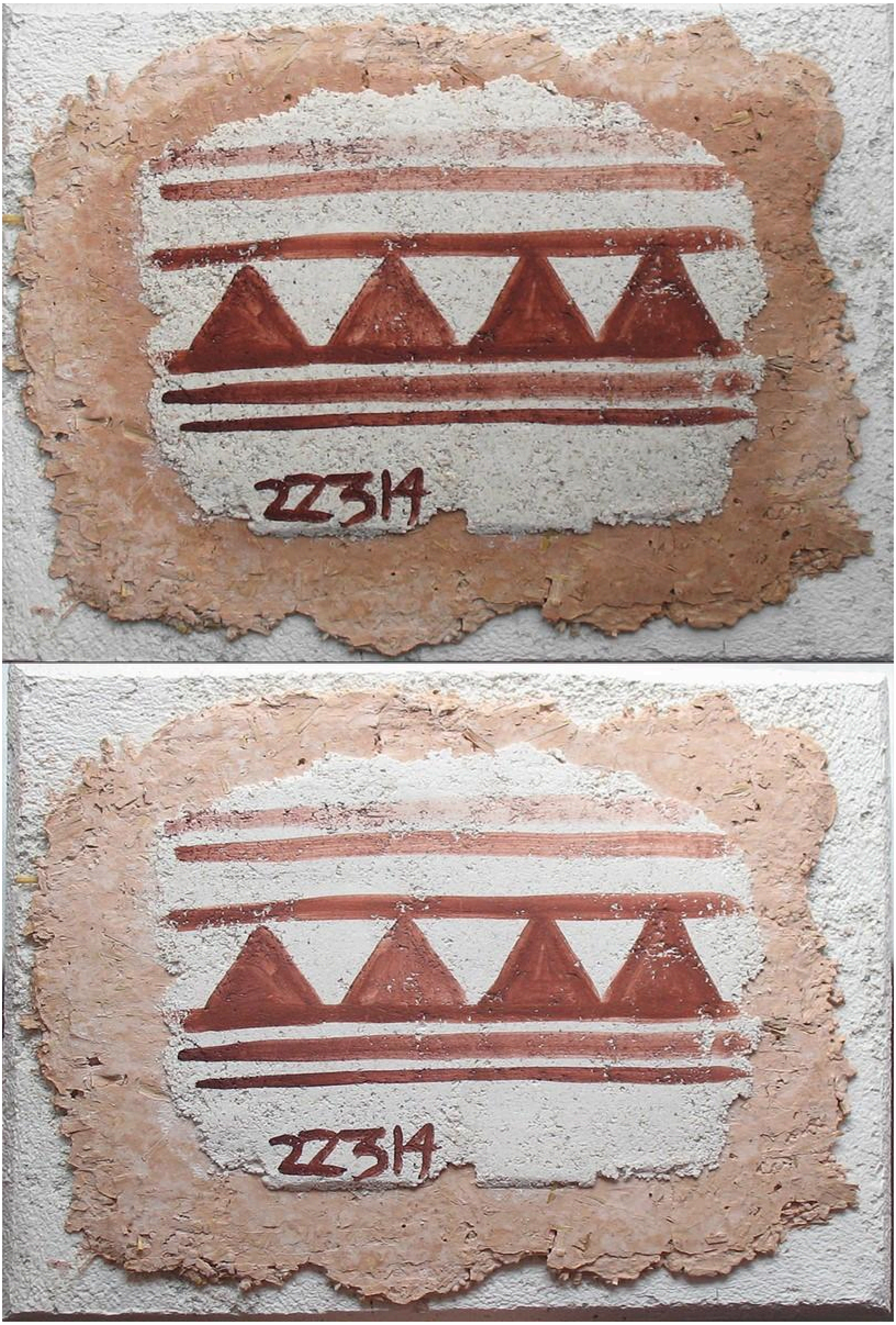

FIG 18. 22314 BRYSBAERT 3: THE FRESH (ABOVE) AND DRY (BELOW) SAMPLE.