Notes on colours and pigments in the ancient world

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There have been plenty of writings about ancient pigments, how to obtain them, what they contain, their physical and chemical properties, and how to identify them and, as they say, buckets of ink have been consumed in the process. What I feel needs emphasising here are some particular aspects that have been frequently overlooked. This paper is nothing other than a number of annotations about colours and pigments in the ancient world. The figurative expression of meaning is the first considered aspect. Blue ultramarine and purple are the two demonstrative considered examples where the "material meaning" is substituted by the "colour meaning". The second considered aspect is the formulae uncertainty. This concerns the artificial pigments as the Ceruse or the Naples Yellow where the comprehension of the recipes is fundamental to understand the ancient composition. Prices, fashion and styles in the Roman world is the last considered aspect. This has strongly conditioned the diffusion of the pigments and, of course, of the colours.

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The figurative expression of meaning

Ultramarine is an intense blue colour with some hints of violet; anyone going to a shop selling painting materials has no difficulty finding ultramarine, whether they are looking for chalk, pencils, paint in a tube or whatever. To tell the truth, the colour is not really codified and, for example, in the case of oil paint tubes, there are some differences between the various manufacturers. It is not therefore codified in colorimetric terms, i.e. in a CIE space, but nevertheless the examples in which it is found have a $L^*a^*b^*$ score range that a colorimetrist would say is quite limited. Of course, this is a bit vague because one needs to consider the question of quantity, i.e., in this case, how the material from the tube one has bought gets "spread" and on what sort of base. Anyone buying ultramarine is going to want to buy one that looks good and in line with the colorimetric scores corresponding to the average idea of a blue ultramarine colour. Certainly one rarely considers what the material in the tube that one buys is made of.

Among the colours being bought by the many painters' ateliers in 15th Century Venice one of the most in demand was ultramarine. It was a very expensive and precious pigment, to the extent that often the client of a painting stipulated in his commission how much gold and ultramarine there should be and specified in particular whether the purchase of them was to be for his or the atelier's account. But the client was not asking for a particular colour; this was the logical consequence. He was thinking of what it was made of: ultramarine was ground lapis-lazuli and it was this that he was looking to buy. It had to be pure, with a good colour, come from Badashan, and perhaps from the very mountain Marco Polo talks about, and have other important characteristics, but it was unthinkable for it not to be lapis-lazuli; it would have been a fraud and the vendor perhaps finish up in the Leads prison. Many instruction books, both before and after Cennini [1], explain how to grind, wash and emulsify lapis-lazuli powder, of which the range of colours and its preciousness became appreciated to such an extent that they took on an iconographic value and the blue cloak of a character with a prominent position had to be obligatorily painted with this very precious lapis-lazuli. But it was, of course, a pigment scorned by Caravaggio.

Now, "ultramarine" signifies a particular type of blue colour. Over time the term has assumed the sole meaning of the colour of what was previously a substance of a certain colour.

If the above is true for ultramarine, in the case of purple one gets to almost surreal levels. Purple was among the most precious of the pigments used by the Romans, especially for dyeing cloth. It was not one colour but rather a wide range of colours obtainable from the liquid that could be extracted, with a somewhat complex process, from a number of molluscs of the Murex species. The use of Murex to obtain purple had already declined by the Renaissance, at least in the western world, and nobody has ever seen anything dyed purple. Spectrographic tests would appear to indicate that some fragments contained in Saint Ambrose's shrine in Milan are dyed purple but there is some uncertainty and, in any case, from a colorimetric point of view, they provide no information. On the basis of Pliny's description [2], it can be deduced that purple had iridescent qualities and that classification was difficult, given that different varieties derived from the different types of molluscs used and from the methods used to obtain the dye, such as, for example, the period in which the molluscs were fished or drying and preservation techniques. Nowadays the term simply signifies a colour. The positive thing is that it is highly codified and this is probably due in particular to the fact that over time it has always had a very strong symbolic and iconographic meaning. For an ancient Roman a purple garment symbolised very high birth and it was always this way from then on; indeed in the ecclesiastic hierarchy it was reserved for the next rank down from the Pope: the purple synonymous of a cardinal's rank.

Of course there are also some intermediate cases like cinnabar (vermilion), which still has a double significance as both a substance and a colour, but if one takes the trouble to read the entire 35th book that Pliny, in his Natural History, devotes to pigments – even if in reality three quarters of the book is devoted to painting and the various painting styles – one realises that in reality what is important for him is precisely the substance, i.e. how to obtain the substances to achieve certain colours. In fact he lists about forty substances that – processed to a greater or lesser extent and some more valuable and others less – provide pigments for painting on either wood or canvas or for frescos. In this regard we need to point out that, when talking of Roman painting, we are referring, by definition, to wall paintings for the obvious reason that it is they that are for the most part preserved so that they are the ones we are able to see. But at the time this was not the case: paintings on wood and canvas were very widespread and, to name just one example, Pliny again tells (N.H. 35th book, 33rd par.) how Nero had a portrait done of himself on an enormous canvas, which was placed on the Esquiline hill and later got destroyed by lightning. With synthetic chemistry it is possible to easily obtain the substance, which

has become less important, and the term has shifted to signifying just the colour. On the other hand, mediaeval ateliers were also paint factories using particular formulae, and an artist's job included making pigments.

Providing further support to the importance given to the raw materials it is sufficient to mention the large space dedicated by both Vitruvius and Pliny to fakes.

Red earth from Lemnus used to fake "minium" (in the Romans' terminology minium was our vermilion, which is a mercury compound), the precious white of Paretonium faked by using clay, indigo faked with clay from Selinunte dyed with woad herb (isatis tinctoria) extracts: these are a few of the many examples mentioned and warned about by Pliny.

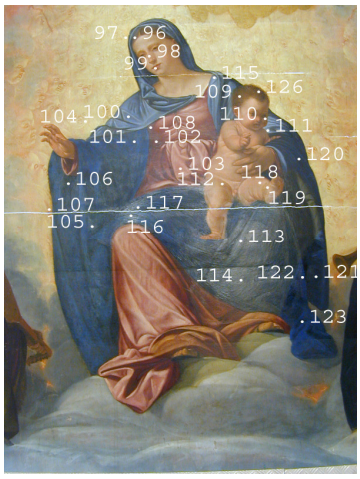

Figure 1: Savoldo – Brera Gallery, Pala di Pesaro (detail). The mantle of the Madonna is ultramarine blue. The painting is on wood (512 ×312 cm) with the figures on a scale of about 1:1. The points indicated with numbers have been analysed both colorimetrically and using X-ray fluorescence during an experimental campaign carried out by laboratories of ENEA – Rome on behalf of "Amici di Brera". The shades of blue are different and the colour varies very significantly as a result of dilution with other pigments, the preparatory coat of paint underneath and the binder used.

Uncertainty about formulae

As is well-known, some pigments are natural, i.e. they can be found in nature, like earths, which, once suitably washed and purified, are ready for use. Other pigments are totally invented substances, which do not exist in nature. Ceruse or white lead (The Romans' Cerussa) is a totally artificial pigment. Sheets of lead exposed to vinegar vapours form a paste, which, when dried, becomes a very attractive, thick and, as we would say today, quite chemically stable white dye. The same applies to Vitruvius' formula [3], which moreover derives from Theophrastus, and also the description of the "Alexandria frit", which is the well-known Egyptian blue, one of the most commonly used pigments in antiquity, a silicate that probably derives from the glass manufacturing technology already present in Egypt since the 3rd millennium BC.

In reality what Theophrastus, Pliny and Vitruvius describe are not formulae but, more than anything, historical annotations about where pigments could be found and how they were extracted or produced. For true and proper instruction books, i.e. manuals for the use of persons wanting to engage in producing pigments, it was necessary to wait until after Heraclius or Theophilus in the 11th Century, although after that there were loads for the rest of the mediaeval period. It should be noted,

however, that in the great majority of cases these books were more than anything reference books for readers "already well acquainted", whereas in fact much of what was known about the aspects of the matter has been lost. If in fifty years or so someone tried to make mayonnaise on the basis of the original recipe by Pellegrino Artusi and knew only that, it is highly doubtful they would be able to achieve anything more than a messy concoction. This would be due to the fact that a recipe book omits information considered implicitly known by the reader. But this is no longer true. In addition there is much uncertainty as regards terminology. Let us consider, for example, yellows.

Yellow ochre (a clay base coloured with limonite) [4] lords it in that is one of the most ancient natural pigments and useful moreover for producing red, because, as well as being found naturally, it could be transformed into red ochre by roasting it in a process similar to producing Usta (our Minium), which the Romans and the Greeks before them obtained by heating up white lead (ceruse).

Going back to formulae and problems with terminology, it is interesting to consider the pigment called Naples Yellow. It has been classified as a pigment with antimony as the principal ingredient, thus differentiating it from yellows based on lead and tin, even if such a rigid classification is very risky, given that there is much crossing and overlapping, as Seccaroni has shown in a very comprehensive text about yellows [5]. The origins of Naples Yellow are considered to be very remote, since the use of antimony can be found in a Neo-Babylonian treatise that describes how to make glass and vitreous pastes. As well as the curious question, which we mention incidentally, of the term "Naples", when throughout the Campania region there is no evidence of any minerals containing antimony, what perplexes is the term "antimony". It is obvious that the tablet engraved in cuneiform letters can not contain the precise term but is extrapolated from another one generally used not only for dyes but especially cosmetics. Moreover the pigment stopped being used and then reappeared, according to classical bibliography, in the mid 18th Century, which was later disproved by a number of tests in the field.

In short, looking at the question further, we pass from an exact codification - Naples Yellow is a pigment based on antimony that started being used in the mid 18th Century - to an overlapping in the use of ingredients (Pb, Sn, Sb) depending on the various manufacturers and the ancient Babylonian formula is perhaps an opacifier [6].

Retracing ancient formulae is therefore somewhat complex and, of course, as in almost everything, has both simple and very difficult aspects. Ceruse, mentioned previously, and artificial vermilion can be taken as two examples. The first can be obtained easily, all things considered, whereas for the second, which requires the use of Theophilus' instruction book, there are some complex interpretational questions.

Figure 2: This fresco in the Arianna's Villa is the result of a rich and refined commission. The border surrounding it (approx. 2 ×2 m) is of Egyptian blue.

Prices, fashions and styles

Pliny, an inexhaustible source of information, even if not always completely reliable, displays, when talking about pigments, two significant similarities with the mediaeval and renaissance worlds. The first is that, as already mentioned, mediaeval commissions often specified that a painting had to contain a certain quantity of precious pigments or that these would be supplied by the client. Pliny said likewise that it was the client of a painting who usually provided: Minium (vermilion), Armenium (azurite), Cinnabaris (probably dragon's blood, i.e. a red vegetable resin), Chrysocolla (i.e. malachite) Indicum (indigo) and Purpurisissum (pigment for painting obtained by purple and clay). These were obviously the most expensive pigments.

The second similarity is the fact that the pigments described by Pliny for use in painting are also continuously recommended as pharmaceuticals: Sinope earth for stopping diarrhoea, Lemnus red clay for spleen pains, ceruse for cleaning the skin but poisonous if drunk, and so on. In the middle ages pigments or their ingredients were sold by apothecaries.

Ancient texts always pay great attention to how much materials cost but comparisons are not always easy and depended on which specific period it was because, like today, prices varied for a whole host of reasons. However, certain prices mentioned, again by Pliny, provide a good indication (1 denarius = 4 sestertii = 16 asses): Sinope 32 asses per pound, Paretone 110, Sandrax 5, Indigo 300, Usta 100, Purpurissimum from 20 to 500 (quality depending).

Egyptian blue does not appear explicitly among the most expensive but was highly appreciated and we know from Vitruvius that it was manufactured at Pozzuoli by a certain Vestorius and therefore easy to obtain. As regards this pigment it should be noted that it was particularly stable and, all things considered, the technology used in its manufacture – Vitruvius provides a quite detailed description of the procedure for making it – does not seem very difficult. It is thus rather surprising that in the middle ages it was replaced by azurite, including that produced artificially, which required a more complex manufacturing process.

There are certainly many factors involved and the ease with which the raw materials could be purchased may also have played a fundamental role in the use of pigments.

The question of Indigo is illustrative. Pliny said that he did not know its composition but only that it came from the Orient. As previously mentioned while discussing forgeries, he cited the fact that woad (herb extracts of isatis tinctoria) could be used more or less as a substitute. Put simply, we could say that in reality they are practically the same thing, given that they are extracted from leaves, in one case the woad and the other indigofera tinctoria. The latter contains more indigotine and this higher concentration results in a material of higher quality and, at the end of the day, a better colour. The Romans used and valued Indigo but, obviously, commercial channels were substantially altered and reduced during the middle ages. The use of the woad herb spread and, given that the colour was the same, the pigment extracted from it was often called Indigo. From the 13th to the 17th Centuries the Tiber valley and the Urbino area became important production centres; the herb for the woad was cultivated, harvested and dried, and then ground into powder from which the pigment was made. However, the commercial links with the Orient were becoming more frequent and less expensive so that indigo, already in powder form, of higher quality and with better results, began to be imported again. Woad production stopped. In the Napoleonic period a trade blockade led a reflowering of woad production but from the mid 19th Century it was definitively abandoned in favour of synthetic products.

The use of a less expensive pigment of a similar colour as a substitute for another was always quite common. In 62 AD Pompeii was struck by a violent earthquake that caused significant damage to

buildings and there are many examples of repair and reconstruction work that are easy to see thanks to their being untouched after the eruption in 79 AD. Some of the repairs are true and proper reconstructions, while others are philological repairs or ones that rebuilt precisely what had been damaged by the earthquake but maybe on a tight budget.

The diffusion of the various pigments was also, of course, connected to fashions preferring one colour of another. Where we talk of frescos here, this does not always mean illustrations, i.e. a scene depicted in most cases in the middle of a wall like a hung painting, but the background on the wall and any decorations. There have been no comprehensive studies done to provide indications about fashions and changes in taste as regards colours but one should beware of the tendency to divide history up into a few long periods, whereas tastes changed rapidly.

Certain questions arising recently are rather interesting. The excavations at Herculaneum have given rise to the following problem. Yellow ochre gets transformed into red ochre as a result of heat, and it has been ascertained that many walls or portions of walls went from yellow to red with the heat of the eruption. How much in exact quantitative term? The dominant colours on the walls were, without doubt, yellow and red but it would be interesting to be able to make a more well-reasoned evaluation, which might make it clear that the widespread use of red on walls was in fact one of yellow.

However, without doubt, the walls, again with reference to the intended background colour and not the scene depicted, were, in the great majority, yellow and red, and from time to time black. Other colours are very rare. White is almost always yellowish and light blue is used to depict an opening towards the sky. Of course, there are some special cases. As remarked by DeCarolis [7], when he describes the “the study in the House of the Gold Bangles” in Pompeii, the composition there that simulates a garden in an indoor location is extremely rare and is probably indicative not of a widespread taste but of a specific request by the client.

Obviously the general colour perceived is green, given that the walls simulate a wooded garden, and the room was called a “study” in a harking back to the term used by humanist scholars in the 14th Century to define small rooms devoted to study and meditation. Further research could clarify many aspects better.

Figure 3: Oplonti. Villa di Poppea. The background on the walls is red. On the one on the left (original) cinnabar has been used and on the one on the right and the back wall red clay (Roman restoration after 62 AD).

References

1. Cennini C (2003), *Il Libro Dell'arte*, F Frezzato (ed.), Neri Pozza. [ISBN 8873059104].
2. Plinio CS (1988), *Naturalis Historia" Lib. IX (60)*, Giulio Einaudi [ISBN 88-06-11420-4].
3. Pollio V, Gros P, Corso A and Romano E (1997), *De Architectura Lib.VII (11)* - Giulio Einaudi [ISBN 88-06-12239-8].
4. Rinaldi S, Quartullo G, Milaneschi A, Pietropaoli R, Occorsio S, Scala FC, Minunno G and Virno C (1986), *La fabbrica dei colori,* Il Bagatto [ISBN-88-7755-0503].
5. Seccaroni C (2006), *Giallorino,* De Luca [ISBN-88-8016-687-5].
6. Cocchiararo A and Omarini S (2006), *Colore e Colorimetria - Indagini storico e colorimetriche sul pigmento Giallo di Napoli,* A. Rizzi (ed.) CET [ISBN-88-7957-252-0].
7. De Carolis E (2007), *Rosso Pompeiano – Lo studiolo della Casa del Bracciale d'oro,* Electa [ISBN-978-88-370-5933-0].