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GREEN PIGMENTS: TRADITION AND MODERNITY IN PAINTING ACCORDING TO PORTUGUESE 19TH CENTURY TECHNICAL LITERATURE

Sónia Barros dos Santos*, António João Cruz*,**

* Portuguese Catholic University, Oporto, Portugal, ssoniab@gmail.com

** Polytechnic Institute of Tomar, Portugal, ajcruz@netvisao.pt

Abstract

The massive industrialization of the nineteenth century societies together with breakthroughs in Chemistry such as the discovery of new elements and compounds, allowed the production of new pigments. In this process, many new synthetic green pigments were added to the painter's palette. There is a significant lack of information of how the spreading of these products occurred in peripheral countries in Europe. Based in technical literature published in Portugal between 1788 and 1904 this study shows that there is in average a large gap between the discovery and the commercialization of new green colours and their first references in Portuguese technical literature.

Keywords: Green pigments, Portugal, Nineteenth century, Technical literature

INTRODUCTION

During the 19th century a large number of new pigments, dyes and lakes appeared due to chemical science and industry development. Their discovery was economically advantageous and encouraged, since some had a great impact in industry namely in the fundamental textile and dyeing fields. A new generation of colourmen based on consistent chemical knowledge emerges and the painter moves away from the traditional setting as workshop's habits and structure are simplified and new painting contexts and techniques are allowed by new materials. Concomitantly, the gap between artists and their knowledge about materials increases as industrialization develops [1-3].

Green traditional pigments include natural products such as malachite, green earth and green lakes. Malachite and its artificial varieties have not intense colours. The same comment applies to green earth, a stable pigment but transparent in oil media. Vegetable green lakes had a poor permanence and were not appreciated for oil painting. Yet, the lack of good natural colour agents was not corrected by the introduction of the first artificial green pigments. Artificial copper compounds such as verdigris, whose production was variable according to

ages and places, result in chemically different substances, generally unstable and with poor compatibility with other pigments. Nevertheless, verdigris and green earth could be easily found in palettes until late 19th or early 20th century. Due to these problems, the green colour was frequently obtained through the use of mixtures of blue and yellow pigments, whether purchased as mixed greens [4] or prepared in the palette. There was an obvious need and appetence for better green colours. After the late 18th century the new modern synthetic green pigments developed had a good acceptance by artists. For instance, Scheele's green, named after the Swedish chemist who invented it in 1775, was promptly adopted despite its high toxicity and dirty tone. It was replaced by other arsenic green pigments like Schweinfurt and emerald green whose characteristics were similar. Prussian and ultramarine greens are also among these new materials alongside green compounds based in recently discovered chemical elements such as chromium, zinc and cobalt. Chromium had a relevant role, giving origin to several colours that could replace copper greens. Chromium greens dry well and are stable. Among them, viridian, a deep and transparent colour was particularly appreciated by impressionists, together with Schweinfurt green. Another pigment, cobalt green, a mixed oxide of cobalt and zinc, is permanent but has a poor colouring strength. It was never very attractive and had a limited and late use considering its discovery date [4-8].

The adoption of these new products depends on different factors, namely their availability in trade markets, their price and characteristics. Also, personal aspects, such as the artist's knowledge about them and his willingness to change must be taken into account. According to recent surveys, the first reference to new blue synthetic pigments in 19th century Portuguese technical literature only appears, in average, 37 years after the beginning of their commercialization [9]. For new yellow pigments such average delay is 52 years [10]. Regarding green pigments, what is the situation? What are the pigments, traditional and modern, mentioned in literature? How did authors characterize them? When were they first mentioned? Which was the delay compared to the dates of their introduction in markets? Despite the common practice of pigments' adulteration in this period and the difficulties of studying historical pigments based in a non-standardized terminology [11-13], written sources indisputably provide relevant data about the adoption of new materials. The obtained results will be discussed within the context of what happened in countries central to pigments production and new materials development.

GREEN PIGMENTS IN 19TH CENTURY PORTUGUESE TECHNICAL LITERATURE

Green pigments were divided in two groups – traditional and modern pigments – each including seven different classes. This study, as others interpreting 19th century (and earlier) written sources, was confronted with both the variety and the inconsistency of materials names related to their geographic and historical period of use. The use of the same designation for more than one material and, reversely, one material with many designations, presents

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inevitable classification difficulties. Consequently, some pigments could not be identified and therefore were not included in the mentioned classes. They are discussed after these classes.

TRADITIONAL GREEN PIGMENTS

Among the published works analysed [14-27] and discussed previously [9,28] seven different classes of traditional greens were found: malachite, green ashes, verdigris, atacamite, green earth, vegetable green lakes and mixed greens. The first four are copper greens, the fifth consists of iron oxides. Mixed green are here defined as green colours prepared by colourmen usually by co-precipitation of blue and yellow pigments and are available in market in ready-to-use presentation. Therefore, rather common instructions given to artists for mixing, most usually, blue and yellow pigments in their own palettes were not considered, although Macedo stated his preference for greens mixed by the artist himself rather than ready-made paints, defined above as mixed greens: "*greens mixed by painters in palette are most frequently preferable to the same hues already prepared*" [23, p. 13].

Malachite was named *verde montanha* [20] and *verde da Hungria* [24]. Under the designation *verde montanha*, the only reference we can guarantee, based in the description, is malachite dates from 1875 [20]. In 1815, the pigment with the same name was merely mentioned as a "bluish green" [16], based in the 17th century Portuguese writer Filipe Nunes. Because this designation was also given to a green ashes recipe [19], 1815 reference is not represented in Fig. 1. We would like to emphasize that this exclusion postpones the first reference to 1875. *Verde montanha* was also found in 1898 [24], but for the same reason has no presence in Fig. 1.

Green ashes or verditer are referred in one treatise as *cinzas verdes produzidas por o cobre and as verde de montanha* [19]. The recipes clearly justified this interpretation, although in the same publication the designation *cinzas verdes* (green ashes) has also been applied to Scheele's green [19], in accordance with the bibliography of the time [4-8]. Other names found for green ashes are *cinzas esverdeadas* [20], *cinza verde* [24] and *cendre vert* (a watercolour from Lefranc) [26]. It is classified as poor quality material [24]. If the above mentioned reference *verde montanha* in malachite class is in fact green ashes, the first written appearance is antecipated to 1815.

Verdigris is *verde destilado do verdete* [14], *verde estilado* [17], *verdete cristalizado* [18], *verdete* [16,18,24], *verde, verdete* and *óxido de cobre* [20], *verde de água* [20], *verde gris* [23], *verde crhystalisado* [24], *verde-escuro chrystalisado* [24], *verdete distillado* [24], *verde cinzento* [24] and, in the last references, *vert de gris* [26,27]. This French name is given to a colour made by *Lefranc* sold by *Favrel Lisbonense*, described as copper acetate [26]. According to one of the sources, neutral verdigris is preferred to basic verdigris when a more fine and light colour

is wanted and for the neutral hydrated variety two distinct driers are recommended [18]. This isolated remark suggests that the colour had bad drying qualities, which is denied by the literature on the subject. In the last years of the century, verdigris was classified among other pigments of inferior quality or as a material to be avoided [23,24].

Atacamite, seldom used as a pigment, is therefore an unexpected reference that appears only once as *verde peruviano* [24].

Green earth is *terra verde* [15, 21,23], *terra verde de Verona* [20,24], *verde terra* [16] (an archaism with origin in a 17th century author, Filipe Nunes [29]) and, in a similar form, *verde da terra* [24]. Manuel de Macedo writes that it is used by restorers in *veladura* (glaze) [21], but thirteen years later he advises against its use, without justification [23]. In that same year (1898), the bad opinion is shared by Castro da Silva, who mentions it as a variable (unstable) pigment [24]. Such recommendations are in accordance with foreign authors from this period or earlier [30]. In *Favrel Lisbonense* catalogues the colours *terre verte naturel et brulée* by french colourmaker *Lefranc* [26,27] are inaccurately described as iron oxides, thus demonstrating some confusion regarding its composition, since it is partially incorrect.

Among the **vegetable green lakes** are included *verde de Avinhão ou grão claro* [15], *verde bexiga* [16,17,20,24], whose use in aqueous media is mentioned [17,20] and *verde íris* [20,24] or *(verde) gaio* [20], a pigment for miniature painting. *Laca verde (de clorophylle)* [19], a rare material based in grass, and *laque verte* [26,27], a *Lefranc* product, described as Persian berries lake, found in *Favrel's* catalogues also belong to this class.

Mixed greens are named *verdacho* or *verdaccio* and sap-green by Macedo [22]. In earlier centuries and in archaic forms, *verdacho* could correspond in Portugal and Spain to green earth [29,32]. However, green earth was named by Macedo as *terra verde* [21,23] and *verdacho* and *verdaccio* must match another colour. According to bibliography [7,8], *verdaccio*, designation that seems to have been used mainly in southern Europe, is classified as a mixed green (that may include green earth). This late use of the name also suggests the author might have known Cennini's *Libro del Arte. Sap-green* is also mentioned, in English, by Macedo and recommended for oil painting [22]. Although it is the most common vegetable lake in 19th century [6], it must be noticed that this is a late reference to a clearly imported ready-made product that, unlike true sap-green, is to be used in oil painting. For such reasons, Macedo's sap-green was classified as a mixed green, according to recognized and contemporary bibliography [4,5,31].

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MODERN GREEN PIGMENTS

Seven classes of synthetic modern green pigments were found in literature, namely: Scheele's green, Schweinfurt green, cobalt green, chromium oxide green, chrome green, viridian and ultramarine green. Chrome green in this study is defined as mixed greens made necessarily with chrome yellow.

Scheele's Green appears as *verde de Scheele* [18,21-23] and in c. 1902 Favrel catalogue as *vert mineral* [26]. In 1844-45 Lúcio presents several recipes for this copper arsenite, yet none has a specific designation: *azul fornecido pelo cobre*, despite the name *azul* (blue), is obtained from potassium arsenate and copper sulphate; *verde mui bello* was made with copper sulphate, potassium carbonate and arsenic trioxide; finally, *cinzas verdes* its prepared from copper, calcium oxide and arsenic trioxide [18].

Schweinfurt green is named *verde Schueinfurt* [18], *verde de Paulo Veronez* [22] *verde veronez* [21], *vert Véronese* [26,27] and also as *verde-esmeralda* [22,24].

Cobalt green is named *verde de cobalto* [22], *cobalt green*, of *"English"* origin [23, p. 13] and *vert de cobalt* [26,27]. *Verde cobalto* is classified as a stable colour [24], opinion coincident with the majority of foreign authors.

Chromium oxide green appears under the name *oxido verde de crómio (protoxido de crómio)* and three manufacture procedures are described, together with the indication of use in ceramics and other non-specified objects [19]. It is also found in early 20th century in *Favrel's* catalogue as *vert de chrome* by *Lefranc* [26]; its composition (chromium oxide), excludes the interpretation of chrome green, as one might expect based on its designation only.

Chrome green include *verde inglez* [18,24], *vert anglais* (lead chromate and iron cyanide) [26], *vert de chrome anglais* [27], *cinabre vert jaune* (green yellow cinnabar), which is described as lead chromate and iron cyanide [26], and *cinabre vert* [26]. The source where this last name appears, states that the pigment is a mercury sulphide, but that composition is incompatible with a green colour. However, the data provided about *cinabre vert jaune* lead to its inclusion here. As stated before, one reference to *vert de chrome* [26] did not apply to this mixed green, but to chromium oxide green.

Viridian is named *protóxido de chromio hidratado* [19], *vert d'émeraude* of French provenience [23] and similarly, *vert émeraud* (viridian) by *Lefranc* sold by *Favrel Lisbonense* [26,27].

Ultramarine green is listed as *outremer vert* [26]. Despite the name has been given to other pigments, the mentioned composition (sodium sulphate and aluminium silicate) allows this interpretation.

As mentioned earlier, some designations could not be classified due both to lack of information in Portuguese documentary sources and to the multiplicity of interpretations. Such is the case of *verde azeitona* (olive green) [22], applied to chromium oxide green and several other mixed greens; besides, such designation may easily correspond to a hue rather than a specific pigment. Similarly, *verde da Saxónia* (Saxony green) [24], *verde da Prússia* (Prussian green) [24] and *verde imperial* (imperial green) [24] were applied to different pigments. A different situation is the strange *jaune de Naples vert* (green Naples yellow) by *Lefranc* found in c.1902 *Favrel*'s catalogue [26], whose composition description (lead antimoniate and lime sulphate) clearly indicates a yellow colour. The described composition is most probably an error due to its name, but unlike the above mentioned *cinabre vert* (green cinnabar), there is no other match in Portuguese literature and it is not referred in bibliography consulted. Finally, the designations *verde de chromio* [23] and *verde chromo* [24] could not be classified mainly due to the fact that in Portuguese literature such designations were attributed both to chrome and chromium oxide greens, as mentioned earlier, and because no composition or additional information was provided.

In Fig. 1 depicts when each pigment was mentioned. Most traditional pigments persist throughout the century. Exceptions to this are atacamite and mixed greens, appearing in only one source. Although only two mixed ready-to-use greens were detected (*verdacho* or *verdaccio* and *sap-green*), it must be mentioned that most of the analyzed literature refers to the attainment of green colours by mixing blue and yellow in the palette, but never specifying which blues or yellows. No account of that could be given in this survey of green pigments historical names and, besides they do not correspond to the adopted definition for mixed greens. Green ashes are mentioned after the 40's decade until early 20th century. However in the final years a bad opinion about this material exists and the last reference, c. 1902, refers to watercolour only. This pigment was progressively abandoned by the end of the century and such finding in Portuguese literature seems to follow this trend. Although found in the 80's decade in works by Henrique Pousão [33,34], it is probable that malachite followed the same path. Further study for early Portuguese 20th century has to be made referring to these materials.

Fig. 1 shows that most of modern pigments appear in the 40's decade and persist during the century, namely Scheele's green, chromium oxide green, Schweinfurt green, chrome green and viridian. Cobalt green appears for the first time in 1886 but is referred recurrently until the end of the century, confirming the late adoption of the pigment that European literature proposes. Ultramarine green has a fleeting appearance, c. 1902, fact that could too be interpreted as a minor presence in paintings, in conformity with its description in foreign publications.

For each modern pigment found in the Portuguese technical literature, Fig. 2 shows the time lapse between its discovery and the first written reference. Fig. 3 depicts the time lapse between its introduction in European markets and the first reference in the Portuguese literature. Together they demonstrate a slow and late adoption of these new painting materials.

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In average 49 years separate the discovery date and the first Portuguese written reference. Such delay drops to 36 years considering the date of introduction in markets and the first reference in Portuguese publications. They also show that, excluding compounds of minor relevance in painting such as cobalt and ultramarine greens, the time lapse between discovery or introduction in markets and the first written reference becomes smaller, especially as the century reaches the fourth decade.

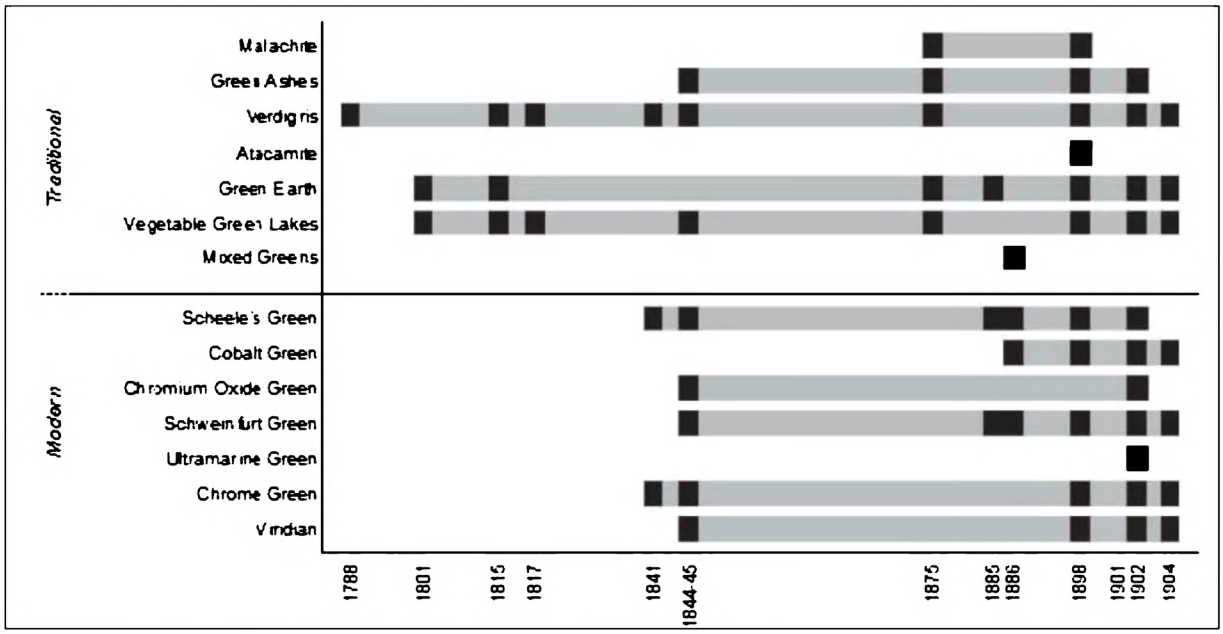

Fig. 1: Green pigments in 19th century Portuguese technical literature.

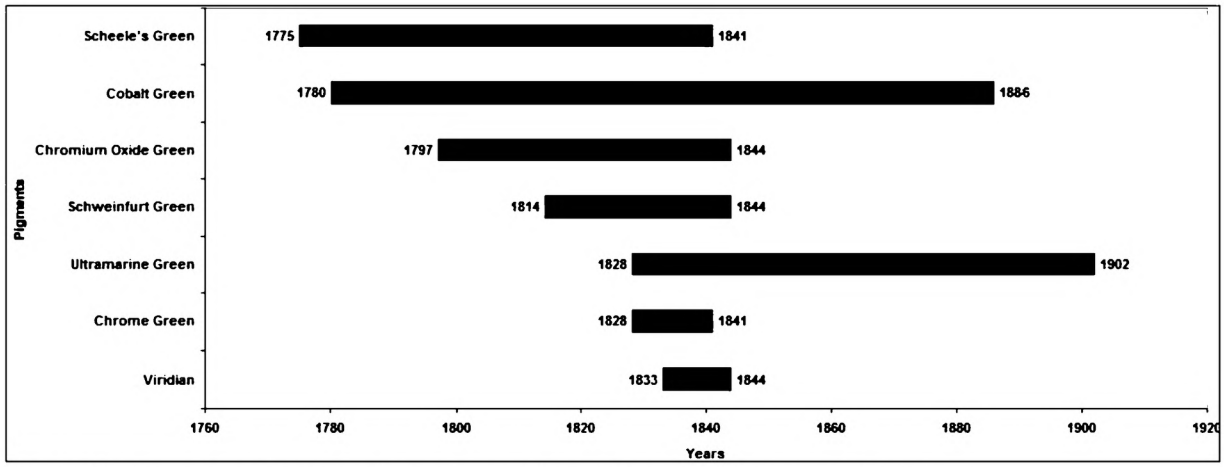

Fig. 2: Modern green pigments: discovery and first reference in Portuguese literature.

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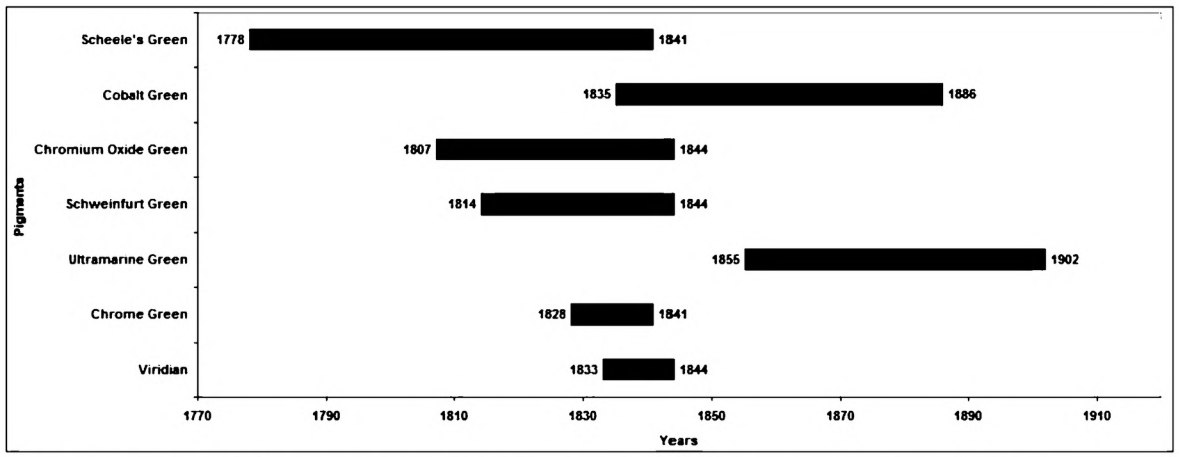

Fig. 3: Modern green pigments: market introduction and first reference in Portuguese literature.

Like in yellow and blue colour ranges, French brand *Lefranc* was sold in the country in the early 20th century. There are clear signs, particularly in Macedo's and Castro da Silva's works that English and French brands were also available in the 80's. Advertisements show that paints by *Winsor & Newton* were sold in *Araújo & Sobrinho*, a firm established since 1829 in Oporto (Fig. 4).


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Fig. 4: Araújo & Sobrinho advertisement of Winsor & Newton materials (Comércio do Porto special Christmas edition, 1894).

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In 1817, Ferreira da Silva, writing about paints preparation for miniature painting, says he intends to make the artist more autonomous and "*avoid dependence from English and French paints*" [17, p. 116]. International influence, namely French, English and German can be traced in the 40's Portuguese publications – these countries' books and newspapers circulated in Portugal and through them came access to other countries knowledge as can be seen in several archives and libraries in Lisbon or Oporto. Also, the urge to industrialize the country is felt repeatedly throughout several governments in the second half of the century and pigments and dyes are focused in chemistry and textile dyeing industry in recently created industrial schools.

CONCLUSIONS

We have observed the persistence of materials considered obsolete in other countries: atacamite, green ashes and malachite. Considering written sources, traditional and modern greens coexist in Portuguese artists' palettes, data confirmed by studies addressing painting analysis [33-37]. The adoption of modern green pigments began most likely during the 40's decade, confirming a certain traditionalism and resistance to change. However, it has to be noticed that some important pigments such as Schweinfurt, chrome green and viridian (with time lapses between discovery and first reference respectively of 30, 13 and 11 years) seem to have had a faster introduction. The information is indicative of the circulation and adoption of the major new synthetic pigments in this peripheral European country. Although fine arts education remained traditionalist in procedures, analogue areas like decorative painting or illustration and after-school painters' habits tend to show another reality. Such conclusions require further study based in trade records.

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REFERENCES

1. Callen, A., *The Art of Impressionism. Painting technique & the making of modernity.* New Haven – London: Yale University Press (2000).
2. Bomford D., Kirby J., Leighton J., Roy A., *Art in the Making. Impressionism.* London: The National Gallery (1990).
3. Ball P., *Bright Earth: Art and the invention of color.* Chicago: University of Chicago Press (2003).
4. Eastaugh N., Walsh V., Chaplin T., Siddall R., *Pigment Compendium. A dictionary of historical pigments.* Oxford: Elsevier Butterworth-Heinemann (2004).
5. Carlyle L., *The Artist's Assistant: Oil painting instruction manuals and handbooks in Britain 1800-1900 with reference to selected eighteenth-century sources.* London: Archetype Publications (2001).
6. Harley R. D., *Artists' Pigments. c.1600-1835. A study in english documentary sources*, 2nd ed. London: Archetype Publications (2001).
7. Perego F., *Dictionnaire des Matériaux du Peintre.* Paris: Éditions Belin (2005).
8. Guineau B., *Glossaire des Matériaux de la Couleur et des Termes Techniques Employés dans les Recettes de Couleurs Anciennes.* Turnhout: Brepols Publishers (2005).
9. Santos S. B., Cruz A. J., *Traditional and modern blue pigments in Portuguese 19th century technical literature*, in A. Macchia, E. Borrelli, L. Campanella (ed.), *YOCOCU 2008. Youth in Conservation of Cultural Heritage. Proceedings*, Rome, Italian Association of Conservation Scientists - Italian Society of Chemistry, (2009), pp. 44-50. ISBN 978-88-86208-59-8.
10. Santos S. B., Cruz A. J., *O desenvolvimento da ciência e da técnica no séc. XIX e os pigmentos amarelos usados em pintura em Portugal segundo a literatura técnica*, in *Livro de Anais. Scientiarum Historia II*, Rio de Janeiro, Universidade Federal, (2009), pp. 385-391. ISSN 2176-123X.
11. Carlyle L., *Authenticity and adulteration: What materials were nineteenth-century artists really using?*. The conservator **17**, 1993, pp. 56-60.
12. Townsend J. H., Carlyle L., Khandekar N., Woodcock S., Later nineteenth century pigments: Evidence for additions and substitutions. The Conservator 19, 1995, pp. 65-78.
13. Clarke M., *A nineteenth-century colourman's terminology.* Studies in Conservation 54, 2009, pp. 160-169.
14. Sampaio, D.C., *Dissertação sobre as Cores Primitivas com hum Breve Tratado de Composição Artificial das Cores.* Lisboa: Regia Officina Typografica (1788).
15. *Meio de se Fazer Pintor em Três Horas.* Lisboa: Typographia Chalcographica, Typoplastica, e Litteraria do Arco do Cego (1801).
16. Taborda J. C., *Regras da Arte da Pintura.* Lisboa: Impr. Regia (1815).
17. Silva R. F., *Elementos de Desenho e Pintura e Regras Gerais de Perspectiva.* Rio de Janeiro: Eduardo e Henrique Laemmert (1817).
18. *Segredos Necessários para os Officios, Artes, e Manufacturas.* New edition entirely revised and added by J. A. A. S. Lisboa: Typographia de José Baptista Morando (1841).
19. Lúcio J. B., *Collecção de Receitas, e Segredos Particulares*, 6 vols. Coimbra: Typographia de M. Caetano da Silva (1844-1845).
20. Rodrigues F. A., *Diccionario Technico e Histórico de Pintura, Esculptura, Architectura e Gravura.*

Lisboa: Impr. Nacional (1875).
21. Macedo M., *Restauração de Quadros e Gravuras.* Lisboa: David Corazzi (1885).
22. Macedo M., *Desenho e Pintura.* Lisboa: David Corazzi (1886).
23. Macedo M., *Manual de Pintura*. Lisboa: Companhia Nacional Editora (1898).
24. Silva F. L. T. C., *Pintura Simples*, 2 vols. Lisboa: Typographia do Commercio (1898).
25. Trindade R. G., *Encyclopedia de Cento e Vinte e Quatro Receitas Colligidas e Traduzidas do Francês.* Porto: Joaquim Maria da Costa (1901).
26. Varella J. N., *Favrel Lisbonense.* Lisboa (about 1902)
27. Varella J. N., *Favrel Lisbonense.* Lisboa (1904)
28. Santos S., (2010). *A cor na literatura técnica artística portuguesa durante o século XIX* – study financed by QREN and Programa ON.2 – o Novo Norte project *Materials and techniques of northern Portugal painters.* http://citar.artes.ucp.pt/mtpnp/estudos/materiais_sec_XIX_01_contexto_historico.pdf (site accessed the 8th of April 2010).
29. Cruz A. J., Pigmentos e corantes das obras de arte em Portugal, no início do século XVII, segundo o tratado de pintura de Filipe Nunes, Conservar Património, 6, 2007, pp. 39-51.
30. Gettens R. J.; Fitzhugh E. W., Malachite and green verditer, in A. Roy (ed.), *Artists' Pigments. A handbook of their history and characteristics. Volume 2*, Washington, National Gallery of Art, 1993, pp. 183-202.
31. Field G., *Chromotography, or, a treatise on colours and pigments, and their powers in* painting. London: Charles Tilt (1835).
32. Bruquetas Galan R., *Tecnicas y Materiales de la pintura española en los siglos de oro*, 2nd ed. Madrid: Fundación de Apoyo a la Historia del Arte Hispánico (2007).
33. Correia A. M., Clark R. J. H., Ribeiro M. I., Duarte, M. L. T. S., *Pigment study by Raman spectroscopy of 23 paintings by the Portuguese artist Henrique Pousão (1859-1884).* Journal of Raman Spectroscopy, 38, 2007, pp. 1390-1405.
34. Correia A. M., Oliveira M. J. V., Clark R. J. H., Ribeiro M. I., Duarte M. L., *Characterization of Pousão Pigments and Extenders by Micro-X-ray Diffractometry and Infrared and Raman Microspectroscopy.* Analytical Chemistry, 80, 2008, pp. 1482-1492.
35. Cabral J. M. P., Ribeiro I., Cruz A. J., Características técnicas da pintura de Silva Porto, in *Silva Porto, 1850-1893. Exposição Comemorativa do Centenário da Sua Morte. Museu Nacional de Soares dos Reis*, Lisboa: Instituto Português de Museus, 1993, pp. 495-514.
36. Ribeiro I., Oliveira M. J., Carmo A. M., Alfredo Keil: a mestria com simplicidade, in *Alfredo Keil. 1850-1907, Galeria de Pintura do Rei D. Luís.* Lisboa: IPPAR, 2001, pp. 245-271.
37. Cruz A. J., *A pintura de Columbano segundo as suas caixas de tintas e pincéis.* Conservar Património, **1**, 2005, pp. 5-19.