ANNATTO IN AMERICA AND EUROPE. TRADITION, TREATISES AND ELABORATION OF AN ANCIENT COLOUR

María Luisa Vázquez de Ágredos Pascual[1], Antonio Fernando Batista dos Santos[2] and Dolores Julia Yusá Marco[3]
Instituto Universitario de Restauración del Patrimonio de la Universidad Politécnica de Valencia
[3] Laboratorio de análisis físico-químicos y control medioambiental de obras de arte
[1]Universidad de Valencia, Facultad de Geografia e Historia, Departamento de Historia del Arte
[2] IPHAN - Instituto do Patrimônio Histórico e Artístico Nacional. Minas Gerais, Brasil

CONTACT AUTHOR: María Luisa Vázquez de Ágredos Pascual, m.luisa.vazquez@uv.es

ABSTRACT: *The high quality of the annatto dye (Bixa orellana L.) and the plethora of products derived and used from this plant in Pre-Columbian and Colonial times are reflected in numerous etnohistorical writings that were redacted in the New World throughout the sixteenth, seventeenth and eighteenth centuries. Those manuscripts reveal abundant information about the methods employed with annatto to obtain the dying substances: orelline and bixin, which was classified as a "lesser or false dye" in the technical manuals published in eighteenth-century in Europe, it is mean, as one of the many dyes of unstable nature that were so widely employed to obtain different hues from the same colour and reduce costs. On the other hand, the particularly warm and bright colours produced by annatto on mixing with different concentrations of other colourants goes to explain why it was one of the most appreciated and used dyes in Pre-Columbian and Colonial textile and painting art.*
The study of the annatto considering the dye tradition in ancient America and Europe, the close lecture on those etnohistorical writings, and the chemical-analytical knowledge recently, has made it possible to present this paper, which provides to the specialists in conservation-restoration and history of art an important information and a detailed study about the origin, properties and uses of one of the oldest and most highly valued colourants in America and Europe.

KEYWORDS: annatto, ancient american dyes, ancient american pigments-lake, pre-columbian art, pre-columbian textiles, european art,analytical chemistry, etnohistorical writings

1. RESEARCH AIM

The chemical characterization of Pre-Columbian painting conserved on the ancient Maya palaces, temples and royal tombs of twenty-three settlements in Mayan lowlands (Mexico and Guatemala) and its social, economical and historical interpretation is one of the lines of research promoted by the Laboratorio de análisis físico-químicos y control medioambiental de Obras de Arte de la Universidad Politécnica de Valencia since 2003. Light microscopy (LM), scanning electron microscopy-x-ray microanalysis (SEM/EDX), X-ray diffraction (XRD), Transmission Electron Microscopy (TEM), Fourier Transform Infra-red spectroscopy (FT-IR), Voltammetry of Microparticles and Gas Chromatography/Mass Spectrometry (GC/MS) identified the original materials and techniques employed in this millenarian Pre-Hispanic civilization. According with the analytical results, in those works of art the painters used different pigments (Vázquez de Ágredos Pascual, 2007a: 58; Vázquez de Ágredos Pascual, 2007b: 125; Vázquez de Ágredos Pascual, 2006), such as calcium carbonate ($CaCO_3$), carbon black (C), red and yellow ochre (goethite FeOOH; limonite $Fe_2O_3.nH_2O$), hematite (Fe_2O_3), specular hematite (Fe_2O_3), cinnabar (HgS), malaquite (Cu_2CO_3 $(OH)_2$) and azurite (Cu_3 $(CO_3)_2(OH)_2$), in combination with several pigments-lake, that were prepared by crushing different natural dyes and various types of silicates (clays above all) with a moderate thermal treatment. Although the most popular pigment-lake in Maya colour palette was Maya blue, there were another of high quality and value, such as oranges and reds that were prepared with annatto and several blood wood trees, which also served as cotton dyes. The historical and chemical study of those dyes and pigments-lake are absolutely essential to the specialist in conservation-restoration in order to know the organic nature of several colours that were used in numerous works of art in ancient America and modern Europe and, in this sense, to understand their own degradation process before the right intervention. According with this, the present text provides the first systematic research about the annatto or "achiote" dye (*Bixa orellana L.*), using the analytical techniques and above all the etnohistorical writings.

It is interesting to note that annatto was not the only name given by the ancient cultures of Mesoamerica to identify the dyestuff that could be extracted from the plant species known scientifically as *Bixa orellana L.*, and this went under many different names according to region. *Achiotl* was the name given by the ancient peoples of Central Mexico, including the Aztecs living in the Postclassic city of Tenochtitlán when the Spanish reached the New World at the end of the fifteenth century. Since very ancient times the Zapotecas of the nearby region of Oaxaca, had known this as *bia* while the Maya commonly referred to the plant as *oox,* its seeds as *k'uxub* or *chaya* (Guatemala) and the cakes prepared with its colouring as *kiwi*. In the Andes cultural area there were various names for annatto, the most well-known being *guandur*, *huantura*, *mandur*, *rucú*, *shambuquiro* and *urucú*, while in the Antilles the species and the dyestuff were known as *bija.*

2. EXPERIMENTAL

2.1 Introduction. The high importance of the colourants in ancient Pre-Columbian and Colonial art

The ancient civilizations of America had an abundance of colourants, ranging from the yellows and oranges derived from various carotenoid and flavonoid vegetable species, red and violets from anthocyanin pigments, quinine reds and oranges, including those of animal origin (*Dactylopius coccus costa* and *Dactylopus confussus cockerell*), and indigoid blues and purples (*Indigofera suffruticosa Mill.* or *Purpura patula L.*). The vast majority of these colourants served for all manner of purposes in these Pre-Hispanic cultures, ranging from standard dying processes (textile dye), medical uses (pharmocopea), painting (preparation of lake-pigments for suitable artistic use), ritual celebrations (body paint) and more domestic or everyday uses (cosmetics and food colourants and condiments). One of the most highly appreciated colorants in Pre-Columbian times was annatto or "achiote" (Bixa orellana L.), alongside others of vegetable origin such as those produced from the blood wood tree or Campeche wood (*Haematoxylum campechianum*), Brazil wood (*Haematoxylum brasiletto Karst.*), Gliricidia (*Gliricidia sepium Jacq. Steud*), Fustic wood (*Clorophora tinctorea*) and particularly indigo or añil (*Indigofera suffruticosa Mill.*) (Ver figura 1), which was employed to prepare one of the most emblematic and complex pigments in ancient art: the Maya blue (Ver figuras 2 y 3) (Doménech et al., 2007a: 1335; Doménech et al., 2007b: 4585; Doménech et al., 2007c: 2812; Doménech et al., 2006: 6027; Vázquez de Ágredos Pascual,2007).

It is of some note that it was these same colourants that raised the interest of the Spanish crown from the very start of the conquest and particularly with regards to cochineal, indigo and blood wood, followed by annatto roughly a century later (Sarabia, 1994*).* Carlos I was the first to encourage the cultivation and importation of these dyes to Castille from his new American domains for export to different countries and markets in Western Europe, and subsequently brought about the decline of some of the colorants previously employed in the old continent from ancient times to dye and paint, and particularly that of woad (*Isatis tinctorea*), which from medieval times had largely been produced in Germany and in the French region of Toulouse, together with that of kermes (*Coccus illicis*), which had been widely produced and employed in Italy and other parts of eastern and western Mediterranean (Vázquez de Ágredos et al., 2007: 131).

This decision by the Spanish monarch only went to reproduce a long-standing tradition in Europe that dated back to the fourteenth century, and where the more influential Italian cities in the textile sector promoted the arrival of exotic colourants on trade routes that ran from Southeast Asia to Venice which was then considered as the gateway to the West. Sixteenth-century Europe, subsequently, had two main points of entry of dyes from the Far East and America in Italy (port of Venice) and Spain (ports of Cadiz, Barcelona and La Coruña) respectively (Contreras, 1996), and one which offered succulent economic benefits to both powers and which in the case of the latter was to last well into the eighteenth century. In this regard, and in accordance with the specialized treatises of the day and chemical-analytical results recently obtained at the archaeological and ethnological material workshop and the Laboratorio de análisis físico-químicos y control medioambiental de obras de arte de la Universidad Politécnica de Valencia (Batista do Santos, 2007: 103) (Ver figura 4), the annatto colourant not only continued to remain in high demand as one of the most widely employed dyes in the eighteenth-century textile industry in Europe, but in certain countries such as Spain its use as a dye considerably increased with respect to the previous century when it first began to be imported on a large scale to Europe, Asia and Africa, and establishing itself at the same level as other high quality dyes held in high esteem by the textile industry, such as cochineal, indigo, turmeric, Brazil wood, safflower, pomegranate and weld (*Reseda luteola*), this latter of native origin.

Figure 1. The indigo plant (Indigófera suffruticosa Mill)

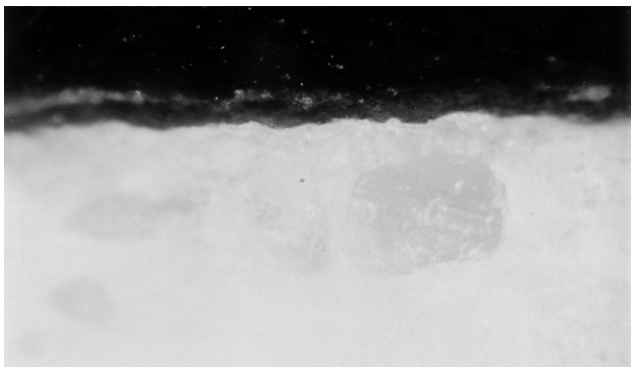

Figure 2. Optical microscope stratigraphic section of Maya blue from the mural paintings at Structure A of Mulchic (north Yucatan, México)

Figure 3. A fragment of the mural painting of Mulchic (Late Classic period, c. 700/750 AC)

As a result of which, annatto then recovered in the eighteenth century part of the hegemonic position it had held in Mesoamerica during antiquity as an important colourant for the dyeing of textiles, among other uses described in a following section and which, as opposed to that of dyeing, were not taken up in the Old World.

2.2. Material and methodology of the research

The study of the annatto in this research combines the dates of etnohistorical writings and some results obtained with chemical analysis of Maya murals paintings sited in more of twenty Pre-

Columbian cities, and in particularly:

Yucatan's Peninsula, Mexico: Acanceh, Culubá, Chacmultún, Chichén Itzá, D´zula, Ek'Balam, Kiuic, La Reforma, Mayapán, Mulchic, Sacnicté (Yucatan), and Calakmul, Dzibilnocac, Hochob, El Tabasqueño, Rio Bec, Santa Rosa Xtampak (Campeche).

Department of Peten, Guatemala: Chilonché, La Blanca, Nakum, San Clemente, Tzikin Tzakán and Yaxhá.

2.3 Results and discussion of the etnohistorical: Annatto as a textile dye and pigment in America and Europe. Study from etnohistorical writings and analytical chemistry

Many of the ethnohistorical texts written in the American since the sixteenth century include very precise descriptions of the annatto shrub, the process to obtain the colourant and the use of this substance by the ancient Pre-Columbian civilizations for very diverse ends, and mainly dyeing, painting, medicine and rituals. Martín de la Cruz (*Libellus de Medicinalibus Indorum Herbis* or *Manuscrito de la Cruz Badiano*), Fray Bernardino de Sahagún (*Historia General de las Cosas de Nueva España*), Francisco Hernández (*Historia de las plantas de Nueva España*), Fray Diego de Landa (*Relación de Cosas de Yucatán*) or Alonso de Zorita were just some of the chroniclers who dedicated part of their manuscripts to annatto and the different artistic, social and cultural traditions related to its handling, manufacture and use.

According to that described by some of these authors, it would appear that the shrub was grown in orchards and gardens around the houses. The copious fruits of this shrub, collected around April, contain the highly sought after colouring which is found in the pulp surrounding the orange coloured seeds set in each half of the seed pod (Ver igura 5). The procedure followed in Pre-Columbian and colonial times to remove the colourant from the surface of these seeds was somewhat more complex than that normally employed in ancient America with the vast majority of dyes and which, in general terms, was simply based on the maceration of the vegetable part containing the colour (bark, pulp, shoots, leaves or roots) in cold, warm or hot water, depending on each case. However, the annatto seeds needed to be crushed and deposited in fat solutions to precipitate the colourant and certain oils were commonly employed to this effect, such as chia (*Salvia hispanica L*), Mexican prickly poppy or chicalote (*Argemone mexicana*), pumpkin seed or mamey, among others. These types of solutions or their equivalents of alkaline nature caused the shedding of the main colourants contained in annatto: that of insoluble bixin, of bright red colour, and that of the orelline, of yellow hue, found in concentrations of around 80% and 20% respectively. With the aid of this type of fatty or alkaline dissolutions, the annatto seed precipitated the dye which gradually sedimented in the bottom of a container before being decanted, sun-dried and prepared in the traditional dye cakes or balls referred to by many of the chroniclers of the West Indies when describing the market stalls where dyers and painters obtained their pigments, colorants and other products required for their trade, such as binders and mordents.

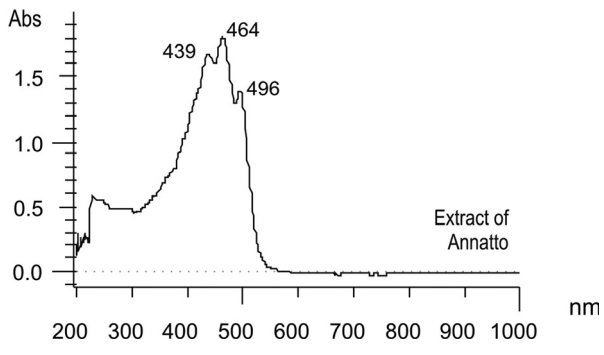

Figure 4. Spectrum UV-vis of annatto extract

While it is true that annatto was one of the dyes that could be readily purchased at any of these stalls, it was also the case that, on numerous occasions, the chroniclers mentioned this as one of the colourants usually mixed with cochineal (Figure 6), and occasionally adulterating the same. It would appear that cochineal, considered the third most precious item in New Spain after gold and silver, was adulterated far more often than expected, as this would not otherwise explain the reason behind the approval of the first rulings ordered in Mexico as from 1550 and continuing from the sixteenth to the eighteenth century to supervise the quality and sale of cochineal, and the fact that one of its chapters was exclusively dedicated to the fraudulent practice commonly occurring in terms of weight and quality. The role of annatto in the adulteration of this precious colourant was very specific: to give colour to the cochineal that had been intentionally mixed with wild cochineal, flour, gypsum, fuller's earth, crushed maize or onion seeds, among other whitish substances of similar properties, to camouflage any sign of paleness in the cochineal by which to detect the deceit, and where the red dye extracted from the blood wood tree was also employed to similar effect.

Otherwise, since very remote times the characteristic brightness of annatto made it one of the most widely employed dyes in the Pre-Columbian age for the dyeing of cotton woven by the ancient cultures of Mesoamerica into clothing, blankets and the diverse textiles used by the upper classes to decorate the interiors of their distinguished abodes. Pre-Columbian art offers numerous testimonials of this textile production where annatto and other dyes of similar importance gave a touch of colour and distinction, particularly when placed at the service of the ruling classes. A close examination of Justin Kerr's ceramic collection reveals the decoration of the palaces habited by Maya royalty and their court (Coe, and Kerr, 1997; Schele and Miller, 1986; Reents-Budet, 1994). There, in the middle of an audience with the king, during the celebration of a particular political or ritual episode or in the intense work performed by the court artists, including the *ts´ib* (the scribe), it is possible to detect the dyed cotton curtains arranged as a backdrop behind the throne (Figure 7). The monarchs reclines on comfortable dyed cotton cushions arranged on this throne and sits on a woven mat which serves as a symbol of his royalty and known as *pop* in the Maya language. In all these palatial textiles and in the clothing of the noble habitants (Figure 8) there is a predominance of red and orange hues which remit to very specific colorants: annatto, cochineal and blood wood, and which further explains why these three dyes were the most widely traded in Mesoamerica since Pre-Classic times onwards.

Annatto was not purely restricted to the dyeing of textiles and to camouflage adulterated cochineal and was further tied to Pre-Columbian art by its use to prepare lake pigments which formed part of the colour palette of these ancient pre-Columbian civilizations, particularly in those areas with poorer soils lacking in mineral diversity and which required the preparation of pigments of suitable artistic use on the basis of colorants, this being a situation very much related to Maya art. In this regard, and while it is true that it was essentially the blue and green colours that were prepared using this process, chemical analysis of mural painting in over twenty-five archaeological cities of the Maya lowlands conducted at the Laboratorio de análisis físico-químicos y control medioambiental de obras de arte de la Universidad Politécnica de Valencia has shown that it was also common in these works to prepare other types of lake pigment, and particularly the reds and oranges that could well have been based on annatto (Ver figuras 9 y 10). There is also an ethnographic reference which confirms the use of annatto by the ancient Maya in their mural paintings, this being recorded by Edward H. Thompson in the indigenous communities to the north

of Yucatan (Mexico) at the beginning of the twentieth century and where the American anthropologist indicated that "following the tradition of the ancients, annatto continued to this day to be used to colour stucco and as a preparation base for these works" (Thomson, 1932). With regard to the perseverance of annatto as a pigment or raw material for artistic purposes, it may also be indicated that annatto continues to be employed in Central America to prepare red and yellow varnishes, these latter being formed in alkaline dissolutions.

Figure 5. Optic microscopy of the colorant adhered to annatto seeds

We do not possess any information to suggest that the ancient Mesoamerican employment of this colourant as a pigment transcended to Europe between the seventeenth and eighteenth centuries, regardless of the fact that its use as such was recorded in certain specialized dictionaries (Sanz and Gallego, 2001). This marks a considerable difference with the other dyes exported from the New World to Europe via the Kingdom of Castille from the sixteenth century onwards and particularly indigo and cochineal, which were frequently employed by the mannerist painters (Anaya, (1992).

3. CONCLUSIONS

In ancient America colourants had a high artistic, economic and symbolic value, as has been described by the chroniclers of the West Indies in their manuscripts, and as recorded by the iconography of Pre-Columbian art in each and every one of the complex civilizations which co-habited the said cultural area, as is the case of the Maya who have received the main focus of our attention. The high quality of some of these Pre-Columbian colourants, together with the elevated prices that these could reach in European markets in the sixteenth century, aroused the interest of the Spanish monarchy to export these dyes to Castille from their new dominions in America, and which resulted in the rapid expansion of indigo, cochineal and blood wood first, and annatto later throughout Europe. These new colourants were widely employed throughout the seventeenth and eighteenth centuries as excellent quality dyes of great economic value in the textile industry and painting art, and subsequently succeeded in extending and prolonging the principal uses of these products as known and employed by their respective Pre-Columbian cultures.

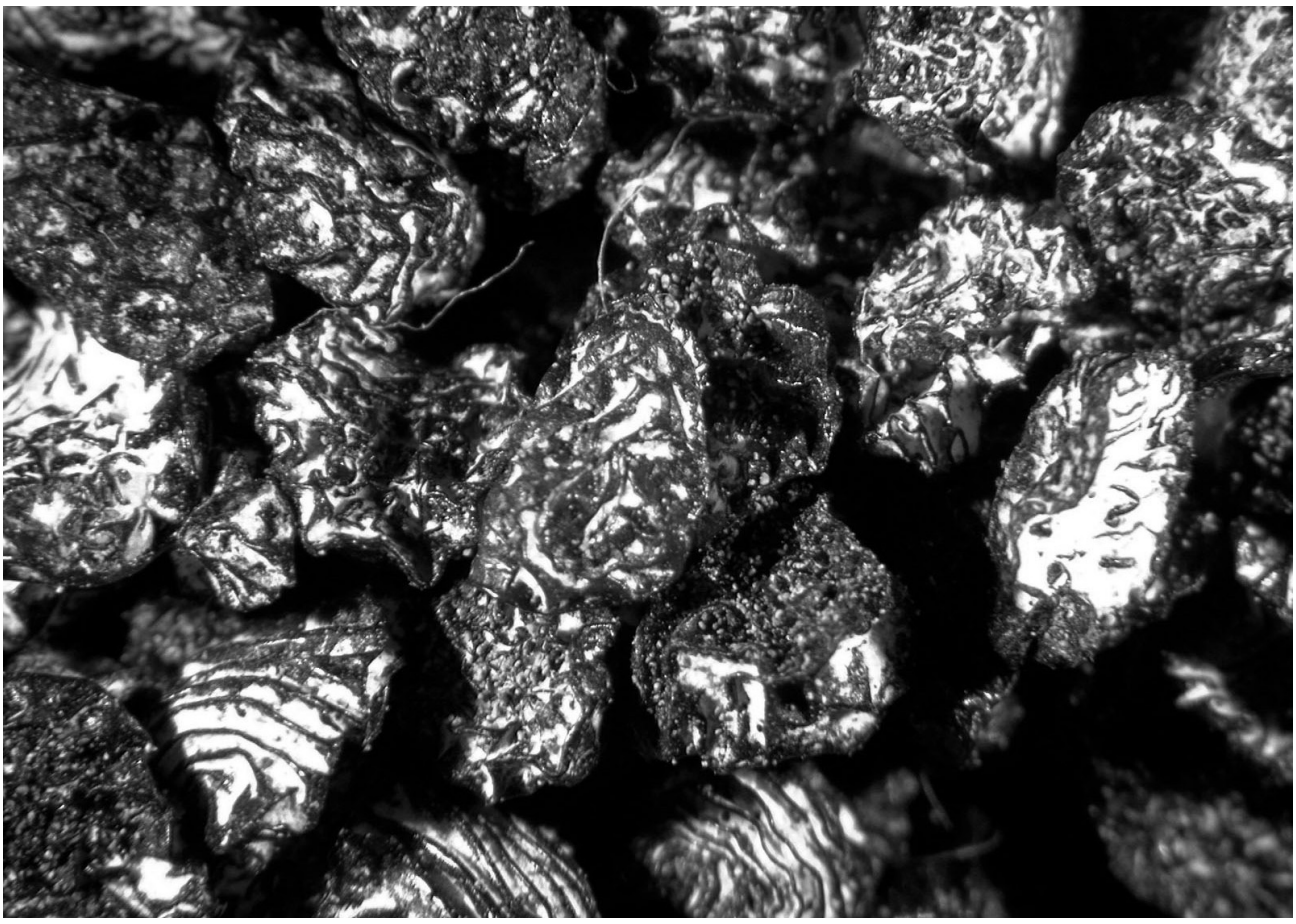

Figure 6. Optic microscopy of cochineal

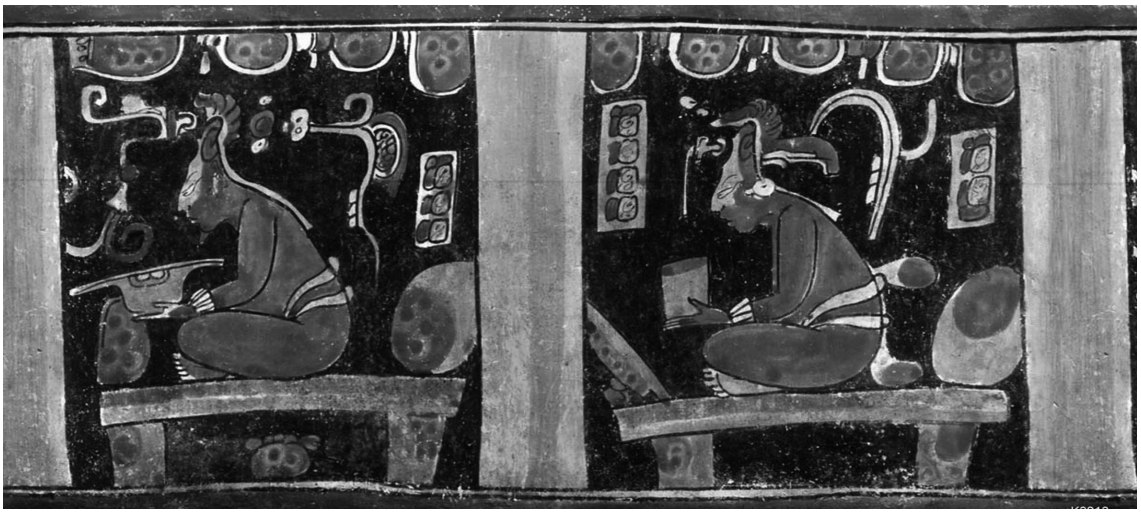

Figure 7. Kerr photographic catalogue (Inv. nº K3813). The Maya artists are working in a workshop with red cotton curtains

Figure 8. Kerr photographic catalogue (Inv. nº K2573). Note the red skirt worn by the king in presence of the queen

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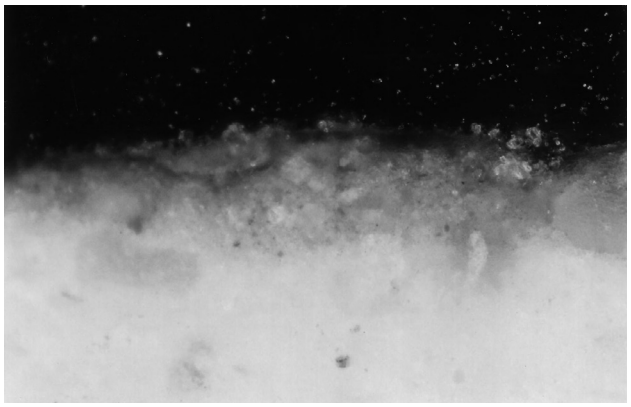

Figure 9. Optic microscopic cross-section of Maya blue from the mural paintings at room 64 of the Ek´Balam Acropolis (Yucatan, México). The reddish primer is made with a colouring of vegetable nature, maybe annatto

Figure 10. The ancient Pre-Columbian city of Ek´Balam

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Versión Española

TITLE: ***Achiote en América y Europa. Tradición, tratadística y elaboración de un antiguo color***

ABSTRACT: *RESUMEN. La alta calidad del tinte del achiote (Bixa orellana L.) y la inmensa cantidad de productos que se derivaron y utilizaron de él en tiempos precolombinos y coloniales fue mencionada en numerosas fuentes etnohistóricas que se redactaron en el Nuevo Mundo entre los siglos XVI, XVII y XVIII. Esos manuscritos nos ofrecen abundante información sobre los métodos que se emplearon para obtener las sustancias tintóreas del achiote: orellina y bixina, la cuál fue clasificada como "tinte menor o falso" en los manuales técnicos que se redactaron en Europa durante el siglo XVIII, es decir, como uno de los muchos tintes de naturaleza inestable que por aquel entonces se utilizaron ampliamente para obtener diversos matices partiendo de un mismo color y así abaratar costes. Por otra parte, la particular luminosidad y belleza de los diferentes colores que proporcionaba el achiote al mezclarlo con otros colorantes en concentraciones diversas, explica que fuese uno de los tintes que más se apreció y utilizó en los textiles y pinturas de época prehispánica y colonial.*
El estudio del achiote considerando la tradición tintórea de la antigua América y Europa, la lectura pormenorizada de esas fuentes etnohistóricas y el conocimiento químico-analítico que recientemente ha sido reunido sobre el tema, ha hecho posible este artículo, el cual ofrece a los especialistas en conservación y restauración e historia del arte una detallada información sobre el origen, las propiedades y usos de uno de los colorantes más antiguos y altamente valorados de América y Europa.

KEYWORDS: *achiote, tintes de la antigua América, pigmentos-laca de la antigua América, arte precolombino, textiles precolombinos, arte europeo, química-analítica, fuentes etnohistóricas*