

# Reconstruction Exchange: Case Study in 16th Century Red Dyes

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*Making and Knowing Project  
Refashioning the Renaissance*

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# Overview of dye chemistry and process

# Dye definition and sources

A **DYE** is a compound that absorbs into and colors another material, and is generally a complex organic material.

Natural dyes have historically been extracted from:

- **PLANTS**

- Such as alkanet, annatto, archil, brazilwood, buckthorn berries, cudbear, cutch, fustic, madder, indigo, litmus, logwood, morinda, quercitron, safflower, saffron, sassafras, sumac, turmeric, turnsole, walnut, weld, and woad

- **INSECTS**

- Such as kermes, lac dye, cochineal

- **LICHENS** (algae or fungi) and **SHELLFISH**

- Such as archil (lichen) and Tyrian purple (extracted from mollusks)

Synthetic dyes were first derived in 1856 (from coal-tar extracts to create mauve)

## **DYESTUFFS**

The raw organic materials used to create a dye



# Natural colorants

While colors can be extracted from all plants and some animal products, not all of these colorants have **good dyeing properties**.

They are not **COLORFAST**



# Color fastness

## FASTNESS

The resistance of color to fading.

A colorfast dye will maintain its color when exposed to light, steam, high temperatures, soap, salts, and other environmental conditions.

## LIGHT FASTNESS

How resistant a color is to fading when it is exposed to light, especially sunlight.



Light fastness tests of textiles dyed with natural colorants. Small squares of each sample were exposed to light of varying intensities and for different durations. The squares exposed to the brightest light for the longest time have faded the most.

<http://www.conservationphysics.org/fading/fade.pdf>

<http://cameo.mfa.org/wiki/Fastness>

# What creates, changes, or affects the color?

- Dyestuffs
- Textile
- Dyeing time
- Dyeing temperature
- Mordants
- Additives
- Acidity/alkalinity of dye bath

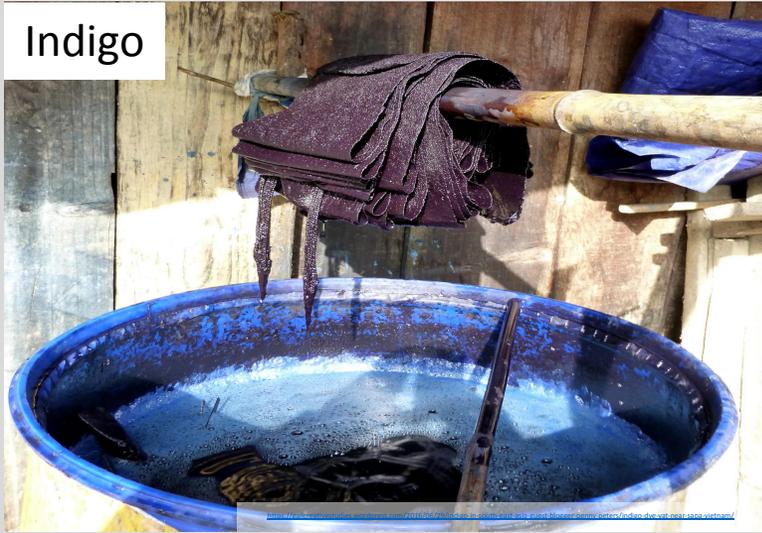


# Classification of organic dyes

# Types of dyes (by chemical class)

## Indigoids

Indigo



## Anthraquinones

Cochineal



<http://www.dtcrafts.co.uk/dyesFixers/earthdyes/dy201.html>

## Flavonoids

Weld



<http://www.bushareswoolworks.com/products/weld-natural-dye>

## Carotenoids

Turmeric



<http://www.saniapell.com/homemade/the-colour-of-food-homemade-fabric-dyes/>

## Neo-flavonoids/homoisoflavonoids

Logwood



<http://www.dtcrafts.co.uk/dyesFixers/naturalDyes/ds002pic.html>

# Types of dyes (by process)

## DIRECT DYES

Colorant forms a direct bond to the textile fiber



Turmeric

<http://www.saniapell.com/homemade/the-colour-of-food-homemade-fabric-dyes/>

## MORDANT DYES

Colorant needs to bind to a coordination metal as a bridge between the dye and textile fiber



Cochineal

<http://www.dtcrafts.co.uk/dyesFixers/earthues/dy201.htmlw>

## VAT DYES

A chemical reaction (reduction) in the dye vat is needed to bind the dye to the textile



Indigo

<https://gailcreativestudies.wordpress.com/2016/06/29/indigo-in-south-east-asia-guest-blogger-penny-peters/indigo-dye-vat-near-sapa-vietnam/>

# Mordant Dyes

# Mordant dyes

Mordants are the largest natural dye class.



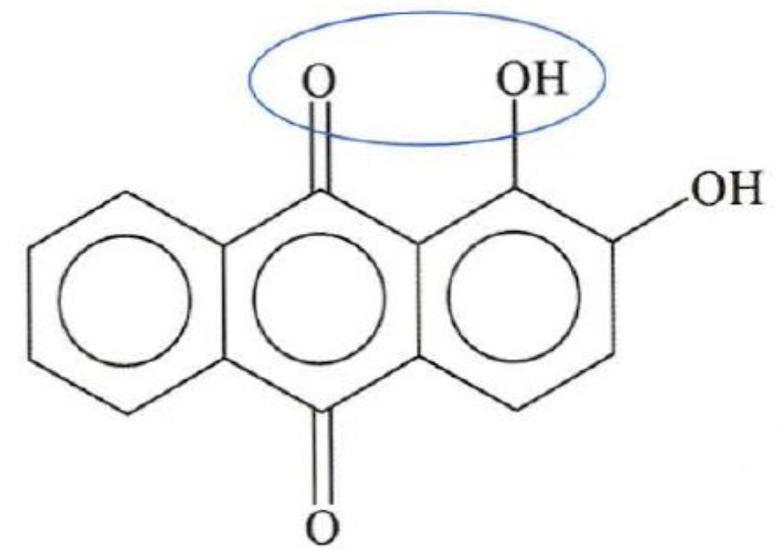
The word “mordant” is derived from the Latin *mordere*, “to bite”, as historically it was thought that the mordant would allow the dye to bite onto the fiber to create a colorfast textile.

# Mordant dyes

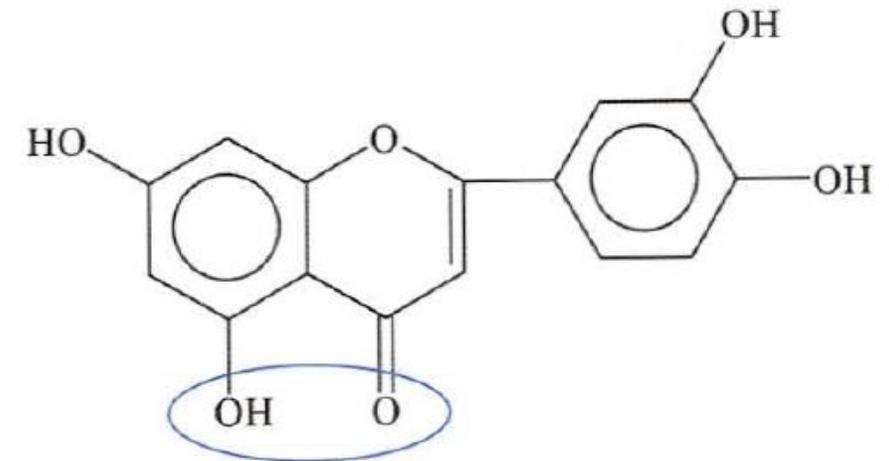
Mordants are commonly metal salts or other coordination metals that form a bridge between the textile fiber and the dye, resulting in a dye-metal-textile complex. The mordant attaches via neighboring C=O and C-OH groups in the dye.

Due to this complexation, mordant dyes have very good fastness to washing and better light fastness.

It is important to be aware that mordant dyes will also dye directly to give a (pale) color to unmordanted wool. This means that, in the case of a mordanted textile, part of the dye attached to the textile fiber may be bound directly to it, while another part is bound via the mordant. The part that is dyed directly will show poor fastness to light and washing.



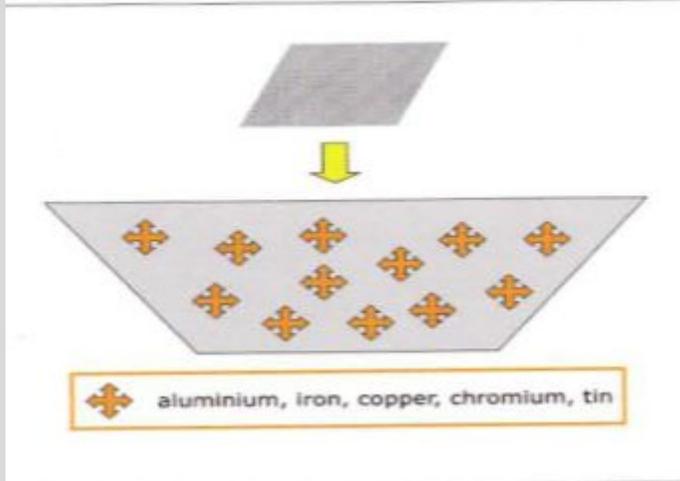
**Figure 2** Probable position for coordination with aluminium ions taking alizarin as an example (Sanyova 2000/1: 66–78).



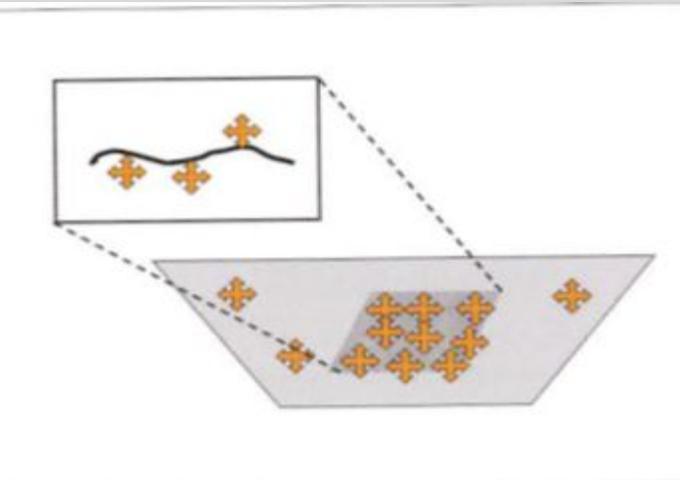
**Figure 3** Probable position for coordination with aluminium ions taking luteolin as an example (Amat *et al.* 2010).

# Mordant dye process

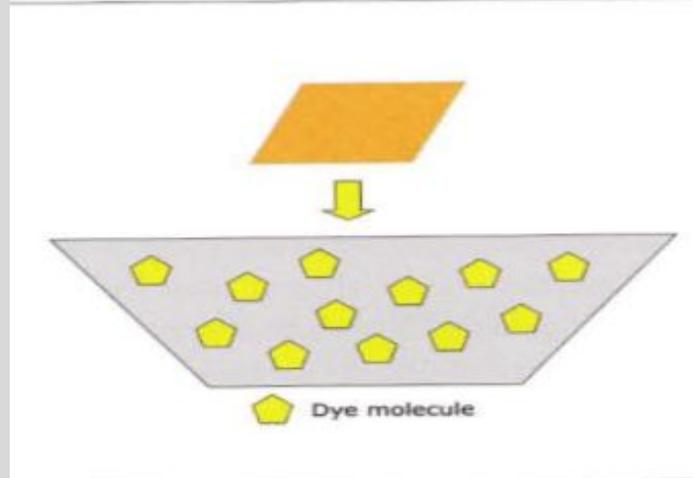
(1) Mordant bath is prepared by dissolving metal salts in water. Textile is then added



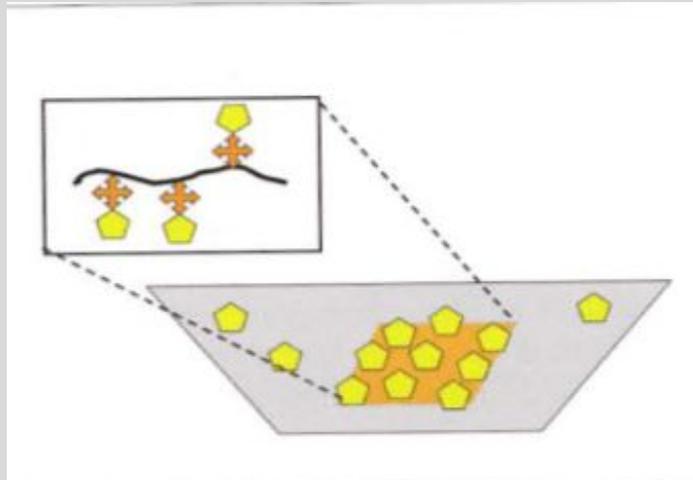
(2) Metal is bound to the textile



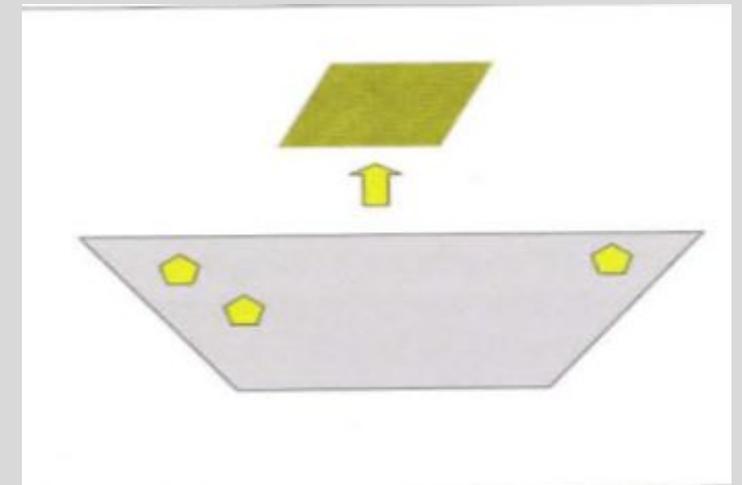
(3) Mordanted textile is added to dye bath



(4) Dye molecules bind to coordination metals of mordanted



(5) Dyed textile is removed

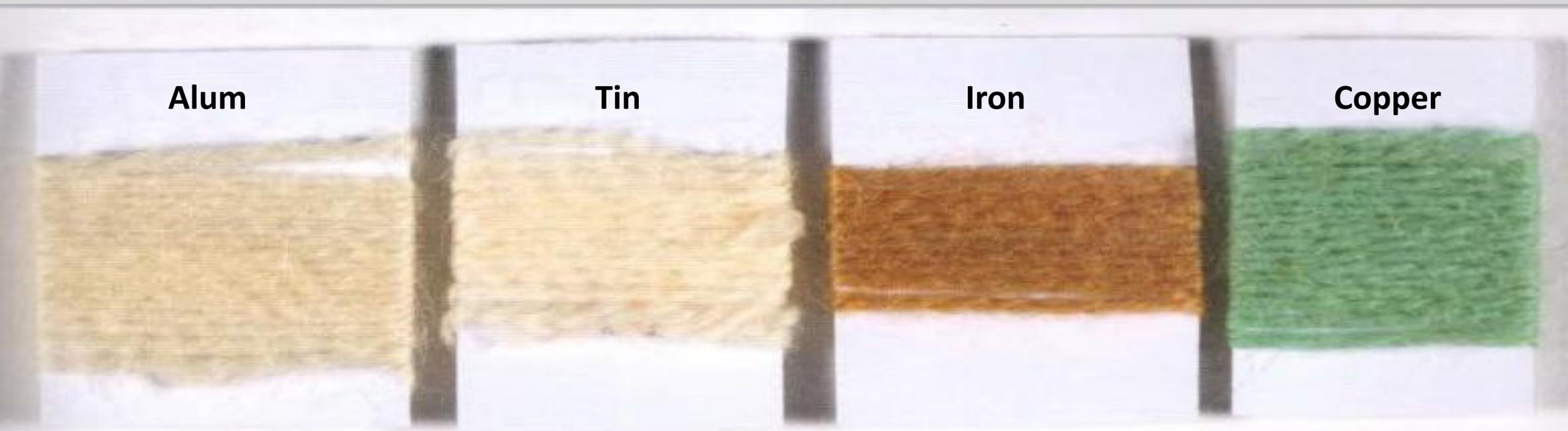


Mordants

# Mordants

Metal salts, including those of aluminum, tin, iron, copper, and chromium.

Mordants help form a dye-metal-textile complex to create a colored textile that is more color and light fast (or in some cases, completely facilitating the coloring of the textile).



# Mordant: Aluminum

Used since antiquity.

Aluminum is the most important and most vastly used mordant.



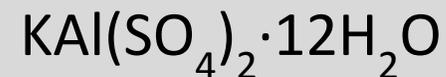
<http://www.chem.uiuc.edu/chem103/aluminum/AllIndex.htm>



[https://en.wikipedia.org/wiki/Potassium\\_alum#/media/File:Potassium\\_alum\\_octahedral\\_like\\_crystal.jpg](https://en.wikipedia.org/wiki/Potassium_alum#/media/File:Potassium_alum_octahedral_like_crystal.jpg)

Most commonly extracted from alum (also known as potash alum or potassium alum).

**Aluminum potassium sulfate,**



- Acidic – pH of 3

# Mordants: other metals used since antiquity

## Iron

- Usually in the form of iron(II) sulfate (also known as ferrous sulfate, vitriol, green vitriol, copperas)  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$

- Sometimes iron acetate

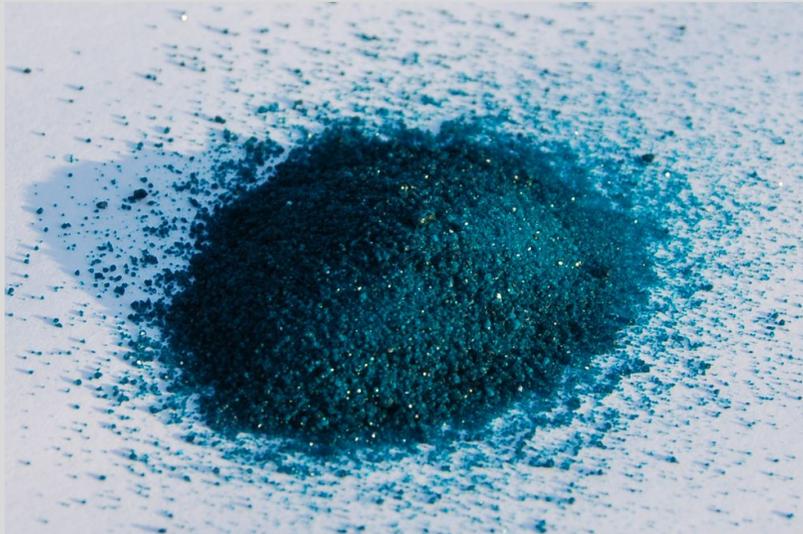
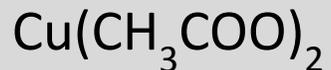


## Copper

- Usually copper(II) sulfate (also known as cupric sulfate, blue vitriol, Roman vitriol)



- Sometimes copper acetate



# Mordant: Plant-based used since antiquity, Tannin

Tannins, in the form of oak galls, bark, wood, and leaves of certain tree families like oak, sumac

- Tannic acid  $C_{76}H_{52}O_{46}$



Oak galls formed on *Quercus infectoria*



Sumac

<https://en.wikipedia.org/wiki/Sumac#/media/File:SumacFruit.JPG>

# Mordants: used more recently

Since 17<sup>th</sup> century

- Tin, usually as tin(II) chloride (also known as stannous chloride)  $\text{SnCl}_2$

Since 19<sup>th</sup> century

- Chromium usually as chromate  $\text{CrO}_4^{2-}$  or dichromate  $\text{Cr}_2\text{O}_7^{2-}$

Potassium chromate



Potassium dichromate



Stannous chloride



# Additive: Potash

Potassium carbonate  $K_2CO_3$

- Alkaline – pH of 12

Addition of potash to dye baths is based on historical examples

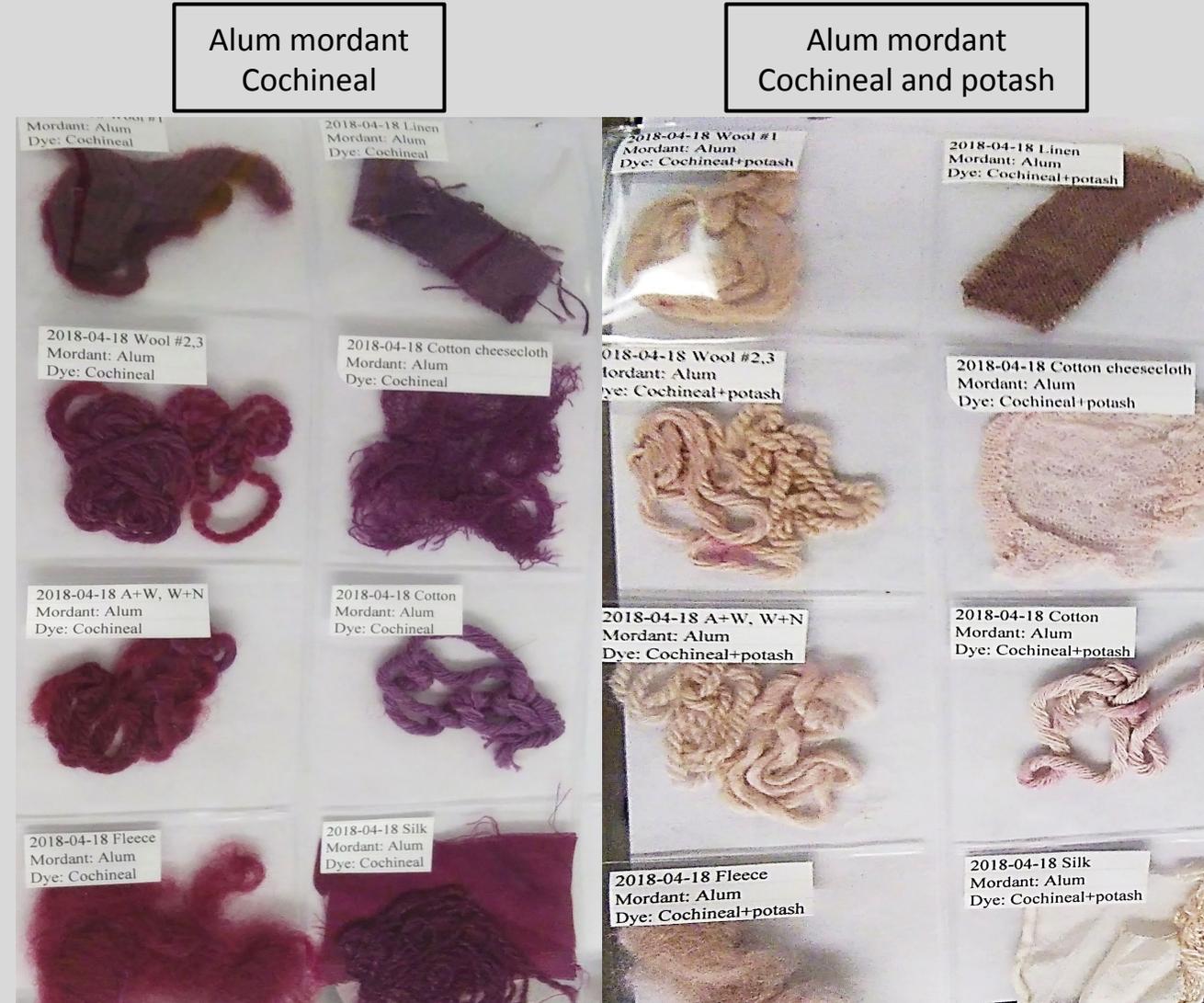


It can result in:

- Greater solubility of the dyestuff
- A different hue due to a reversible pH change of the dye
- Perhaps a conversion of the dye glycosides (sugars) to the corresponding free dye molecule
- Perhaps conserve the glycosides in the dyestuffs (seen in weld which becomes brighter)

## Effect on dye color

- Anthraquinone dyes, particularly **kermes** and **cochineal** become much paler while **madder** becomes dull or pale
- In historical recipes, it is much more common to find preparation of these dyes in “sour water” aka acidic conditions.



Textiles

# Textiles

The chemical interaction between the dye and the textile fiber is dependent on the dye itself and the type of fiber to be dyed.

There are two main textile groups: those with proteinaceous fibers - primarily wool and silk - and those such as cotton or linen that have cellulosic fibers.

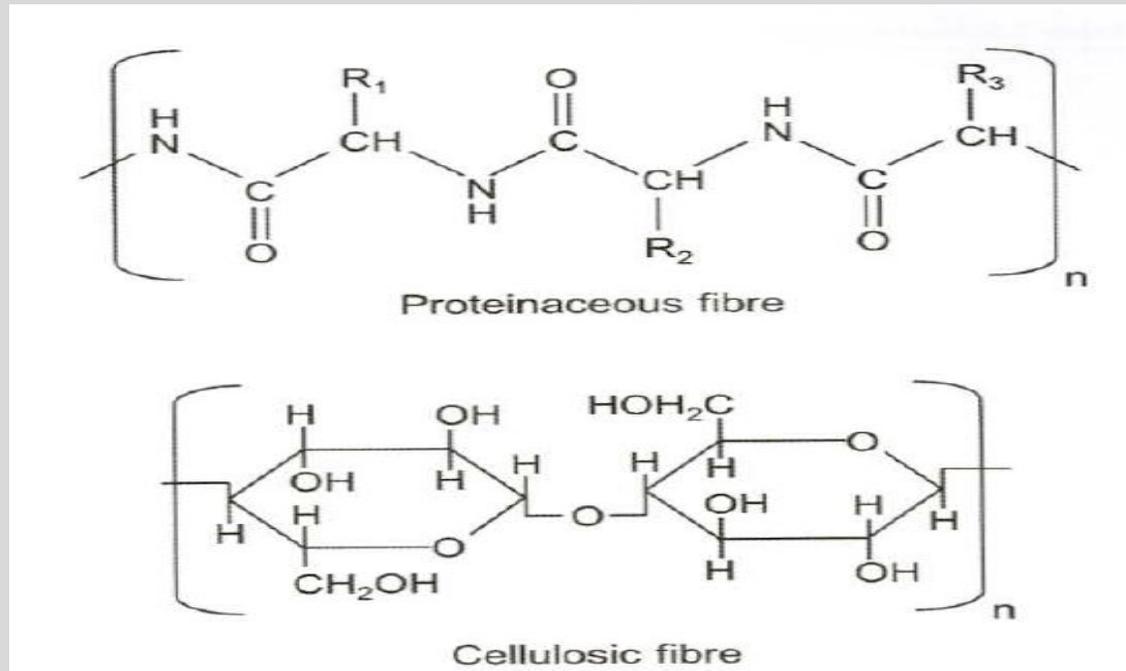


Figure 1 The basic structure of proteinaceous and cellulosic fibres.



# Common red colorants in Early Modern Europe (1400-1700)

# Safflower or bastard saffron

Botanical name: *Carthamus tinctorius* L.

Chemical class: carthamin (C-glucosylquinochalcone)

Region: Mediterranean, spread to southern and central Europe

Dye type: Direct

Petals contain a water-soluble yellow dye that is discarded in the process of obtaining an alkali-soluble red. Textile is dyed by placing in red alkaline solution and adding an acid like lemon juice.



<http://collections.vam.ac.uk/item/O485844/fukusa-gift-cover-unknown/>

Japanese (ca. 1868-1912), silk

# Henna

Botanical name: *Lawsonia inermis* L

Chemical class: lawsone or isojuglone (naphthoquinone)

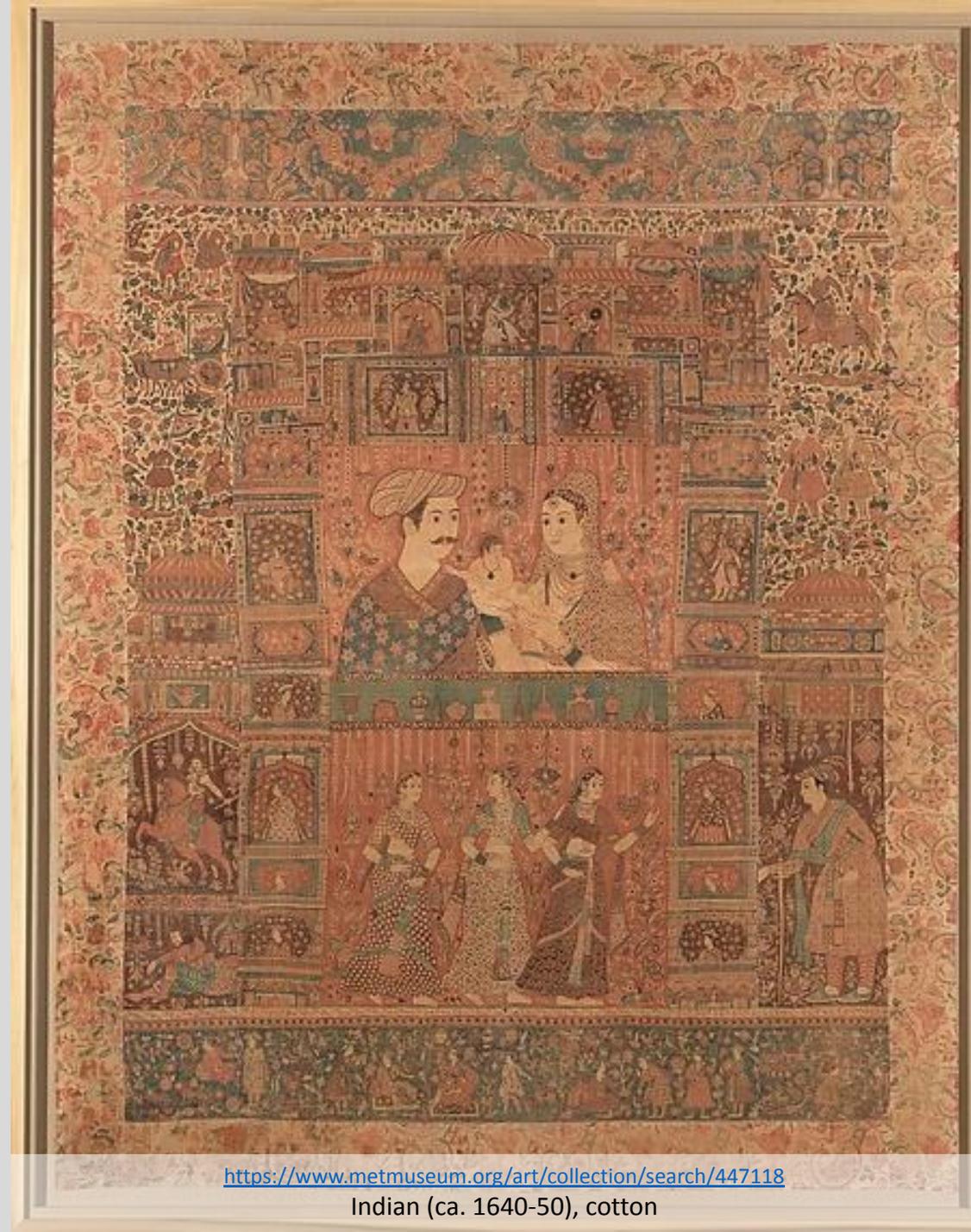
Region: India, tropical and subtropical regions, spread to Mediterranean, Spain, and Sicily

Dye type: Direct or mordant dye.

Leaves are used to obtain orange-red to brown colors.



<http://www.tropicos.org/Name/19200244>



<https://www.metmuseum.org/art/collection/search/447118>

Indian (ca. 1640-50), cotton

# Lac

Species name: *Kerria lacca*, *Kerria chinensis*

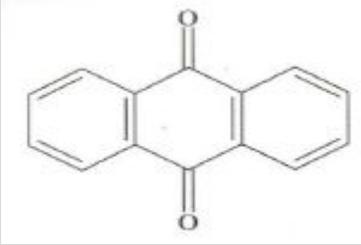
Chemical class: laccaic acid and erythrillaccin among other similar constituents (anthraquinone)

Region: Southeast Asia. Spread to Mediterranean and then Europe.

Dye type: Mordant dye.

Scale insect parasitic on several tree species including bastard teak (*Butea monosperma* (Lam.))

Secretes a protective coating that encloses itself in a sticky brown mass similar to resin, known as sticklac. When purified, this is known as shellac which was less economically important than the dye unlike today.



<http://collections.vam.ac.uk/item/O61099/hanging-unknown/>

Indian (ca. 1700), cotton and silk



[https://www.researchgate.net/figure/Some-lac-insects-known-from-the-new-world-a-kerria-lacca-on-Albizia-sp-Peradeniya\\_fig1\\_51254451](https://www.researchgate.net/figure/Some-lac-insects-known-from-the-new-world-a-kerria-lacca-on-Albizia-sp-Peradeniya_fig1_51254451)



15. Fragment of a caftan or robe with deer in a pearl roundel. Eastern Iran or Sogdiana, 8th–9th century. Compound twill weave silk (*samū*), the bright pink dyed with lac; 13 3/8 x 17 1/8 in. (34 x 44 cm). The Metropolitan Museum of Art, Purchase, Rogers Fund, by exchange, 2006 (2006.472)

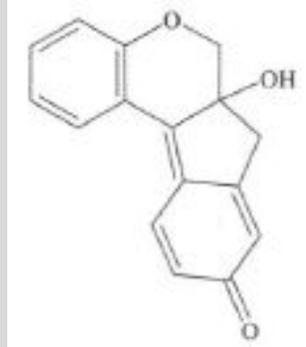
# Redwoods

(sappanwood, brazilwood)

Chemical class: Brazilin, colorless until oxidized by air becoming orange-red brazilein (homoisoflavonoid)

Dye type: Mordant dye.

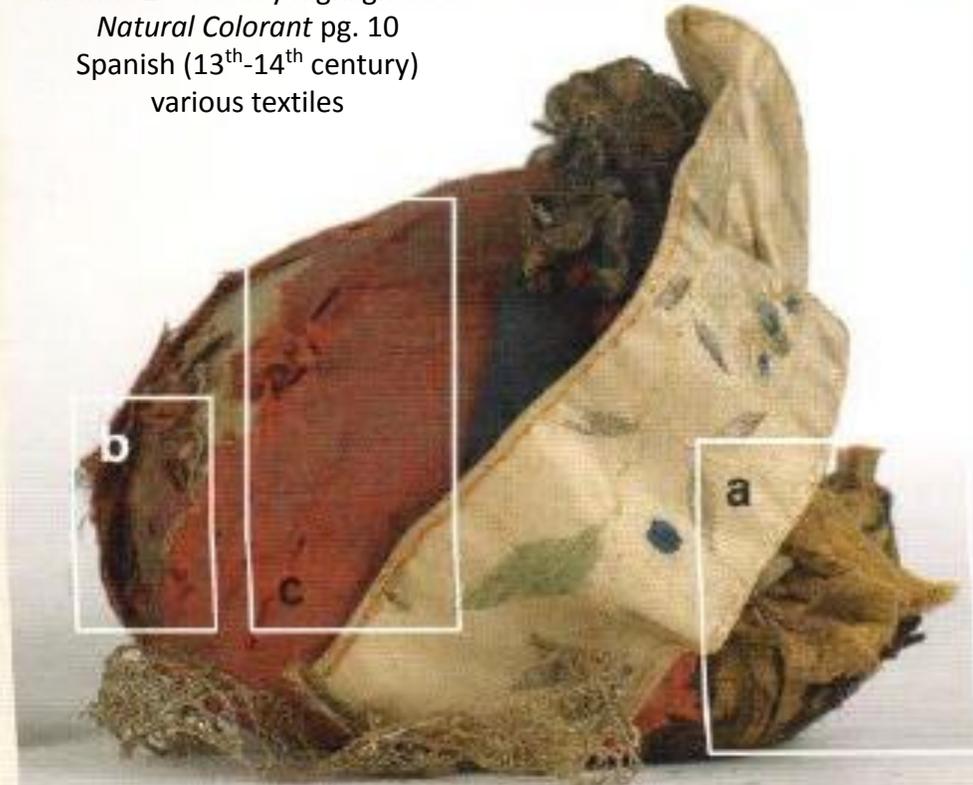
Extracted from orange-red wood, inner bark of trees, such as **sappanwood** (*Caesalpinia sappan* L.) - region: Central and southern India, Burma, Thailand, Indochina, southern China, Malaysia. Imported into Europe in early Middle Ages; **brazilwood** (*Caesalpinia brasiliensis*) and **pernambuco wood** (*Caesalpinia echinata* Lamarck) - region: Brazil and Caribbean Islands, then imported into Europe; **peachwood** (*Haematoxylum brasiletto* Karsten) - region: Central America, then imported into Europe.



Brazilwood



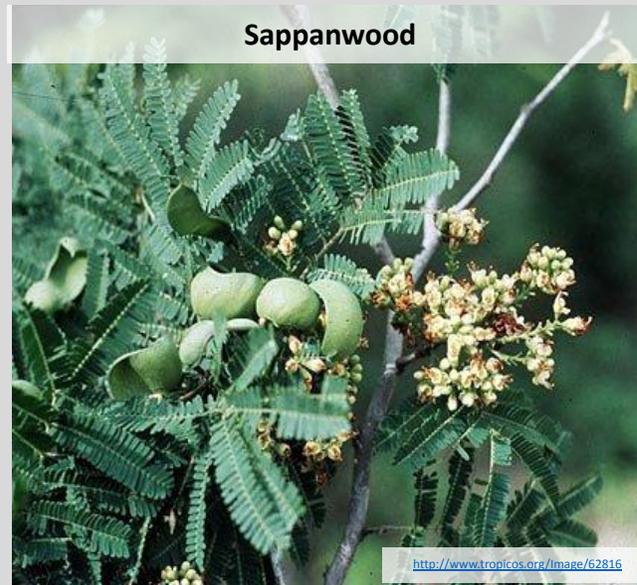
KIK-IRPA 2007 study highlighted in *Natural Colorant* pg. 10  
Spanish (13<sup>th</sup>-14<sup>th</sup> century)  
various textiles



Logwood



Sappanwood



# Madder

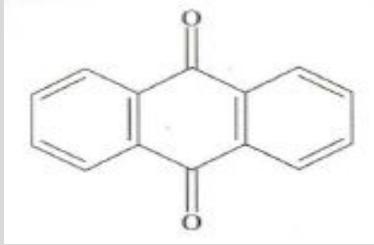
Botanical name: *Rubia tinctorum* L.

Chemical class: alizarin (anthraquinone)

Region: Native to Middle East and east Mediterranean, then spread to Europe.

Dye type: Mordant dye.

Range of red-orange-brown dyes obtained from the roots of a bedstraw.



<https://www.metmuseum.org/art/collection/search/445750>

Egyptian (5<sup>th</sup>-8<sup>th</sup> century), linen and wool



<http://collections.vam.ac.uk/item/O146101/jacket-unknown/>

Iranian (ca. 1800-1870), cotton and silk

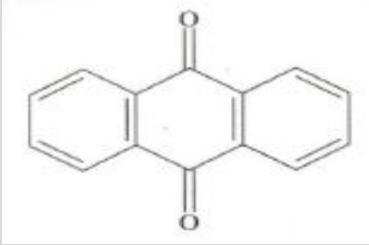
# Kermes

Species name: *Kermes vermilio*

Chemical class: kermesic acid (anthraquinone)

Region: Limestone coastal regions around the Mediterranean in Spain, southern France, North Africa, and the eastern Mediterranean.

Dye type: Mordant dye.



<http://www.projectnoah.org/spottings/255006061>



<http://shop.kremerpigments.com/en/dyes-und-vegetable-color-paints/natural-organic-dyes-und-vegetable-color-paints/4920/kermes-lice>

Scale insect parasitic to an evergreen oak (*Quercus coccifera* L.). Scarlet red color used to dye the highest quality fabrics. Used extensively throughout Europe until the arrival of cochineal from the New World in 16<sup>th</sup> century.

Dye is contained in the unhatched eggs of insect, and so can be extracted from females with unhatched eggs (more common) or from the eggs directly.

# Kermes



<http://collections.vam.ac.uk/item/O264602/woven-silk-unknown/>  
Spanish (ca. 15<sup>th</sup> century), silk damask



<http://collections.vam.ac.uk/item/O261109/woven-silk-unknown/>  
Spanish (ca. 14<sup>th</sup> century), woven silk and satin

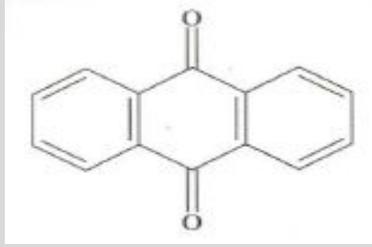
# Cochineal

Species name: *Dactylopius coccus*

Chemical class: carminic acid (anthraquinone)

Region: Cultivated in Mexico and Peruvian Andes, before Spain brought to Europe in 1523 where it spread rapidly.

Dye type: Mordant dye.



Scale insect found on prickly pear or Barbary fig cactus (*Opuntia ficusindica* (L.)).

Led to decline of use of kermes as it is almost **20% by weight more potent than kermes**. Dye is extracted from females with unhatched eggs.

# Cochineal



<https://www.metmuseum.org/art/collection/search/91678>  
British (1750-75), silk and wool (uniform for redcoats)



<https://www.metmuseum.org/art/collection/search/307941>  
Peruvian (15th-16th century), cotton & camelid hair



<https://www.metmuseum.org/art/collection/search/320804>  
Peruvian (ca. 16<sup>th</sup>-17<sup>th</sup> century), camelid hair and cotton

# Historical Recipe Examples

# Bolognese Manuscript (pg. 554)

*Original Treatises, Dating from the XIIIth to XVIIIth Centuries, on the Arts of Painting in Oil, Miniature, Mosaic, and on Glass of Gilding, Dyeing, and the Preparation of Colours and Artificial Gems* by Mary P. Merrifield (1804)

## MADDER

328. To dye scarlet. —Take ʒ lb- of sandal wood and J lb. of madder, boil them together with plain water until reduced to one -half, and then add half a fogliecto1 of ley for its maestra to make the colour deeper, and a piece of quicklime, and boil it until reduced to one-third; then prepare the skins for dyeing as in the other recipes.

# Bolognese Manuscript (pg. 588)

*Original Treatises, Dating from the XIIIth to XVIIIth Centuries, on the Arts of Painting in Oil, Miniature, Mosaic, and on Glass of Gilding, Dyeing, and the Preparation of Colours and Artificial Gems* by Mary P. Merrifield (1804)

## MADDER

367. To dye thread red. —Take some madder well pounded, and put it into a little ley made from vine ashes, and let it boil, and put the thread to boil in the ley for some time; then remove it from the fire, and let it dry; when it is dry alum it, and then boil it in a little verzino well boiled with water and ley mixed together; then dry it in the wind without sun, and it will be fine.

# The Plictho (pg. 109-110)

*The Plictho: instructions in the art of the dyers which teaches the dyeing of woolen cloths, linens, cottons, and silk by the great art as well as by the common* by Giovanventura Rosetti (active 1530-1548)

## MADDER

### To dye wool or cloths in red.

48. For each pound of wool take 4 ounces of roche alum and make it boil one\*hour and a half. Wash it very well in clear water. Then after it is well washed, take for each pound of wool 4 ounces of madder and make it boil in clear water. Throw in the madder when it is about to boil, then the wool, and let it boil for half an hour, stirring constantly. On washing it becomes well dyed, that is, red.

Plictho 48: To dye wool or cloths in red.

For each pound of wool take 4 ounces of roche alum and make it boil one hour and a half. Wash it very well in clear water. Then after it is well washed, take for each pound of wool 4 ounces of madder and make it boil in clear water. Throw in the madder when it is about to boil, then the wool, and let it boil for half an hour, stirring constantly. On washing it becomes well dyed, that is, red.

# The Plictho (pg. 127)

*The Plictho: instructions in the art of the dyers which teaches the dyeing of woolen cloths, linens, cottons, and silk by the great art as well as by the common* by Giovanventura Rosetti (active 1530-1548)

## MADDER

To make a fine wool with madder follow this manner.

101. When you are about to mordant you take 6 pounds of alum for each dozen pounds of wool by weight, and one pound of grain and mordant according to the usage. When you are ready to madder, you will take twelve pounds of madder for each dozen pounds as above I said, and three pails of strong water. Put your wool into the cauldron when it is good and hot, and have it well raked. When it is about to boil poke it well under the water and go two shots. Then take it out and drain it in the basket and wash well. Give it then a new bath while it is good and hot and then take it out. If you wish you can have it washed and you will have good color and pretty wool.

# The Plictho (pg. 151)

*The Plictho: instructions in the art of the dyers which teaches the dyeing of woolen cloths, linens, cottons, and silk by the great art as well as by the common* by Giovanventura Rosetti (active 1530-1548)

## MADDER

### To dye silk in madder.

132. First one must aluminate silk and for each pound of silk take four ounces of madder that is madder of Flanders,<sup>60</sup> and if it were madder of another sort take of it two pounds for each pound of silk.<sup>146</sup> When you want to dye put the madder into the cauldron with the water and let the madder be well pestled. Then make fire until the water gets hot and scalding to the hand. See that you have your silk in loops and go handling the silk in the water above said. Then take it out and wring the silk by hand. Then return it to the cauldron, that is, into the liquor. When you get the color to your liking, take it out, and when it is cold wring it by hand. Then wring it on the hook and then set it to dry in the sun.

plictho notes pg 191

The use of a solution of bran helped cleanse the goods of its impurities and made it more amenable to the absorption of the alum and subsequently the dyestuff.

plictho 192

The use of a small amount of tartar along with the alum is characteristic of many of the dyeing recipes; the use of tartar was noted in preceding formulas and will also be found in subsequent ones. It was probably an empirical thing which may or may not have been important. It is conceivable that the tartar would tend to regulate the pH and hence the rate of exhaustion of the alum. Also, since the alums normally used were impure in many ways, the tartar could have a certain amount of sequestering effect on some inorganic impurities.

# The Plictho (pg. 152)

*The Plictho: instructions in the art of the dyers which teaches the dyeing of woolen cloths, linens, cottons, and silk by the great art as well as by the common* by Giovanventura Rosetti (active 1530-1548)

## KERMES

To dye silk in color of grain.

136. Take one pound of silk and one pound of grated white soap. The soap you set into river water and that you make it boil for one hour. After grating the soap, you will put the silk into said soaping and make it boil one hour as said, with the silk inside. Then take the said silk and wash it well with cold water. Then heat up some other water, and wash the silk in the said hot water. When it is washed, let the said silk stay in that hot water for one day and one night. Then for each pound of silk you take four ounces of roche alum and have it well dissolved in the water. When it is well dissolved let it cool. Then take the silk and wash it with two or three waters and wring it by hand. Then you put into the alum water and leave the silk stay one day inside the said water. Then take it out and wash it well and wring it well by hand. Then have two ounces of madder and four ounces of grain, and one half bucket of water. Warm it on the fire and put first the madder into the cauldron, and then the grain and stir well. When it is hot have your silk and go treating through the said dye for the space of half an hour. Then take it out and let it cool and wring it well by hand and put it to dry without giving it the sun.

# The Plictho (pg. 108)

*The Plictho: instructions in the art of the dyers which teaches the dyeing of woolen cloths, linens, cottons, and silk by the great art as well as by the common* by Giovanventura Rosetti (active 1530-1548)

## KERMES

To dye cloth a very beautiful scarlet, in the manner of this  
City of Venice.

46. First weigh your cloth, and for each piece of cloth use about 6 ounces of grain. For the mordanting, for each pound of cloth, use a half ounce of roche alum, and 1 ounce of white tartar well pestled and sifted. Have a cauldron, and have clear water and put into it the alum and the tartar. Make beneath a good fire to the end that it wants to boil. Then put in the cloth and make it boil continually for one hour with a good fire below. Then you will take out the cloth and send it to be washed in water that is well running and wash well and then prepare the full cauldron. Set it on the fire and see that inside there be four pails of strong water, well fatted and well pungent, together with the water. As it shows signs of wanting to boil, put in the grain but first see that it is well pestled. When it is about to boil put in the cloth and dive it, that is, poke it beneath, and give it four or five swishes on the turn wheel. Then remove out the cloth and let it cool. Then send it to wash in running water. Then prepare a new bath and give it two or three baths, that is with the bran, and for each bath one pound of roche alum and one pound of tartar. If the cloth is too open, give it a new bath, that is a quarta of bran without tartar, and one pound of arsenic well pestled. Note that it needs to boil one quarter of an hour,\*each and every new bath, with bran. Also if the cloth were to be overloaded, give it a new bath with bran without tartar, with a pound of roche alum.<sup>64</sup>

# The Plictho (pg. 113)

*The Plictho: instructions in the art of the dyers which teaches the dyeing of woolen cloths, linens, cottons, and silk by the great art as well as by the common* by Giovanventura Rosetti (active 1530-1548)

## KERMES

To make wool scarlet<sup>81</sup> by means of grain for workers' cloth.  
61. When you are about to mordant your wool take 4 pounds of alum for each dozen pounds of wool by weight and one and a half pounds of grain. Make it boil two hours and allow it to stand in the bath for the space of three hours. When it is about time to give the grain you will have it washed very well and take 6 pounds of grain of Provence and 4 pounds of grain of Certio or Corinth for each dozen pounds by weight, and two dippers of strong water. Put it into the cauldron while the water is little more than tepid, stir well and then put in the wool and rake it well and make it boil thus for the period of an eighth of an hour. Then remove it and have it well washed in the baskets as is usual. Then give it a clean bath that is near the boil and when you put in the wool make it reach the boil. Then remove it and you will have beautiful wool.<sup>82</sup>

# *Neueroffneter curioser Schatz-Kasten* (Anon. 1706: 556, translated)

As quoted in Kirby, et. al. *Natural Colorants*

## COCHINEAL

To dye nice carmine-coloured cloth. One has to take for 8 pounds of woollen cloth 2 *Loth* of cochineal, 2 quarters of wheat flour, or *Gaitz* [?]; the bran must be soaked in water for 8 days so that the water gets really acid. When one wants to dye then, the water must be poured off from the bran into the kettle. But the cochineal must be soaked before in warm water overnight. When one now dyes, a good fire must be made under it to warm the [bran) water. Then take a little of it [the warmed bran water], stir it with some dye and put it in the kettle as long as one still has some dye. When now it starts to boil, and one wants to give it an after-treatment [*meistem*], one must take lye extracted three times, or one takes 1.5 or 2 quarters of ashes of pressed wine-grapes, pours it into lukewarm water, and passes the dyed cloth through it until the shade is to your liking.

# Paduan Manuscript (pg. 698)

*Original Treatises, Dating from the XIIIth to XVIIIth Centuries, on the Arts of Painting in Oil, Miniature, Mosaic, and on Glass of Gilding, Dyeing, and the Preparation of Colours and Artificial Gems* by Mary P. Merrifield (1804)

## COCHINEAL

109. To make a colour like carmine. — Take powdered cochineal, put it into a ley, and add to it some finely pulverized crystallized arsenic, which is proper for precipitating the colour; it will then turn out well.

# Paduan Manuscript (pg. 710)

*Original Treatises, Dating from the XIIIth to XVIIIth Centuries, on the Arts of Painting in Oil, Miniature, Mosaic, and on Glass of Gilding, Dyeing, and the Preparation of Colours and Artificial Gems* by Mary P. Merrifield (1804)

## COCHINEAL

139. To make super-excellent carmine. —Take an egg, make a hole in it so that the white will run out, then take mercury and fill the egg with it, stop up the hole and lute it according to the best of your ability; then bury it two feet deep in horsedung which is very much exposed to the sun, and do this in the dog days. Leave it in this situation for 40 days, then take it out, with great care, lest it should break ; then break it, and you will find in it a living animal; let the animal die, and preserve it, it will fall to powder; use this powder, which will be a most splendid carmine, for painting and miniatures, but you must beware of the smell at the beginning.

# Paduan Manuscript (pg. 660)

*Original Treatises, Dating from the XIIIth to XVIIIth Centuries, on the Arts of Painting in Oil, Miniature, Mosaic, and on Glass of Gilding, Dyeing, and the Preparation of Colours and Artificial Gems* by Mary P. Merrifield (1804)

## COCHINEAL

22. How to prepare cochineal. —Boil it with lemon juice, garlic juice, and burnt alum.

# Paduan Manuscript (pg. 682-684)

*Original Treatises, Dating from the XIIIth to XVIIIth Centuries, on the Arts of Painting in Oil, Miniature, Mosaic, and on Glass of Gilding, Dyeing, and the Preparation of Colours and Artificial Gems* by Mary P. Merrifield (1804)

## COCHINEAL

83. To render any colour more brilliant and permanent. –Take the rectified spirit of urine in a glass phial, and mix your colour with this. Leave it, mixed, in the gentle heat of ashes, or of hot water, for half an hour, the mouth of the phial being stopped. Then separate the colour from the spirit, and you will find it more florid, and much more permanent. But if the spirit is not to be obtained, a ley prepared from calcined tartar, nitro fixo,<sup>1</sup> and the salt of urine may be used. If in this ley are boiled crimson woollen cloths, a most wonderful cochineal colour is obtained, which is commonly called "scarlato col secreto." The same may be said of the other colours. If copper is dissolved in the spirit of nitre [nitric acid] and then precipitated by a solution of salt of tartar, there will be a green colour much less corrosive than the other colours. If by the same spirit ceruse is dissolved, and then precipitated by a solution of gold, there will be a very white and delicate colour.

# The Plictho (pg. 145-147)

*The Plictho: instructions in the art of the dyers which teaches the dyeing of woolen cloths, linens, cottons, and silk by the great art as well as by the common* by Giovanventura Rosetti (active 1530-1548)

To dye silk in perfect crimson color.

122. First arrange the silk over the small rods that it be eight ounces of silk each. Couple them two by two so that it stays well in cooking. It needs half a bucket of water for each pound of silk. See that your work load is pocketed in manner that in the pocket it be not too tight, in fact better wide. Take eight ounces of black soap for each pound of silk to be worked and it need be boiled at a gentle boil a half hour and no more. Then take it out of the pocket, and wash it well to advantage so that in such manner that by the hand is known its seroop. To alumate it, take 8 ounces of alum for each pound of cooked silk and that the roche alum be fine. Note that as you dissolve the roche alum it needs be dissolved in river water that is well boiling in a cauldron. Let it cool, and when it is cool take it out and throw it into a tub and over that, as much water that in all it be one bucket for each pound of cooked silk. It makes the water biting as it must be, that is, one bucket of bath for each pound and see that you understand. When you want to use the water, divide it and make it to eight rods of about eight ounces each, and you put them in that tub where is the bath of alum. Make it stay well under the water and it must stay in the said alum fourteen hours and up to thirty. As you take out the silk from the alum, wash it well to advantage, and when you will have done this, divide it again as is said above for dyeing.

Also, the crimson needs to be soaked and it needs to soak according to the season, and especially when you work urgently. See that it be well soaked above all, and that it be well ground similarly to advantage. Then make up the bath and put in as much water as is half a bucket per pound of load. Then put bath into the cauldron and make a bright fire and see that it boil. As it begins to boil, have set up three fazi of poppo for each pound of load, and it must be well pestled and sifted. You will put the said poppo into the cauldron and stir well and then put your load inside and go turning it over as usual, with a good fire

below and that it fail not and that it be a bright fire. Make it boil thus a half hour and not more. Then take it out and have ready a tub of water and put it in immediately as you take it out of the cauldron. Wash it therein, and squeeze it well to advantage. Then you will go to wash it at the river so that the grease of the crimson comes out of the silk.

Having done this, divide it and return to give it the aluming in a tub and that it be sweeter than the first one. Put your load inside as you did the other time, and let it stay inside fifteen hours to advantage\*and then take it out and wash it well in river water. Then divide it up and make rods as above to dye the silk the second time. Then have ready first a half bucket of bath as before and make it boil and when it raises the boil see that there are made ready two fazzi of popo for each pound of silk worked. Soak it in the cauldron, pestled as I said above at first, and it needs a half fazo of indigo that has been to soak 24 hours, for each pound, and that has been soaking in a vase of glass. Throw it inside and stir well and then put in your load as you did before. Make it boil a half hour with bright fire and then take it out and it will be dyed competently. Have set up two tubs of water and first wash your load in one and then throw it into the other and then to the flowing river to advantage. And this is approved by Master Matthio of Odati from Venice.

Note this rule; with four pounds of crimson one makes good color and with five one does better, and up to six for each pound of silk. But do not pass beyond this relation to the cooked silk because it dyes perfectly and do not pass that sign.

And it needs crimson, minute and German and it will be perfect color.

When the crimson that you want to grind is soaked it is divided by eye and you take for the first time two thirds and the second the rest and manage as is said above.<sup>136</sup>

COCHINEAL

Reference, materials, and  
resources

# Sources of historical evidence

- **Analysis of existing objects, such as surviving textiles and paintings in museum collections**
  - However, it must be kept in mind that these represent only a small part of history. They are items that have been selectively collected by museums or upper class. Many were made for or bought by the elite, were luxury or just generally expensive items
- **Recipe books and collections, instruction manuals**
- **Work orders, inventories, accounts, orders for materials, import records, and guild regulations**

# References and Links

- Jo Kirby et al, *Natural Colorants for Dyeing and Lake Pigments: Practical Recipes and their Historical Sources* (Archetype Publications, London, 2014)
- Phipps, Elena. *Cochineal Red: the Art History of a Color*. New York (N.Y.: The Metropolitan Museum of Art, 2010. Print.)
  - Full pdf available for free download here: [https://www.metmuseum.org/art/metpublications/cochineal\\_red\\_the\\_art\\_history\\_of\\_a\\_color](https://www.metmuseum.org/art/metpublications/cochineal_red_the_art_history_of_a_color)
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- CAMEO: Conservation & Art Materials Encyclopedia Online: [http://cameo.mfa.org/wiki/Main\\_Page](http://cameo.mfa.org/wiki/Main_Page)
  - CAMEO is a searchable information resource developed by the Museum of Fine Arts, Boston. The MATERIALS database contains chemical, physical, visual, and analytical information on historic and contemporary materials used in the production and conservation of artistic, architectural, archaeological, and anthropological materials.
- <http://shop.kremerpigments.com/en/>
- <https://maiwa.com/pages/natural-dyes>
- Greenfield, Amy Butler. *A Perfect Red Empire, Espionage, and the Quest for the Color of Desire*. Harper Perennial, 2006.
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- Cardon, Dominique. *Natural Dyes: Sources, Tradition, Technology and Science*. Archetype, 2007.
- Gettens, Rutherford J., and George L. Stout. *Painting Materials: a Short Encyclopedia*. Dover Publications, 1966.
- Vejar, Kristine. *The Modern Natural Dyer a Comprehensive Guide to Dyeing Silk, Wool, Linen, and Cotton at Home*. Abrams, 2015.
- Short History of Cochineal Red: <https://artechne.wp.hum.uu.nl/short-history-of-the-cochineal-red/>
- Putting the Red in Redcoats: [http://www.history.org/foundation/journal/Summer12\\_newformat/dye.cfm](http://www.history.org/foundation/journal/Summer12_newformat/dye.cfm)
- A short introduction (about cochineal): [https://medium.com/@zip\\_lehnus/paint-it-red-cochineal-the-wonder-bug-51d280c41d56](https://medium.com/@zip_lehnus/paint-it-red-cochineal-the-wonder-bug-51d280c41d56)

# Material sourcing (general)

See also [Materials and sourcing - READ ME](#)

- ❑ **Kremer Pigments**
  - ❑ <http://shop.kremerpigments.com/en/>
  - ❑ Order online or visit the New York storefront: 247 West 29th Street New York, NY 10001
- ❑ **Natural Pigments**
  - ❑ <https://www.naturalpigments.com/>
  - ❑ Order online
- ❑ **Maiwa**
  - ❑ <https://maiwa.com/>
  - ❑ Order online or visit retail locations in Vancouver, Canada
- ❑ **Dick BLICK Art Materials**
  - ❑ <https://www.dickblick.com>
  - ❑ Order online or visit numerous locations in New York and the USA
- ❑ **Michaels Art and Craft Supplies**
  - ❑ <https://www.michaels.com>
  - ❑ Order online or visit numerous locations in New York and the USA
- ❑ **TALAS Bookbinding, Archival & Conservation Supplies**
  - ❑ <http://www.talasonline.com/>
  - ❑ Primarily a mail order business, but storefront located: 330 Morgan Ave, Brooklyn, NY 11211
- ❑ **Test Fabrics**
  - ❑ <http://testfabrics.com/index.php>
  - ❑ Order online
- ❑ **Knitty City specialty yarn and craft store**
  - ❑ <http://www.knittycitynyc.com/>
  - ❑ Stock sometimes includes undyed raw materials (and they are happy to order specialty yarns or wool on your behalf)
  - ❑ Storefront: 208 West 79th St, New York, NY 10024
- ❑ **Find in your garden or local park or even the grocery store!**

## MORDANTS:

Name	Chemical formula	Source	Appearance
Alum	Potassium aluminum sulfate	<a href="#">Kremer #64100</a>	Clear, colorless crystals
Iron	Iron sulfate (iron(ii) sulfate heptahydrate)	<a href="#">Kremer #64200</a>	Light green, humid salt
Galls	Aleppo galls (formed on Quercus infectoria) - tannic acid and gallic acid	<a href="#">Aleppo galls, whole (oak apples, gallnuts)</a> <a href="#">Kremer #37400</a>	Light brown/tan, slightly spiked round pieces (1-4cm diameter)
Copper	Copper sulfate pentahydrate	<a href="#">Alpha Chemicals (amazon.com)</a>	Blue crystals, 2mm-4mm
Additive: potash	Potassium carbonate	<a href="#">Kremer #64040</a>	White, non-toxic, hygroscopic, granular powder or crystals

**DYESTUFFS:**

Name	Scientific name	Source
Madder	Rubia tinctorum	<a href="#">Kremer #37201</a>
Dyer's Broom	Genista tinctoria	<a href="#">Terravita (Cindy Kok + Yuan Yi Fall 2015)</a>
Weld	Reseda luteola	<a href="#">Kremer #36250</a>
Brazilwood	Paubrasilia	met museum (oct. 08, 2015) c/o Nobuko Shibayama ["Brazilwood Sawdust," Gift of B. Barrette, Jan. 2000]
Cochineal	Dactylopius coccus	<a href="#">Kremer #36040</a>
Logwood	Haematoxylum campechianum	<a href="#">Kremer #36100</a>
Tumeric	Curcuma longa	Trader Joe's
Galls	Formed on Quercus infectoria by the female Gallwasp, Cynips Gallae-tinctoria	<a href="#">Aleppo galls, whole (oak apples, gallnuts) Kremer #37400</a>
Buckthorn (ripe)	Rhamnus catharticus	<a href="#">Kremer #37380</a>

## TEXTILES:

Name	Description and Link	Appearance
<b>Wool #1</b>	<a href="#">100% wool, undyed from LB Collection® Pure Wool Yarn</a>	Thick, roving/woolen (not tightly spun, fuzzy texture) yarn
<b>Wool #2</b>	<a href="#">100% wool, undyed from Catskills Merino Sheep, New York</a>	Thin, worsted (tightly spun), slightly curly/crimped yarn
<b>Wool #3</b>	<a href="#">100% baby alpaca, undyed from Island Alpaca Company, Martha's Vineyard</a>	Thin, worsted (tightly spun), straight and smooth yarn
<b>A+W</b>	A+W = "alpaca" + "wool" Knitty City - Cascade Yarns "Eco Highland Duo", Col. 2204, Lot. 7A8897, made in Peru, CAS-0805-2204 70% undyed baby alpaca, 30% undeyed Merino wool	Thin, worsted (tightly spun), straight and smooth yarn
<b>W+N</b>	W+N = "wool" + "nylon" Knitty City - MountainTop by Classic Elite Yarns "Mohawk Wool", Color 3316, Lot 831, made in USA, CE-3316-3 undyed: 60% merino wool, 30% Romney wool, 10% nylon	Thin, roving/woolen (not tightly spun, fuzzy texture) yarn
<b>Cotton</b>	100% cotton, undyed twine (butcher's string)	Thick, worsted yarn
<b>Cheesecloth</b>	100% cotton, undyed	Loosely woven textile, mesh-like
<b>Linen</b>	<a href="#">100% linen Utrecht Unprimed Belgian Linen Canvas Type 185</a>	Rectangular pieces, woven linen threads
<b>Silk</b>	Jaquard Silk Scarf, 100% chinese silk, hand rolled hems, ready to dye, Habotai 8mm x 15" x 60"	Rectangular pieces, woven linen threads
	<a href="#">Jaquard Silk Scarf Habotai</a>	Close woven, very thin and light, white strips
	<a href="#">See also sister company "silkconnection" with same information</a>	
	<a href="#">Silk yarn, 100% Tussah silk, 2 ply lace weight, Undyed and Natural (Lace Weight) Ready to Dye</a>	Thread
<b>Cascade Eco wool</b>	<a href="#">Cascade yarns, ecological wool, 100% undyed peruvian highland wool (col. 8010, Lot 7C1211), purchased at Knitty City NYC</a>	Chunky, worsted (tightly spun)
<b>Fleece</b>	Ashford Corriedale, 100% corriedale wool, color: 091 "natural white"; undeyed, probably unbleached, from Knitty City NYC	Unspun, fluffy white wool
<b>TestFabrics</b>	<a href="#">Conservation-quality fabrics from Test Fabrics</a>	Various (silk taffeta, silk satin)