XVIII. Continuation of Mr. Henry's Considerations relative to the Nature of Wool, Silk, and Cotton, as Objects of the Art of Dying, &c.

(FROM P. 60.)

Silk, when taken from the cone, is covered with a kind of varnish, which makes it feel rough and hard to the touch, tarnishes its whiteness, and is
is generally said to be of such a nature as to be neither soluble in water, nor in spirit of wine. It has been thought that the only solvent for this substance is a solution of alkaline salt; and this is commonly applied in the form of soaps. The soaps should always be of the best quality; for, inferior soaps, especially those made with animal fat, are not only less powerful in their action, but are apt to stain or discolour the silk. The silk in this operation loses about one fourth of its weight. The matter separated from it is highly putrefactive, for, if a hank of silk which has been thus treated be not washed, after the operation, it will in a few days grow hot, flint, and be covered with small white worms, which feed on the foamy and glutinous matter remaining in the silk. The liquor in which it has been boiled also soon putrefies, and becomes useless. Could this animal matter, says M. Macquer, be precipitated from the soaps, before putrefaction takes place, the soaps might be recovered, and thus a considerable saving made to the dyer.

* Macquer, Art de la Teinture en Soie.
The use of the best soaps has been recommended; but even these are suspected of being detrimental to the whiteness of the silk; and Chinese silk, which exceeds the European in lustre, is said to be prepared without soap. The French Academy therefore, some years ago, offered a prize for the discovery of a method of cleaning silk without soap; the prize was obtained by M. Rigaut, whose mode was to use a slender alkaline solution instead of soap.

But Mons. l'Abbé Cullumb * has lately gone farther, and has actually dissolved in water the varnish of silk, which has always been supposed to be of that oleo-refinous kind as not to be acted on even by spirit of wine. He exposed a quantity of raw silk to the action of boiling water for nine hours, and found it freed from the varnish, with the loss of one fourth of its weight.

Though the silk by these means acquires a considerable degree of whiteness, if intended to receive some of the most brilliant colours a farther operation is requisite. This consists in exposing

* Journal de Physique, Part II. Vol. XXIX.
the silk to the fumes of burning sulphur, so confined in a stove that none shall escape, but the whole be applied to the material intended to be whitened: of the rationale of this operation Mr. Delaval has given a very ingenious explanation *.

But, though thus rendered more fit for exhibiting the brilliant colours, the attraction of the silk for colouring matter is rather diminished than increased; the raw or unscoured silk being more easily and permanently dyed, than that which has passed the above described process.

Cotton and linen are prepared for the purposes of dying by being boiled in solutions of alkaline salts, and afterwards exposed to the air, and the sun’s rays, in the bleach field. Linen, containing much oily and resinous matter, requires a strong solution of alkaline salts, and that they be in a caustic state; but cotton not having any resinous matter, and not much superabundant oil, the milder alkalies are more beneficially employed for the bleaching of it †.

This

† The new mode of bleaching by means of the dephlogisticated marine acid, which has been introduced into our manufactures.
This bleaching, or steeping in the alkaline leys, leaves in the cotton, however well washed, some earthy matter, which, being unequally distributed, would, when the cotton is to be dyed, render the application of the colour unequal. This, therefore, is to be removed by steeping in a dilute vitriolic acid, which is capable of dissolving and carrying off the earth. But this acid is also to be carefully removed by washing the cloth in water; otherwise, as it becomes dry, the acid, being gradually concentrated by the evaporation of the water, will attack and corrode the cotton.

The intention of these previous preparations seems to be two-fold: the first is, to free the material to be dyed from any extraneous matter, which might, by its want of attraction for water, prevent the absorption of the colouring liquor; for, we find that unbleached stuffs do not imbibe manufactures since the reading of this paper, promise to be of great utility to them; not only by shortening the time required for the process, which has been generally extended from one to two months, and may now be reduced to a few hours, but also by sending up the goods in a state much better adapted to the subsequent processes.

water
water with near so much avidity as those that have been bleached. The second is, that the yarn or cloth may be rendered whiter, and, by reflecting the rays of light more copiously, enable the colouring matter to exhibit more brilliant tints; to these a third intention has been added, viz. to enlarge or dilate the pores of the substance.

But, for some particular purposes, cotton requires a different and more complex preparation. In the process for dying the Turkey or Adrianople red it is boiled, and repeatedly steeped, in mixtures of mineral alkali, oil, and animal excrement; and, though these operations have been considered as only answering the above-described purposes, I trust I shall be able to make it appear, in the sequel of this paper, that important additions are thus made to the cotton, whereby its attraction for colouring matter is increased.

Having thus considered the natures of the different subjects of dying, and the various preparations necessary to render them fit for the reception of colouring matter in general, let us next proceed to some description of the colouring substances which are employed in dying.
These are divided into two classes; viz. those which are themselves possessed of colour; and those which, possessing no colour in themselves, alter the power of the former to transmit the various rays of light, thereby enabling them to exhibit colours different from those which they would naturally exhibit.

When I say that substances do themselves possess colour, I only mean that they possess the power of transmitting particular rays of light, so as to produce, by the action of these rays on the retina, the idea of certain colours.

Though the primitive colours into which a ray of light may be divided are seven, yet the original colours produced by dyers are no more than five; viz. blue, red, yellow, brown, and black. From these, perhaps, the two last may be excluded as compounds; all the other shades, of various denominations, are formed by different combinations of these original colours.

The substances which do themselves contain colouring matter, and are used in dyeing, are chiefly of the vegetable, some of the animal, and in a few instances of the mineral, kingdom. The
last consist of metallic calces, and chiefly those of iron and copper.

Of the two former *, most of their component parts, in which the colouring matter resides, such as their mucilage, their gum, and the salts which they contain, are soluble in water; as, by means of these salts, are also their oily parts: to these the French writers have given the general name of extractive soapy matter. Other constituent parts of vegetables are not soluble in water, viz. some of their oily, their resinous, and their earthy parts.

Yet we should be deceived, as M. Macquer justly observes, if we were to expect to make a perfect separation, by means of water, of the extractive soapy matter from the other parts. For, a portion of that matter is defended from the action of the water, by the resinous and oily substances; while, on the other hand, these are partially dissolved, being rendered capable of uniting to the water, by means of the mucilaginous parts.

* Macquer, Dictionnaire de Chymie.
The colouring animal and vegetable drugs, of the *materia tinctoria*, have been formed by chemistry into three divisions *

First. Those substances which, together with extractive, contain some resinous, and also some portion of earthy, matter in their composition; and the colouring principle having a strong attraction to the earth, and this to the substance to be dyed, a separation from the water is easily effected, and the colour is capable of being applied, and of adhering in a durable manner, without the intervention of any medium. Of this tribe are galls, walnut rinds, the root of the tree sumach, and alder bark; these are called root colours, as being the foundation of others.

Secondly. Other articles of the *materia tinctoria* consist of materials whose parts are either wholly extractive, or, though containing some resinous matter, are capable of being dissolved in water alone; and, being deficient in the earthy principle contained in the articles of the former division, require that an earth be previously intro-

* Macquer, Dictionnaire de Chymie.
roduced into the pores or interstices of the substance intended to be dyed, to form a basis to which the colour may adhere. Without this medium, the attraction of that substance, to the colouring matter, would be so weak as either not to be able to separate it from the water, or, if separated, to retain and prevent it being redissolved by the water, when aided by mechanical means, or by the addition of certain substances which increase its solvent powers, even in a small degree *.

* Many of these colouring bodies, as well as those of the first division, also contain a principle, known by the appellation of the astringent principle, which greatly contributes to their fixity, and has much effect in separating the earthy parts of the salt employed to afford the above-mentioned basis. Under this description are comprehended cochineal, madder, weld, quercitron bark, and several other drugs. But other articles of this division seem to be either deficient in this principle, or else to possess it of so volatile a nature that it readily escapes, and carries along with it the colouring matter, to which it has a close attachment. Of the nature of this principle we shall hereafter give a more particular detail.

Thirdly.
Thirdly. Another class consists of principles so prevalently resinous, that we are obliged to promote their solution in water by fermentation, or by the addition of some substance which may act on the resinous particles. For this purpose alkaline faults, or quicklime, are employed; and by their means we extract the colouring matter of some bodies, such as indigo, archil, safflower, and arnatto. These also attach themselves to the cloth, without the intervention of an earthy medium.

But the degree of fixity is various, in the different articles of the materia tumbroria belonging to all these divisions. Some of them belong to the less or false dye, as it is called, and are liable to be injured, and even destroyed, by the action of the sun's rays, air, water, and alkaline or acid liquors. The ingredients of the good dye, on the contrary, in a great measure withstand the influence of these agents. The former are more easily managed, are cheaper, and more brilliant; but the latter make amends for their other defects, by their solidity and permanency.

The colouring matter itself is formed, perhaps, in a great measure, of the inflammable, in some cases...
cases united to the astringent, principle. The identity of light and phlogiston, or at least that the one is a modification of the other, appears to be pretty clearly proved. Plants totally excluded from the sun's light acquire no colour; and flowers are observed, ceteris paribus, to possess the most beautiful tints in those climates where they enjoy the influence of that luminary the most liberally. This matter, therefore, must of itself be very fugitive, and as phlogistic bodies act on, and dissolve, each other very powerfully, we are hence enabled to account for the destructive effects of solar light on colour, when applied to the dead fibre, from its dissolving the phlogiston, in the same manner, according to Mr. Delaval, as spirit of wine dissolves camphor *.

The acids also act on, and destroy, colouring matter, in proportion to their attraction for phlogiston. Thus, nitrous acid is highly and instantaneously destructive to many colours; but is exceeded in power by the dephlogisticated marine acid. This very active substance is the

* Manchester Memoirs, Vol. II.
strongest test of all others for the goodness of
dyes; for those that can withstand its action will
endure every other hardship without injury.

Again, some chemists have considered iron as
the colouring matter of vegetables, as it certainly
is, in many instances, of minerals. But this
theory does not necessarily exclude phlogiston;
for, it is supposed that the various colours which
plants exhibit may depend on the various states
of *phlogistication* in which the iron exists. Thus
iron when dissolved in vitriolic acid is green;
apply such a degree of heat as may drive off a
part of the remaining inflammable principle and
the acid, it becomes yellow; and, on carrying
the process still farther, it descends to red, and
purple. It must be allowed that iron enters, as a
component part, into most plants, and that its
colours are capable of exhibiting great variety of
colours; but still it is to phlogiston, or light, that
we are to look up as the real cause of colour; this
being the active, while the martial colures can, at
most, be regarded as the passive, principle.

Since the formation of the antiphlogistician theory
indeed, by which the existence of phlogiston
is
is denied, the various colours of plants have been accounted for, from the different proportions of dephlogisticated air they may retain. Plants, when exposed to the action of the sun's rays, have their water decomposed, and part with this pure air; yielding it in proportion to the quantity of light they receive, which, joining with it, gives it elasticity: but plants kept in the dark throw out none of this air, and are white. Those of the same kind, exposed to a weak light, will have some of the air separated, and have a faint degree of colour; and those which undergo the action of a strong light, will exhibit vivid tints. But though we allow of the dephlogisticated air, as producing whiteness, yet we may also acknowledge the effect of phlogiston, in producing colour; and, in fact, the antiphlogistians are obliged to admit of inflammable gas, as a substitute for it; and to acknowledge, that this gas, which they suppose to be the other constituent part of water, is the principle of colour *.

* Journal de Physique, tom. XXVI. p. 1.
The colourless ingredients used in dying consist of alkaline, acid, nitrous, earthy, and metallic salts; which contribute either to extract the colouring matter from other substances which contain it, or, by attenuating or incrustating its particles, to cause the colour to ascend or descend, according to the prismatic range. Thus, acids raise the blue colour of vegetable juices to indigo, violet, red, and yellow; while alkalis reduce the tints, thus raised, to violet, indigo, blue, and, on a farther addition, to green.

In the subsequent part of this paper, we shall proceed to consider the nature of the several bases; endeavour to deduce a theory of dying; and particularly to account for the action of the substances employed in the preparation for the Turkey red, and in the other parts of that process.

**PART SECOND.**

In the former part of this memoir it must have been evident, that the processes which have been already described are founded in chemical principles.
principles; and that a knowledge of chemistry must consequently be advantageous to those who have the direction of such operations, and serve to expedite improvements in them. In those which remain for description, the hermetic art is equally useful. The whole business of dying is, indeed, so truly a chemical process, or rather a combination of several chemical processes, that I am convinced the invention, or at least the principal improvements of the fundamental parts, must have proceeded from men skilled in chemistry. We have seen that the Egyptians were even acquainted with the more complicated kind of dying, or calico printing; and this knowledge was not confined to them, but was possessed by other Eastern nations. From the East also proceeded, to us, chemistry itself; and it is highly probable that the art was of great antiquity, in that part of the globe, and had arrived at a degree of perfection of which we have at present no suitable ideas. To have invented the process of printing, in the manner described by Pliny, the inhabitants of India must probably have known how to prepare
prepare alum *; they must have been acquainted with the manner of dissolving lead in the vegetable acid; they must at least have been acquainted with the component parts of these salts; and they must have had a knowledge of double elective attractions.

In our division of the various colouring substances, of the animal and vegetable kinds, we took notice that there are some, viz. those of the third division, which, not having of themselves a sufficient attraction for the cloth, require to have an earthy substance applied, as an intermedium. The requisites in this earth are, that it should have a strong attraction for the material to be dyed, and also for the colouring principle; and, in many cases, that it should possess perfect whiteness, for the purpose of reflecting the rays of light, so as to enable the tinging matter to exhibit its peculiar colour with the greater brilliancy. If, to these properties be added, that though soluble in acids, its solubility should not be too easy, and that it should even be capable of form-

* The fictitious salt which is now called alum was first discovered in the Eastern countries; but when, where, and by what means, is unknown.

ing insoluble compounds with some other substances, which may be occasionally added to it for that purpose, we have perhaps a complete description of such a basis, or, as it is commonly called, a mordant.

This is a term that appears to have been first introduced by the French dyers, who, apprehending that the intention of passing the substances which were to be dyed through certain saline liquors, the nature of which they did not understand, was to corrode something that opposed the entrance of the colouring principle, and to enlarge the pores of the substances, gave to the liquors the appellation of mordants. A term which, as conveying a wrong idea, it is to be wished were rejected; I shall therefore take the liberty to change the word mordant for basis; adding an epithet occasionally, descriptive of the body from which it is obtained. The substances principally used to afford the white basis for colouring matter are, alum, and solutions of tin, in different acids; but generally in marine acid, or in a mixture of marine and nitrous acid, commonly known by the name of aqua regia.

To be continued in our next.