XVIII. Continuation of Mr. HENRY's Confiderations 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 varnifh, which makes it feel rough and hard to the touch, tarnifhes its whitenefs, and

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is generally faid to be of fuch a nature as to be neither foluble in water, nor in fpirit of wine. It has been thought that the only folvent for this fubftance is a folution of alkaline falt; and this is commonly applied in the form of foap. The foap fhould always be of the beft quality; for, inferior foaps, efpecially thofe made with animal fat, are not only lefs powerful in their action, but are apt to ftain or difcolour the filk. The filk in this operation lofes about one fourth of its weight. The matter feparated from it is highly putrefcent, for, if a hank of filk which has been thus treated be not wafhed, after the operation, it will in a few days grow hot, ftink, and be covered with fmall white worms, which feed on the foapy and glutinous matter remaining in the filk. The liquor in which it has been boiled alfo foon putrefies, and becomes ufelefs. Could this animal matter, fays M. Macquer, be precipitated from the foap, before putrefaction takes place, the foap might be recovered, and thus a confiderable faving made to the dyer *.

* Macquer, Art de la Teinture en Soie.

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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 Cullomb * has lately gone farther, and has actually diſſolved in water the varniſh of ſilk, which has always been ſuppoſed to be of that oleo-reſinous 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.

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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 †.

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* Mancheſter Memoirs, Vol. II. p. 2.

† 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

nufactures ſince the reading of this paper, promiſes 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.

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water with near fo much avidity as thofe that have been bleached. The fecond is, that the yarn or cloth may be rendered whiter, and, by reflecting the rays of light more copioufly, enable the colouring matter to exhibit more brilliant tints; to thefe a third intention has been added, viz. to enlarge or dilate the pores of the fubftance.

But, for fome particular purpofes, cotton requires a different and more complex preparation. In the procefs for dying the Turkey or Adrianople red it is boiled, and repeatedly fteeped, in mixtures of mineral alkali, oil, and animal excrement; and, though thefe operations have been confidered as only anfwering the above-defcribed purpofes, I truft I fhall be able to make it appear, in the fequel of this paper, that important additions are thus made to the cotton, whereby its attraction for colouring matter is increafed.

Having thus confidered the natures of the different fubjects of dying, and the various preparations neceffary to render them fit for the reception of colouring matter in general, let us next proceed to fome defcription of the colouring fubftances 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 dying, are chiefly of the vegetable, ſome of the animal, and in a few inſtances of the mineral, kingdom. The

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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 in-

* Macquer, Dictionnaire de Chymie.

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troduced into the pores or interftices of the fubftance intended to be dyed, to form a bafis to which the colour may adhere. Without this medium, the attraction of that fubftance, to the colouring matter, would be fo weak as either not to be able to feparate it from the water, or, if feparated, to retain and prevent it being rediffolved by the water, when aided by mechanical means, or by the addition of certain fubftances which increafe its folvent powers, even in a fmall degree *.

* Many of thefe colouring bodies, as well as thofe of the firft divifion, alfo contain a principle, known by the appellation of the aftringent principle, which greatly contributes to their fixity, and has much effect in feparating the earthy parts of the falt employed to afford the above-mentioned bafis. Under this defcription are comprehended cochineal, madder, weld, quercitron bark, and feveral other drugs. But other articles of this divifion feem to be either deficient in this principle, or elfe to poffefs it of fo volatile a nature that it readily efcapes, and carries along with it the colouring matter, to which it has a clofe attachment. Of the nature of this principle we fhall 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 ſalts, 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 tinctoria* 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 cafes united to the aftringent, principle. The identity of light and phlogifton, or at leaft that the one is a modification of the other, appears to be pretty clearly proved. Plants totally excluded from the fun's light acquire no colour ; and flowers are obferved, *cæteris paribus*, to poffefs the moft beautiful tints in thofe climates where they enjoy the influence of that luminary the moft liberally. This matter, therefore, muft of itfelf be very fugitive, and as phlogiftic bodies act on, and diffolve, each other very powerfully, we are hence enabled to account for the deftructive effects of folar light on colour, when applied to the dead fibre, from its diffolving the phlogifton, in the fame manner, according to Mr. Delaval, as fpirit of wine diffolves camphor *.

The acids alfo act on, and deftroy, colouring matter, in proportion to their attraction for phlogifton. Thus, nitrous acid is highly and inftantaneoufly deftructive to many colours; but is exceeded in power by the dephlogifticated marine acid. This very active fubftance is the

* Manchefter Memoirs, Vol. II.

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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 calces 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 calces can, at moſt, be regarded as the paſſive, principle.

Since the formation of the antiphlogiſtian theory indeed, by which the exiſtence of phlogiſton

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is denied, the various colours of plants have been accounted for, from the different proportions of dephlogifticated air they may retain. Plants, when expofed to the action of the fun's rays, have their water decompofed, and part with this pure air; yielding it in proportion to the quantity of light they receive, which, joining with it, gives it elafticity: but plants kept in the dark throw out none of this air, and are white. Thofe of the fame kind, expofed to a weak light, will have fome of the air feparated, and have a faint degree of colour; and thofe which undergo the action of a ftrong light, will exhibit vivid tints. But though we allow of the dephlogifticated air, as producing whitenefs, yet we may alfo acknowledge the effect of phlogifton, in producing colour; and, in fact, the antiphlogiftians are obliged to admit of inflammable gas, as a fubftitute for it; and to acknowledge, that this gas, which they fuppofe to be the other conftituent part of water, is the principle of colour *.

* Journal de Phyfique, tom. XXVI. p. 1.

The colourlefs ingredients ufed in dying confift of alkaline, acid, nitrous, earthy, and metallic, falts; which contribute either to extract the colouring matter from other fubftances which contain it, or, by attenuating or incraffating its particles, to caufe the colour to afcend or defcend, according to the prifmatic range. Thus, acids raife the blue colour of vegetable juices to indigo, violet, red, and yellow; while alkalis reduce the tints, thus raifed, to violet, indigo, blue, and, on a farther addition, to green.

In the fubfequent part of this paper, we fhall proceed to confider the nature of the feveral bafes; endeavour to deduce a theory of dying; and particularly to account for the action of the fubftances employed in the preparation for the Turkey red, and in the other parts of that procefs.

PART SECOND.

In the former part of this memoir it muft have been evident, that the proceffes which have been already defcribed are founded in chemical principles

principles; and that a knowledge of chemiftry muft confequently be advantageous to thofe who have the direction of fuch operations, and ferve to expedite improvements in them. In thofe which remain for defcription, the hermetic art is equally ufeful. The whole bufinefs of dying is, indeed, fo truly a chemical procefs, or rather a combination of feveral chemical proceffes, that I am convinced the invention, or at leaft the principal improvements of the fundamental parts, muft have proceeded from men fkilled in chemiftry. We have feen that the Egyptians were even acquainted with the more complicated kind of dying, or *callico printing*; and this knowledge was not confined to them, but was poffeffed by other Eaftern nations. From the Eaft alfo proceeded, *to us*, chemiftry itfelf; 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 prefent no fuitable ideas. To have invented the procefs of printing, in the manner defcribed by Pliny, the inhabitants of India muft probably have known how to 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 factitious ſalt which is now called alum was firſt diſcovered in the Eaſtern countries; but when, where, and by what means, is unknown.

Bergman's Eſſays, vol. I. p. 339. Eng. tranſl.

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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.

XIX.