XXXIV. Conclufion of Mr. HENRY's Confiderations relative to the Nature of Wool, Silk, and Cotton, as Objects of the Art of Dying.

(FROM p. 207.)

FOR the tenth operation, this remaining decoction of galls is to be heated, the thick fediment at the bottom being previoufly feparated by a hair-fieve, and the cotton again treated as in the ninth operation.

The eleventh operation is the aluming of the cotton. Thirty pounds of Roman alum, finely powdered, are put into fixteen gallons of water, gradually heated, and continually ftirred; as foon as it becomes fo hot that the operator can juft eafily bear his hand in it, the fire is to be removed. Six gallons of the firft barilla liquor are then to be added by degrees, and the whole agitated till the folution is complete. The cotton is to be placed in the wringing-tub, about three gallons of the alum-liquor poured on it, and, in proportion as it is foaked up, more is to be added, till about one half of it is employed. The cotton, having been thoroughly worked in the liquor, is to be well wrung and dried, and the portion which is wrung out is to be returned to the remainder in the pan, and ufed in the twelfth operation, which is performed exactly in the fame manner as the eleventh; after which the dried cotton is to be well wafhed, by handfuls, in running water, the workman holding in each hand about twenty ounces of cotton, for two minutes. Each portion is then wrung, and feparated; wafhed and wrung again, and laid upon a coarfe cloth.

cloth. The whole is then carried up from the river, wrung a third time, and hung to dry. The cotton will now be ready for the thirteenth operation, in which the colouring fubftance is applied to it.

The cotton is firft divided into four equal parts, each of which is to be dyed feparately; and thefe are fubdivided into fkains, or parcels, of about a pound and quarter each. The copper pan is then to be filled with water, within about fix inches of the top, and twenty-fix pounds of Smyrna, or rather of Cyprus, madder added to it. As foon as the water becomes milk-warm, fourteen pounds of fheep's blood, as frefh as it can be procured, are to be ftirred into it. When the liquor is fo warm that the workman can juft bear his hand in it, one fourth part of the cotton is to be put into it, fufpended on fticks, by means of which it is moved backwards and forwards in the pan, every five minutes; and the fkains are to be inverted every ten minutes, fo that they may receive the dye equally in every part; this bufinefs is continued for about fifty minutes. The cotton is then hung on five fticks

 only,

only, and ſo ſuſpended by ſtrings as to be wholly immerſed in the liquor, which is now made to boil, and continued boiling for forty-five or fifty minutes. A white froth, which about this time appears on the ſurface, is a ſign that the madder is exhauſted of its colouring matter, and that the cotton can receive no benefit, though it will get no injury, from continuing longer in the liquor. It is then to be withdrawn, carried to be well waſhed in the river, or waſh-wheel, and then wrung and dried.

The other three-fourths of the cotton are then to be ſucceſſively dyed in the ſame manner; freſh ingredients being uſed for each parcel.

The fourteenth operation is repreſented as highly eſſential to the ſucceſs of the proceſs; ſhould it be omitted, the colour, it is ſaid, would not only be ſo unfixed as to loſe much in the ſubſequent operation, but would likewiſe require more time for the enlivening. About eight gallons of the white liquor, which remained after the ſeventh operation, and were directed to be reſerved, are now to be mixed with four gallons of the firſt barilla ley. Two gallons of this

mixture

mixture being put into the wringing-tub, the whole of the cotton is to be washed in it; adding more liquor in proportion as it is soaked up by the cotton, which is afterwards to be wrung and dried.

To this succeeds the fifteenth and last operation; viz. that of enlivening or reviving the colour. The copper pan being about half filled with water, twenty-eight or thirty gallons of the liquor remaining after the first operation are to be added, so that the liquor may reach to within six inches of the top. When the liquor is nearly boiling, the cotton is to be put in, being previously formed into parcels of about two pounds and a half each; nearly four ounces being kept separate, for a purpose hereafter to be described.

The cotton is to be well pressed down in the pan, and confined by sticks. The pan is covered with a wooden lid, having a small hole, through which the small portion of cotton, reserved for that intention, may be occasionally withdrawn, in order to observe the progress of the operation; this hole has a movable cover. The lid is then to be secured by a strong cross of wood, with a straight piece over it; and the sides made close,

so

ſo as to confine the vapour, by laying round the edges of the lid a quantity of damp linen cloth. The fire is then to be raiſed, ſo as to make the liquor boil, and the boiling is to be continued for nine hours.

The proceſs is finiſhed by taking the cotton out of the liquor, wringing, and drying it; but the drying is never to be performed either in a ſtove or in ſtrong ſun-ſhine. The colour will be moſt brilliant if the cotton be dried in the ſhade, with a free acceſs of air.

In the third part I ſhall endeavour to give a theory of dying, (as far as *baſes* are concerned,) and eſpecially of the proceſs of which we have juſt given a detail.

PART THIRD.

Nothing can lead more effectually to the improvement of any art than a right underſtanding of the inſtruments, or agents, employed in the practice of it. Though long experience may eſtabliſh a number of facts, yet, if the *rationale* of the manner by which they are produced be not underſtood, miſapplications are liable to be made; ſimilar

ſimilar practices are purſued where the caſes differ eſſentially; and improvements are attempted at hazard, and often on falſe principles.

Though it may not be granted that, in the ſcouring of the ſeveral materials which are to be ſubjected to the art of the dyer, their tubular pores are enlarged, or even diveſted of any matter which obſtructs them, yet it will not be diſputed that the intention of theſe proceſſes is to remove an oily or a reſinous matter which inveſts the fibres, and fills up the interſtices of the filaments; either rendering the material leſs white, or leſſening its attraction for water, and for the colouring matter intended to be applied. For the more brilliant colours, in order that they may be exhibited in their greateſt luſtre, the ſcouring and bleaching is generally carried to ſuch a degree as only to be ſhort of injuring the texture; and the material always ſuffers a loſs of ſubſtance.

In the preparation for the Turkey red, the caſe ſeems to be different; no bleaching is allowed, and the firſt operation of the proceſs is of a kind that is rather likely to add to the weight than to ſubtract any thing from it. The cotton is boiled

in

in a mixture of barilla, or impure mineral alkali, oil, and animal excrement. Were the fole intention of this operation to fcour the cotton, or, as the dyers phrafe it, to open its pores, would not the barilla alone be more efficacious? And for what reafon can we fuppofe that the fheep's dung, which contains a quantity of foul colouring matter, fhould be added? We have feen that, in the fcouring of filk, where a perfect foap is ufed, fome portion of it adheres, notwithftanding the wafhing the filk undergoes. The cotton is indeed alfo well wafhed after this firft operation, but it is moft likely that water will not be able to remove the whole fubftance of this animalized foap; and it feems alfo probable, that the imperfect foap, or mixture of oil and alkali, together with the dung-liquor, through which the cotton is fo often paffed, will continue to furnifh fomewhat to it; for, animal fubftances contain an acid which is feparated in various forms. We have already feen that faccharine acid is obtainable from them by means of nitrous acid; the blood affords the Pruffian acid, and alfo phofphoric acid. This laft is contained ftill more abundantly in the urine, and in the bones, but we ſhall defer the conſideration of the uſe of animal acid in dying, till we come to treat on the ſubject of baſes.

The idea of animalizing vegetable ſubſtances, to promote their attraction for colouring matter, occurred to me many years ſince; and the late Sir Torbern Bergman ſeems to have held a ſimilar opinion. We have ſeen, in the abſtract I have given of M. Berthollet's analyſis of animal and vegetable ſubſtances, that wool and ſilk yield much acid of ſugar, together with a fatty oil; whereas cotton gives no ſaccharine acid, no oil, and, in ſhort, that the whole ſubſtance is capable of being diſſipated in the form of gas, leaving no reſiduum in the retort, and communicating nothing permanent to the nitrous acid which diſtils into the receiver.

I wiſh that ſome perſon, whoſe opportunities and leiſure are greater than mine, would compare, by ſuch an analyſis, cotton in its natural ſtate, and cotton prepared in the ſeven leading operations for the Turkey red; in order to determine whether it have, by this treatment, acquired pro-

 perties

perties more nearly approaching to animal matter; viz. whether in the latter ſtate it will afford more acid of ſugar, and give over on diſtillation an oily matter, reſembling that obtained from animal ſubſtances.

Another point which it might be important to aſcertain is, what increaſe of weight the cotton acquires after each ſteeping. It appears from the account of the gentlemen appointed to ſuperintend and repeat M. Borelle's proceſs, that, previous to the maddering, or imparting of the colouring matter, the cotton had increaſed to the amount of $\frac{1}{5}$ of its original weight, though it had been well waſhed previous to that operation. In this increaſe, however, was included what it had acquired in the operations of galling and aluming.

The operation of galling, in this as well as ſome other proceſſes of dying, is uſed previous to the application of the baſis to the material. Galls contain an aſtringent matter, to which chemiſts have lately given the appellation of the aſtringent principle, and the Dijon Academicians have proved it to be of an acid nature. It has not only the property of decompoſing metallic, but alſo

earthy,

earthy, folutions, and of combining with the precipitates which fall from them: hence its ufe, previous to the aluming, in the procefs of dying. Steep cotton which has not been galled in a folution of alum, the folution will remain clear, and the cotton, when dried, will be covered with aluminous cryftals: let another parcel of cotton, which has been galled, be immerfed in a fimilar folution, the liquor will become turbid, and plain marks of precipitation will appear.

This aftringent principle is of ftill farther ufe in the art of dying, and we fhall prefently fee the manner in which it acts, when combined in thofe vegetables which afford colouring matter.

Having thus given an account of the previous operations in dying, relative to the application of the bafis, let us next enquire into the principles on which this application is made, and the modes by which it is more firmly attached to the material.

We have already remarked that alum contains an earth in its compofition, united to vitriolic acid. This earth is purely argillaceous, and may be feparated from the acid to which it is united, by any fubftance to which either the earth, or the acid, has a ſtronger attraction than they poſſeſs to each other.

The firſt theory we meet with, to account for the action of alum, and other intermediate ſubſtances uſed to furniſh baſes for colouring matter in dying, is that of M. Hellot; who ſuppoſes that theſe ſaline bodies form vitriolated tartar, a ſalt difficult of ſolution in water, and that the minute cryſtals of this ſalt inſinuate themſelves into the pores of the material to be dyed; that to theſe cryſtals the colouring matter becomes attached, and firmly united, and they to the material, ſo as to reſiſt the ſolvent power of water. Thus, when tartar and alum are uſed, he imagines the vitriolated tartar to be formed from them; and, in every other caſe of dying, he accounts for the production of a vitriolated tartar, but often in a manner by no means ſatisfactory. This vitriolated tartar he deſcribes as cryſtallizing in the dilated pores of the cloth, attracting the colouring matter, and, being difficult of ſolution in water, detaining the colouring particles, which are farther cemented by the crude tartar.

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But, though theſe ſalts are not *eaſily* ſoluble in water, yet a *ſufficient* quantity of water will diſſolve them; and, if the colouring particles were attached to them, they muſt be carried off whenever the ſolution of the ſalts is effected. But, as this is not the caſe, (for, when theſe particles are properly affixed to the material, they are not movable by any quantity of water, however large,) their fixity muſt depend on ſome more permanent baſis.

Mr. Keir, the ingenious tranſlator of Macquer's Dictionary of Chemiſtry, appears to have been the firſt who ſuſpected that the earth of alum was precipitated, and in this form attached to the material; indeed, it ſeems wonderful that this idea did not occur to M. Hellot, who was fully aware that, in the dying of ſcarlet, the cochineal became firmly united to the white calx of tin.

M. Macquer, in the laſt edition of his Dictionary, has been more explicit on this ſubject. From the experiments which have been alluded to, in the ſecond part of this paper, by which laques and carmine are made by pouring ſolutions of alum, or of tin, into clear decoctions of extractive

reſinous

refinous colouring ingredients, he concludes that the fame effects take place in dying; that, when the materials are loaded with thefe earthy or metallic falts, and then thrown into the liquors impregnated with the colouring fubftances, the colouring matter quits the other principles to which it was united, feizes on the earthy bafis of the falt, and, uniting with it, lofes its folubility in water; and, in this combination, becomes attached to the material, in fo permanent a manner as not to be wafhed away by water. M. Macquer, however, does not feem to have been aware, that it is by means of the aftringent principle that this precipitation is effected. All the fubftances which form laques contain this principle; as is evinced by the blacknefs they produce with martial folutions, and to this the colouring principle feems to be clofely united. A few drops of infufion of galls produce an immediate precipitation of the earth of alum from its acid: this precipitation is more copious than that produced by any of the common colouring fubftances, and is, at the fame time, white.

Here

Here again new experiments are ſuggeſted. Let a large quantity of earth of alum be thus precipitated by galls; let the precipitate be well waſhed, and afterwards expoſed in a retort, with a receiver adapted to it, to a ſtrong heat; the aſtringent principle, if united to the earth of alum, being volatile, will probably be driven over into the receiver, and thus the ſuppoſed combination be rendered evident.

Again, let the ſupernatant liquor, from which all the earth has been precipitated, be examined, to ſee in what ſtate of combination the vitriolic acid of the alum remains.

In the common dyes then, with metallic or earthy baſes, the theory is pretty clearly as M. Macquer has repreſented, only taking the aſtringent principle into the account; and, with reſpect to wool and ſilk, nothing more ſeems neceſſary than the impregnation of the one with alum and tartar, and of the other with alum alone, previous to their immerſion in the coloured liquor.

But when cotton is to be dyed, and ſome of theſe baſes are requiſite, not only the baſis is to be precipitated by the aſtringent colouring principle, but the attraction of the material to the basis is to be increased by other *intermedia*. The permanency of the extractive dyes, therefore, depends on the previous treatment of the cotton; and, where alum is employed, of that salt, so as to procure a more copious precipitation of its earth, and to unite it, by means of other substances, to the material.

For this reason, in the common dying of cotton the alum is previously neutralized, by the addition of alkaline salt; whereby, not only the acid is prevented from injuring the cotton, but the alum is put into a state more ready to be precipitated by the astringent colouring matter.

For this reason also, in the process of calico-printing, the earth of alum is made to change its natural acid for the acetous; for, by this means, not only a salt is prepared, capable of dissolving more copiously in water than common alum, but the acetous acid, being more loosely attached to the aluminous earth, is, as it becomes concentrated by drying, easily driven off by heat, the earth being left spread upon, and cemented to, the calico.

When

When ſpeaking of the uſe of animal ſubſtances, it was obſerved, that they yield ſeveral different acids by various modes of analyſis; viz. the phoſphoric, the ſebaceous, the Pruſſian, and the ſaccharine. Of theſe, the two firſt are formed in the animal ſyſtem; the third is perhaps the creature of fire, and originates from a combination of ſome of the more ſimple conſtituent parts of animal ſubſtances; and, of the laſt, it ſhould ſeem that theſe ſubſtances only contain the baſis *. M. Berthollet, by uniting cauſtic alkalies with animal ſubſtances, is ſaid to have found them neutralized, and that the animal matter, when afterwards ſeparated from the alkali, is no longer ſuſceptible of putrefaction. This animalized neutral ſalt may be decompoſed by means of alum; and, while the vitriolic acid ſeizes on the alkali, the earth of alum becomes intimately combined with the animal acid. It appears to me highly probable, that this acid is ſupplied to the cotton, in the proceſs for dying the Adrianople red; that the attraction between the cotton and acid being ſtrong, and that between the latter and the earth of alum being likewiſe

* Critical Review, vol. LXII. p. 377.

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powerful, ſuch an union is effected as aſſiſts in rendering the material capable of attracting and retaining the colouring matter, in as forcible and permanent a manner as can be done either by wool or ſilk.

The uſe of the galls alſo, in this and other proceſſes, ſeems intended to promote a ſimilar purpoſe. Cotton, either unbleached, or which has undergone no proceſs but that of bleaching, when immerſed in a ſolution of alum, produces no change in the appearance of the ſolution; but, as has been already ſhewn, cotton previouſly ſteeped in an infuſion or decoction of galls ſoon renders the liquor turbid, occaſioning a precipitation of the earth of alum on the cotton.

The imperfect ſoap alſo, formed by the union of the alkali and oil, when mixed with the alum, will both decompoſe that ſalt, and be itſelf decompounded, and a ſoap of a different nature will reſult, from the union of the oil with the earth of alum. M. Berthollet, who has made ſeveral experiments on earthy and metallic ſcaps, found this argillaceous ſoap to be totally inſoluble in water, and in ſpirit of wine. It is probable alſo, that the blood, which is employed with the madder,

der, may fupply both animal falts, and a glutinous matter, to the cotton. This feems to be the ufe of the blood, and not, as M. Borelle fuppofes, to communicate a pink tinge to the madder.

Here then appear to be feveral different fubftances employed, tending to form infoluble compounds with the argillaceous earth of the alum. But whether, when depofited on the cloth, they remain fo many diftinct compounds, or may all unite into one infoluble body, I do not pretend to determine.

M. Macquer, whofe opinions always deferve the moft refpectful attention, declares, that the excellence and permanency of the Turkey red depend on the great quantity of alkali, ufed in the procefs of aluming, rediffolving the earth of alum, after its feparation from the vitriolic acid, and forming with it a faline compound, eafily feparable into its conftituent parts, fo that the aluminous earth may be conveniently depofited on the cotton, and united to the colouring matter. The following is a tranflation of his own words, from the laft edition of his Dictionary.

"In examining," fays this excellent chemift, "the effects of all the complicated operations at-

 "tendant

"tendant on the Levant, or Adrianople, procefs, "for giving to cotton a more beautiful and "durable red, by means of madder, than can be "communicated by the common method, I "was ftruck with a fingularity which attends the "aluming in this procefs, and which confifts in "mixing a great quantity of fixed alkali with the "folution of alum, previous to the impregnation "of the cotton with it.

"As the alum is certainly decompofed by the "fixed alkali in this operation, I wifhed to dif- "cover what was the refult; and I found that "the alkali, at the inftant it precipitated the "earth of alum, rediffolved a confiderable part "of it, and that the alkaline falt, with aluminous "bafis, is the real mordant in the Levant procefs. "I have actually determined, by fuitable experi- "ments, firft, that both fixed and volatile alkalies, "efpecially if cauftic, are capable of diffolving and "reducing to a faline ftate a fufficiently large por- "tion of earth of alum, even in the moift way; and "that, by calcination, fixed alkalies become ca- "pable of diffolving a fomewhat larger quantity of "this earth; fecondly, that this alkaline earthy "falt is decompofed, even by water alone, but ftill

"more

"more easily by means of a decoction of madder, "or other extractive tinctures, on the colour of "which the earthy part of the salt seizes, and "forms with it a laque, or coloured precipitate, in "the same manner as those mordants which are "formed of an acid combined with an earth or a "metal; thirdly, I have proved, by several "experiments, that when cotton or linen is im-"pregnated with a strong solution of this alka-"line mordant, without any other preparation "than scouring and galling, these substances re-"ceive, in the madder-bath, a red much more "beautiful and deep than can be given them, "when alum alone is used *."

Notwithstanding my deference for the opinion of this great man, I must, on this occasion, differ from him, for reasons which, it is hoped, will prove satisfactory.

1st. The portion of barilla used in the operation of aluming is only six pounds, supposing the whole quantity employed to be dissolved in the first liquor; but, as there are two other solutions made

* Macquer, Dictionnaire de Chymie, 2 edit. tom. 4. Article Teinture.

before the whole of the ſalt is diſſolved, it is probable that ſix gallons of the firſt liquor will not contain near one half of that weight; for, the barilla being dry and hard, and the mineral alkali leſs ſoluble than the vegetable, the firſt water will act but ſlowly on it; and it is obſervable, that, through the whole proceſs, the ſecond liquor is conſidered as the ſtrongeſt, and is uſed for mixing with the oil. Beſides, not much above one half of the barilla conſiſts of aërated mineral alkali; we may therefore conclude, that the amount of this ſalt contained in ſix-gallons of the firſt barilla liquor (the quantity added to thirty pounds of alum) does not exceed one pound and a half. Now, as 100 parts of alum contain 38 of vitriolic acid, theſe will require, for their ſaturation, 37 of aërated mineral alkali; ſo 30 parts of alum, containing 11.4 of that acid, theſe will require, for their ſaturation, 11.1 of the ſame alkali; whereas, the quantity employed amounts only to 1.5, or rather more than $\frac{1}{8}$ of the quantity requiſite for the neutralization of the acid; and, as a ſuperabundant quantity of the precipitant, above what is neceſſary to the ſaturation of the acid, is requiſite before re-ſolution of the precipitate

pitate can take place, we have, in this cafe, no reafon to expect it.

2dly. The quantity of alkali employed is not fuperior to that ufed in the aluming, in other proceffes for dying with madder; viz. $\frac{1}{6}$ or $\frac{1}{8}$ of the alum.

3dly. The alkali, being aërated, is in the moft unfavourable ftate for rediffolving the aluminous earth; and,

4thly. The re-folution of the aluminous earth takes place only fo long as any of the fuperabundant vitriolic acid remains unneutralized, except the addition of alkali be continued after the precipitation of the aluminous earth is wholly effected; and it cannot be fuppofed that the alkali, with which the cotton has been impregnated, in the previous operations, added to that contained in the barilla liquor, mixed with the alum, can be fuch, even if it were in an uncombined ftate, as to produce fuperfaturation.

It fhould feem probable, therefore, that the permanency of the Turkey red depends on the caufes already affigned, and that its brightnefs is produced by the action of the mineral alkali on the madder. This appears, at firft fight, difcordant

cordant with the theory of Mr. Delaval, that alkalies reduced red colours to crimson, and these to purple; whereas, in the present case, the red is brightened by boiling in a strong solution of mineral alkali; but the fact is perfectly agreeable with that theory; for, the madder-colour is too much inclining to a dusky orange, and this, by means of the incrassating alkali, descends to red.

Before I conclude, permit me to advance a few circumstances relative to the black dye.

For the dying of black, the calx of iron is the mordant employed, and this, uniting with the astringent principle of the galls, forms a black pigment, which is attracted by, and adheres to, the material to be dyed.

The late Dr. Lewis had ascertained, by a number of well-conducted experiments, that the colouring matter of ink consisted of a very finely attenuated calx of iron, combined with this principle. He found also, that this matter, (which, if not kept suspended by some mucilaginous substance, separates and precipitates from the liquor,) resembles in some degree martial æthiops; but that it was not, like that powder, attracted by the magnet till after it had been exposed to a red heat, when it loſt its blackneſs, and became of a ruſty brown colour; a proof that the black colour of ink, or that of the black dye, which is formed on ſimilar principles, does not depend merely on the iron acquiring phlogiſton from the galls. He alſo found, that both acids and alkalies deſtroy blackneſs thus produced; the former by diſſolving the ferruginous body, the latter by acting on the aſtringent principle; he, however, was of opinion, that this principle was of a fixed, not of a volatile nature. But our worthy preſident, Dr. Percival, very early ſuſpected that this aſtringent principle poſſeſſed ſome volatility; in ſupport of his opinion, he mentions artichoke-ſtalks loſing their aſtringent principle by being dried in an oven. He likewiſe appears to be the firſt who obſerved the action of acids and aſtringents on each other.

The ſubject has been farther purſued by the Dijon Academicians; from the reſult of whoſe experiments it appears, that the aſtringent principle is ſoluble in water, in ſpirit of wine, in oils, and in ether; that it riſes copiouſly in diſtillation, reddening the blue vegetable juices, but is capable of uniting, with equal facility, with acids

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and with alkalies; that, though it does not revive iron, without the aid of fire, yet gold and ſilver are precipitated by it in their metallic form; and that it is capable of decompoſing moſt metallic ſolutions, and of giving different colours to their precipitates.

Dr. Percival had endeavoured to produce an ink, by macerating iron filings, without their being combined with any acid; but, making his infuſion without heat, he did not ſucceed. The Dijon chemiſts, not content with making a ſimilar attempt, boiled the liquor; and thus obtained a violet-coloured ink, the traces of which were as well defined, and permanent, as thoſe produced by ink prepared in the common way, even without the addition of gum. Hence it ſhould ſeem, that the heat not only enabled the aſtringent principle to diſſolve the iron, but alſo extracted a mucilaginous matter, which ſupplied the place of gum.

I have related theſe facts, in order to elucidate ſome circumſtances attending the dying of black. Green vitriol was formerly uſed, but the calx of iron is too much dephlogiſticated in this ſalt, and the black produced by it is not permanent. Solutions of iron in acetous acid have of late been pre-

preferred, eſpecially for cotton; and even ſolutions of that metal, made by macerating it with alder-bark and water, in which the aſtringent principle ſhould ſeem to unite with the vegetable acid to form the ſolvent. In theſe ſolutions the iron is not too much deprived of its phlogiſton, and, contrary to thoſe made in mineral acids, they improve with age; for, the vegetable acid tending to putridity evolves phlogiſton, which unites with the iron; whereas the vitriolic ſolution is continually parting with that volatile principle, and thereby not only becoming leſs fit for producing blackneſs, but the calx of iron, when highly dephlogiſticated, is very injurious to the texture of the cloth.

The improvements made in dying black are perhaps the ſtrongeſt proofs that can be given of the utility of chemical knowledge; nor can a more apt inſtance be adduced of the inconvenience ariſing from the want of it than the French proceſs, related by M. Macquer, for this purpoſe; in which no leſs than thirty different ingredients are directed to be employed, ſeveral of which are the ſame things under different denominations, and others tend directly to deſtroy each other.