DR. JOHN ROBISON, *PR. of NAT. PHIL.* EDINBURGH

THE

PHILOSOPHICAL MAGAZINE:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

AGRICULTURE, MANUFACTURES,

AND

COMMERCE.

BY ALEXANDER TILLOCH,

MEMBER OF THE LONDON PHILOSOPHICAL SOCIETY, ETC. ETC.

"Nec aranearum ſane textus ideo melior, quia ex ſe fila gignunt. Nec noſter vilior quia ex alienis libamus ut apes." Just. Lips. *Monit. Polit.* lib. i. cap. 1.

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THE

PHILOSOPHICAL MAGAZINE.

I. *Letter from* C. HUMBOLDT *to* C. FOURCROY, *Member of the French National Institute.*

Cumana, October 16, 1800.

THE capture of the island of Curacao, by the English and the Americans, having obliged the agent of the republic, C. Bressot, and general Jeannet to re-embark their troops, in order to return to Guadaloupe, they have put into this port for want of provisions; and though they intend to remain only twenty-four hours, I have endeavoured to collect for you some objects worthy of your attention, and which I hope will reach you in safety. You are well enough acquainted with the nature of my travels, and the difficulty and expense attending conveyance in the centre of a vast continent, to know that my object is rather to collect ideas than things. A society of naturalists sent out by government, accompanied with painters, collectors, packers, &c., might be able to embrace all the detail of the descriptive part of natural history, and, no doubt, would do so; but a private person, of a very moderate fortune, who undertakes a voyage round the world, ought to confine himself to objects more interesting. To study the formation of the globe, and the strata which compose it; to analyse the atmosphere; to measure, with the most accurate instruments, its elasticity, its temperature, its humidity, its electric and magnetic charge; to observe the influence of climate on the animal and vegetable œconomy; to compare, on a grand scale, the chemistry and physiology of organized beings;—such is the labour which I have proposed. But, without losing sight of this principal object of my voyage, you may readily conceive that, with much zeal and a little activity, two men, who traverse an unknown continent, may at the same time collect a great many things, and make a great many observations.

During the ſixteen months we have been traverſing the vaſt territory ſituated between the coaſt, the Orenoquo, Rio-Nigro, and the river of the Amazons, C. Bonpland has dried, with duplicates, more than ſix thouſand plants. I have deſcribed with him on the ſpot twelve hundred ſpecies, great part of which appeared to us to belong to genera not deſcribed by Aublet, Jacquin, Mutis, or Dombey. We have collected inſects, ſhells, and different kinds of wood proper for dyeing; we have diſſected crocodiles, lamantins, apes, and the gymnotus electricus, the fluid of which is abſolutely galvanic and not electric; and have deſcribed a great many ſerpents, lizards, and fiſh.

I have made drawings of a great number of objects; in a word, I flatter myſelf that if I have erred it is rather through ignorance than want of activity. What enjoyment to live in the midſt of theſe riches of nature, ſo majeſtic and grand! Behold, then, the deareſt and moſt ardent of my wiſhes gratified! Amidſt the thick foreſts of the Rio-Nigro; ſurrounded by ferocious tygers and crocodiles; my body tormented with the ſtings of the formidable moſkitos and ants; having had for three months no other aliment than water, bananas, and manioc, among the Otomaqua Indians, who eat earth; or on the banks of the Caſquiara, under the equator, where, in the courſe of a hundred and thirty leagues, no human being is ſeen;—in all theſe embarraſſing ſituations I never repented of my undertakings: my ſufferings have been great, but they were only momentary.

When I left Spain I intended to proceed directly to Mexico, thence to Peru and the Philippines; but a malignant fever, which broke out in our frigate, induced me to remain on this coaſt of South America; and, thinking it poſſible to penetrate thence into the interior, I undertook two journeys, one to the miſſions of the Chayma Indians of Paria, and the other to that vaſt country ſituated to the north of the river of the Amazons, between Popayan and the mountains of the French part of Guyana. We twice paſſed the grand cataracts of the Orenoquo, and thoſe of Atures and Maypura, in lat. 50° 12′ and long. 5° 39′, W. dep. from Paris 4° 43′ and 4° 41′ 40″. From the mouth of the Guaviara and the rivers Atabapo, Temi, and Tuamini, I cauſed my pirogua to be carried by land as far as the Rio-Nigro, while we followed on foot through foreſts of Hevea, Cinchona, and Canella Wintertona. I deſcended the Rio-Nigro as far as Saint Carlos * that I might determine its longitude by Berthoud's

* The error in the latitude (d'Anville's chart) is more than two degrees, as it had never been determined by aſtronomical inſtruments.

time-

time-keeper, with which I am ſtill well ſatisfied. I aſcended the Caſquiara inhabited by the Ydapaminares, who eat nothing but ants dried in the ſmoke. I penetrated to the ſources of the Orenoquo, even beyond the volcano of Duida, or as far as the ferocity of the Guaica and Guaharribo Indians would permit me to venture, and I deſcended the whole of the Orenoquo, by the force of its current, as far as the capital of Guyana; performing a journey of 500 leagues in twenty-ſix days, without counting thoſe on which we ſtopped.

My health has withſtood all the fatigues of a journey of more than 1300 leagues; but my poor companion, C. Bonpland, had nearly fallen a victim to his zeal and devotion for the ſciences. After our return, he was attacked by a violent fever, accompanied with a dangerous vomiting; which, however, was ſpeedily cured.

The river of the Amazons has been inhabited for 200 years by Europeans; but on the Orenoquo and the Rio-Nigro, it was only about thirty years ago that the Europeans ventured to form a few ſettlements beyond the cataracts. Thoſe which exiſt do not comprehend above 1800 Indians, from the eighth degree to the equator; and there are no other whites than ſix or ſeven miſſionary monks, who did every thing they could to facilitate our journey.

From St. Thomas, the capital of Guyana, lat 8° 8′ 24″, long. 4° 25′ 2″, we croſſed once more the great deſert called Elanos, inhabited by wild cattle and horſes. I am now employed in conſtructing a map of the country through which I have travelled. I have been ſo fortunate as to make aſtronomical obſervations in fifty-four places. I obſerved at Caraccas, Cumana, and Tuy, twelve eclipſes of the ſatellites of Jupiter; an eclipſe of the ſun on the 28th of October 1799. By theſe means, and the chronometer, I flatter myſelf I ſhall be able to give a very exact map. We ſhall embark here at length for the Havannah, from which we ſhall proceed to Mexico.—Such is the ſummary of my travels. I know that you, Chaptal, Vauquelin, Guyton, are all intereſted in my fate; and for that reaſon I am not afraid of tiring you.

We have ſcarcely any communication here with Europe. I have often attempted to write to you, as well as to our friends Vauquelin and Chaptal. I have ſent you ſome experiments on air, and the cauſe of miaſmata. I have ſent to Delambre and Lalande, extracts from my ſmall aſtronomical obſervations. Have any of theſe reached the place of their deſtination? By the conſul of the republic at Saint Thomas I tranſmitted to you the milk of a tree which the Indians call the *cow*, becauſe they drink this milky juice, which is not at all prejudicial, but exceedingly nourishing. By the help of the nitric acid I have made caoutchouc, and I mixed soda with that destined for you, according to the principles which you yourself fixed.

In the month of January last we sent, by the corvette Philippina, a collection of seeds for the *Jardins des Plantes* at Paris. We know they have arrived, and must have been delivered to citizens Jussieu and Thouin by the ambassador of the republic at Madrid. By the flag of truce, which we expect here from Guadaloupe, the musæum will receive other articles; for at present we must be satisfied with presenting you a few objects for your chemical analysis.

I have procured for you the *curare*, or celebrated poison of the Indians on the Rio-Nigro. I undertook a journey to Enneralda on purpose to see the liane, which produces this juice, but unfortunately we found it without flowers; and to see the method practised by the Catarapeni and Maquiritares Indians for making this poison. I shall give you, some other time, a more ample description of it. I shall only add, that I send you the *curare* in a box of tin plate*, and the branches of the plant *maracury*, which produces the poison. This liane grows, but not in great abundance, among the granitic mountains of Guandia and Yumariquin, under the shade of the theobromacacao and the caryocar. The Indians take off the epidermis and make an infusion of it cold, having first expressed the juice; they then leave the water over the epidermis half expressed, and afterwards filter the infusion. The filtered liquor is yellowish: it is then baked, and concentrated by evaporation and inspissation to the consistence of molasses. This matter contains already the poison, but not being sufficiently thick to daub over the points of their arrows, they mix it with the glutinous juice of another tree, which they call *kiracaguero*. This mixture is again baked till the whole is reduced to a brownish mass. You know that the *curare* is taken internally as a stomachic: it is not noxious but when it comes into contact with the blood, which it deoxydates. It is only a few days ago that I began to make experiments upon it; and I have found that it decomposes atmospheric air. I beg you will try to de-oxydate with it the metallic oxyds, and that you will examine whether the experiments of Fontana were properly made.

I add to the *curare* and the *maracury*, the *dapitche*, the *leche de pindare*, and the earth of the Otomaquas. The *dapitche* is a state of the elastic gum, which, is, no doubt, un-

* This box, and the other articles announced here, have not yet reached C. Fourcroy.

known

known to you. We discovered it in a place where there is no hevea, in the marshes of the mountain of Javita, lat. 2 5′, which are famous on account of the terrible serpents, of the boa kind, found in them.

Among the Pormisano and Paragini Indians we saw musical instruments made of the caoutchouc, and the inhabitants told us they found it in the earth. The *dapitche* or *zapir* is really a spongy white mass found under the roots of two trees, which appeared to us of a new genus, the *jacio* and the *curvana*, and of which we shall one day give a description. The juice of these trees is a very aqueous milk, but it appears that it is a malady in these trees to lose the juice by the roots. This discharge causes the tree to perish, and the milk coagulates in the moist earth, where it is preserved from the contact of the air. I send you the *dapitche* itself, and a mass of caoutchouc made from it, merely by exposing it to heat or dissolving it over the fire. This production, and the milk of the *cow*, in your hands, will serve to throw new light on this substance, so curious in a physiological point of view.

The *leche de pindare*, which is the dried milk of a pindar-tree, is a natural white varnish. The Indians cover their vessels and *tacuma* with this milk when it is fresh. It dries speedily, and forms a very beautiful varnish; but, unfortunately, it becomes yellow when dried in a large mass; and it is in this state that I send it to you.

In regard to the earth of the Otomaquas, I must observe that this nation, so hideous by the paintings which disfigure their bodies, when the Orenoquo is very high, and they can find no tortoises, for three months eat scarcely any thing but a kind of fat earth. There are some of them who eat a pound and a half of it per day. Some of the monks assert that they mix with it the fat of the tails of crocodiles: but this is false. We found among the Otomaquas stores of the pure earth which they eat: they give it no other preparation than that of burning it slightly, and rendering it moist. It appears to me astonishing that people can be robust and eat a pound and a half of earth daily, while we find that earth produces a very pernicious effect among children. My own experiments on earths and their properties, however, give me reason to suspect that they may be nourishing; that is to say, that they may act by affinities.

I add for the musæum, because it has fallen into my hands, the smoking instrument of the Otomaquas, and a shirt of the Piroas, a neighbouring nation. This smoking instrument is none of the smallest, as you will see. It is a kind of plate, on which they place the raſped and rotten fruit of a mimoſa, mixed with ſalt and a little quick-lime. The Otomaqua holds the plate in one hand and in the other the tube, the two ends of which enter his noſtrils, that he may inhale this ſtimulating tobacco. This inſtrument has a hiſtorical intereſt: it is common only to the Otomaquas and the Omeguas, two nations who at preſent are 300 leagues diſtant from each other, among whom Condamine ſaw it. It proves that the Omeguas, who, according to an old tradition, came from Guaviara, may be deſcended from the Otomaquas, and that the city of Manoa was ſeen by Phillip de Vure between Meta and Guaviara. Theſe facts are intereſting in regard to the origin of the fable of the *Dorado*.

The ſhirt, which one of my people wore for a long time, is the bark of the tree called *morima*, without any preparation. You ſee that ſhirts grow upon trees in this country, and near the Dorado, where I found no mineral curioſities but talc and a little titanium.

It has been impoſſible for us to arrange the ſeeds and plants of the Rio-Nigro deſtined for Thouin, Juſſieu, and Desfontaines, who will not altogether have forgotten me. We have very uncommon things; for example, new kinds of *beſaria*, new genera of palms; all which we ſhall ſoon diſpatch, and be aſſured that we ſhall not loſe ſight of the intereſts of the muſæum. But alas! captain Baudin has ſet out, and we are here! This is very hard and diſtreſſing. We ſhall perhaps find him in the South Sea.

I beg you will remember me to the reſpectable members of the National Inſtitute: my reſpects to Berthollet, Chaptal, Vauquelin, Guyton, Juſſieu, Desfontaines, Halley, Delambre, Laplace, Cuvier. In the letter which I ſend to Delambre I forgot an eclipſe, which I beg you will add to it.

Immerſion of the 3d ſatellite on the 4th of October 1800, at Cumana, at 16 h. 59′ 36″ mean time.

P.S. Repeat, I beg of you, my requeſt to the Board of Longitude for the *Connoiſſances des Tems*. I regret the death of general Deſaix. What a loſs to the republic and all mankind!

II. *A Treatise on the Cultivation of the Vine, and the Method of making Wines.*

[Continued from Vol. IX. p. 342.]

III. *General Precepts respecting the Art of managing Fermentation.*

WHEN the grapes have acquired the proper degree of maturity, if the atmosphere be not too cold, and if the vintage be of the proper volume, fermentation has no need of aid or assistance. But these conditions, without which it is impossible to have a good result, are not always united, and it belongs to art, in order to obtain a good fermentation, to combine all these favourable circumstances, and to remove every thing prejudicial.

The faults of fermentation arise naturally from the quality of the grapes, which is the subject of it; and from the temperature of the air, which may be considered as a very powerful auxiliary.

Grapes may not contain a sufficiency of sugar to produce a sufficient formation of alcohol: and this vice may be owing to the grapes not having attained to maturity, or to the sugar being diluted in too considerable a quantity of water; or because sugar, by the nature of the climate, cannot sufficiently develop itself. In all cases there are two ways of correcting the vice which exists in the nature of the grapes; the first consists in conveying into the must that principle which it wants: a proper addition of sugar presents to fermentation the materials necessary for the formation of alcohol, and the deficiency of nature is supplied by art. The antients, it appears, were acquainted with this process, since they mixed honey with the must which they caused to ferment. At present, direct experiments have been made on this subject; but I shall confine myself to transcribe here the results of those made by Macquer.

"In the month of October 1776 I procured from a garden at Paris a quantity of the white grapes called *pineau* and *mélier* sufficient to make from twenty-five to thirty quarts of wine. They were waste grapes, and taken, purposely, in a bad state of maturity, that there might be no hopes of making potable wine from them: in nearly about a half of them, single grapes and even whole clusters were so green that their acidity was insupportable. Without taking any other precaution than to separate what were putrid, I caused the rest to be bruised with the stalks, and the juice to be expressed

expreſſed with the hand: the muſt which iſſued from them was exceedingly turbid, of a dirty-green colour and of a ſweetiſh ſour taſte, in which the acid predominated ſo much that it cauſed thoſe who taſted it to make wry faces. I diſſolved in this muſt a ſufficient quantity of brown ſugar to give it the taſte of pretty good ſweet wine; and, without boiler, funnel, or furnace, I put it into a caſk in an apartment at the bottom of the garden, where it was left to itſelf. Fermentation took place in it on the third day, and maintained itſelf for eight days in a very ſenſible manner, but ſtill very moderate. After that time it ceaſed ſpontaneouſly.

"The wine thence reſulting being newly made, and ſtill turbid, had a pretty ſtrong and pungent vinous odour; its taſte was ſomewhat harſh; while that of the ſugar had diſappeared as completely as if it had never exiſted. I ſuffered it to remain in the caſk during the winter; and having examined it in the month of March, I found that, without having been drawn off or ſtrained, it had become clear; its taſte, though ſtill pretty ſtrong and pungent, was, however, much more agreeable than it had been immediately after the ſenſible fermentation; it had ſomething ſweeter and more racy, but was mixed with nothing that approached to ſugar. I then put the wine in bottles, and having examined it in the month of October 1777, I found it to be clear, fine, exceedingly brilliant, agreeable to the taſte, generous, and warm; in a word, like good white wine made from pure grapes which has nothing luſcious, the produce of a good vineyard in a good year. Several connoiſſeurs, whom I made to taſte it, gave it the ſame character, and could not believe that it had been made from green grapes, the taſte of which had been corrected with ſugar.

"This ſucceſs, which exceeded my hopes, induced me to make a new experiment of the ſame kind, and ſtill more deciſive, on account of the extreme greenneſs and the bad quality of the grapes which I employed.

"On the 6th of November 1777 I cauſed to be collected, from the top of an arbour in a garden at Paris, a kind of large grapes which never ripen properly in this climate, and which we know only under the name of *verjus*, becauſe they are uſed for no other purpoſe than to expreſs the juice before it becomes ſpoiled, that it may be employed as a kind of ſour ſeaſoning in cookery. Thoſe here alluded to had ſcarcely begun to rot though the ſeaſon was far advanced, and they had been abandoned on the arbour as leaving no hope of their acquiring ſufficient maturity to be fit for the table. They were ſtill ſo hard that I reſolved to make them burſt over the fire

fire in order to extract the juice: the quantity they furnished was about eight or nine quarts. This juice had a very acid taste, in which there could scarcely be distinguished a very slight saccharine savour. I dissolved some of the commonest cassonade until it appeared to me to be very saccharine. I required a great deal more than for the wine of the preceding experiment, because the acidity of the latter must was much stronger. After the sugar was dissolved, the taste of the liquor, though very saccharine, had nothing agreeable, because the sweet and the sour were perceived pretty strongly and separately in a disagreeable manner.

"I put this kind of must into a jar so as not to be entirely full, and covered it only with a cloth: as the season was already very cold, I placed it in an apartment where the heat was always maintained at 12 or 13 degrees (59 to 61 F.) by means of a stove.

"Four days after the fermentation was not yet very sensible, the liquor appeared to me to be as saccharine and as acid; but these two tastes beginning to be better combined, the result was a whole more agreeable to the taste.

"On the 14th of November the fermentation was in full force: a lighted taper introduced into the empty part of the jar, was speedily extinguished.

"On the 30th the sensible fermentation had entirely ceased, and the taper was no longer extinguished in the interior of the jar. The wine which resulted from it was, however, very turbid and whitish; its taste had scarcely any thing saccharine; it was strong, pungent, and pretty agreeable, like that of generous warm wine, but a little gaseous and green.

"I closed the jar and put it into a cool place, that the wine might bring itself to perfection by insensible fermentation during the whole winter.

"Having examined this wine on the 17th of March 1778, I found that it was almost entirely clear, the remains of its saccharine as well as its acid taste had disappeared. The latter was that of pretty strong wine made from pure grapes: it was not unpleasant, but had no perfume or *bouquet*, because the grapes, which we call *verjus*, contain no odorous principle or aroma: these excepted, this wine, which was quite new, and which still had to gain by that fermentation which I call *insensible*, promised to become racy and agreeable."

These experiments seem to me to prove, beyond all doubt, that the best method of remedying the want of maturity in grapes is to follow the process indicated by nature; that is to say, to introduce into the must that quantity of saccharine principle necessary which it could not give them. This method

thod is the more practicable, as not only ſugar, but alſo honey, molaſſes, and every other ſaccharine matter of an inferior price can produce the ſame effect, provided they have no diſagreeable acceſſary taſte which cannot be deſtroyed by good fermentation.

Bullion cauſed the juice of grapes, taken from his park at Bellegames, to ferment by adding from 15 to 20 pounds of ſugar per *muid**. The wine they produced was of a good quality.

Rozier, long ago, propoſed to facilitate the fermentation of muſt, and ameliorate wines by the addition of honey, in the proportion of a pound to two hundred of muſt. All theſe proceſſes depend on the ſame principle, viz. that no alcohol is produced where there is no ſugar; and that the formation of alcohol, and conſequently the generous nature of wine, is conſtantly proportioned to the quantity of ſugar exiſting in the muſt: it is thence evident that wine may be carried to any degree of ſpirituoſity required, whatever may be the primitive quality of the muſt, by adding to it more or leſs ſugar.

Rozier has proved, and the ſame reſult may be obtained by calculating the experiments of Bullion, that the value of the produce of the fermentation is very far ſuperior to the price of the matters employed; ſo that theſe proceſſes may be preſented as objects of œconomy and matter of ſpeculation.

It is poſſible alſo to correct the quality of the grapes by other means, which are daily practiſed. A portion of the muſt is boiled in a kettle; it is concentrated to one-half, and then poured into a vat: by this method the aqueous portion is in part diſſipated, and the portion of ſugar being then leſs diluted, the fermentation proceeds with more regularity, and the produce is more generous. This proceſs, almoſt always uſeful in the north, cannot be employed in the ſouth, but when the ſeaſon has been rainy or when the grapes have not been ſufficiently ripe.

The ſame end may be attained by drying the grapes in the ſun, or expoſing them for the ſame purpoſe in ſtoves, as is practiſed in ſome wine countries.

It is perhaps for the ſame reaſon, always with a view to abſorb the moiſture, that plaſter is ſometimes put into the vat, as was practiſed by the antients.

It ſometimes happens that the muſt is both too thick and too ſaccharine: in that caſe the fermentation is always ſlow and imperfect; the wines are ſweet, luſcious, and thick; and it is not till after remaining a long time in the bottles that

* 280 quarts.

it becomes clear, loses its disagreeable thickness, and only exhibits good qualities. The greater part of the white Spanish wines are in this situation. This quality of wine has however its partisans, and there are some countries where the must is concentrated for that purpose, in others the grapes are dried in the sun or in stoves till they are reduced almost to the consistence of an extract.

It would be easy in all cases to excite fermentation, either by diluting the must, when too thick, with water, or by agitating the vintage in proportion as it ferments: but all this must be subordinate to the end proposed to be obtained, and the intelligent agriculturist will vary his processes according to the effect which he intends to produce.

It must never be forgotten, that the fermentation ought to be managed according to the nature of the grapes and agreeably to the quality of the wine that may be required. Burgundy grapes cannot be treated like those of Languedoc. The merit of the one consists in a peculiar flavour, which would be dissipated by a strong and lengthened fermentation: that of the other in the great quantity of alcohol which may be developed in them; and here the fermentation in the vat must be long and complete. In Champagne, the grapes destined for the white brisk wines are collected in the morning before the sun has caused all the moisture to evaporate; and in the same country the grapes destined for making red wine are not cut until they have been well dried by the rays of the sun. In one place artificial heat is necessary to excite fermentation, in another the nature of the must is such that the fermentation would require to be moderated. Weak wines must be fermented in casks, strong wines ought to be suffered to work in the vat. Every country has processes prescribed to it by the nature of its grapes, and it is highly ridiculous to attempt submitting every thing to a general rule. It is of importance to be well acquainted with the nature of the grapes employed and with the principles of fermentation: by the help of this knowledge a system of conduct may be formed which cannot fail of being highly advantageous, because it is founded not on hypothesis but on the nature of things.

In cold countries, where the grapes are very aqueous and little saccharine, they ferment with difficulty: fermentation in that case may be excited by two or three principal means:

1st, By the help of a funnel of tin plate with a very wide tube, which descends to within four inches of the bottom of the vat, and through which boiling must is introduced into it. Two pailfuls may be used for 300 bottles of must. This process, proposed by Maupin, has produced good effects.

 2d, By

2d, By shaking the vintage from time to time: this motion is attended with this advantage, that it renews the fermentation when it has ceased or become weak, and causes it to be uniform throughout the mass.

3d, By laying a covering not only over the vintage, but round about the vat.

4th, By heating the atmosphere of the place in which the vat stands.

It often happens that the working of the vintage slackens, or that the heat is unequal through the mass: it is to obviate these inconveniences, especially in cold countries, where they are more frequent, that the vintage is from time to time trod upon. Gentil made two vatfuls, of eighteen butts each, and with grapes from the same vines, and collected at the same time: the grapes were freed from the skins, stalks, &c. and bruised; the juice of both was perfectly equal in quality, and the vintage was put into vats of equal size: the weather, but particularly in the morning and at night, was exceedingly cold.

At the end of some days the fermentation began: it was observed that the centre of the vats was exceedingly warm and the edges very cold; the vats were so close as to touch each other, and both experienced the same temperature. They were pressed down with a long pole. The cold vintage was pushed from the edges towards the centre where the heat was strongest: it was pressed down several times, and by these means an equal heat was maintained throughout the whole mass. The fermentation in the vat where this process had been followed was finished twelve or fifteen hours sooner than in the other. The wine was far better, it was more delicate, had a superior taste, and was more highly coloured and more generous. No one would have said that it was produced from the same grapes.

The antients mixed aromatic substances with the vintage in a state of fermentation, in order to give their wines peculiar qualities. We are told by Pliny that it was usual in Italy to sprinkle pitch and resin over the vintage *ut odor vini contingeret et saporis acumen*. In all the works of that period we find numerous recipes for perfuming wines; but these different processes are no longer used. I am, however, inclined to think that they were of great benefit. This very important part of oinology deserves the particular attention of the agriculturist. When we consider the custom followed in some countries of perfuming the wines with raspberries, the dried flowers of the vine, &c. we may even presage the happiest effects from it.

Darcet

Darcet has communicated to me the following facts, which I take the earliest opportunity of publishing here, as they may give rise to experiments proper for improving the art of vinification.

"I took," says he, "a cask called half a *muid*, which I filled with the juice of untrod grapes, and such as had run of itself from the grapes as carried from the vineyard to the press: it therefore had very little colour.

"This cask contained about 150 quarts. I took about thirty quarts, which I evaporated and concentrated to nearly about one-eighth of the volume of the liquor; four pounds of common sugar were added, and a pound of grapes *de careme*, after care had been taken to bruise them: the whole, somewhat warm, was then put into the cask, which was filled up with the same must that had been kept apart. A bunch, of about half an ounce, of absinthium, dried and well preserved, was then put into the cask, and the cask was slightly covered, with its lid inverted: fermentation soon took place, and proceeded in a brisk and free manner.

"Besides this piece of must, I caused to ferment also a jar of the same containing about twenty-five or thirty quarts, with half an ounce of sugar per quart: this wine fermented very well in this jar, and it served me for filling up during the fermentation and after the first drawing off, which was performed at the usual time, and repeated a year after: it was afterwards put into bottles at the expiration of a year, or in the following winter.

"This wine was made in September 1788, during fine weather, and in a very good year.

"It kept very well even in the bottle, it neither became sour nor turbid at the end of several days; I have still two or three bottles of it: it begins to fade."

IV. Ethiology of Fermentation.

The phænomena and results of fermentation are so highly interesting in the eyes of the chemist and the agriculturist, that, after having considered them merely under a practical point of view, we must now consider them under the relation of science.

The two phænomena which seem most worthy of attention from the chemist, are the disappearance of the saccharine principle and the formation of alcohol.

As in fermentation there is no absorption of air, nor addition of any foreign matter, it is evident that all changes which take place in the operation can be referred only to the departure of thofe fubftances which are volatilifed or precipitated.

Thus, by ftudying the nature of thefe fubftances, and afcertaining their conftituent principles, it will be eafy for us to judge of the changes which muft have been produced in the nature of the firft materials of fermentation.

The materials of fermentation are the fweet and faccharine principle diluted in water. This principle is formed of fugar and extractive matter.

The fubftance volatilifed is the carbonic acid gas, and that precipitated is a matter analogous to the ligneous fibre mixed with potafh.

The principal product of fermentation is alcohol.

It is evident that the tranfition of the faccharine principle to alcohol cannot be conceived but by calculating the difference which muft be produced in the faccharine principle by the departure of the principles that form carbonic acid gas which is volatilifed, and the depofit which is precipitated.

Thefe principles are, in particular, the carbon and the oxygen: here, then, we find carbon and oxygen taken from the faccharine principle by the progrefs of fermentation; but in proportion as the faccharine principle lofes its oxygen and its carbon, the hydrogen, which forms the third conftituent principle, remaining the fame, the characters of the latter element muft predominate, and the fermenting mafs muft attain to that point at which it will only prefent an inflammable fluid.

In proportion as the alcohol is developed, the liquid changes its nature; it no longer has the fame affinities, nor, confequently, the fame diffolving power. The fmall quantity of extractive principle which remains after having efcaped decompofition is precipitated with the carbonat of potafh; the liquor becomes clear, and the wine is made.

Vinous fermentation, then, is nothing but the continued departure of carbon and oxygen, which produces on one hand the carbonic acid, and on the other alcohol. The celebrated Lavoifier fubjected to calculation all the phænomena and refults of vinous fermentation, comparing the products of the decompofition with its elements. He affumed as the bafis of his calculations the data furnifhed to him by analyfis both in regard to the nature and the proportions of the conftituent principles before and after the operation. We fhall here tranfcribe the refults obtained by this great man.

Materials

Materials of Fermentation for a Quintal of Sugar.

		lib.	oz.	dr.	gr.
Water		400	0	0	0
Sugar		100	0	0	0
Yeaſt of beer in paſte compoſed of	Water	7	3	6	44
	Dry yeaſt	2	12	1	28
	Total	510	0	0	0

Detail of the conſtituent Principles of the Materials of Fermentation.

lib.	oz.	dr.	gr.		lib.	oz.	dr.	gr.
407	3	6	44	Of water compoſed of				
				Hydrogen	61	1	2	71·40
				Oxygen	346	2	3	44·60
100	0	0	0	Sugar compoſed of				
				Hydrogen	8	0	0	0
				Oxygen	64	0	0	0
				Carbon	28	0	0	0
2	12	1	28	Dry yeaſt compoſed of				
				Carbon	0	12	4	59·00
				Azot	0	0	5	2·94
				Hydrogen	0	4	5	9·30
				Oxygen	1	10	2	28·76
				Total	510	0	0	0

Recapitulation of the conſtituent Principles of the Materials of Fermentation.

		lib.	oz.	dr.	gr.	lib.	oz.	dr.	gr.
Oxyg.	Of the water	340	0	0	0	411	12	6	1·36
	Of the water of the yeaſt	6	2	3	44·60				
	Of the ſugar	64	0	0	0				
	Of the dry yeaſt	1	10	2	28·76				
Hydr.	Of the water	60	0	0	0	9	6	0	8·70
	Of the water of the yeaſt	1	1	2	71·40				
	Of the ſugar	8	0	0	0				
	Of the yeaſt	0	4	5	930				
Carb.	Of the ſugar	28	0	0	0	28	12	4	59·00
	Of the yeaſt	0	12	4	59·10				
Azot of the yeaſt						0	0	5	2·94
					Total	510	0	0	0

Table of the Results obtained by Fermentation.

lib. oz. dr. gr.	Substance	Component	lib.	oz.	dr.	gr.
35 5 4 19	Of carbonic acid, composed of	Oxygen	25	7	1	34
		Carbon	9	14	2	57
408 15 5 14	Of water, composed of	Oxygen	347	10	0	59
		Hydrogen	61	5	4	27
57 11 1 58	Of dry alcohol, composed of	Oxygen combined with hydrogen	31	6	1	64
		Hydrogen combined with hydrogen	5	8	5	3
		Hydrogen combined with carbon	4	0	5	0
		Carbon	16	11	5	63
2 8 0 0	Of dry acetous acid, composed of	Hydrogen	0	2	4	0
		Oxygen	1	11	4	0
		Carbon	0	10	0	0
4 1 4 3	Of saccharine residuum, composed of	Hydrogen	0	5	1	67
		Oxygen	2	9	7	27
		Carbon	1	2	2	53
1 6 0 50	Of dry yeast, composed of	Hydrogen	0	2	2	41
		Oxygen	0	13	1	14
		Carbon	0	6	2	30
		Azot	0	0	2	37
510 0 0 0			510	0	0	0

Recapitulation of the Results obtained by Fermentation.

lib. oz. dr. gr.	Element	Source	lib.	oz.	dr.	gr.
409 10 0 54	Oxygen	Of the water	347	10	0	59
		Of the carbonic acid	25	7	1	34
		Of the alcohol	31	6	1	64
		Of the acetous acid	1	11	4	0
		Of the saccharine residuum	2	9	7	27
		Of the yeast	0	13	1	14
28 12 5 59	Carbon	Of the carbonic acid	9	14	2	57
		Of the alcohol	16	11	5	63
		Of the acetous acid	0	10	0	0
		Of the saccharine residuum	1	2	2	53
		Of the yeast	0	6	2	30
438 6 6 41			438	6	6	41

lib.

	lib.	*oz.*	*dr.*	*gr.*		*lib.*	*oz.*	*dr.*	*gr.*
	438	6	6	41	Brought over	438	6	6	41
Hydrogen	71	8	6	66	Of the water - -	61	5	4	27
					Of the water of the alcohol	5	8	5	3
					Combined with the carbon in the alcohol -	4	0	5	0
					Of the acetous acid -	0	2	4	0
					Of the saccharine residuum	0	5	1	67
					Of the yeast - -	0	2	2	41
Of Azot	0	0	2	37	- - - -	0	0	2	37
	510	0	0	0		510	0	0	0

By reflecting on the results exhibited by these tables, we may clearly see what takes place in the vinous fermentation: it is first observed that, of the 100 pounds of sugar employed, 4 lib. 1 oz. 4 dr. 3 gr. remained in the state of undecomposed sugar; so that the quantity of sugar really subjected to operation was only 95 lib. 14 oz. 3 dr. 69 gr.; that is to say, 61 lib. 6 oz. 45 gr. of oxygen, 7 lib. 10 oz. 6 dr. 6 gr. of hydrogen, and 26 lib. 13 oz. 5 dr. 19 gr. of carbon. But by comparing the quantities it will be found that they are sufficient to form all the spirit of wine, all the carbonic acid, and all the acetous acid, produced by the fermentation.

The effects of vinous fermentation are reduced, then, to the separating into two portions the sugar, which is an oxyd; oxygenating the one at the expense of the other to form carbonic acid; deoxygenating the other in favour of the former to produce a combustible substance, which is alcohol; so that, if it were possible to combine these two substances, the alcohol and carbonic acid, sugar would be re-formed. It is to be observed also, that the hydrogen and carbon are not in the state of oil in the alcohol; they are combined with a portion of oxygen, which renders them miscible with water: the three principles, oxygen, hydrogen, and carbon, are here, then, still in a kind of state of equilibrium; and, indeed, by making them pass through an ignited glass or porcelain tube, they may be re-combined two and two, and water and hydrogen, carbonic acid and carbon, are again found.

[To be continued.]

III. *Luminous Appearance of Ocean-Water caused by Animals: in a Letter from Professor* MITCHILL, *of New-York, to Professor* BARTON, *of Philadelphia* *.

SO obvious an appearance as the phosphorescence of ocean-water was ascribed to animals as long ago as the time of Pliny. Some of these adhering to the rigging of vessels in windy and stormy weather, and shining in the dark, seem to have caused the appearances known formerly by the names of Castor and Pollux. Much has been offered on this subject, both physically and historically, you know, by Charles Frederic Adler, in his *Dissertatio de Noctiluca Marina*, which is well worthy of perusal. He has given a magnified figure of a microscopic worm, which, in the sea of China, makes the salt water luminous. It is called by some French writers *scolopendre marine luisante*, and by Linné *nereis noctiluca*. Some of the sea-jellies and sea-blubbers have also been long known to be occasionally luminous. The principal part of these are *medusas*, which, at a very early day, obtruded themselves on the attention of naturalists. But, notwithstanding all this, the philosophical world seems still to be a good deal undecided as to the real cause of the phosphorescence of the ocean. I have therefore recorded the following facts, which fell under my own eye, hoping they may not be without their use in explaining the phænomenon. Pennant, in his British Zoology, vol. iv. expresses very just ideas on the subject.

On the evening of Saturday, the 13th of September 1800, about high water, as we were preparing, between seven and eight o'clock, to bathe in the bay, my attention was called to a remarkable luminous appearance at the water's edge on the beach. The wind was from the southward, and the day had been so warm, that about two P. M. the quicksilver in a thermometer hanging in a shaded piazza, on the south side of the house, had risen to 89 degrees. At this moment it stood as high as 76. The distance from the chamber windows to high water mark is 210 feet. It seemed as if the beach was covered with coals of fire, and that bright sparkles were constantly emitted among them: The small undulation which moved to land looked like a wave of flame rolling along the shore; and the water beyond, to the distance of a few rods, exhibited frequent corruscations of extraordinary brightness. On going down to the water, I found the sand covered with mollusca animals, the greater part of which were the *medusa simplex*. Thousands of them had just been

* Communicated to the Editor by the Author.

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left by the receding tide, and were yet alive. Being incapable of living long out of the water, and unable to ſurvive until the next flood, they ſeemed to be under the influence of their laſt vital movements. They lay ſo thick under foot, that at every tread many of them were cruſhed to pieces. Beſides their ſpontaneous power to become luminous, whenever they were moved they emitted light; and this happened indifferently, whether their gelatinous bodies were agitated through the medium of air, water, or the direct contact of the feet or fingers. On walking among them, and thereby exciting their luminous action, the beach reſembled melted metal in a red-hot ſtate; or the phænomenon might be compared to a radiant glory ſurrounding the feet, to the diſtance of a foot and a half, or more, at every tread. In ſeveral inſtances, the light emitted by a ſingle one, when taken, in its freſh and vivid ſtate, into my hand, was ſufficient to enable me to determine the time of night by my watch, the minute and hour hands being plainly to be ſeen: but this brightneſs was but tranſient. Frequently the creature emitted not a particle of light; and then, on a ſudden, the luminous appearance would be conſpicuous, and as quickly diſappear. The ſucceſſion of theſe lucid emanations, from the creatures lying in ſuch numbers upon the wet ſand, reſembled, if ſmall things may be compared with great, the unſteady light of the fixed ſtars; and, indeed, the twinkling of theſe phoſphoreſcent animals below, and of the celeſtial bodies above, afforded a ſpectacle ſo ſingular and ſo ſplendid, that I ſpent good part of the evening in admiring it. I remarked, alſo, that the ſand on which theſe animals were left by the tide was luminous; and found, on cruſhing them to pieces in my hand, that a faint phoſphoreſcence was imparted both to the ſand and to my ſkin: but in neither caſe did it laſt long.

But what was as ſingular as any part of the phænomenon, was the effect produced by them upon our bodies and clothes while we were bathing. Whenever the water near one of them was agitated, a large fire-ball ſeemed to burſt upon the view beneath the water; and whenever this happened in contact with one of the limbs, cauſed ſome of us inſtantaneouſly almoſt to ſtart, for fear of being burned. Where any of the ſlimy matter was left, ſomewhat of a luminous appearance was perceptible on our clothes, giving them and our ſkins ſometimes the appearance of phoſphoric ſpots, and ſometimes the more extraordinary ſemblance of being painted over with liquid fire. There were more than one ſpecies of animal; for beſides thoſe which, by their magnitude, were very plain ſubjects for examination, there were ſome luminous ſpots as ſmall as points, and as minute as the eye could diſcern. Theſe adhered to our clothes and ſkins, and, when taken up with the water in veſſels of glaſs, were too ſmall or too pellucid to be diſtinguiſhed by the naked eye, though they contributed eminently towards the effect of this ſubmarine illumination. This, I preſume, was the *nereis noctiluca*, an inteſtinal animal. I ſucceeded in diſcovering another ſpecies, which was a ſlender worm of about a quarter of an inch long, and emitted, at times, a bright light of a greeniſh hue. This was probably a larger ſpecies of nereis.

Not being well acquainted with the nature of thoſe molluſca-beings, I apprehended ſome inconvenience from ſuch a maſs of animal matter left on the ſhore to putrefy ſo near the houſe. But my cauſe of alarm vaniſhed before the next riſing ſun: for, during the receſs of the tide, they all periſhed; though, inſtead of remaining a great maſs of dead gelatinous creatures on the beach, this whole collection of living animals, whoſe vivid exhibitions of light evinced their being alive near midnight, had ſo totally diſappeared before four o'clock, that no other trace of their having been there could be diſcerned, than ſome phoſphoreſcence in the ſand, on being ſtirred up by the foot or taken up in the hand. They had loſt their organiſation, and, in ſo ſhort a time, diſſolved into a kind of ſlime, which penetrated the ſand, and was mingled with the water of the next flood. On examining the ſpots at ſix o'clock next morning, before the beach was covered by the tide, not a veſtige of one of this numerous ſhoal of animals was diſcoverable by day-light. A ſpectator of the morning ſcene could not have known, by any thing diſcernible, that ſuch a brilliant exhibition had been made there the preceding evening, or that a ſingle animal had been caſt aſhore on the ſpot.

I put ſeveral of the larger ſpecies of theſe creatures into glaſſes of their native ſalt water, and carried them into my chamber. During the night I made repeated obſervations upon them, and found that the light they afforded was neither perpetual nor extended to their whole bodies. It was intermitting, and confined to certain lines paſſing from one extremity of the creature to another. The light was of a blueiſh colour, and the ſtreams of it were highly beautiful. Theſe animals lived all night in the water, and were as lively as ever in the morning. They were almoſt tranſparent, and nearly of the colour of the fluid in which they were ſuſpended; yet, on placing them in a good light, they were found ſufficiently opaque to be diſtinctly examined. Their figure was globoſe, or rather elliptical, ſhaped like a walnut. The largeſt were about an inch and a half in length, and the leaſt as ſmall as the eye could diſcern. Their ſtructure was too delicate to allow them to be examined in any other manner than in their floating ſtate. They were about of the ſame weight with ſea water. At their option they could readily aſcend and deſcend in it. And as they have no air-veſſels like fiſhes, they accompliſhed their riſe and fall by a mere change of their ſpecific gravity; contracting themſelves into a ſmaller volume if they wiſhed to ſink, and expanding themſelves to a wider bulk if they intended to ſwim. Before ten o'clock next morning ſeveral of them were evidently dying, and before forty-eight hours had elapſed all of them were dead, and ſo entirely diſorganiſed that not a film or membrane was left; but the water, which was a little turbid, had a ſmall mud-like ſediment, and ſmelled ſtrong of phoſphorated hydrogenous gas.

The nearneſs of their approach to pellucidity diſplayed their internal ſtructure to the eye without the trouble of anatomiſing. They might be looked through without the aid of a diſſecting inſtrument; and their blood, though not red, but nearly of the pale colour of their bodies, reflected light enough in the day-time to enable it to be ſeen in motion, briſkly circulating through the arterious and venous tubes. This view of the circulation of the blood through the whole œconomy of a healthy animal, was one of the moſt intereſting appearances in animated phyſiology that I ever had beheld. This creature, like the echinus, and many more, had no heart, but the veſſels were endowed with muſcular power enough to propel their fluids without the aid of ſuch an organ. The pulſations of the arteries could be eaſily counted, and the little waves of the circulating fluid diſtinguiſhed as they paſſed from the larger extremity, where the motion was moſt evident, to the ſmaller, where it was more evaneſcent, and terminated in correſponding veins. In theſe animals the circulation not only proceeds, as in other creatures, one while ſwiftly, and at another ſlowly, but, at times, is totally intermitted or ſuſpended, and this, ſeemingly, *ad arbitrium.* Eight large arteries received the pale blood from a common trunk, and conveyed it from one extremity toward the other. They were about equi-diſtant, and gave the animal a ſomewhat ſtriped appearance, ſuch as a ſlight intermixture of arſenic imparts to glaſs. The termination of theſe arteries in continuous veins was very plain to be ſeen, until their ramifications upon the parts which appeared to be nutritive viſcera became too minute for ſight, after which the inviſible tubes ſeemed to connect their branches into a common canal, or vena cava, whence the eight arteries before mentioned derived their ſupply.

Such being the manner in which their juices circulated, it could now be underſtood in what part the luminous exhibition was made. I was ſoon ſatisfied it was in the arteries, and not in the veins; and the diaphanous conſiſtence of the animal permitted this light to be ſeen through its ſubſtance as plain as through cryſtal. The blood, after entering the arteries, and during its ſubjection to their action, became luminous, and paſſed through like ſtreams of ignited metal or electric emanations. And this vaſcular illumination, variouſly refracted in paſſing through the pellucid ſubſtance of the creature, through the water in which it floated, and through the atmoſphere to the eye, made the whole body, when ſeen at a diſtance, appear luminous. Theſe ſtreams of light, however, were not conſtant. They not only intermitted when the circulation of the blood was intermitted, and the action of the veſſels ſtopped; but very commonly, while the fluids were paſſing through their tubes with the utmoſt rapidity, there would be no phoſphoreſcence at all: then, again, one or more, and ſometimes all the arteries, would ſuddenly exhibit the lucid phænomenon, and the creature and the ſurrounding water flaſh with light. This luminous evolution was not confined to the nocturnal exiſtence of the animal; for, on attentively examining their functions by day, when the light was too faint to be ſeen, it could be eaſily diſtinguiſhed, by the colour of the fluid in the veſſels, that the ſame action was going on. It appeared of a blueiſh, or ſomewhat irideſcent hue, along the courſe of the arteries, though its feebler light, like that of a taper, was loſt amid the ſplendour of the ſolar rays. The ſame proceſs, however, is going on during the day-time, in theſe creatures, though unobſerved, that we behold in the dark.

One of theſe meduſas may be compared to a glaſs lanthorn, freely permitting the light produced within it to diffuſe itſelf to the ſurrounding ſpaces, while an external obſerver can thereby diſcern what is going on in the inſide. I am ſo entirely ſatisfied of the connection between this evolution of light and the circulation of arterious blood, that I want no clearer evidence to that point. It is probable that in an animal which is entirely deſtitute of lungs as well as of heart, the pulmonary function may be performed by the vital veſſels themſelves. In theſe creatures I believe this to be the fact.

The light, then, which theſe marine animals exhibit, may be concluded to be produced by a function in them analogous

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to the reſpiration of animals which are of larger ſize and more complicated ſtructure. The only reaſon why it is viſible from their bodies is, that the gelatinous matter of which they conſiſt is tranſparent. It is not improbable the ſame phænomena would be as obvious in the bodies of other creatures, and of even human beings, if the opacity of the materials of which we conſiſt did not hinder the light within us from ſhining ſo as to be ſeen.

The remarks hitherto made chiefly refer to the larger ſpecies of light-emitting creatures. The ſame apply, as far as I can judge, to all the ſmaller ſpecies. A veſſel of the water, containing no viſible animalcula, was carried, the ſame evening, to my chamber. When agitated from without, it ſparkled; and if ſtirred by the finger within, the number of ſhining ſpots increaſed. When left to reſt, lucid points were frequently to be ſeen arranging themſelves at the ſurface of the water, where it touched the inſide of the glaſs. Some of this water, that was poured upon the table, appeared full of ſhining points, like ſparks of fire. There was not a doubt in my mind, that theſe phænomena, like the others, were animalcular; yet, on viewing the water in the morning, it was as tranſparent as ſea water uſually is, and not a ſingle creature was to be diſcerned in it. The preſumption, therefore, is, that this form of marine light is alſo owing to animalcules, though too ſmall to be diſcerned by the eye unaſſiſted by optical glaſſes. I am ſomewhat doubtful whether the tranſparency of theſe minute light-emitting creatures would allow them to be diſtinguiſhed if I had had a microſcope with me.

Reaſoning in this manner, I became perſuaded that the luminous appearance of ocean water in other caſes, wherein no flaſh or ſparkle was diſtinctly to be ſeen, or traced to an individual point, but an indiſtinct glow alone appeared, as around the blades of ores, or near the bows and rudders of veſſels in motion, that the phænomenon was, in like manner, referable to animalcular action. And I terminated my ſpeculation by concluding, that the light emitted from millions of theſe viewleſs aquatic animals concurred to produce the general luminous appearance of the ocean in which they float, by the ſame rule that innumerable cluſters of fixed ſtars, as modern aſtronomers teach us, produce the luminous ſpots or milky hue of thoſe portions of the heavens where Omnipotence has placed them.

I have ſaid nothing about the manner in which the light is evolved in theſe animals. If it is by the decompoſition of oxygenous air that light is ſo freely emitted, what becomes of the caloric? for their bodies are not ſenſibly heated, nor warmer than the fluid in which they swim. Still it is not to be denied, that in the decomposition of that triple fluid there may be an evolution of caloric sufficient for the œconomy of creatures so small, and of a structure so nice and exquisite as these, and yet not be measurable by our thermometers; and that oxygen may mingle with their fluids in due quantity. And it may be easily conceived, that during the process light may be evolved, sufficient, in rapidity and quantity within them, to occasion, by transmission through their pellucid forms, the phænomena of these and all other luminous oceanic meteors.

The animalcular origin of this phænomena is corroborated by this additional consideration. At the time when the salt water is remarkably luminous in some places, there is very little of it to be seen in others, though but a few rods distant. At such times, I found that by taking up parcels of the water, and viewing it, there were abundance of lucid points in those which were most luminous, and but few in those which were feebly so. The light proceeding from these invisible *intestinas*, when nearly and narrowly examined, radiates from numberless shining particles or centres; and, when viewed from a distance too remote to permit these lucid centres to be seen, the effect produced on the organ of vision is a general and weaker impression, as if every drop of water was luminous, by reason of something chemically dissolved in it.

The same creatures are not capable of emitting light for a long continuance of time. If shaken, touched, or agitated, their luminous faculty soon becomes exhausted, and the water in which they float immediately returns to its ordinary colour. This is so much the case, that if a very luminous portion of water (I do not mean a current) be much moved by the limbs of several persons swimming or wading in it, its luminous quality will in a few minutes be sensibly diminished. Therefore, when a boat is rowed along, or a ship is moved by the wind, or when a stream rushes over rocks, or against any kind of obstacle, the light emitted in such instances is produced by a succession of animals, each of which, on being stimulated, evolves, in its turn, a certain proportion and duration of light, and in this manner gives continuance or permanency to the phænomenon.

In October 1772, Mr. Forster observed the southern ocean, beyond the Cape of Good Hope, illuminated in a similar manner. (Voyage round the World by Cook and Forster, vol. iii. p. 45.) The curious inquirer will be struck with the correspondence of the phænomena off Table-Bay, and those in Long-Island Sound. The circumnavigator ascribed the luminous

luminous appearance of the ſea water, in 34 degrees ſouth latitude, to animals of the ſame genus which cauſed it in 40° 40 north. He ſaw the ocean luminous in 58° ſouth, during March 1773, while the weather was tempeſtuous, and ſo cold that the quickſilver in the thermometer was as low as $33\frac{1}{4}$° at noon. Thus it appears theſe creatures can live in water of any temperature above the freezing point. (*Ib.* p. 97.)

An opinion has been entertained, that, during the ſhining of the ſun, its rays are abſorbed by the ocean, and that the extrication of them again makes its water luminous. It has been conjectured, too, that the water of the ocean becomes occaſionally ſo highly electrical, that the brightneſs it manifeſts is but the evidence of a high charge of electricity. There has been publiſhed, too, an idea that the phoſphoric matter extricated from putrefying fiſh in the ocean, was the cauſe of this marine reſplendence. And others have even been inclined to think that the light proceeded from ſome attrition of ſaline particles againſt each other, or ſome unknown combinations formed among them. The true cauſe of the phænomenon, I am inclined to conclude, is neither of theſe, but univerſally, as far as my knowledge of the ſubject extends, is a function of animals. Theſe are often conſpicuous in tempeſts, when

> High o'er the poop the audacious ſeas aſpire,
> Uproll'd in hills of fluctuating fire. FALCONER.

And though the timid may be impreſſed with additional alarm at this appearance,

> Not ſo the man of philoſophic eye
> And inſpect ſage; the waving brightneſs he
> Curious ſurveys, inquiſitive to know
> The cauſes and materials, yet unfix'd,
> Of this appearance beautiful—— THOMSON.

It is remarkable how far theſe creatures, on ſome occaſions, are carried up our rivers. During the drought of the year 1796, when ſea crabs were plentifully caught in the Hudſon as high as Poughkeepſie (eighty miles from New-York), the water of the river was luminous in the neighbourhood of Pollepell's iſland, as I ſailed through the Highlands one dark night.

I forbear to trace the analogies between theſe aquatic animals and the numerous aërial ſpecies which emit light. Leaving theſe to your ſagacity and penetration, I have only to conclude by renewing the aſſurances of my reſpect.

SAMUEL L. MITCHILL.

Cedar-Grove, Oct. 1, 1800.

IV. *Researches on Alumine. Read Dec.* 18, 1800, *in the Society of Physics and Natural History at Geneva. By* THEODORE DE SAUSSURE.

On the Combination of Alumine with the Carbonic Acid.

I. ONE cannot help being astonished that, though most of the combinations of alumine with the acids are known, we have still but imperfect notions respecting the union of this earth with a substance so widely diffused as the carbonic acid. When desirous of repeating the experiments of M. Humboldt on the absorption of oxygen gas by simple earths, I was induced to consider alumine in its different states, and particularly in that in which most chemists consider it as a carbonat. On this subject I have made some observations, which may serve to throw new light on this combination.

Opinions of some Chemists respecting the Carbonats of Alumine.

II. Bergman, in a dissertation on the aërian acid, says*: "Fixed air attacks pure argil with difficulty, that is to say, the earth of alum dried and hardened; the precipitation of alum, however, by aërated alkali, proves that it may take up a small quantity when it is attenuated; for though the liquor, when well filtered, appears limpid, it is remarked that, when left a few days to the open air, and a heat capable of promoting the extrication of the fixed air, it becomes turbid, and insensibly deposits a little earth, which was held in solution by the volatile fluid. The argil of Cologne itself gives, in a strong heat, a quantity of fixed air which exceeds its volume several times. It is mixed with a little inflammable air, which rises at the commencement of the operation."

Bergman then gives the proportions of the carbonic acid in artificial carbonat of alumine, and finds, that 100 parts of aërian acid may unite with 30 of pure alumine.

III. Fourcroy, in his Elements of Chemistry, and his work entitled *Système des Connoissances Chimiques* †, admits also the combination of alumine with carbonic acid gas under the denomination of carbonat: 1st, According to the experiments of Bergman; 2d, According to his own. He observed that, if the precipitation of the sulphat of alumine by an alkaline carbonat be made cold, little or no effervescence is produced, because, in his opinion, a part of the carbonic

* French edition of his works, Vol. I.

† Vol. IV. p. 61.

acid gas which is separated from the alkali joins the precipitated alumine and the other part the liquor, which then holds in solution real carbonat of alumine, which may be obtained by volatilising the acid gas. He then says, that natural aluminous earths are very frequently found combined with carbonic acid, which may be separated by a stronger acid.

Gren announces *, that alumine has no affinity for carbonic acid. This author enters into no detail on this subject, and he seems to support his opinion on the effervescence produced during the decomposition of the sulphat of alumine by the alkaline carbonats.

C. Hassenfratz has since that time given the specific gravities of alumine and the carbonat of alumine. Several other authors have admitted, and still admit, aluminous carbonats, both artificial and natural.

IV. I shall now give the result of my researches on this combination. I dissolved sulphat of alumine, known under the name of Roman alum †, in water, and precipitated it from the liquor cold by a saturated solution of the carbonat of potash. Little or no effervescence was produced, as was observed by Fourcroy (III). This effect, however, does not take place but when the solution is diluted with a certain quantity of water. The alumine obtained by this operation, after having been washed several times while still moist, and dried at the temperature of the atmosphere, was equal in weight to the twenty-nine hundredths of the sulphat of alumine employed: it dissolved in nitric acid with a strong effervescence, and lost about seven hundredths of its weight of carbonic acid gas. The precipitation of the sulphat of alumine by the carbonat of soda exhibited results nearly similar. I shall here add, that

* Manuel de Chimie, § 449 and 516.

† For these experiments I made choice of a sulphat of alumine which contained but a very small quantity of the oxyd of iron, and I ascertained, by comparative experiments on alumine, as pure as it possibly could be, that this small dose of oxyd had no sensible influence on the results which I am about to give. The iron in the common sulphat of alumine is at its minimum of oxydation. None of it was precipitated by the alkaline prussiats till after the mixture had been exposed to the free air and the heat; and it may be easily proved that, if alumine extracted from alum was employed in the repetition of Humboldt's experiments, it was by the presence of the oxyd of iron that several chemists have been led into an error respecting the absorption of the oxygen gas of the atmosphere by an earth supposed to be pure, and which was not so. For alumine, purified by repeated solutions in potash, never, when moistened, exercised any other action on the oxygen gas of the atmosphere in the experiments I made on this subject. Common alum, sufficiently pure for the alumine extracted from it to give the same results in its purifications, may be often found.

that the quantity of the carbonic acid gas difengaged was not conftant in the different operations, and that it appeared to me to vary in the ratio of the concentration of the alkaline carbonats, and in particular of the fuperabundant quantity which I added of thefe carbonats to decompofe the fulphats. The precipitates in all thefe cafes were wafhed in fuch a manner as to avoid every error in this ratio.

V. A hundred parts of the fame fulphat of alumine, precipitated by carbonat of ammonia in excefs, furnifhed only 23 parts of alumine dried at the temperature of the atmofphere. The earth diffolved in acids with a difengagement of carbonic acid gas, but it loft in aërian acid only *one and a half per cent.* during the operation.

Berthollet, in his ingenious refearches on affinities, found that alumine precipitated by ammonia from potafhed fulphat of alumine ftill retained potafh and acid. To purify this earth, I diffolved it in muriatic acid, and precipitated it again by carbonat of ammonia. The 23 parts of alumine were, by this purification, reduced to 21 parts. They loft then one and a half *per cent.* of carbonic acid gas by their folution in the acids. They could not form octaëdral cryftals with fulphuric acid; and the imponderable quantity of muriatic acid which they retained could not produce any fenfible error. In the following experiments I fhall give the name of *pure alumine* to the earth obtained from alum fubjected to this double precipitation.

I divided the pure alumine into two parts, one of which was pulverifed, and the other left in its natural ftate of aggregation. They were expofed to the open air for eighteen months on a tablet in my laboratory, after which period the pulverifed alumine produced no effervefcence*. The alumine which had not been pulverifed, and which was placed in the fame circumftances, produced a very fenfible one. This phænomenon inclined me to think that the effervefcence of the alumine, which I believed to be in the ftate of carbonat, arofe from the carbonat of ammonia retained in the unpulverifed alumine, and which had been volatilifed in the other, all the parts of which prevented free accefs to the external air. I, indeed, found that potafh triturated with the effervefcent alumine, difengaged it from ammonia, and did not produce the fame effect on the fame earth when pulverifed.

* This fact is contrary to that announced by Fourcroy. (*Syftême des Connoiffances Chimiques*, tom. ii. p. 145.) He fays alumine gradually takes up the carbonic acid gas of the atmofphere. It would be of importance to know the details of th s obfervation, which, in my opinion, was never made but by the author here quoted.

VI. I precipitated by liquid ammonia a ſolution of pure alumine, and obtained, after the precipitate had been dried, a quantity of ſpongy alumine, equal in weight to that which I had obtained from the ſame quantity of a ſolution of alumine when I decompoſed it by carbonat of ammonia, and when I did not add an exceſs of precipitant. A hundred parts of potaſhed ſulphat of alumine, entirely decompoſed by ammonia or the carbonat of ammonia, furniſhed 21 parts of ſpongy alumine dried in a temperature of between 72 and 85 degrees of Fahrenheit's thermometer. Theſe 21 parts were reduced to 9, by deſiccation, in a violent fuſing heat. A hundred parts of the alum which I employed, contained, then, no more than about nine parts of pure dried alumine: a proportion very different from that which ſome authors have aſcribed to the compoſition of this ſalt.

VII. I diſſolved alumine to ſaturation in nitric acid diluted with water, and placed in this ſolution a rhomboidal cryſtal of carbonat of lime. A ſlow efferveſcence was produced, which even continued for ſeveral weeks. The alumine depoſited by this operation produced no efferveſcence with acids. On this occaſion it appeared to be doubtful whether calcareous earth alone be a medium proper for uniting alumine with carbonic acid; and, if I thought there was reaſon to aſcribe to this cauſe the great quantity of carbonic acid which I found in the dolomies, it was becauſe I was deceived by the extraordinary quantity of alumine contained in ſome ſpecimens which I analyſed. Mr. Tennant had more reaſon to aſcribe the properties of the dolomies to the triple combination of the carbonic acid with the calcareous earth and the magneſia, which the dolomies always contain in a large quantity, while the pureſt contain only an infinitely ſmall quantity of alumine. It appears that the dolomie is to the *bitter-ſpath* of the Germans what marble is to calcareous ſpar.

I ſubjected to diſtillation alumine precipitated from its ſulphat by carbonat of ammonia, and dried at the temperature of the atmoſphere. I obtained from this operation, after a long and ſtrong incandeſcence, only water, but no carbonic acid gas.

VIII. I thought I ſhould be able to explain the experiment of Fourcroy, which proves the pure and ſimple combination of alumine with carbonic acid, becauſe it is not diſengaged with efferveſcence during the decompoſition of aluminous ſolutions by alkaline carbonats, by aſcribing its reſult, in part, to the triple and concrete formation of an aluminous combination of carbonic acid and alkali; but I abandoned that opinion by obſerving that, when a ſolution of alumine is decompoſed

composed only in part by carbonat of soda and potash, an alumine is obtained, which makes no sensible effervescence with acids, though there was no effervescence during its precipitation. I then thought that the water of the solution, which must be a little diluted to produce no effervescence, might be alone sufficient to retain the carbonic acid. But this quantity of water, compared with the volume of the carbonic acid which ought to result from the decomposition of the alkaline carbonat, could retain by its own affinity for the carbonic acid only a very small part of that which remained in the solution. May we not here suppose, agreeably to the ideas of Berthollet respecting affinities, that the alumine precipitated contributes by its mass, conjointly with the acidiferous solution and the alkali, to retain the carbonic acid? We shall find hereafter that the carbonated water dissolves alumine. But this solution, when filtered, seems also to abandon its carbonic acid in the open air as easily as pure carbonated water.

IX. I have already mentioned (II.) what Bergman states, that when a solution of alumine is precipitated by alkaline carbonats, there is formed in the liquor, when it has been exposed several days to the free air and heat, an earthy deposit, arising from the expulsion of the carbonic acid which held it in solution. I repeated this experiment with all the alkalies saturated with carbonic acid, but I never could observe any precipitation posterior to that of the alumine by the alkaline carbonat; and I think it probable that the result Bergman obtained was because his alumine was not pure, or because his alkalies, being imperfectly saturated with carbonic acid, had dissolved a small quantity of earth. Besides, the precipitate I ought to have obtained would have been a combination of alumine and alkaline carbonat.

Being desirous to ascertain, by a more direct experiment than the preceding, if carbonated water was capable of dissolving alumine, I put into two-necked bottles pure alumine recently precipitated by carbonat of ammonia, and still moist. I diluted it with a great quantity of distilled water: I caused to circulate for eight hours, into this mixture, a current of carbonic acid gas. This water, when filtered, was subjected to ebullition: it immediately became turbid and deposited alumine, which potash was able to dissolve. The carbonated water of alumine became turbid also on being mixed with some drops of ammonia; and, at last, by the mere agitation of the corked bottle, in which it was, when only half full.

I collected two or three grains of the alumine, precipitated from the carbonated water by means of its exposure to the air: it it produced no effervescence by dissolving in acids, even when I made the proof, before it was completely dried at the temperature of the atmosphere. The case is the same with the alumine deposited at the bottom of bottles in which the carbonic acid gas had circulated.

X. Bergman, then, had reason to announce that alumine, carbonic acid, and water, can enter into combination, though the experiments on which he founded his assertion do not appear to me proper for proving it; but he ought not to have admitted, that alumine with carbonic acid formed a concrete carbonate.

On the other hand, Gren had some reason for saying that alumine, precipitated from its solutions by alkaline carbonates, did not present itself in the form of carbonate of alumine. But he ought not to have inferred that alumine has no affinity for carbonic acid, since we have seen that carbonated water dissolves that earth. Under these two points of view, both these chemists seem to have been deceived, though with opposite sentiments, as too often happens when a particular truth is given out as a general truth.

Of Native Carbonates of Alumine.

XI. Hitherto I have examined only those aluminous carbonates considered as the production of art. It now remains for me to speak of those which are considered as natural. I shall not examine whether the carbonic acid forms compound or ternary combinations with alumine and another earth or a metallic oxide. There is no need to say, that because these combinations exist, we ought to conclude that the carbonic acid forms with alumine a concrete carbonate. Bergman infers that the latter compound exists in nature, because the argil of Cologne, exposed to a strong heat, gave him several times its volume of carbonic acid gas. If we put out of consideration the ternary or quaternary combinations in which the argil of Cologne may be found, since it contains the half or the fourth of its weight of substances foreign to alumine, the conclusion of Bergman would be just, if it were certain that its earth contained no vegetable or animal matter. But as the greater part of the argils found at the surface of the earth contain some, and as they detonate slightly with nitre, little credit can be given to the observation of Bergman; especially as he adds, that the carbonic acid gas he obtained was mixed with hydrogen gas, which seems to announce here the decomposition of some vegetable or animal matter, or of water present with carbon in this argil *.

* See Home's Principles of Agriculture and Vegetation.

There is another earth of the fame kind, but much freer from foreign principles. It is denoted in moft authors under the name of the pure argil of Hales (*reine thonefde de Werner*). the place where it was found, in the garden of the college of Hales, and in the neighbourhood of an apothecary's fhop; its exterior form, its fmall quantity, and its purity, have made fome authors fuppofe that it was a production of art. This may be, but it merits no lefs the attention of naturalifts, fince it has characters which alumine prepared artificially has not. M. Lenz fays, the pure argil is found in other places than at the college of Hales; but he does not fay whether it be cryftallized like that which is here alluded to.

M. Schreber, who analyfed this fubftance, confiders it as a combination of alumine with carbonic acid, water, and a little lime, filex, iron, inflammable matter, and, fometimes, gypfum. I have not been able to procure the details of the labour of this naturalift on this earth, but the fmall quantity (about five grammes or 77 grains) which I had at my difpofal was fufficient to perfuade me that it contained no carbonic acid. I fhall here defcribe the principal external characters of it, according to the fpecimens from which I obtained my refults. It is as white as fnow; its external form is kidney or mufhroom; it has a fine earthy fracture, is tender and almoft friable; adheres little to the tongue, is fomewhat translucid at the edges, and feems fine to the touch, but not fat*.

* Pure fpongy or gelatinous alumine is not fat or unctuous, or at leaft it is not more fo than any other earth reduced to the fame ftate of divifion: it does not even become fo by being mixed with water after it has been dried at the temperature of the atmofphere. Under thefe circumftances it cannot refolve itfelf with that liquid into a connected pafte, more or lefs vifcous, like the greater part of the native clays: alumine is indebted for its unctuofity, which is improperly confidered as one of its effential characters, only to its mixture with other fubftances.

The cafe is the fame with the *earthy odour*, which is confidered as effential to moiftened alumine, and which, in my opinion, does not belong to this earth, when difengaged from every combination. It is found that this odour decreafes in argil in proportion as it is deprived of the oxide of iron. Moiftened alumine, obtained from common alum, affects the organs of fmell in a manner fcarcely fenfible; but the earthy odour no longer exifts in alumine purified by potafh, when it has been again moiftened after being dried in the common temperature of the atmofphere. If a delicate fmell can diftinguifh it at the moment of its precipitation, it is becaufe the alumine, after having been diffolved once in potafh, retains a fmall quantity of the oxide of iron; for alumine, purified in one operation by this laft procefs, can furnifh by alkaline pruffiates, a quantity of pruffiate of iron very fuperior to that which always exifts in the pureft alkaline pruffiates. By means of trituration with oxide of iron, I communicated to inodorous alumine an aluminous or earthy odour. It is poffible that this fubftance may communicate the fame odour to other earths, for Vauquelin found that fome chalcedonies exhaled an aluminous odour when triturated, though they contained no alumine.

 By

By a microfcope of a magnifying power equal to 200 or 300, it appeared, as Schreber has remarked, that it is compofed of fmall tranfparent prifmatic cryftals, compreffed and terminated by blunted pyramids. I was not able to difcover this cryftallization in alumine prepared artificially.

At the firft degrees of incandefcence it lofes about two-thirds of its weight. Alumine lofes only fifty-eight hundredths.

A decoction of it in water did not change teft paper, but it became turbid by the oxalate of potafh and folution of barytes. This folution, evaporated to drynefs in a gentle heat, left a refiduum which was only the 0·022 part of the alumine employed. It was compofed of fulphate of lime, and a yellow matter, fufceptible of being carbonated by combination, and fimilar to vegetable extract.

A gramme (15·44 grains) of the argil of Hales, diffolved cold, a hundredth part excepted, in nitric acid, without producing any effervefcence. None was produced when the folution was made at a heat equal to 60° of Reaumur (167° Fahr.). The fulphuric acid diffolved it alfo cold, almoft entirely, and without effervefcence.

A folution of this earth by the nitric acid was not rendered turbid by muriate of platina.

The fame folution was precipitated, cold, by carbonate of ammonia in excefs. The liquor, when filtered, was expofed to ebullition, to try whether it contained glucina. By this operation it became pretty turbid; the new fubftance was carefully collected, and weighed, when dried at the temperature of the atmofphere, about feven-hundredths of the native argil: but I doubt whether it was glucina; for it produced no effervefcence when diffolving in nitric acid, as glucina would have done in the like cafe, according to the experiments of Vauquelin. A folution of it in nitric acid in excefs was not precipitated by pruffiate of potafh, oxalate of potafh, and fulphuric acid; but it was by ammonia. This precipitate was foluble in potafh; it was therefore not gadolinite. Was it a new fubftance, or alumine united to a bafe, which gave it the property of diffolving in carbonate of ammonia? Thofe who poffefs argil of Hales in fufficient quantity may be able to determine this queftion.

Potafh was able to diffolve, an imponderable quantity of the oxide of iron excepted, the alumine precipitated from the nitric acid by the carbonate of ammonia in the preceding operation. This alumine, feparated from potafh, cryftallized in octaedra with the alkaline addition requifite in fuch a cafe.

The argil of Hales, projected into nitre in fufion, produced no detonation; it fhowed only in obfcurity a very faint blue

 trace,

trace, which undulated at the surface of the salt. But this effect is doubtful: when projected on ignited iron, it retained a light scarcely sensible.

In the last place, I subjected to distillation, at a red heat, in a luted glass retort, one gramme and a half (23·16 grains) of this substance. I obtained some drops of a liquid transparent as water, and a quantity of air which did not exceed the capacity of the vessels used for distilling. This air contained one or two hundredths of carbonic acid gas; a quantity inferior to what I expected to obtain by the decomposition of water and the inflammable matter contained in the clay. The carbonic acid gas, naturally belonging to the air of the vessels anterior to the distillation, must be deducted from the estimation I have given.

XII. I shall recapitulate, in a few words, the principal results of these observations:

1st, Alumine does not form with carbonic acid a concrete carbonate of alumine; or, at least, no one has been able to form that combination.

2d, The substance, hitherto considered as artificial concrete carbonate of alumine, is the result of the union of alumine with alkali and carbonic acid. This acid does not, probably, enter into this combination but by its affinity for the alkali.

3d, Alumine does not seem to unite with carbonic acid but in the case when the latter is dissolved in water; when this earth precipitates itself from this solution by the volatilization of the carbonic acid, it does not appear in the state of carbonate.

4th, Native clays, considered by some authors as carbonates of alumine, did not appear to me to be in that state.

5th, The native argil of Hales, precipitated from its solutions in nitric acid by carbonate of ammonia in excess, leaves in solution in the latter salt, a substance or combination which deserves further examination.

[To be continued.]

V. *Description of a Horse without Hair.* *By* C. De Lasteyrie, *Member of the Philomatic Society*.*

THE first men who observed nature, struck with the wonders which it continually presented to their minds, fell into the marvellous, because they were as yet unacquainted with its laws, its means, and its powers. Such is the origin

* From the *Journal de Physique*, Floreal, an. 9.

of

of those ridiculous tales and absurd suppositions to be found in antient authors, and which have been transmitted, from age to age, till the period when mankind began to examine with more accuracy, and to make better observations.

By multiplying researches they have been rendered more exact: at present there is no necessity for believing a fact merely because it contains something of the marvellous, or is mentioned by such or such an author.

Is the horse without hair, which forms the subject of this article, to be considered as a new variety in the species, or are the characters by which this seems to be indicated a mere accident, produced by disease, or the effect of art? The proofs I have obtained, and the observations I have made on this animal, incline me to believe that it is an individual of a peculiar variety. "Instead of contracting the limits of its power," says Buffon, speaking of nature, "we must enlarge and extend them even to immensity; we must see nothing impossible, we must suppose every thing, and believe that every thing which can be really exists!" Though the number, indeed, of the travellers who give themselves the trouble to make observations is very inconsiderable, we however are daily made acquainted with new facts, and we see nature extended in proportion as we give extension to our researches. By comparing the countries, the productions of which are known with those which have not yet been examined by naturalists, it may be easily perceived that the field which remains for us to be passed over is of greater extent than that passed over by our predecessors. If the number of the substances contained in the bowels of the earth, and that of the beings which elude our researches at its surface, is prodigious, may we not also believe that there exist substances and beings more easily to be discovered, of which, however, we have as yet no accounts?

I shall now relate the history of the horse without hair and mane, such as I received it.—He was purchased, about ten years ago, at Vienna, by a Frenchman named Alpi, formerly employed in the menagerie of Versailles, by whom he was exhibited in several towns of Germany with other animals, and afterwards sold, for fifty louis, to the Veterinary School at Berlin. This horse had been taken from the Turks during the last war, and carried by an Austrian officer to Vienna. Alpi exhibited him under the name of the Horse of the Nile, and said he came from Africa. He yoked him to a cart on which he carried about his animals. Four years ago he was in the Veterinary College of Berlin.

This horse appears to me to be about twenty years of age;

 he

he eats the same food, and in the same quantity, as common horses: he is meagre, as he always had been from the time he was brought to the Veterinary School. He is strong and vigorous, trots somewhat hard on account of his age, and because he has been employed in the draught. He is very sensible to cold, and therefore during winter is always kept exceedingly warm. His head is small and well made, the neck pretty, and the chest open; his legs, on which he stands well, are slender; but the rest of his body is not so beautiful, on account of his age and meagre state.

He differs from other horses only in the want of hair, the depression of his forehead, and the noise he makes when breathing. I have carefully observed all the parts of his body, even the interior of the ears, and I have found only a black bristle, about three-tenths of an inch in length, on the lower eye-lid of the left eye. His skin is of a black colour inclining to gray, with some white spots on the flanks and groin. It is plaited on the upper part of the chest, is very soft to the touch on the whole body, and has a shining and unctuous appearance. What gives reason to believe that the want of hair in this animal is neither the effect of art nor the result of disease is, that the skin on the nose, around the nostrils, and on the upper and lower lips, differs from that of other horses, and has all the characters above indicated: it has almost all the appearances of that of the Turkish dog. A very distinguishing character is the depression in the middle of the forehead, measuring from the anterior angle of the eyes and the angle of the mouth. This depression, which contracts the aperture formed by the nasal bone, occasions some embarrassment to the animal in breathing, and at each inspiration and expiration it makes a noise which may be compared to that made by a person when the nostrils are obstructed. This noise increases when the animal has been running, or employed in hard labour. He has, however, strong lungs and good wind.

VI. *Description of a newly invented Galvanometer, and an Account of some Experiments made with Volta's Pile upon several of the Gases. By* W. H. PEPYS *jun. Esq.* *

DURING a course of experiments upon atmospheric electricity, with which I occupied myself in the year 1798, I

* Communicated by the author.

had

had frequently occafion to make ufe of the gold-leaf electrometer invented by Mr. Bennet.

I had often been wifhing that fome inftrument could be devifed to meafure the galvanic action of a plate of filver and one of zinc, when connected with the tongue and upper lip; and as fome philofophers had all along maintained that the galvanic and electric fluid were the fame, the delicate fenfibility of the gold-leaf electrometer fuggefted the idea of accommodating it to the object I had in view, for which purpofe I adopted the following conftruction:

Fig. 1. (Plate I.) reprefents the galvanometer complete, the top or lid, to facilitate the defcription, being fhown above the glafs cylinder inftead of being inferted in its mouth, as it is when the inftrument is in ufe. The top confifts of two circular plates of brafs faftened to each other, and attached to a cork which fits into the cylinder. The undermoft plate has an oblong hole cut though it (as has alfo the cork), and from this hole a groove paffes to the outer edge of the plate to admit a thin flip of filver AA, and allow it to flide backwards or forwards between the plates, for the purpofe of moving the gold leaves *a*, attached to the filver, nearer to or further from the upright pieces B and C. This part of the conftruction is alfo fhown in fig. 2. which reprefents the metallic part of the cover inverted, AA being the flip of filver. One end of the filver, viz. that which defcends into the cylinder (fig. 1.), is flit, for the purpofe of receiving the gold leaves.

BB, CC, are two pieces of zinc, the uprights of which can be made to approach to or recede from each other by means of a flide in the tranfverfe pieces at the bottom of the jar, and which is reprefented in fig. 3. The two pieces of zinc are kept at the diftance defired by means of the fcrew D, fig. 1 and 3.

The zinc BB, properly fpeaking, is of two pieces, attached by a joint at E to facilitate the arrangement when the inftrument is intended to be put in action.

The bottom-part *m*, which receives the glafs cylinder, is of box-wood, and is furnifhed with glafs feet, FFF, for the purpofe of occafional infulation.

The inftrument being fitted up to my liking, I tried its effect by introducing the exterior end of the flip of filver between my upper lip and gum, and laying the moveable piece of zinc upon my tongue. The diftance of the two pieces of zinc was 1-4th of an inch. I could not perceive the fmalleft effect to take place. I tried it with the zinc pieces 1-8th of an inch afunder, and alfo at the diftance of 1-16th, but ftill

 without

without obferving any divergence of the gold leaves or any peculiar tafte.

When the gold came into abfolute contact with the zinc the tafte was inftantly perceptible, in the fame manner as when an immediate connection is eftablifhed between zinc and filver, by bringing them into contact between the teeth after they have been properly difpofed in the mouth; but I could never perceive, when they were fenfibly afunder, the fmalleft effect, and therefore, after repeated fruitlefs attempts to increafe the action by enlarging the furfaces of the metals in contact with the mouth, laid the inftrument afide, as ufelefs, except as a more delicate electrometer.

As I attributed my want of fuccefs not fo much to any error either in the principle or conftruction of my inftrument, as to the fmallnefs of the galvanic charge, M. Volta had no fooner made his pile known, than it occurred to me, that, as a ftronger charge might now be obtained, the inftrument I had conftructed would certainly be affected by it, *if the electric and galvanic fluid poffeffed identity*.

My friend, Mr. Henry Lawfon, having conftructed a pile, confifting of 80 pieces of zinc, and as many of filver, we made the experiment together. The filver of the galvanometer was connected with the upper piece of the pile, which was zinc, while the filver end of the pile was in contact with the zinc of the galvanometer. The fliding pieces BC were then adjufted, and, at the diftance of 1-3d of an inch from each other, the gold leaves diverged: upon prefenting excited glafs they opened ftill further, proving it to be that ftate called plus, or pofitive.

We then reverfed the connection, making the lower or zinc end of the galvanometer join the upper or zinc end of the pile, and the filver flip join the lower or filver end of the pile. In this cafe, excited glafs made the leaves to clofe, while excited fealing-wax opened them further.

When we made this trial of the galvanometer, the pile was giving fhocks, that were taken with a fenfation equal to what would have been experienced from a charge of as much coated furface of electricity as would, if difcharged through the galvanometer, have torn and deftroyed the gold leaves, while by galvanifm they were only diverged equal to about 1-4th of an inch: even fealing-wax flightly excited, prefented to the inftrument, kept the leaves in conftant motion.

Since that time I have performed a number of experiments with Volta's pile; indeed, I have repeated almoft all the experiments with it which have yet been made public, befides making

making feveral a little different from any I have yet heard of, and in all of them I have found the galvanometer fo ufeful an inftrument, that I can recommend it with fome confidence to thofe who are fond of fuch experiments.

I fhall not encroach upon the pages of the Philofophical Magazine by detailing the refults of experiments in which others have anticipated me; but fhall, as briefly as poffible, ftate a few experiments refpecting the action of the galvanic pile on feveral of the gafes, which prefent fome new facts on this interefting fubject.

In thefe experiments an exhaufted transfer was fcrewed upon the top of a graduated glafs cylinder, open at the bottom. The cylinder being filled with water and placed over a pneumatic tub, was then charged with gas to any particular divifion, and the divifion noted, by which means the quantity allowed to afcend into the transfer, upon opening a cock interpofed between it and the cylinder, was known; and confequently, whether any or what quantity of the gas under experiment was abforbed by the procefs.

I. The pile being placed, with a fmall tube containing diftilled water, and connecting wires of fine filver, in the exhaufted transfer, the quantity of atmofpheric air admitted from the adjoining graduated cylinder was regiftered. After ftanding in this way for 36 hours, out of 200 cubic inches of atmofpheric air, 40 were found to have been abforbed. During the whole time of the abforption, gas was formed in the fmall tube of water, and a floculent oxyd was precipitated.

II. When oxygen gas, obtained from the oxymuriat of potafh, was ufed, the power of the pile was confiderably increafed; the one wire gave out gas more rapidly, while a much more copious floculent precipitate was formed by the other. Leaving this experiment during the night, 200 cubic inches of oxygen were found to have been abforbed by the morning. Water had afcended from the pneumatic tub, and not only filled the graduated cylinder, but rifen fo high into the transfer, that the pile was half immerfed in it. The exhauftion, thus produced, maintained a column of water of about 16 inches in height.

III. Azotic gas, procured by the decompofition of atmofpheric air by the fulphuret of potafh, totally ftopped the action of the pile, neither gas nor precipitate appearing in the fmall tube of water.

IV With hydrogen gas the effect was the fame. I could not perceive that the pile had the fmalleft action.

It is proper that I fhould obferve here, that the cloths interpofed between each pair of metals in thefe experiments

were

were moistened with a solution of common salt. If the cloths be soaked in acids, the result, as every one knows, will be very different; the pile will then act as powerfully even in *vacuo* as in atmospheric air.

An anonymous correspondent, in the last number of the Philosophical Magazine, notices the increased action of the pile by acids; but because he finds that the alkalies, particularly pure ammonia, also increase its action most powerfully, infers, that the fluid excited in the pile does not arise from the action of acids, or from *any combination of oxygen with the metals*. Before making such an inference, he ought to have tried his pile in such circumstances as would have precluded the possibility of oxygen having access to it. In vacuo his pile would have speedily ceased to act, even with solutions of alkali interposed between the pairs of plates. He ought also to have examined the state of the residual water in the two glasses, connected by means of a syphon, before he proceeded to overturn the Lavoisierian system from the circumstance of oxygen gas being produced in the one glass and hydrogen gas in the other.

The last paragraph in his paper is equally inconclusive, where he would infer, because an electrometer gives signs of negative electricity when a drop of water is let fall upon a piece of red-hot iron placed upon it, that therefore positive electricity and water form hydrogen air. The presence of hydrogen is not necessary to the electrometer indicating negative electricity; if the water be converted into vapour, the effect is produced: indeed, the vapour of any kind of liquid produces the negative state.

VII. *Observations on the Means of increasing the Quantities of Heat obtained in the Combustion of Fuel. By Count* RUMFORD*.

IT is a fact which has been long known, that clays, and several other incombustible substances, when mixed with sea-coal, in certain proportions, cause the coal to give out more heat in its combustion than it can be made to produce when it is burnt pure or unmixed; but the cause of this increase of heat does not appear to have been yet investigated with that attention which so extraordinary and important a circumstance seems to demand.

Daily experience teaches us, that all bodies—those which

* From the *Journals of the Royal Institution of Great Britain.*

are

are incombuſtible, as well as thoſe which are combuſtible, and actually burning,—throw off, in all directions, heat, or rather calorific (heat-making) rays, which generate heat wherever they are ſtopped or abſorbed: but common obſervation was hardly ſufficient to ſhow any perceptible difference between the quantities of calorific rays thrown off by different bodies, when heated to the ſame temperature, or expoſed in the ſame fire; although the quantities ſo thrown off might be, and probably are, very different.

It has lately been aſcertained, that when the ſides and back of an open chimney fire-place, in which coals are burned, are compoſed of fire-bricks, and heated red-hot, they throw off into the room incomparably more heat than all the coals that could poſſibly be put into the grate, even ſuppoſing them to burn with the greateſt poſſible degree of brightneſs. Hence it appears that a red-hot burning coal does not ſend off near ſo many calorific rays as a piece of red-hot brick or ſtone, of the ſame form and dimenſions; and this intereſting diſcovery will enable us to make very important improvements in the conſtruction of our fire-places, and alſo in the management of our fires.

The fuel, inſtead of being employed to heat the room directly, or by the direct rays from the fire, ſhould be ſo diſpoſed or placed as to heat the back and ſides of the grate; which muſt always be conſtructed of fire-brick or fire-ſtone, and never of iron or of any other metal. Few coals, therefore, when properly placed, make a much better fire than a larger quantity; and ſhallow grates, when they are conſtructed of proper materials, throw more heat into a room, and with a much leſs conſumption of fuel, than deep grates; for a large maſs of coals in the grate arreſts the rays which proceed from the back and ſides of the grate, and prevents their coming into the room; or, as fires are generally managed, it prevents the back and ſides of the grate from ever being ſufficiently heated to aſſiſt much in heating the room, even though they be conſtructed of good materials, and large quantities of coals be conſumed in them.

It is poſſible, however, by a ſimple contrivance, to make a good and an œconomical fire in almoſt any grate, though it would always be adviſable to conſtruct fire-places on good principles, or to improve them by judicious alterations, rather than to depend on the uſe of additional inventions for correcting their defects.

To make a good fire in a bad grate, the bottom of the grate muſt be firſt covered with a ſingle layer of balls, made of good fire-bricks or artificial fire-ſtone, well burnt, each ball

ball being perfectly globular, and about $2\frac{1}{2}$ or $2\frac{3}{4}$ inches in diameter. On this layer of balls the fire is to be kindled, and, in filling the grate, more balls are to be added with the coals that are laid on; care must, however, be taken in this operation to mix the coals and the balls well together, otherwise, if a number of the balls should get together in a heap, they will cool, not being kept red-hot by the combustion of the surrounding fuel, and the fire will appear dull in that part; but if no more than a due proportion of the balls are used, and if they are properly mixed with the coals, they will all, except it be those perhaps at the bottom of the grate, become red-hot, and the fire will not only be very beautiful, but it will send off a vast quantity of radiant heat into the room, and will continue to give out heat for a great length of time. It is the opinion of several persons who have for a considerable time practised this method of making their fires, that more than one-third of the fuel usually consumed may be saved by this simple contrivance. It is very probable that, with careful and judicious management, the saving would amount to one-half, or fifty per cent.

As these balls, made in moulds, and burnt in a kiln, would cost very little, and as a set of them would last a long time, probably several years, the saving of expense in heating rooms by chimney fires with bad grates, in this way, is obvious; but still it should be remembered, that a saving quite as great may be made by altering the grate, and making it a good fire-place.

In using these balls, care must be taken to prevent their accumulating at the bottom of the grate. As the coals go on to consume, the balls mixed with them will naturally settle down towards the bottom of the grate, and the tongs must be used occasionally to lift them up; and, as the fire grows low, it will be proper to remove a part of them, and not to replace them in the grate till more coals are introduced. A little experience will show how a fire made in this manner can be managed to the greatest advantage, and with the least trouble.

Balls made of pieces of any kind of well-burnt hard brick, though not equally durable with fire-brick, will answer very well, provided they be made perfectly round; but if they are not quite globular their flat sides will get together, and by obstructing the free passage of the air amongst them, and amongst the coals, will prevent the fire from burning clear and bright.

The best composition for making these balls, when they are formed in moulds, and afterwards dried and burnt in a kiln,

kiln, is pounded crucibles mixed up with moiſtened Sturbridge clay; but good balls may be made with any very hard burnt common bricks, reduced to a coarſe powder, and mixed with Sturbridge clay, or even with common clay. The balls ſhould always be made ſo large as not to paſs through between the front bars of a grate.

Theſe balls have one advantage, which is peculiar to them, and which might perhaps recommend the uſe of them to the curious, even in fire-places conſtructed on the beſt principles; they cauſe the cinders to be conſumed almoſt entirely; and even the very aſhes may be burnt, or made to diſappear, if care be taken to throw them repeatedly upon the fire when it burns with an intenſe heat. It is not difficult to account for this effect in a ſatisfactory manner, and in accounting for it we ſhall explain a circumſtance on which it is probable that the great increaſe of the heat of an open fire, where theſe balls are uſed, may, in ſome meaſure, depend. The ſmall particles of coal and of cinder which, in a common fire, fall through the bottom of the grate and eſcape combuſtion, when theſe balls are uſed can hardly fail to fall and lodge on ſome of them; and, as they are intenſely hot, theſe ſmall bodies which alight upon them in their fall, are ſoon heated red-hot, and diſpoſed to take fire and burn; and, as freſh air from below the grate is continually making its way upwards amongſt the balls, every circumſtance is highly favourable to the rapid and complete combuſtion of theſe ſmall inflammable bodies. But if theſe ſmall pieces of coal and cinder ſhould, in their fall, happen to alight upon the metallic bars which form the bottom of the grate; as theſe bars are conductors of heat, and, on account of that circumſtance, as well as of their ſituation, *below* the fire, never can be made very hot, any ſmall particle of fuel that happens to come into contact with them, not only cannot take fire, but would ceaſe to burn ſhould it arrive in a ſtate of actual combuſtion.

Theſe facts are very important, and well deſerving of the attention of thoſe who may derive advantage from the improvement of fire-places, and the œconomy of fuel.

There are ſome circumſtances which ſtrongly indicate that an admixture of incombuſtible bodies with fuel, and eſpecially with coal, cauſe an increaſe of the heat even when the fuel is burnt in a cloſed fire-place. No fire-place can well be contrived more completely cloſed than thoſe of the iron ſtoves in common uſe in the Netherlands; but in theſe ſtoves, which are heated by coal fires, a large proportion of wet clay is always coarſely mixed with the coals before they are introduced into the fire-place. If this practice had not been found to be

uſeful,

ufeful, it would certainly never have obtained generally; nor would it have been continued, as it has been, for more than two hundred years.

The combination of different fubftances, combuftible and incombuftible, to form, artificially, various kinds of cheap and pleafant fuel, particularly adapted for the different proceffes in which the fuel is employed, is a fubject well worthy of the attention of enterprizing and ingenious men. How much excellent fuel, for inftance, might be made, with proper additions and proper management, of the mountains of refufe coal-duft that lie ufelefs at the mouths of coal-pits? and how much would it contribute to cleanlinefs and elegance if the ufe of improved coke, or of hard and light fire-balls, could be generally introduced in our houfes and kitchens, inftead of crude, black, powdery, dirty fea-coal! Of the great œconomy that would refult from fuch a change, there cannot be the fmalleft doubt.

It is a melancholy truth, but, at the fame time, a moft indifputable fact, that, while the induftry and ingenuity of millions are employed, with unceafing activity, in inventing, improving, and varying, thofe fuperfluities which wealth and luxury introduce into fociety, no attention whatever is paid to the improvement of thofe common neceffaries of life on which the fubfiftence of all, and the comforts and enjoyments of the great majority of mankind, abfolutely depend.

Much will be done for the benefit of fociety, if means can be devifed to call the attention of the active and benevolent to this long neglected, but moft interefting, fubject.

The Royal Inftitution feems to be well calculated to facilitate and expedite the accomplifhment of this important object. Indeed, it is more than probable that this precifely is the object which was principally had in view in the foundation and arrangement of that eftablifhment.

VIII. *On the Use of Steam as a Vehicle for conveying Heat from one Place to another. By Count* RUMFORD*.

MORE than fifty years ago, colonel William Cook, in a paper prefented by him to the Royal Society, and publifhed in their Tranfactions, made a propofal for warming rooms by means of metallic tubes filled with fteam, and communicating with a boiler fituated out of the room; which propofal was accompanied by an engraving, which fhowed,

* From the *Journals of the Royal Inftitution of Great Britain*, vol. i.

ſhowed, in a manner perfectly clear and diſtinct, how this might be effected. Since that time this ſcheme has frequently been put in practice, with ſucceſs, both in this country and on the continent *. Many attempts have likewiſe been made, at different periods, to heat liquids by means of ſteam introduced into them; but moſt of theſe have failed: and, indeed, until it was known that fluids are nonconductors of heat, and, conſequently, that heat cannot be made to *deſcend* in them (which is a recent diſcovery), theſe attempts could hardly ſucceed; for, in order to their being ſucceſsful, it is abſolutely neceſſary that the tube which conveys the hot ſteam ſhould open into the loweſt part of the veſſel which contains the liquid to be heated, or on a level with its bottom;—but as long as the erroneous opinion obtained, that heat could paſs in fluids in all directions, there did not appear to be any reaſon for placing the opening of the ſteam-tube at the bottom of the veſſel, while many were at hand which pointed out other places as being more convenient for it.

But to ſucceed in heating liquids by ſteam, it is neceſſary, not only that the ſteam ſhould enter the liquid at the bottom of the veſſel which contains it, but alſo that it ſhould enter it coming from above. The ſteam-tube ſhould be in a vertical poſition, and the ſteam ſhould *deſcend* through it previous to its entering the veſſel, and mixing with the liquid which it is to heat; otherwiſe, this liquid will be in danger of being forced back by this opening into the ſteam-boiler; for the hot ſteam, being ſuddenly condenſed on coming into contact with the cold liquid, a vacuum will neceſſarily be formed in the end of the tube; into which vacuum the liquid in the veſſel, preſſed by the whole weight of the incumbent atmoſphere, will ruſh with great force and with a loud noiſe; but if this tube be placed in a vertical poſition, and if it be made to riſe to the height of ſix or ſeven feet, the liquid which is thus forced into its lower end will not have time to riſe to that height before it will be met by ſteam, and obliged to return back into the veſſel. There will be no difficulty in arranging the apparatus in ſuch a manner as effectually to prevent the liquid to be heated from being forced backwards into the ſteam-boiler; and, when this is done, and ſome other neceſſary precautions to prevent accidents are taken, ſteam may be employed with great advantage for heating

* Although one ſhould naturally imagine that the notoriety of theſe facts would have been ſufficient to prevent all attempts in our days to claim a right to this invention, yet it is ſaid that a patent for it was taken out only a few years ago.

liquids, and for keeping them hot, in a variety of cafes, in which fire, applied immediately to the bottoms of the containing veffels, is now ufed.

In dyeing, for inftance, and in brewing, and in the proceffes of many other arts and manufactures, the adoption of this method of applying heat would be attended, not only with a great faving of labour and of fuel, but alfo of a confiderable faving of expenfe in the purchafe and repairs of boilers, and of other expenfive machinery: for, when fteam is ufed inftead of fire for heating their contents, boilers may be made extremely thin and light; and, as they may eafily be fupported and ftrengthened by hoops and braces of iron, and other cheap materials, they will coft but little, and feldom ftand in need of repairs. To thefe advantages we may add others of ftill greater importance: boilers intended to be heated in this manner may, without the fmalleft difficulty, be placed in any part of a room at any diftance from the fire, and in fituations in which they may be approached freely on every fide. They may, moreover, eafily be fo furrounded with wood, or with other cheap fubftances which form warm covering, as moft completely to confine the heat within them, and prevent its efcape. The tubes, by which the fteam is brought from the principal boiler, (which tubes may conveniently be fufpended juft below the ceiling of the room,) may, in like manner, be covered fo as almoft entirely to prevent all lofs of heat by the furfaces of them; and this to whatever diftances they may be made to extend.

In fufpending thefe fteam-tubes, care muft, however, be taken to lay them in a fituation *not perfectly horizontal* under the ceiling, but to incline them at a fmall angle, making them rife gradually from their junction with the top of a large vertical fteam-tube, connecting them with the fteam-boiler, quite to their fartheft extremities: for, when thefe tubes are fo placed, it is evident that all the water formed in them, in confequence of the condenfation of the fteam in its paffage through them, will run backwards and fall into the boiler, inftead of accumulating in them, and obftructing the paffage of the fteam, which it would not fail to do were there any confiderable bends or wavings, upwards and downwards, in thefe tubes, or of running forward and defcending with the fteam into the veffels containing the liquids to be heated, which would happen if thefe tubes inclined downwards inftead of inclining upwards as they recede from the boiler.

In order that clear and diftinct ideas may be formed of the various parts of this apparatus, even without figures, I fhall diftinguifh each part by a fpecific name. The veffel in which water is boiled in order to generate ſteam, and which, in its conſtruction, may be made to reſemble the boiler of a ſteam-engine, I ſhall call the *ſteam-boiler:* the vertical tube, which, riſing up from the top of the boiler, conveys the ſteam into the tubes (nearly horizontal), which are ſuſpended from the ceiling of the room, I ſhall call the *prime conductor:* to the horizontal tubes I ſhall give the name of *horizontal conductors,* or ſimply, *conductors of ſteam:* and to the (ſmaller) tubes, which, deſcending perpendicularly from theſe *horizontal conductors,* convey the ſteam to the liquids which are to be heated, I ſhall, excluſively, appropriate the appellation of *ſteam-tubes.*

The veſſels in which the liquids are put that are to be heated, I ſhall call the *containing veſſels.* Theſe veſſels may be made of any form; and, in many caſes, they may, without any inconvenience, be conſtructed of wood, or of other cheap materials, inſtead of being made of coſtly metals, by which means a very heavy expenſe may be avoided.

Each ſteam-tube muſt deſcend perpendicularly from the horizontal conductor, with which it is connected, to the level of the bottom of the containing veſſel to which it belongs; and, moreover, muſt be furniſhed with a good braſs cock, perfectly ſteam-tight; which may beſt be placed at the height of about ſix feet above the level of the floor of the room.

This ſteam-tube may either deſcend within the veſſel to which it belongs, or on the outſide of it, as ſhall be found moſt convenient. If it comes down on the outſide of the veſſel, it muſt enter it at its bottom, by a ſhort horizontal bend; and its junction with the bottom of the veſſel muſt be well ſecured, to prevent leakage. If it comes down into the veſſel, on the inſide of it, it muſt deſcend to the bottom of it, or at leaſt to within a very few inches of the bottom of it, otherwiſe the liquid in the veſſel will not be uniformly and equally heated.

When the ſteam-tube is brought down on the inſide of the containing veſſel, it may either come down perpendicularly, and without touching the ſides of it, or it may come down on one ſide of the veſſel, and in contact with it.

When ſeveral ſteam-tubes, belonging to different containing veſſels, are connected with one and the ſame horizontal ſteam conductor, the upper end of each of theſe tubes, inſtead of being ſimply attached, by ſoldering, to the under ſide of the conductor, muſt enter, at leaſt one inch, within the cavity of it; otherwiſe the water reſulting from a condenſation of a part of the ſteam in the conductor, by the cold air which ſurrounds it, inſtead of finding its way back into

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the ſteam-boiler, will deſcend through the ſteam-tubes and mix with the liquids in the veſſels below; but when the open ends of theſe tubes project upwards within the ſteam conductor, though it be but to a ſmall height above the level of its under ſide, it is evident that this accident cannot happen.

It is not neceſſary to obſerve here, that, in order that the ends of the ſteam-tubes may project within the horizontal conductor, the diameters of the former muſt be conſiderably leſs than the diameter of the latter.

To prevent the loſs of heat ariſing from the cooling of the different tubes through which the ſteam muſt paſs in coming from the boiler, all thoſe tubes ſhould be well defended from the cold air of the atmoſphere by means of warm covering; but this may eaſily be done, and at a very trifling expenſe. The horizontal conductors may be incloſed within ſquare wooden tubes, and ſurrounded on every ſide by charcoal-duſt, fine ſawduſt, or even by wool; and the ſteam-tubes and prime conductor may be ſurrounded, firſt by three or four coatings of ſtrong paper, firmly attached to them by paſte or glue, and covered with a coating of varniſh, and then by a covering of thick coarſe cloth. It will likewiſe be adviſable to cover the horizontal conductors with ſeveral coatings of paper; for, if the paper be put on to them while it is wet with the paſte or glue, and if care be taken to put it on in long ſlips or bands, wound regularly round the tube in a ſpiral line, from one end of it to the other, this covering will be uſeful, not only by confining more effectually the heat, but alſo by adding very much to the ſtrength of the tube, and rendering it unneceſſary to employ thick and ſtrong ſheets of metal in the conſtruction of it.

However extraordinary and incredible it may appear, I can aſſert it as a fact, which I have proved by repeated experiments, that if a hollow tube, conſtructed of ſheet copper $\frac{1}{25}$ of an inch in thickneſs, be covered by a coating only twice as thick, or $\frac{1}{10}$ of an inch in thickneſs, formed of layers of ſtrong paper, firmly attached to it by good glue, the ſtrength of the tube will be more than doubled by this covering. I found by experiments the moſt unexceptionable and deciſive, (of which I intend, at ſome future period, to give to the public a full and detailed account,) that the ſtrength of paper is ſuch, when ſeveral ſheets of it are firmly attached together with glue, that a ſolid cylind of this ſubſtance, the tranſverſe ſection of which ſhould amount to only one ſuperficial inch, would ſuſtain a weight of 30,000 lbs. avoirdupois, or above 13 tons, ſuſpended to it, without being pulled aſunder or broken. The ſtrength of hemp is ſtill much

much greater, when it is pulled equally, in the direction of the length of its fibres. I found, from the results of my experiments with this substance, that a cylinder of the size above mentioned, composed of the straight fibres of hemp, glued together, would sustain 92,000 lbs. without being pulled asunder.

A cylinder, of equal dimensions, composed of the strongest iron I could ever meet with, would not sustain more than 66,000 lbs. weight; and the iron must be very good not to be pulled asunder with a weight equal to 55,000 lbs. avoirdupois.

I shall not, in this place, enlarge on the many advantages that may be derived from a knowledge of these curious facts. I have mentioned them now in order that they may be known to the public; and that ingenious men, who have leisure for these researches, may be induced to turn their attention to a subject, not only very interesting on many accounts, but which promises to lead to most important improvements in mechanics.

I cannot return from this digression without just mentioning one or two results of my experimental investigations relative to the force of cohesion, or strength of bodies, which, certainly, are well calculated to excite the curiosity of men of science.

The strength of bodies of different sizes, similar in form, and composed of the same substance, or the forces by which they resist being pulled asunder by weights suspended to them, and acting in the direction of their lengths; are not in the simple ratio of the areas of their transverse sections, or of their fractures, but in a higher ratio, and this ratio is different in different substances.

The form of a body has a considerable influence on its strength, even when it is pulled in the direction of its length.

All bodies, even the most brittle, appear to be torn asunder, or their particles separated, or fibres broken, one after the other; and hence it is evident, that that form must be most favourable to the strength of any given body, pulled in the direction of its length, which enables the greatest number of its particles, or longitudinal fibres, to be separated to the greatest possible distance (short of that at which the force of cohesion is overcome), before any of them have been forced beyond that limit.

It is more than probable, that the apparent strength of different substances depends much more on the number of their particles that come into action before any of them are forced beyond the limits of the attraction of cohesion, than on any ſpecific difference in the intenſity of that force in thoſe ſubſtances.

But to return to the ſubject more immediately under conſideration. As it is eſſential that the ſteam employed in heating liquids, in the manner before deſcribed, ſhould enter the containing veſſel at, or very near, its bottom, it is evident that this ſteam muſt be ſufficiently ſtrong, or elaſtic, to overcome, not only the preſſure of the atmoſphere, but alſo the additional preſſure of the ſuperincumbent liquid in the veſſel; the ſteam-boiler muſt therefore be made ſtrong enough to confine the ſteam, when its elaſticity is ſo much increaſed by means of additional heat, as to enable it to overcome that reſiſtance. This increaſe of the elaſtic force of the ſteam need not, however, in any caſe, exceed a preſſure of five or ſix pounds upon a ſquare inch of the boiler, or one-third part, or one-half, of an atmoſphere.

It is not neceſſary for me to obſerve here, that in this, and alſo in all other caſes where ſteam is uſed as a vehicle for conveying heat from one place to another, it is indiſpenſably neceſſary to provide ſafety-valves of two kinds; the one for letting a part of the ſteam eſcape, when, on the fire being ſuddenly increaſed, the ſteam becomes ſo ſtrong as to expoſe the boiler to the danger of being burſt by it; the other for admitting air into the boiler, when, in conſequence of the diminution of the heat, the ſteam in the boiler is condenſed, and a vacuum is formed in it; and when, without this valve, there would be danger, either of having the ſides of the boiler cruſhed, and forced inwards by the preſſure of the atmoſphere from without; or of having the liquid in the containing veſſels forced upwards into the horizontal ſteam conductors, and from thence into the ſteam-boiler. This laſt-mentioned accident, however, cannot happen, unleſs the cocks in ſome of the ſteam-tubes happen to be open. The two valves effectually prevent all accidents.

The reader will, no doubt, be more diſpoſed to pay attention to what has here been advanced, on this intereſting ſubject, when he is informed that the propoſed ſcheme has already been executed on a very large ſcale, and with complete ſucceſs, and that the above details are little more than exact deſcriptions of what actually exiſts.

A great mercantile and manufacturing houſe at Leeds, that of Meſſrs. Gott and Co., had the courage, notwithſtanding the mortifying prediction of all their neighbours, and the ridicule with which the ſcheme was attempted to be treated, to erect a dyeing-houſe, on a very large ſcale indeed, on the principles here deſcribed and recommended.

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On my viſit to Leeds the laſt ſummer, I waited on Mr. Gott, who was then mayor of the town, and who received me with great politeneſs, and ſhowed me the cloth halls, and other curioſities of the place; but nothing he ſhowed me intereſted me half ſo much as his own truly noble manufactory of ſuperfine woollen cloths. I had ſeen few manufactories ſo extenſive, and none ſo complete in all its parts. It was burnt to the ground the year before I ſaw it, and had juſt been rebuilt, on a larger ſcale, and with great improvements in almoſt every one of its details. The reader may eaſily conceive that I felt no ſmall degree of ſatisfaction on going into the dyeing-houſe to find it fitted up on principles which I had had ſome ſhare in bringing into repute, and which Mr. Gott told me he had adopted in conſequence of the information he had acquired in the peruſal of my ſeventh Eſſay. He aſſured me that the experiment had anſwered, even far beyond his moſt ſanguine expectations; and, as a ſtrong proof of the utility of the plan, he told me that his next door neighbour, who is a dyer by profeſſion, and who, at firſt, was ſtrongly prejudiced againſt theſe innovations, has lately adopted them, and is now convinced that they are real improvements. Mr. Gott aſſured me that he had no doubt but that they would be adopted by every dyer in Great Britain in the courſe of a very few years.

The dyeing-houſe of Meſſrs. Gott and Co. which is ſituated on the ground floor of the principal building of the manufactory, is very ſpacious, and contains a great number of coppers of different ſizes; and as theſe veſſels, ſome of which are very large, are diſtributed about promiſcuouſly, and apparently without any order in their arrangement, in two ſpacious rooms, (each copper appearing to be inſulated, and to have no connection whatever with the others,) all of them together form a very ſingular appearance. The rooms are paved with flat ſtones, and the brims of all the coppers, great and ſmall, are placed at the ſame height, about three feet, above the pavement. Some of theſe coppers contain upwards of 1800 gallons; and they are all heated by ſteam from one ſteam-boiler, which is ſituated in a corner of one of the rooms.

The horizontal tubes, which ſerve to conduct the ſteam from the boiler to the coppers, are ſuſpended juſt below the ceiling of the rooms: they are made, ſome of lead, and ſome of caſt iron, and are from four to five inches in diameter; but when I ſaw them they were naked, or without any covering to confine the heat. On my obſerving to Mr. Gott, that coverings for them would be uſeful, he told me that it was intended

intended that they ſhould be covered, and that coverings would be provided for them.

The vertical ſteam-tubes, by which the ſteam paſſes down from the horizontal ſteam conductors into the coppers, are all conſtructed of lead, and are from $\frac{3}{4}$ of an inch to $2\frac{1}{2}$ inches in diameter; being made larger or ſmaller according to the ſizes of the coppers to which they belong. Theſe ſteam-tubes all paſs down on the outſides of their coppers, and enter them horizontally at the level of their bottoms. Each copper is furniſhed with a braſs cock for letting off its contents; and it is filled with water from a ciſtern at a diſtance, which is brought to it by a leaden pipe. The coppers are all ſurrounded by thin circular brick walls, which ſerve not only to ſupport the coppers, but alſo to confine the heat.

The rapidity with which theſe coppers may be heated, by means of ſteam, is truly aſtoniſhing. Mr. Gott aſſured me that one of the largeſt of them, containing upwards of 1800 gallons, when filled with cold water from the ciſtern, requires no more than half an hour to heat it till it actually boils! By the greateſt fire that could be made under ſuch a copper, with coals, it would hardly be poſſible to make it boil in leſs than an hour.

It is eaſy to perceive that the ſaving of time which will reſult from the adoption of this new mode of applying heat will be very great; and it is likewiſe evident that it may be increaſed, almoſt without limitation, merely by augmenting the diameter of the ſteam-tube: care muſt, however, be taken that the boiler be ſufficiently large to furniſh the quantities of ſteam required. The ſaving of fuel will alſo be very conſiderable: Mr. Gott informed me that, from the beſt calculation he had been able to make, it would amount to near two-thirds of the quantity formerly expended, when each copper was heated by a ſeparate fire.

But theſe ſavings are far from being the only advantages that will be derived from the introduction of theſe improvements in the management of heat: there is one, of great importance indeed, not yet mentioned, which alone would be ſufficient to recommend the very general adoption of them. As the heat communicated by ſteam can never exceed the mean temperature of boiling water by more than a very few degrees, the ſubſtances expoſed to it can never be injured by it. In many arts and manufactures this circumſtance will be productive of great advantages, but in none will its utility be more apparent than in cookery, and eſpecially in public kitchens, where great quantities of food are prepared in large boilers; for, when the heat is conveyed in this manner, all the

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the labour now employed in ſtirring about the contents of thoſe boilers, to prevent the victuals from being ſpoiled by burning to the bottoms of them, will be unneceſſary, and the loſs of heat occaſioned by this ſtirring prevented; and, inſtead of expenſive coppers, or metallic boilers, which are difficult to be kept clean, and often ſtand in need of repairs, common wooden tubs may, with great advantage, be uſed as culinary veſſels; and their contents may be heated by portable fire-places, by means of ſteam-boilers attached to them.

As theſe portable fire-places and their ſteam-boilers may, without the ſmalleſt inconvenience, be made of ſuch weight, form, and dimenſions, as to be eaſily tranſported from one place to another by two men, and be carried through a door-way of the common width, (with this machinery, and the ſteam-tubes belonging to it, and a few wooden tubs,) a complete public kitchen, for ſupplying the poor, and others, with ſoups; and alſo with puddings, vegetables, meat, and all other kinds of food prepared by boiling, might be eſtabliſhed in half an hour, in any room in which there is a chimney (by which the ſmoke from the portable fire-place can be carried off); and, when the room ſhould be no longer wanted as a kitchen, it might, in a few minutes, be cleared of all this culinary apparatus, and made ready to be uſed for any other purpoſe.

This method of conveying heat is peculiarly well adapted for heating baths; it is likewiſe highly probable that it would be found uſeful in the bleaching buſineſs, and in waſhing linen. It would alſo be very uſeful in all caſes where it is required to keep any liquid at about the boiling point for a long time without making it boil; for the quantity of heat admitted may be very nicely regulated by means of the braſs cock belonging to the ſteam-tube. Mr. Gott ſhowed me a boiler in which ſhreds of ſkins were digeſting in order to make glue, which was heated in this manner; and in which the heat was ſo regulated, that, although the liquid never actually boiled, it always appeared to be upon the very point of beginning to boil.

This temperature had been found to be beſt calculated for making good glue. Had any other *lower* temperature been found to anſwer better, it might have been kept up with the ſame eaſe, and with equal preciſion, by regulating properly the quantity of ſteam admitted.

I need not ſay how much this country is obliged to Mr. Gott and his worthy colleagues. To the ſpirited exertions of ſuch men, who abound in no other country, we owe one of the proudeſt diſtinctions of our national character—that of being an enlightened and an enterpriſing people.

IX. *An Account of a new Eudiometer.* By Mr. DAVY *.

THE dependance of the health and exiſtence of animals upon a peculiar ſtate of the atmoſphere, and the relations of this ſtate to proceſſes connected with the moſt eſſential wants of life, have given intereſt and importance to inquiries concerning the compoſition and properties of atmoſpheric air.

This elaſtic fluid has been long known to conſiſt chiefly of oxygen and nitrogen mingled together, or in a ſtate of looſe combination, and holding in ſolution water.

A variety of proceſſes have been inſtituted with the view of determining the relative proportions of the two gaſes, but moſt of them have involved ſources of inaccuracy; and lately all, except two (the ſlow combuſtion of phoſphorus, and the action of liquid ſulphurets,) have been generally abandoned.

Both phoſphorus and ſolution of ſulphuret of potaſh abſorb the whole of the oxygen of atmoſpheric air at common temperatures, and they do not materially alter the volume, or the properties of the reſidual nitrogen; but their operation is extremely ſlow, and in many caſes it is difficult to aſcertain the period at which the experiment is completed.

I have lately employed as an eudiometrical ſubſtance the ſolution of green muriate, or ſulphate, of iron, impregnated with nitrous gas; and I have found that it is in ſome reſpects ſuperior to many of the bodies heretofore uſed, as it rapidly condenſes oxygen without acting upon nitrogen, and requires for its application only a very ſimple and a very portable apparatus.

This fluid is made by tranſmitting nitrous gas through green muriate, or ſulphate, of iron, diſſolved to ſaturation in water †. As the gas is abſorbed, the ſolution becomes of a deep olive-brown, and when the impregnation is completed it appears opaque and almoſt black. The proceſs is apparently owing to a ſimple elective attraction; in no caſe is the gas decompoſed; and under the exhauſted receiver it aſſumes its elaſtic

* From the *Journals of the Royal Inſtitution of Great Britain*, vol. i.

† Dr. Prieſtley firſt obſerved this proceſs: for a particular account of it, ſee Reſearches, Chemical and Philoſophical, p. 152. Johnſon.

elaſtic form, leaving the fluid, with which it was combined, unaltered in its properties.

The inſtruments neceſſary for aſcertaining the compoſition of the atmoſphere, by means of impregnated ſolutions, conſiſt ſimply of a ſmall graduated tube, having its capacity divided into one hundred parts, and greateſt at the open end; and of a veſſel for containing the fluid.

The tube, after being filled with the air to be examined, is introduced into the ſolution; and, that the action may be more rapid, gently moved from a perpendicular towards a horizontal poſition. Under theſe circumſtances the air is rapidly diminiſhed; and, in conſequence of the dark colour of the fluid, it is eaſy to diſcover the quantity of abſorption. In a few minutes the experiment is completed, and the whole of the oxygen condenſed by the nitrous gas in the ſolution in the form of nitrous acid.

In all eudiometrical proceſſes with impregnated ſolutions, the period at which the diminution is at a ſtand muſt be accurately obſerved; for, ſhortly after this period, the volume of the reſidual gas begins to be a little increaſed, and, after ſome hours, it will often fill a ſpace greater by ſeveral of the hundred parts on the ſcale of the tube, than that which it occupied at the maximum of abſorption.

This circumſtance depends upon the ſlow decompoſition of the nitrous acid (formed during the experiment) by the green oxide of iron, and the conſequent production of a ſmall quantity of aëriform fluid (chiefly nitrous gas)*; which, having no affinity for the red muriate, or ſulphate, of iron produced, is gradually evolved, and mingled with the reſidual nitrogen.

The impregnated ſolution with green muriate is more rapid in its operation than the ſolution with green ſulphate. In caſes when theſe ſalts cannot be obtained in a ſtate of abſolute purity, the common or mixed ſulphate of iron may be employed. One cubic inch of moderately ſtrong impregnated ſolution is capable of abſorbing five or ſix cubic inches of oxygen, in common proceſſes; but the ſame quantity muſt never be employed for more than one experiment.

A number of comparative experiments, made on the conſtitution of the atmoſphere at the Hotwells, Briſtol, in July, August,

* The decompoſition of nitrous acid, by ſolutions containing oxyde of iron, at its minimum of oxydation, is a very complex proceſs. The green oxyde, during its converſion into red oxyde, not only decompoſes the acid, but likewiſe acts upon the water of the ſolution; and ammoniac is ſometimes formed, and ſmall portions of nitrous oxyde and nitrogene evolved with the nitrous gas.

Auguſt, and September, 1800, with phoſphorus, ſulphurets of alkalies, and impregnated ſolution, demonſtrated the accuracy of the proceſſes in which the laſt ſubſtance was properly employed. The diminutions given by the ſulphurets were indeed always greater, by a minute quantity, than thoſe produced by phoſphorus and impregnated ſolutions: but the reaſon of this will be obvious to thoſe who have ſtudied the ſubject of Eudiometry. In no inſtance was it found that 100 parts in volume of air contained more than 21 of oxygen: and the variations connected with different winds, and different ſtates of temperature, moiſture, &c. were too ſmall, and too often related to accidental circumſtances, to be accurately noticed.

In analyſing the atmoſphere in different places, by means of impregnated ſolutions, I have never been able to aſcertain any notable difference in the proportions of its conſtituent parts. Air, collected on the ſea at the mouth of the Severn, on October the 3d, 1800, which muſt have paſſed over much of the Atlantic, as the wind was blowing ſtrong from the weſt, was found to contain 21 per cent. of oxygen in volume; and this was nearly the proportion in air ſent from the coaſt of Guinea, to Dr. Beddoes, by two ſurgeons of Liverpool.

If we compare theſe reſults with the reſults gained more than twenty years ago, by Mr. Cavendiſh, from experiments on the compoſition of atmoſpherical air, made at London and Kenſington; conſidering, at the ſame time, the reſearches of Berthollet in Egypt and at Paris, and thoſe of Marti in Spain, we ſhall find ſtrong reaſons for concluding that the atmoſphere, in all places expoſed to the influence of the winds, contains very nearly the ſame proportions of oxygen and nitrogen: a circumſtance of great importance; for, by teaching us that the different degrees of ſalubrity of air do not depend upon differences in the quantities of its principal conſtituent parts, it ought to induce us to inſtitute reſearches concerning the different ſubſtances capable of being diſſolved or ſuſpended in the air, which are noxious to the human conſtitution; particularly as an accurate knowledge of their nature and properties would probably enable us, in a great meaſure, to guard againſt, or deſtroy, their baneful effects.

X. An

X. *An Account of the Improvements of the Port of London, and more particularly of the intended Bridge, consisting of a single Arch of 600 Feet Span.*

NOTHING tends so much to promote the improvements of a state, as the establishing of an easy and uninterrupted communication through all its districts. It has therefore been a leading object with every well-wisher of his country, to render the general intercourse as perfect and convenient as possible. Public roads and bridges have been the means chiefly employed to establish this intercourse: bridges, as requiring scientific and mechanical knowledge, and, in many cases, the utmost exertions of talents and skill, have frequently engaged the attention of persons of eminence and learning.

It would be an amusing task to trace the progress of this useful art, from the rude efforts of the savage, in his unassisted state, to the magnificent works of civilized nations, when science, wealth, and increased population, have united to overcome difficulties considered before as unsurmountable.

When a work is to be performed, mankind, at first, make use of the materials which are nearest at hand, and which require the least skill in the preparation; timber and stone were therefore the materials with which bridges were first constructed, and those edifices have been rendered more or less perfect, in proportion to the quality of the materials, the state of the arts, and the degree of wealth and power, in the countries in which they were erected.

In our oldest bridges, it is evident, there has been much timidity, and only a small portion of skill: in deep water, the lower parts of the piers have been constructed with timber, and the masonry begins to take place at the line of low water; the arches are of narrow span, and the masonry employed in them is frequently composed, partly of rubble, and partly of squared stone. In time, means were devised (by using coffer-dams and caissoons) to place the masonry as low, commonly lower than the natural bed of the river; the arches were also formed of a bolder span, and the masonry was made much more perfect, being all of squared stone. In this manner, bridges have been constructed in Italy, France, and the British isles, which have justly been considered, not only as works of general utility, but of great magnificence.

In like manner, timber bridges have been gradually improved, from the rough trunk of a tree thrown across a small stream,

ſtream, to the bold and ingenious labours of the Swiſs carpenter at Schaffhauſen.

Bridges continued to be chiefly compoſed of timber or of ſtone, till of late years: on account of œconomy, in ſome caſes, they have been built with bricks.

Metals not being generally found in a pure ſtate, require much labour and expenſe to make them ſubſervient to the purpoſes of man, and therefore, in the uncultivated periods of ſociety, were not applied to works of great magnitude; but the important improvements in chemical and mechanical knowledge, have, in a great degree, removed thoſe difficulties, and rendered them not only the moſt powerful, but the moſt uſeful means of man.

Iron being the moſt abundant, cheap, and generally uſeful, of all the metals, has of late years been applied in all works where great ſtrength was required in proportion to the weight of the material: hence cylinders, beams and pumps for ſteam-engines, boats * and barges for canals and navigable rivers, beams † and pillars for large buildings and bridges, have been conſtructed of iron.

The firſt iron bridge we know of, is over the river Severn, near Coalbrookdale, in Shropſhire; it conſiſts of one arch 100 feet and 6 inches in the ſpan, and riſes 45 feet: there are five ribs, each caſt in two pieces, ſecured where they join at the crown of the arch by a caſt-iron key plate, and connected together, horizontally and vertically, by caſt-iron braces, formed with dovetails and forelocks; the ribs are covered with caſt-iron plates, and the railing to the ſides is of iron: the total weight of iron is 378½ tons. The project's being carried into execution was chiefly owing to the genius and exertions of Mr. John Wilkinſon and Mr. Abraham Darley, iron maſters, whoſe ſcientific knowledge and extenſive practice, in all that regards the manufacture of iron, have long been known to the public. The bridge was built by Mr. Abraham Darley, and the iron work was caſt at Coalbrookdale in the year 1779. It was a bold effort; for, in the firſt inſtance of adopting a new material, they exceeded the ſpan of the centre arch of Black-friars bridge, which had been conſidered as a great exertion with ſtone.

* Mr. John Wilkinſon has conſtructed boats and barges of iron, ſome of which are uſed on the river Severn, and the others upon the canals in Staffordſhire and Worceſterſhire.

† A large manufactory for ſpinning flax into thread, by machinery worked by a ſteam-engine, has been erected at Shrewſbury by Meſſrs. Benyon, Marſhall, and Bage, where there are four heights of floors, and a roof compoſed of brick arches, which are ſupported by caſt-iron beams and pillars.

The iron work of this bridge has fully juſtified the idea of making uſe of that metal; for it is at this time as perfect as when it was firſt put up, except the cracking of ſome of the ſmall pieces, owing to the giving way of the abutments of ſtone, which, it is to be regretted, were not made ſufficiently ſtrong to oppoſe the great maſs of alluvial earth, of which the very high and ſteep adjoining banks are compoſed; for, if thoſe abutments had been fortunately built on the coal meaſures, no ſuch ſlip could have taken place.

The ſecond iron bridge was built over the ſame river, about two miles above the former one, at a place called Buildwas; it was erected at the expenſe of the county of Salop, agreeably to a plan, and under the direction, of Mr. Telford, who is employed as ſurveyor of the public works of that county: it was alſo caſt at Coalbrookdale in 1795 and 1796. It conſiſts of one arch 130 feet in the ſpan, and riſes, from the ſpringing to the ſoffit of the arch, 27 feet. In this bridge, as it was neceſſary to keep the roadway as low as poſſible, the principle of the Schaffhauſen bridge is in ſome degree adopted; for the outſide ribs are made to go up as high as the tops of the railing; they are connected with the ribs that bear the covering plates by means of pieces of iron, dovetailed in the form of king-poſts. The plates which form the covering over the lower ribs are caſt with deep flanches, are laid cloſe to each other, and form an arch of themſelves, ſo that, altogether, the bridge is compact and firm. The weight of iron is 173 tons, 18½ cwt. Some ſmaller bridges, and an aqueduct at Longdon, (the firſt made of iron over a navigable canal,) have alſo been made under Mr. Telford's directions, in Shropſhire.

The next bridge, on a large ſcale, which was made of iron, was that over the river Wear, at Monk-wearmouth, in the county of Durham. This bridge is 236 feet in the ſpan, and the arch riſes only 34 feet: it is compoſed of very ſhort caſt-iron frames, which are connected together by bars of wrought iron, and hollow tubes with flanches and ſcrews; the ribs are covered with timber planking. The weight of caſt iron uſed in this bridge is 205 tons, hammered iron 55 tons. This bridge was built under the direction, and chiefly at the expenſe, of Rowland Burdon, eſq.; it was caſt at the manufactory of Meſſrs. Walkers, of Rotherham, in Yorkſhire, and does much honour to the projector and to the iron maſters. It was a conſiderable ſtep in the practice of bridge building, being nearly double the ſpan of the arch of Buildwas, and conſiderably more than double that of the centre arch of Blackfriars bridge. This will, perhaps, appear raſh

to

to thofe who have not had an oportunity of confidering the qualities of iron, or who have not carefully compared its ftrength with the ftrength of the materials formerly ufed in conftructing bridges. In great works it is proper we fhould proceed with caution; but the very principle of improvement muft be wholly abandoned, if the demonftrations of fcience and the evidence of practical knowledge are to be difregarded. To thofe who will take the trouble of comparing the fpecific gravity and the ftrength of caft iron with thofe of ftone, it will not appear extraordinary, that by ufing that metal, the practice of bridge-building may be changed, and the openings of archways made to extend far beyond what has hitherto been attempted. The advantages to be derived from this practice are obvious, and become of great national importance in every country where the free navigation of rivers is intimately connected with its profperity.

We have been led into the confideration of this fubject by the information we have received refpecting the plans for rebuilding London bridge. Underftanding that there was a plan for conftructing a bridge over the Thames of a fingle arch of caft iron, we have made particular inquiries, and have authority to fay that the following is a correct ftatement of the hiftory, principles, and plan of this defign:

The manufactures, trade, and commerce of Great Britain having increafed to an extent unparalleled in the hiftory of nations, a great proportion of which is carried on through the metropolis by means of the fine river upon which it is fituated, and the important centre it forms for the commerce of great part of the world; although this river forms an excellent channel to admit the intercourfe of fhips of the largeft burthen within a few miles of the city, yet, from the increafe of the number and fize of the veffels frequenting the port of London, great inconveniences and loffes have been experienced in tranfacting the bufinefs connected with the fhipping. The diftance at which the large fhips are obliged to lie, the confufion of fhipping in the river, the lofs of time in loading and difcharging goods, the expenfe of lighterage, the frequency of thefts, the delays and vexation experienced by the merchant and manufacturer, have at laft given rife to propofitions and plans to remedy thofe evils. On this great national fubject, which embraces fuch a variety of objects, opinions have, of courfe, been various, and fome of them contradictory: this produced much difcuffion while the bufinefs remained with an open committee of the houfe of commons; and, although much ufeful information was obtained, yet no project appeared to be finally agreed on, and brought to maturity.

This

This led to the judicious measure of appointing a select committee, consisting of members who were not concerned in any of the projects brought forward. This committee has made three most valuable reports to the house of commons, wherein every thing relative to the port of London, and the general commerce of the kingdom, as far as it is connected with this port, has been arranged with an accuracy and precision which will enable the legislature and the public to comprehend, at one view, a subject which requires information beyond the power of any individual to bring together.

In this great plan, they have judiciously divided the port of London into three parts. The first is the docks in the Isle of Dogs, which are calculated to accommodate the West India trade, which, usually arriving in large fleets, contributed in a peculiar degree to the crowded and embarrassed state of the river, and which, from the valuable nature of their cargoes, were very much exposed to depredation. There is also, in this part, a canal, by means of which those ships that wish to come up the river, may avoid the circuitous route by Greenwich and Deptford.

The second part is the docks in Wapping, which are intended for the accommodation of several great branches of our trade which are subject to heavy duties. And

The third is, the improvement of the river from the Tower, upwards, to Blackfriars bridge; and this third part includes the rebuilding of London bridge. By this means, colliers and coasting vessels, and all vessels of light burthen, are to be admitted to pass the new London bridge, and ship and discharge goods immediately at wharfs and warehouses, to be constructed along the banks of the river, and opposite to the centre of the city.

The two first parts of the plan have been sanctioned by parliament, and have been undertaken by incorporated companies, excepting the canal, which is now executing under the direction of the city of London.

The committee have, in their third report, also recommended a general plan for improving the third or upper part of the port of London; that is, by removing the present London bridge, and replacing it with one of cast iron, 65 feet high in the clear above high water, with inclined planes connecting it with the present streets, and such other improvements as may grow out of this alteration. Also, deepening the bed of the river, to admit of ships of two hundred tons lying afloat at low water; and contracting the width of the river, in order to preserve its present velocity, and to acquire space for wharfs and warehouses, and for the inclined planes, without

without encroaching upon the property which is now connected with the ſhores.

The portion of this plan which has been more immediately under the conſideration of the committee during the preſent ſeſſions of parliament, has been a deſign by Meſſrs. Telford and Douglaſs, in which it is propoſed to conſtruct the bridge of a ſingle arch compoſed wholly of caſt iron: the ſpan of the arch is 600 feet, being the width to which, by Mr. Jeſſop's report, the river ought to be contracted, if it is excavated to have 13 feet at low water: the height in the clear above high water is 65 feet, being the elevation determined by the reſolution of the committee laſt ſeſſions.

The boldneſs and ſimplicity of this deſign render it an object of attention, not only to the committee, who are engaged in conſidering the further improvement of the port of London, but to men of ſcience and practical engineers, and to all who feel an intereſt in the improvement and credit of their country.

It is now generally admitted that the preſent London bridge ought to be removed, being expenſive and dangerous in itſelf, and forming an obſtruction in the moſt valuable part of the river. If the preſent bridge is to be removed, the new bridge ſhould be rebuilt upon that plan which ſhould leave the river clear of obſtacles, and, at the ſame time, reflect moſt credit on the Britiſh artiſts.

If a ſingle arch can be conſtructed without endangering the ſolidity and duration of the ſtructure, moſt undoubtedly there can be only one opinion as to the propriety of adopting it. It would be a great national work, combining the greateſt degree of utility and magnificence, and ſuperior in its kind to any thing the world has yet ſeen.

In a work of this nature it would have been imprudent to have been guided by the judgment or opinion of any individual; it therefore became neceſſary to collect the ſentiments of all the perſons moſt eminent for ſcientific knowledge and practical ſkill: this has been done by the committee in the moſt effectual and impartial manner that could be deviſed, by tranſmitting copies of the plans, explanatory drawings, and the queries relating thereto, to perſons who are well qualified to inveſtigate the ſubject: thoſe gentlemen have taken it up with an impartiality, candour, and patriotiſm, which does them much honour, and have furniſhed able and ſatiſfactory demonſtrations and opinions. The reſult is, that an arch, of the plan and dimenſions referred to their conſideration, may be conſtructed ſo as to be rendered a ſubſtantial and durable edifice.

The

The particulars of these masterly disquisitions are contained in the Appendix to the fourth Report of the Select Committee for the further improvement of the port of London: they will be the means of throwing much new light on this important subject, and will, most probably, change the principles and practice of this species of architecture.

It would require many drawings and much detail to convey an adequate idea of the form and construction of this magnificent arch; it cannot properly be shown as whole in a drawing upon any scale that would suit a publication of this nature. We understand the public curiosity will be speedily gratified with a perspective view, taken from the Surrey side of the present London bridge, on a plate four feet long and two feet wide, and which, besides the new bridge, comprehends the principal objects in the cities of London and Westminster, from Bow church to Whitehall; and the proposed wharfs, warehouses, and terraces, between the bridges. The bridge part is engraved by that eminent artist Mr. Lowry, whose scientific knowledge is only exceeded by his dexterity as an engraver; and all the rest by Mr. Malton, whose views of London have done him honour, and qualify him to give the back ground with a precision which no other artist could be expected to equal.

According to this plan, the bridge is to be composed wholly of cast iron, which is much less liable to decay or alteration than hammered iron. The ribs are to be cast in portions of as large a size as to be conveniently moulded, and cast correctly, and such as can be readily managed in the removing and putting up: they are to be connected together by cross and diagonal tyes and braces, placed in such a manner that any of the pieces of the ribs or tyes, or braces, may be taken out separately, and be replaced without injury or interruption to the bridge. The ribs will receive the weight and pressure in a direction that the stress will operate upon the pieces of iron endways; therefore, before the bridge can give way, the iron must be crushed to pieces. All the frames or ribs are to be connected vertically and horizontally from the soffit of the arch to the roadway, so that the whole bridge will act as one frame, and by that means lessen the lateral pressure against the abutments, and guard against any error in the equilibration of the arch. The ribs are to be so disposed that they spread from the middle of the bridge to the abutments, with the view of causing the abutments to embrace a greater space on the shore, to increase the width of the bridge, to accommodate the roadway in turning towards the inclined planes, and to prevent any tendency the bridge might have to side

 vibrations:

vibrations: the ſide vibrations will be further oppoſed by the croſs and diagonal tyes and braces, and by the plate or grating which is to be laid acroſs the ribs to receive the roadway. The roadway is to be compoſed, firſt of a light, dry, and durable ſubſtance, laid next to the iron plates; ſecondly, of a compact ſubſtance, which will not admit of water paſſing through it; and, thirdly, of the ſide-paths and pavements for the driving-way.

The whole external form of the bridge is to be compoſed of Gothic tracery; the railing is alſo to be of Gothic work, with Gothic pinnacles to receive the lamps; ſo that the bridge will, at a diſtance, have the appearance of a frame of light Gothic tracery, finiſhed on the top with that wildneſs of outline of which the Gothic ſtyle is ſo capable.

The abutments, by the ſpreading form of the bridge, their connection with the entrances at each end, and with the wharfs at each ſide of it, will occupy a ſpace on the ſhore ſufficient to form an ample foundation for an edifice capable of reſiſting any preſſure whatever. The form and connection of the maſonry will alſo be calculated to diſtribute the reſiſtance through the whole maſs, in the ſame manner as if it was a ſolid rock of equal magnitude: additional ſtrength will alſo be gained by the land arches, or warehouſes, which are under the inclined planes.

By making three entrances or avenues with the additional width of the bridge at each end, advantages nearly equal to thoſe ariſing from three bridges will be afforded to the public. In all reſpects, therefore, the bridge will be an original deſign, as its important ſituation and diſtinguiſhed name juſtly demand.

The ſcaffolding upon which the iron arch will be turned, is to be formed by driving rows of piles into the river, the top of which will be above low-water mark; theſe piles to be properly braced together; upon them will be raiſed a proper framing to ſupport the part of the iron work which will reſt upon them: at a convenient diſtance, to admit barges to paſs, another ſet of piles and frames will be fixed, and theſe frames will alſo be braced together, at a proper height, over the barge openings, which will admit of gangways being made quite acroſs the river, ſo that the whole will become one general frame from ſhore to ſhore. The top being made to ſuit the curve of the ſoffit of the arch, the iron work will then be fixed upon it with facility and eaſe. The weight of the whole iron work, when diſtributed over ſo great a ſpace, is very ſmall, when compared with works conſtructed with ſtone. The ſcaffolding will not, therefore, require

quire to be of the large dimenſions which may at firſt be imagined: the truth of the principles was fully proved by the very ingenious, though apparently ſlight, ſcaffolding, over which the arch of Wearmouth was turned; and they may be illuſtrated by ſtating, that the greateſt ſtone arches are turned upon centres formed of timber. When the courſes of ſtone have been brought up to near the crown of the arch, on each ſide, the whole reſts upon the timber centres, and in large arches this weight is very great: the centre muſt, however, be equal to ſupport the weight; otherwiſe it would give way, and the ſtone-work would fall down.

The iron arch is, in fact, no more than a framing ſimilar to that for the centring for a ſtone arch, with this difference, that the iron framing has little more to carry than its own weight. The iron work having much more ſtrength than timber, may be made proportionally ſmaller. In making and putting up timber centres, there muſt be props and ſupports, and the ſcaffolding for ſupporting the iron framing may be compared to theſe props and ſupports.

By deepening and embanking the river, much uſeful ſpace will be gained, and the properties along each bank of the river, as well as the ſtreets adjoining, and leading from thence into the city, will, by a judicious arrangement, be rendered very valuable. Depoſits, and public markets for coals, may alſo be formed under the wharfs, by which means the lighterage of coals brought from the pool up as far as Blackfriars bridge would be completely ſaved. This plan is propoſed by Mr. Douglaſs, who has given a full deſcription of it in the Appendix to the third Report of the Select Committee of the Houſe of Commons. From his eſtimates on the general conſumption of coal in London, it appears, that the ſavings in two years will be adequate to the expenſe of erecting the new iron bridge. This plan merits mature conſideration. The coals being regularly ſupplied, would tend to prevent ſudden injurious competition, which of late years has been ſuch a burthen on the public.

If this part of the plan for improving the port of London be ſucceſsfully executed, we ſhall no longer be reproached by foreigners, that we have one of the fineſt rivers in the world running through our principal city, yet that we ſuffer its uſefulneſs to be in a great meaſure deſtroyed by maintaining a ſtone embankment acroſs the moſt valuable part of it, by ſuffering its ſhores to exhibit an extent of mud, inſtead of converting them into uſeful wharfs; and its banks to be covered with mean and ſhapeleſs buildings, inſtead of edifices ſuited to ſo noble a ſituation, and worthy the commercial metropolis of Europe.

XI. *On the Purification of Rapeseed Oil.* *By* C. THENARD*.

TO purify oil of rapeseed, mix 100 parts of the oil with from $1\frac{1}{2}$ to 2 parts of sulphuric acid, and stir the mixture. The oil will immediately change its colour; it will become turbid and assume a blackish-green tint, and at the end of three quarters of an hour it will be full of flakes. You must then give over stirring it, and add gradually double its weight of water to remove the sulphuric acid, which, if allowed to remain too long with the oil, would not fail to exercise too strong an action on it, and to char it. The mixture must then be beat for at least half an hour, to bring the moleculæ of the oil, the acid, and water, into contact with each other; after which it is to be left at rest.

When it has rested about eight days, the oil will float on the surface of the water, and the latter will itself float on a black matter, precipitated from the oil by the sulphuric acid: it is this matter which colours the oil, and prevents it from burning with facility. Three very distinct strata, then, are established, as is here seen: the upper one is oil; the second is aqueous, and contains a little sulphuric acid; and the third is carbonaceous. The oil which forms the upper stratum, after these eight days of rest, is far from being limpid: twenty days, in my opinion, would be necessary for it to purify itself merely by repose; but by filtration it may be immediately obtained perfectly clear and transparent. For this purpose, pounded charcoal, and a piece of linen or cotton cloth, may be employed: the two last substances are preferable to any other. The same cloth will serve several times, only it must be carefully cleaned.

By following this process with attention, you may obtain oil which has much less colour, odour, and taste, than that commonly used; which will burn with the greatest facility, and without any residuum; and which is equal to the purest oil sold in the shops, &c. The loss is very inconsiderable.

If you are desirous of obtaining it still purer, it may be exposed again to the same treatment; but, in that case, for 100 parts of oil, one hundredth part of concentrated sulphuric acid will be sufficient. The sulphuric acid will not form in oil which has been once purified a blackish precipitate; on the contrary, it produces a very scanty precipitate, of a grayish-white colour. This precipitate is more difficult to be separated than the former.

* From *Journal de Physique*, Floreal, an. 9.

When

When the oil has been treated with two hundredth parts of fulphuric acid, if it be fuffered to digeft for twenty-four hours with the fourth of its weight of chalk or carbonate of lime, or of argil, you will obtain it almoft as clear as water. Lime, however, cannot be employed with advantage, as it would occafion too much wafte; but, in my opinion, argil would give very advantageous refults: it retains, indeed, a pretty large quantity of oil, but, by means of a prefs, the laft portions of the oil may be extracted from the argil almoft entirely.

XII. *Refearches refpecting the Laws of Affinity.* By C. BERTHOLLET, *Member of the French National Inftitute.*

[Continued from Vol. IX. p. 352.]

XII. *Of Complex Affinities.*

1ft, UNDER the more general name of *complex affinity* I fhall examine that which has been confidered as arifing from the concourfe of four affinities, and which is generally diftinguifhed by the name of *double affinity*.

To give an idea of the action of four affinities, Bergman examines what takes place when a folution of fulphate of potafh and muriate of lime are mixed together. This, fays he, is as if one fhould put into the quantity of water employed the proportions of fulphuric acid, muriatic acid, lime, and potafh, which enter into the compofition of thefe falts: the two bafes act by their affinities on thefe two acids; but though the affinity of the potafh for the fulphuric acid be ftronger than that which it has for the muriatic acid, the affinity of the muriatic acid for the potafh, however, added to the affinity of the fulphuric acid for the lime, gives a fum of forces greater than the affinity of the fulphuric acid for the potafh, and that of the muriatic acid for the lime, which determines an exchange of bafes; fo that, inftead of fulphate of potafh and muriate of lime, there are produced fulphate of lime and muriate of potafh. This explanation is always founded on the fuppofition, that the affinities are conftant forces independently of the quantities and the ftate of faturation.

2d, When the two bafes act conjointly on one acid, the latter divides itfelf, or rather divides its action, in the ratio of their maffes. Inftead of one acid there are here two; and if no feparation is effected, either by precipitation or cryftallifation, the acids will both act upon the two bases equally in the ratio of their masses: if each of the acids were first combined with a base, after the mixture of the solution of the two salts, the sum of the reciprocal forces of the acids and the alkalies would be the same as before; no muriate of potash or sulphate of lime will be formed, but there will be a combination of potash, lime, sulphuric acid, and muriatic acid, which will give the same degree of saturation as before the mixture. Hence it happens, that when two salts, which, by an exchange, ought to produce combinations which would have very different proportions, are mixed, neither acidity nor alkalicity, which would necessarily show themselves if an exchange took place, are observed, as has been very well remarked by Guyton.

3d, It has been concluded, merely from the result of the precipitation and the crystallisation that has been observed, that an exchange of bases has taken place; but this effect has not been ascribed to its real cause.

We have seen (Art. V.) that the force of cohesion determines the separation which in elective affinities takes place by precipitation or crystallisation: it is the same force also which produces the same effect in complex affinities. When I mix a solution of the sulphate of potash with that of the muriate of lime, and when the quantity of water is not great, the lime, in the contact in which it finds itself with the sulphuric acid (No. 1.) experiences the effect of the force of cohesion in a higher degree than the potash. It is therefore a new force which is added to those which before existed; it must decide the combination of the sulphuric acid with the lime at the time of its precipitation.

4th, If we take a view of all the known decompositions which arise from complex affinities, we shall find that the excess of affinity in opposing affinities is always ascribed to those substances which have the property of forming a precipitate or a salt that may be separated by crystallization; so that, from the degree of the solubility of the salts which can be formed in a liquid, may be predicted the order of the affinities of the substances by which Bergman and other eminent chemists would represent the forces in the symbolical tables; for they always ascribe a superiority of affinities to the two substances which ought to form a combination insoluble in regard to the quantity of the solvent.

Lime, magnesia, barytes, and strontian, form with carbonic acid an insoluble salt; all the soluble combinations of these earths, mixed with alkaline carbonates, produce an exchange, the result of which is the formation and precipitation of carbonates with an earthy base.

Barytes

Barytes forms with the fulphuric acid an infoluble falt: when the folution of a fulphate is mixed with that of a falt having a bafe of barytes, there is always formed and precipitated a falt with a bafe of barytes.

As lime forms a fulphate very little foluble, and which is in a great meafure precipitated if there be not a great deal of water, it equally changes its bafe with all the foluble fulphates till the period when precipitation ceafes to take place by the folubility of the fulphate of lime. The fulphate of lime having ftill much more folubility than fulphate of barytes, falts with a bafe of barytes, which are more foluble, decompofe the fulphate of lime.

Oxide of filver forms an infoluble falt with muriatic acid: all falts of filver which are foluble being mixed with foluble muriates, there is precipitated muriate of filver. Mercury, if not too much oxidated, has a fimilar action.

As muriate of lead is little foluble, the falts which the oxide of lead forms with other acids, and which poffefs folubility, produce a precipitate with foluble muriates; but, as an infoluble falt is made with fulphuric acid, the folution of muriate of lead produces a folution of fulphate of lead when mixed with foluble fulphates.

5th, When water, then, in which different falts have been put in folution is made to evaporate, thefe falts feparate according to the order of their folubility, and it is by it that one can judge of the changes of bafe which may take place.

But the folubility of falts varies according to temperatures: it is therefore the relative folubility, according to the different temperatures, that muft be confidered. The nitrate of potafh mixed with the muriate of foda will cryftallize at a low temperature, but the muriate of foda will feparate itfelf even during the time of the evaporation: no exchange of bafes will take place, becaufe the nitrate of foda is a little more foluble cold than the nitrate of potafh; and becaufe, on the contrary, the muriate of potafh is a little more foluble warm than muriate of foda.

6th, I confider here only the principal refult, arifing from a force of cohefion, of fuch a nature, that it makes the effect of the forces oppofed to it to difappear; but when there does not exift a confiderable cohefion in the combinations which can be formed, the mutual action of the fubftances which remain in the liquid ftate of the folvent, and of the proportions which vary by the cryftallization of the newly-feparated combination, muft produce different effects. The experiments I have begun, will foon throw further light on this fubject.

 7th, An-

7th, Another circumstance which may change the action of complex affinities is, the formation of a triple salt which is precipitated; but, by knowing the degree of the solubility of this combination, we may still foresee the composition which must take place. The same consideration may be applied to those affinities called *elective.*

8th, A precipitate is sometimes effected by the mixture of two saline substances which have the same acid; for instance, by a mixture of the muriate of magnesia and the muriate of lime. It is probable that two combinations are then formed, one with an excess of acid and a small part of the two bases, the other with the greatest part of the two bases and a small portion of acid.

This effect is analogous to what we have observed in Art. IX. No. 3; but here it is the mutual affinity of the two bases which determines the precipitation.

9th, We have seen in Art. VII. that heat, by increasing the volatility of a substance, weakens its combination. This cause acts no less in the complex than in the elective affinities. It is a force added to those which act, and determines the union and the separation of those substances which have the greatest tendency to form a volatile combination.

Whenever, therefore, it is desired to know what will happen, by exposing two salts to the action of heat, it is only necessary to examine whether one of the two bases and one of the two acids possess a greater degree of volatility than the remaining base and acid; and we may be assured that, on applying a sufficient degree of heat, the combination of the most volatile base and acid will be formed and sublimed, while the more fixed base and acid will also remain combined. Among the bases, ammonia and the oxide of mercury, and among the acids, the carbonic and muriatic, afford several illustrations of this truth.

10th, Efflorescence ought also to be considered as a force which, in the complex affinities, may determine a combination possessing this property; and to this is owing the formation of natron in the valley of the lake of Natron, and other places where the same circumstances occur.

The observations which I have presented to the Institute of Egypt, which will form a sequel to the interesting discovery of the valley of the lakes of Natron, for which we are indebted to general Andreossi, prove that the circumstances necessary to the formation of natron are, 1. A sand, which contains much carbonate of lime; 2. Moisture; and, 3. The presence of the muriate of soda: I have also remarked, that the stalks of the reed, in a great degree, facilitate the production

tion of this fubftance. I have promifed to explain the formation of the carbonate of foda by means of thefe circumftances, which I fhall now endeavour to perform.

Calcareous fand, conftantly impregnated with moifture, may be confidered as a folution of the muriate of foda, which acts upon the carbonate of lime. Now it follows, from what has been explained in Art. IV. that infolubility caufes a great diminution in the mutual action of a folid and a liquid fubftance, but that it does not deftroy it. This action is oppofed to the infolubility of the carbonate of lime, which is not abfolute. A folution muft therefore be formed of a fmall quantity of carbonate of lime, and, confequently, (No. 1 and 2,) the conftituent parts of this carbonate and of the muriate of foda, which are in folution, exert a reciprocal action; otherwife the prefence of the carbonate of lime would not be a condition neceffary to the formation of the carbonate of foda*.

We muft, therefore, confider the humidity of the calcareous fand, in which the carbonate of foda is formed, as a folution of muriate of foda and a fmall quantity of carbonate of lime: hence foda and carbonic acid are both prefent, and the efflorefcence, which is a property of the carbonate of foda, ought to be confidered as a new force that tends to remove it from this combination. In fhort, when, in a foil impregnated with muriate of foda, we meet with the ftalks of reeds which favour the efflorefcence, the carbonate of foda not only accumulates round thefe ftalks, but fometimes it is not formed without fuch affiftance, when certain circumftances, fuch as a too argillaceous nature of the foil, &c. are little favourable to its production; fo that at a fhort depth muriate of foda only is difcoverable.

* The folution of the carbonate of lime by the muriate of potafh and by the fulphate of potafh, which indubitably act like the muriate of foda, has been proved by a direct experiment, for which we are indebted to Guyton. (*Mem. de Scheele*, part ii. note de la page 18.) "The folution of fulphate of potafh, muriate of potafh, &c. poured in lime-water which has been rendered milky by water impregnated with carbonic acid gas, immediately caufed the precipitate to difappear. There was likewife no earthy precipitate when water, charged with carbonic acid gas, was poured in a mixture of lime-water and a folution of thefe neutral falts; the liquor always contained a portion of uncombined alkali." Guyton combats the opinion of Scheele, who did not obferve any decompofition with the muriate and fulphate with bafe of potafh, but only with the falts with bafe of foda.

The difference of opinion between thofe celebrated chemifts arofe from the circumftance, that one afcertained the decompofition only by the efflorefcence, which is peculiar to falts with bafe of foda (Art. VIII.), while the other obferved it in a liquid, but in the latter inftance it is much more limited.—B.

I wiſhed to aſcertain the truth of this explanation in a trough placed in one of the gardens belonging to the Inſtitute. For this purpoſe, ſome carbonate of lime and ſiliceous earth, both well waſhed, were mixed together, to which was added a certain proportion of muriate of ſoda: a hole was made in this mixture, for the purpoſe of pouring in water occaſionally, and keeping up the neceſſary degree of moiſture. An incruſtation of muriate of ſoda is formed at the ſurface, which already ſtrongly changes the colour of paper tinged with brazil wood, like the alkalis; but we cannot expect to obtain an efflorescence ſo conſiderable as to be perceptible to the ſight, till after a much greater length of time.

11th, The preceding obſervations ſhow that the only difference which diſtinguiſhes the complex affinities from thoſe called *elective*, is, that in the former, ſubſtances are brought into action which are nearly in an uniform degree of ſaturation; and that, in the latter, there is a ſubſtance preſent which is not yet ſaturated (or ſeveral ſuch ſubſtances may be preſent); ſo that, in the former, a new degree of ſaturation is eſtabliſhed only in proportion to the combinations which are capable of being ſeparated; whereas, in the latter, the action of the unſaturated ſubſtances becomes in equilibrio with that of the ſubſtances which were already ſo; whence it happens that the force of coheſion and that of elaſticity produce their effect more completely in the complex than in the elective affinities.

XIII. *Some Account of the Life of the celebrated Mathematician* BOSCOVICH.

ROGER JOSEPH BOSCOVICH was born at Raguſa, in Dalmatia, on the 18th of May 1711. It is aſſerted in the *Gazette de France* for 1775, that his mother lived to the great age of one hundred and two. His ſiſter, alſo, is ſaid to have attained to a great age, and to have been much eſteemed for her poems, written in the Italian language. Boſcovich entered into the order of the jeſuits on the 1ſt of October 1725; in November 1740 he was appointed profeſſor of mathematics in the Roman college, and diſtinguiſhed himſelf by ſeveral excellent mathematical and aſtronomical diſſertations on the rotation of the ſun, on the inequalities in the motion of Jupiter and Saturn, on light, on dioptrics, on the tides, on the atmoſphere of the moon, and the method of calculating the orbits of comets. In the year 1750 he was employed by cardinal Valenti, miniſter of ſtate to pope

pope Benedict XIV. to measure a degree of the meridian in the territories of the church; an undertaking which he accomplished in a satisfactory manner, in conjunction with father Maire of the same order, and of which he gave an account in a work published at Rome in 1755 under the title of *De Literaria Expeditione per Pontificiam Ditionem*, &c. This work was afterwards translated into French, and published at Paris, with the title of *Voyage Astronomique et Géographique dans l'Etat de l'Eglise*, &c.

The measuring of a degree of the meridian in Austria and Hungary by F. Liesganig, in Piedmont by F. Beccaria, and in America by Mason and Dixon, were undertaken on the suggestion of Boscovich, and by means of the influence which he had in different courts on account of the great reputation he had acquired in the mathematics: on the same account he was chosen by the Royal Society of London to observe the second transit of Venus in California; but the dissolution of his order, which happened about that time, prevented his acceptance of this appointment.

In the year 1759 he published at Vienna his *Philosophiæ naturalis Theoria*, and in 1763 he was invited to be professor of the mathematics at Pavia, where he taught for six years. He afterwards removed to Milan, on an invitation from the imperial minister, count Firmian, to be professor of astronomy and optics; and while in this situation he founded the observatory of the jesuits in that city, which gave rise to the imperial observatory, and that now called the Cisalpine observatory of Brera.

In the year 1773, on the destruction of the order of the jesuits, Boscovich was invited to France by his friends in that country, among whom were De la Borde, Durfort, the ministers Boynes and Vergennes, and madame de Sivrac. On this occasion he was naturalised, and obtained the appoinment of *directeur d'optique et de la marine*, with an annual salary of 8000 livres.

Boscovich was a poet of no inconsiderable merit; for the dry and abstruse study of the mathematics damped neither the fire of his genius nor destroyed those powers of the imagination by which those born poets are peculiarly distinguished. His Latin poem on eclipses is highly worthy of notice, both on account of its internal poetical merit, and of the ability and clearness with which the author gives precepts for the most difficult calculations, and explains the most complex parts of the theory of astronomy. It has been translated into French by Barruel. The esteem in which Boscovich was held, occasioned his being involved also in political nego-

negotiations. The republic of Lucca entrusted him with the defence of its interests in regard to its waters and boundaries, then under discussion with the deputies of Tuscany; and he was sent to Vienna to defend this cause before the emperor. This business he brought to a happy conclusion, and thereby rendered an essential service to the republic. He travelled a great deal, and visited most parts of Europe, and even Turkey. His Tour to Constantinople went through two editions, one in Italian in 1762, and a German translation in 1772.

So much merit did not remain free from those animosities which are generally excited by great talents. Some circumstances which took place at Paris on the part of some of the literati of that capital, gave him considerable uneasiness; and, as he possessed great sensibility, they made a greater impression on his mind than they perhaps ought to have done. On this account he resolved, in 1783, to leave Paris, and to proceed to Italy, in order to collect and publish his whole works, which appeared at Bessano in 1786, though said to be printed at Strasburgh, in five quarto volumes, under the title of *Opera ad Opticam et Astronomiam pertinentia.* The part relating to nautical astronomy was translated into German, and published separately at Leipsic, in 1787, by Eschenbach. He wrote also the principles of the mathematics and philosophy, together with a treatise on telescopes, which F. Charles Scherser translated into German and published at Vienna, in 1765.

In the year 1786 he went to Milan, and was employed by the emperor Joseph to superintend the measuring of a degree of the meridian and the construction of a map of Lombardy; but a fit of apoplexy, with which he was seized on the 12th of February, put a period to his existence in the 76th year of his age.

Boscovich was a man much beloved in society; his conversation was animated and agreeable, and his facility for poetical composition was such, that he could readily dictate verses in the course of conversation with his friends. To the variety, the strength, and the cultivation of his talents, he added the most respectable moral principles, and a deportment which rendered the attachment of his friends no less lively than their esteem and respect. Before we conclude this article it deserves to be remarked, that several men of great mathematical genius have been born on the eastern coast of the Adriatic: Boscovich, Pasquich, Vega, Cagnoli, and Bogdanich, were natives of Dalmatia, Carinthia, Albania, and Croatia, &c. all excellent mathematicians.

XIV. *Account*

XIV. *Account of the Discovery of Silver in Herland Copper Mine.* *By the Rev.* MALACHY HITCHINS *.

HERLAND Mine is situated in the parish of Gwinear, about seven miles north-east of St. Michael's Mount, on the southern coast of Cornwall; and two miles and a half from the mouth of the river Hayle, on the northern coast of the same county; it is contiguous to Prince George mine.

It commences in a valley on the west, and passes through a hill, which is first of steep, and then of moderate, ascent, for upwards of half a mile eastward; when the principal copper lodes, which follow this direction, meet with a large cross lode, by which, and by other cross courses and flookans, which intersect them in their farther progress, they are repeatedly heaved, and so disordered by these heaves, in their form and position, and so changed by them, in respect to their composition, as hardly to be recognized.

The strata of the district in which this takes place, consist of the common metalliferous sort of argillaceous slate called *killas*.

The copper lodes of this district are remarkable for the shortness of their continuity; for, whereas other lodes may be traced to an indefinite extent in the same line of direction, these, on the contrary, are observed to taper away gradually, and terminate, to all appearance, at a short distance, completely and irrecoverably.

This mine was worked about twenty years ago, when it was sunk to the depth of one hundred fathoms from the surface. It was again set to work about eight years since; has now four fire-engines and two steam-whims on it; and is sunk to a depth of one hundred and fifty-five fathoms below the surface, or, as the miners call it, from *grass*.

It is in this latter period of its history, that a discovery has been made of a considerable quantity of silver ore, in a particular part of the mine, the singularity of which discovery, in this country, has much excited the curiosity of the public.

For, although the numerous veins of lead in Cornwall are richly impregnated with silver, and occasionally yield small quantities of silver ores, and even specimens of native silver, yet, hitherto, no instance had been known of their yielding this precious metal in such abundance; nor had any circumstances, in the natural history of the mineral veins of this

* From the *Transactions of the Royal Society for* 1801.

country,

country, borne any analogy to those which accompanied the present discovery.

These circumstances, therefore, having been examined with more attention than usual, shall be stated with as much precision as it is possible to obtain, from the report of those practical miners only who have hitherto inspected them.

The facts which deserve to be first noticed are, the confined and insulated position of the mass of silver ore; its great depth from the surface of the mine; and its contiguity to a copper lode.

The lode in which it occurs is one of those cross courses, as they are here called, which intersect and derange the copper lodes, and consequently are of a more recent formation.

Lodes in this direction are usually filled with quartz, but frequently produce galena; and sometimes, instead of galena, sulphurated antimony. They appear here to conform to the same laws, except in the particular instance now to be described, which forms, indeed, a very remarkable exception.

No ores of silver were observable in this lode until at the depth of one hundred and ten fathoms from the surface, or eighty below the adit or level; and, at the farther depth of thirty-two fathoms, they disappeared.

They have been discovered only in the neighbourhood of one of the intersected copper lodes, extending no where above twelve feet from this lode, on the north, or above thirty-two feet from it on the south, and acquiring this their greatest extent at the deepest level; for the usual dimensions of the silver ore are not more than six feet in the former situation, and twelve feet in the latter.

It is remarkable that, at the point of contact or intersection, the contents of the silver lode are so poor as to be scarcely worth saving; and those of the copper lode are much less productive of copper than at a little distance from this point. Moreover, that the copper lode, in the vicinity of the intersection, seems to have been influenced by the same causes of improvement and declension as the cross lode; being richer or poorer in copper, as the latter was, at a correspondent level, in silver.

The richest mass of silver ore was found at the depth of two fathoms above the level at which it disappears.

After this brief account of the most striking facts, it may be proper to enter into a more particular description of the two lodes which appear, by their intersection, to have generated this body of extraneous matter.

The copper lode bears nearly east and west by the compass;

paſs; the croſs lode nearly north and ſouth, or at right angles to it.

The former is about two feet broad, on an average; and it dips or underlies ſouth, one foot in a fathom. The breadth of the latter is about two feet and a half, on an average; and its underlie is eaſt, about eight inches in a fathom.

The heave of the copper lode is about eighteen or twenty inches to the right, in the language of the Corniſh miner; the expreſſion being ſo far appropriate and convenient, as it refers to the uſual ſituation of the obſerver in the heaved lode.

The copper lode is filled with layers of ore and ſtony matter, the latter of which is here called *caple*; but the ore is uſually found contiguous to the walls of the lode.

The contents of the croſs lode are more ſingular, in reſpect to their local poſition, and more various. Only the eaſtern ſide of it produces ſilver ore, the breadth of which is in general about ſix or eight inches, although in ſome places it is greater. The other part of the lode is chiefly compoſed of quartz, intermixed with iron, manganeſe, and wolfram, together with a ſmall portion of cobalt and antimony.

The ſilver ore, ſtrictly ſpeaking, is a mixture of galena, native biſmuth, gray cobalt ore, vitreous ſilver ore, and native ſilver; which, in reſpect to their proportions, follow the order in which they are here enumerated, the galena being the moſt prevalent. The native ſilver, of which ſpecimens of the greateſt beauty have been reſerved for the cabinets of the curious, is found chiefly in a capillary form, in the natural cavities of the lode.

About one hundred and eight tons of this ore have been raiſed. The miners continue to ſink near the ſame point of interſection; and ſeem confident that both lodes will ſoon become richer, becauſe ſimilar inſtances of declenſion and recovery have frequently occurred in the copper lodes of this mine, and becauſe the two lodes appear to have a reciprocal influence on each other.

Unfortunately, however, the extent of their ſpeculation is limited by the great depth of the preſent workings; for, forty-five fathoms have been ſunk ſince the firſt diſcovery of the ſilver; and twenty, or twenty-five fathoms more, are as much as can be ſunk in this mine, with its preſent mechanical powers of drawing the water; at which level, viz. one hundred and eighty fathoms from the ſurface, it would be ſomewhat deeper than any mine in Cornwall, and about one hundred and thirty fathoms below the level of the ſea at low water mark.

The other croſs lodes in this mine produce no ſilver; moſt of them being flookans, or lodes which are effentially different from the argentiferous crofs lode, in the nature of their conftituent mafs. There is one, however, in the eaftern part of the mine, which, from its refemblance to that, is thought likely to produce filver, whenever it fhall be explored to the fame depth, at its point of interfection; although thefe hopes may probably be fallacious, for the argentiferous lode interfects five other copper lodes, viz. two on the north, and three on the fouth fide, without producing any filver.

XV. *Account of New Publications.*

I. *Philofophical Tranfactions of the Royal Society of London for the Year* 1801. *Part I.*

THIS Part contains:—1. The Croonian Lecture. On the Irritability of Nerves. By Everard Home, Efq. F.R.S. —2. The Bakerian Lecture. On the Mechanifm of the Eye. By Thomas Young, M.D. F.R.S.—3. On the neceffary Truth of certain Conclufions obtained by means of imaginary Quantities. By Robert Woodhoufe, A.M. Fellow of Caius College.—4. On the Production of artificial Cold by Means of Muriate of Lime. By Mr. Richard Walker.—5. Account of a monftrous Lamb. In a Letter from Mr. Anthony Carlifle to the Right Hon. Sir Jofeph Banks, Bart. K.B. P.R.S. —6. An anatomical Defcription of a male Rhinoceros. By Mr. H. Leigh Thomas, Surgeon.—7. Demonftration of a Theorem, by which fuch Portions of the Solidity of a Sphere are affigned as admit an algebraic Expreffion. By Robert Woodhoufe, A.M. Fellow of Caius College, Cambridge.— 8. Account of the Difcovery of Silver in Herland Copper Mine. By the Rev. Malachy Hitchins.—Account of an Elephant's Tufk, in which the Iron Head of a Spear was found imbedded. By Mr. Charles Combe. In a Letter to the Right Hon. Sir Jofeph Banks, Bart. K.B. P.R.S.— 10. Defcription of the Arfeniates of Copper and of Iron from the County of Cornwall. By the Count de Bournon.— 11. Analyfis of the Arfeniates of Copper and of Iron, defcribed in the preceding Paper; likewife an Analyfis of the red octaedral Copper Ore of Cornwall; with Remarks on fome particular Modes of Analyfis. By Richard Chenevix, Efq. M.R.I.A.—Appendix.—Meteorological Journal kept at the Apartments of the Royal Society, by Order of the Prefident and Council.

II. *Journals*

II. *Journals of the Royal Institution of Great Britain. Numbers 2 and 3.*

Each sheet of these journals is counted as one Number, price sixpence. The contents of No. 2 and 3 are:—1. A Report on the Progress which has been made in the Arrangement of the Royal Institution, its present State, and its probable future Prosperity and Utility.—2. Observations relative to the Means of increasing the Quantities of Heat obtained in the Combustion of Fuel. By Count Rumford.—3. On the Use of Steam as a Vehicle for conveying Heat from one Place to another. By Count Rumford.—4. An Account of a new Eudiometer. By Mr. Davy.

The three last-mentioned articles will be found copied into the preceding pages of our present Number.

III. *An Epitome of Chemistry. By* William Henry. *Small* 12*mo.* Johnson, St. Paul's Church-Yard.

[Concluded from Vol. IX. p. 268.]

Though we have already laid before our readers a pretty ample extract from this useful little volume, we believe they will not be displeased by a further one. Among the rules for ascertaining the purity of chemical preparations are the following:

" *Sulphuric Acid—Acidum Vitriolicum of the London Pharmacopœia.—Oil of Vitriol.*

" The specific gravity of sulphuric acid should be 1850. It should remain perfectly transparent, when diluted with distilled water. If a sediment should occur, on dilution, it is a proof of the presence of sulphate of lead or lime.

" Iron will be detected in sulphuric acid by saturating a diluted portion of it with pure carbonate of soda, and adding prussiate of potash, which will manifest the presence of iron by a prussian blue precipitate. Copper may be discovered by pouring, into a similar saturated solution, pure solution of ammonia; and lead may be detected by the sulphuret of ammonia. The latter metal, however, is generally precipitated, on dilution, in combination with sulphuric acid.

" Sulphate of potash or of soda may be found by saturating the diluted acid with ammonia, evaporating to dryness, and applying a pretty strong heat. The sulphate of ammonia will escape, and that of potash or of soda will remain, and may be distinguished by its solubility and other characters.

"*Nitric and Nitrous Acids—Acidum Nitrosum, Pharm. Lond. Aquafortis.*

"The nitr*ic* acid should be perfectly colourless and as limpid as water. It should be preserved in a dark place, to prevent its conversion into the nitr*ous* kind.

"These acids are most likely to be adulterated with sulphuric and muriatic acids. The sulphuric acid may be discovered by adding to a portion of the acid, largely diluted, nitrated or muriated barytes, which occasion, with sulphuric acid, a white and insoluble precipitate. The muriatic acid may be ascertained by nitrate of silver, which affords a sediment at first white, but which becomes coloured by exposure to the direct light of the sun. Both these acids, however, may be present at once; and, in this case, it will be necessary to add a solution of nitrate of barytes as long as any precipitate falls, which will separate the sulphuric acid. Let the sediment subside; decant the clear liquor, and add the nitrate of silver. If a precipitate appear, muriatic acid may be inferred to be present also.

"These acids should have the specific gravity of 1550.

"*Muriatic Acid—Acidum Muriaticum, P. L. Spirit of Salt.*

"This acid generally contains iron, which may be known by its yellow colour, the pure acid being perfectly colourless. It may also be detected by the same mode as was recommended in examining sulphuric acid.

"Sulphuric acid is discoverable by a precipitation on adding the muriate of barytes.

"The specific gravity of this acid should be 1170."

IV. *Analytical Essays towards promoting the Chemical Knowledge of Mineral Substances. By* Martin Henry Klaproth, *Professor of Chemistry, Assessor to the Royal College of Physicians, Member of the Royal Academy of Sciences at Berlin, and various other learned Societies. Translated from the German.* 1 *Vol. 8vo.* p. 592. *London: Cadell and Davies.*

THE merits of Klaproth as an analyser are too well known to require commendation. The learned translator, Doctor Gruber, could not have rendered a more acceptable service to English chemists than by giving them the present translation, which is faithful and accurate. We subjoin a short extract from the work.

Chemical

*Chemical Examination of the Elastic Quarz**, *(Sand-Shiefer, flexible Sand-stone,) from Brazil.*

The singular elastic flexibility, so seldom occurring in the mineral kingdom, in which this fossil, in its form and appearance, resembles novaculite (Turkey hone); has attracted the attention of naturalists, but at the same time has led many persons to doubt its existence as a natural substance, and to suspect that this may probably be a product of art. It comes from Brazil, near Villa-rica, the principal town of the province of Minas Geraës, which fact was, for a while, kept a secret. There it occurs in not very thick strata, whose hanging and shading sides are cased over by a gray crust of $\frac{1}{4}$ inch thick; and from thence it was brought to Portugal the first time, in the year 1780, by the marquis de Lavradio, viceroy at Rio de Janeiro. Among the specimens I have seen, that of the imperial cabinet at Vienna, so remarkable for its precious fossils, is by far the greatest; it being 26 Vienna inches long, 16 inches broad, and 1 inch thick. It is, however, probable that this stone, together with its remarkable physical property mentioned before, was already known in the sixteenth century; and that it is the same with that described by Gassendi, *in Vita Peireskii* †, in the character of a flexible whetstone (novaculite); as suggested by the authors of the *Göttingische Gelehrte Anzeigen*, when this stone has again been brought into notice ‡.

On inspecting with a microscope the homogeneous or integrant parts of which this elastic stone is aggregated, and which may be easily separated by compressure or levigation, I found them all alike; that is, they were all flat, longish plates or scales, perfectly clear and pellucid. All their difference consisted in the variety of their outlines; some truncated more sharply, others more obtusely; others longer, but very thin; while others were broader and shorter; but most of them I perceived on one or both sides notably sinuated. I am inclined to think, that the elasticity of this fossil originates solely from the form of its aggregation. For, as may be distinctly seen at the first glance in the entire stone,

* Schriften der Berliner Gesellschaft Naturforschender Freunde, b. vi. 1785, p. 322.—The miners indicate by these expressions the greater or less slope in the strata, though chiefly with reference to rake-veins, not fully perpendicular. The hanging side is that toward the day, and is also called *hanger*; and the hading side, which likewise goes by the name *ledger*, is the under one next to the bed of the stratum. See *Williams's Natural History of the Mineral Kingdom*, 8vo. Edinb. 1789. vol. i. p. 269. Transl.

† Libr. iv. ad annum 1630. p. 254. edit. 1706.

‡ Of the year 1784, No. 211.

all thofe longifh lamellæ are interwoven in one fingle direction, and implicated in fuch a manner, that each junction refembles a vertebra, or hinge. With this idea, alfo, correfponds the particular kind of the flexibility of the ftone, which is not tough or coriaceous. For, if the ftone be held upright and fhaken, it vibrates with fome noife to and fro; but as foon as its agitation is difcontinued, its parts conjoin again firmly by a force like a fpring.

I now proceed to its chemical analyfis.

As, on triturating, I found the particles of the ftone extremely hard, which was indeed previoufly afcertained by its faculty of cutting glafs with eafe, and of ftriking fire with fteel, I endeavoured to facilitate its decompofition by previous mechanical comminution.

To effect this, I fubjected one hundred grains to red heat, and quenched them in cold water; but I obferved, that by this, neither their weight nor their hardnefs had decreafed. They were then reduced to an impalpable powder in an agate mortar, mixed with four parts of dried carbonated foda, and ignited under the muffle in a porcelain faucer, during fix hours, in a moderate degree of heat; by which the mixture only conglutinated, without actual fufion. The ignited mafs was pulverized with water, fuperfaturated with muriatic acid, digefted and filtered. A quantity of very loofe filiceous earth, to the weight of 96½ grains, remained on the filter.

The feparated muriatic fluid was treated with Pruffian alkali; and the blue precipitate, thence arifing, ignited. It weighed one grain; of which, however, only ½ grain can be reckoned as oxide of iron, entering into the 100 grains of the decompofed foffil.

At laft, by faturating the folution with carbonated potafh, a tender earth was thrown down; which, after wafhing, drying, and ignition, weighed 2½ grains; and, examined by means of fulphuric acid, was found to be aluminous earth.

Confequently, hundred parts of elaftic quarz from Brazil have yielded,

Silex - -	96,50
Alumine -	2,50
Oxide of iron -	0,50
	99,50

There are fometimes very fmall blackifh grains, like points, mingled with this ftone. As thefe probably are garnets, or cryftals of horne-blende, it feems that the portion of iron and alumine difcovered in the foffil chiefly proceeds from them.

XVI. *Pro-*

XVI. *Proceedings of Learned Societies.*

ROYAL SOCIETY OF LONDON.

THERE was no meeting on the laſt Thurſday in May, on account of Whitſun week.

On the 4th of June a deſcription of a new aſtronomical inſtrument was read; as was alſo a meteorological journal, kept at Clifton, near Briſtol.

June 11. An account of a method of preparing, in the humid way, a ſimilar ſubſtance to James's powders. By Richard Chenevix, Eſq.

Alſo an account, by Mr. Ware, of the removal of cataracts from the eyes of a boy who had been blind from his infancy; with a detail of the child's obſervations on firſt beholding forms.

June 18. A curious and highly intereſting paper on galvaniſm, by Mr. Davy, containing an account of ſome galvanic combinations formed by the arrangement of ſingle metallic plates with different ſtrata of fluids analogous to the pile of ſignor Volta. All theſe combinations are formed by the arrangement of different chemical agents with ſingle metallic plates. The moſt powerful claſs may be formed by arranging plates of copper or ſilver, and cloths moiſtened, ſome in nitrous acid, ſome in ſolution of ſulphuret of potaſh, and ſome in ſolution of ſulphate of potaſh, in the following order: metallic plate, acid, ſolution of ſulphate of potaſh, ſolution of ſulphuret of potaſh;—then, if the ſpecific gravities of the fluids are in the order of their arrangement, *i. e.* that of the acid greateſt, and that of the ſolution of ſulphuret leaſt, but little mixture or chemical action between them will take place. Twelve plates of copper arranged in this way give ſenſible ſhocks, and rapidly produce the common appearances in water. In all the galvanic combinations with ſingle plates, the metallic ſurface which oxidates is the ſurface which in the circuit with wires produces hydrogen from water.

On the ſame evening were read ſome additions, by Dr. Hulme, to his paper of laſt year, on the ſpontaneous light emitted by various bodies. Some very curious experiments were detailed reſpecting the immerſion of the luminous bodies in the different gaſes, and the effects thereby produced upon them.

On the 25th there was read a highly intereſting paper on the identity of the galvanic and electric fluids, by Dr. Wollaſton. The doctor has ſucceeded in decompoſing water by means of common electricity, as rapidly as by the pile of

Volta. He has obviated the difficulty which occurred from the fluid paſſing more or leſs in the form of ſparks, by employing a gold and a ſilver wire, inſulated in oppoſite ends of a glaſs tube, and preſenting to each other as fine a point as they could poſſibly be made to take. The tube in which they were inſerted contained the water to be decompoſed, and made part of an electric circuit.

Some valuable additions to Mr. Aſhley Cooper's paper on the membrana tympani were read the ſame evening, giving an account of ſeveral caſes of perſons being reſtored to hearing by this membrane being ſimply punctured.

ROYAL INSTITUTION OF GREAT BRITAIN.

Since our laſt notice, a ſhort courſe of lectures on pneumatic chemiſtry have been delivered by Mr. Davy. They were extremely ingenious, and excited a conſiderable degree of intereſt. The concluding lecture was on the 20th of June, on reſpiration; and after the lecture an opportunity was given to ſuch as wiſhed it, to breathe ſome of the nitrous oxide, the gas of which we gave ſo full an account in our ſixth volume under the name of *gaſeous oxide of azote*.

Mr. Groſvenor Bedford, Mr. Stodart, and Mr. Underwood, breathed the gas; and the effects it produced, eſpecially on the laſt, were truly wonderful. He experienced ſo much pleaſure from breathing it, that he loſt all ſenſe to every thing elſe, and the breathing-bag could only be taken from him at laſt by force. The irreſiſtible tendency to muſcular action produced by this gas was ſuch as cannot be deſcribed; it muſt be witneſſed to be conceived.

Profeſſor Pictet, of Geneva, who is now on a viſit in this country, count Rumford, and other philoſophers of eminence were preſent, and ſeemed not a little gratified with the exhibition of this gas.

On the 23d of June a ſelect party met at the Inſtitution to try the effects of the gaſeous oxide. Count Rumford, Sir Charles Blagden, Dr. Woolaſton, Profeſſor Pictet, and other ſcientific gentlemen were preſent. Several of them breathed the gas, and were more or leſs affected with pleaſurable ſenſations and other effects uſually produced by the inhalation of this gas.

Another galvanic courſe was alſo given by Mr. Davy, which, being delivered in the fore part of the day, was attended not only by men of ſcience but by numbers of people of rank and faſhion; a proof that this Inſtitution bids fair to promote a taſte for philoſophical purſuits among thoſe whoſe wealth

wealth has but too often foftered the idea that fuch fubjects were beneath the notice of *independence*. The fubftance of thefe lectures will, we underftand, be publifhed in the journals of the Royal Inftitution.

We are forry to ftate that the Inftitution has loft the future fervices of Dr. Garnett, that gentleman having given in his refignation within thefe few days to the managers. His reafons for withdrawing we have not heard; we are happy, however, to learn that his medical abilities will ftill be devoted to the fervice of the public.

SOCIETY FOR THE ENCOURAGEMENT OF ARTS, MANUFACTURES, AND COMMERCE.

This ufeful body, to whom the public are indebted for numerous improvements which, moft probably, would never have been introduced but for the emulation it excites among all ranks, and the liberal patronage it affords to every thing calculated to benefit the community, had its annual meeting for the diftribution of premiums and honorary rewards, at the Society's rooms in the Adelphi, on the 26th of May.

A concife but interefting hiftory of the Society, embracing an account of its origin and progreffive advancement, and afferting with proper confidence, yet with becoming modefty, the fervices it has rendered to the arts, manufactures, and commerce of the country, was read by Mr. Taylor, the fecretary; after which the names of the fuccefsful candidates were proclaimed, and the rewards of the Society delivered to them by the hands of the chairman, accompanied with the hearty gratulations of a numerous and highly refpectable meeting.

FRENCH NATIONAL INSTITUTE.

A commiffion appointed by this body has lately been occupied with experiments in galvanifm, on which fubject the following notice was read by C. Cuvier:

Accident, the parent of almoft all difcoveries, has lately favoured the philofophical world in a manner which will render this epoch very remarkable in the hiftory of the fciences. Some bits of metal brought into contact have manifefted phænomena which no fagacity could forefee, and have opened to us a field as vaft as it is fertile in important applications.

The influence of thefe phænomena becomes more and more extended. Being at firft confined, according to every appearance, to the animal œconomy, it feems now to act an important part in chemiftry. It is to the genius of Volta,

 above

above all, that we are indebted for this new discovery. His opinion, that galvanism was only an application of electricity to the animal œconomy, having been confirmed by several men of science, he endeavoured to find out the means of increasing its effects so far as to render the real nature of them evident to every body; and he found that, by multiplying the pairs of metals, disposing them always alternately, and keeping them moist—attractions, repulsions, and commotions, perfectly similar to those occasioned by the Leyden flask, are produced; and that, in general, a pile, formed of silver, zinc, and moistened pasteboard alternately, immediately manifests all the appearances of vitreous electricity at the extremity where the silver is, and of the resinous at that where the zinc is placed. There is, however, this difference, that a Leyden flask, once discharged, exhibits no more effects unless it has been again charged; whereas Volta's pile constantly charges itself so that its effects are incessantly renewed; and it is only by discharging it with very large conductors that it can be diminished for a moment.

Besides, the Leyden jar will always discharge itself by the means of water. If there be the least moisture in continuity between its two surfaces, its effects are annihilated; but with however much water the pasteboard-pieces of Volta's pile may be impregnated, its effects lose none of their intensity: they do not cease till the pile is entirely immersed in water.

These differences ought to excite some doubts respecting the perfect identity of galvanism with electricity; and other phænomena, still more extraordinary, increase these doubts. If the ends of two metallic wires be immersed in water, one of which communicates with the resinous or negative extremity of the pile, and the other with the vitreous or positive; and if they be kept at a little distance from each other, there are disengaged from the extremity of the former bubbles of hydrogen gas, and from that of the other oxygen gas, which becomes fixed in the metal when the latter is oxidable, or, if it be not so, rises in bubbles; and this action continues as long as the apparatus remains in this state. But it is not in this that the great singularity of the phænomena consists, and it is here that galvanism begins to enter the province of chemistry.

It would have been very natural to consider this gas as the product of the decomposition of water, if a particular circumstance had not excited doubts in regard to this explanation. That the disengagement may take place, the ends of the wires must be at a certain distance; if they touch, no bubbles are seen. How comes it that the oxygen and hydrogen, arising from

from the fame molecule of water, fhould appear at points fo far diftant? And why does each of them appear exclufively at the wire connected with one of the extremities of the pile, and never at the other?

Such was the ftate of our knowledge refpecting galvanifm at the time of the notice given to the clafs three months ago. All the experiments made in France and other countries, arranged and confirmed by a commiffion, have conducted to the three following refults:—an augmentation of intenfity, according to the number and extent of the metallic furfaces brought into contact; a continued renewal of the action; and a production of the two gafes by the communication of the two extremities of the pile with water.

But for three months paft philofophers have redoubled their efforts; their curiofity has been excited, above all, by the laft phænomenon: fome have imagined they could diftinguifh in it the bafes of a new fyftem of chemiftry; others, more prudent, have fufpended their judgment, or have endeavoured to refer the facts to the theories already known. But, whatever might be their individual fyftem, they ought all to have begun by a fimilar refearch—by trying to produce the two gafes in feparate quantities of water.

If the two quantities of water are perfectly infulated, the gas does not appear: if they are made to communicate by a metallic wire, there is only a double production of gas; that is to fay, each extremity of the intermediate wire acts in the portion of water in which it is immerfed, as if the wire came immediately from the extremity of the pile oppofed to that which communicates with that portion, fo that each portion gives at the fame time two gafes.

But if fulphuric acid be interpofed between the two quantities of water, the gafes manifeft themfelves each on its own fide. The cafe is the fame if a communication be eftablifhed between the water by the means of a living body, fuch as the hand. Thus, the production of each gas in the feparate quantities of water is completely proved.

It is evident that there are only three poffible ways of explaining thefe facts: either the galvanic action tends in each quantity of water to take away one of its conftituent parts, leaving the other in excefs; or it decompofes the water, and, fuffering one of the gafes to be difengaged at the end of one of the wires, conducts the other, in an invifible manner, to the extremity of the other, to fuffer it to be there difengaged; or, in the laft place, the water is not decompofed, but its combination with fome principle or other, emanating from the pofitive poſitive ſide of the pile, produces oxygen gas, and with that emanating from the negative ſide, hydrogen.

The two firſt opinions have been advanced in the claſs by Monge, and the other in a memoir by Fourcroy; the third belongs to ſome foreigners, and particularly profeſſor Richter of Jena. It appears to be ſo much in contradiction with the whole of the other chemical phænomena, that it would have been impoſſible to admit it, even if the experiment in queſtion could not have been ſatisfactorily explained in another manner.

The memoir of Fourcroy is the reſult of very numerous experiments made by Vauquelin and Thenard; and he adds to a very ingenious explanation of the principal fact, a multitude of circumſtances before unknown. Theſe authors admit the exiſtence of a peculiar fluid which they call the galvanic, and which circulates from the poſitive ſide of the pile towards the negative. According to them, this fluid, on iſſuing from the poſitive ſide, decompoſes the water, and ſuffers the oxygen to eſcape in bubbles; but it combines with the hydrogen to form a liquid which traverſes the water, or the ſulphuric acid, or the human body, in order to reach the extremity of the negative wire, where the galvaniſm abandons its hydrogen, and, in its turn, ſuffers it to eſcape in the form of gas, while it itſelf penetrates the wire.

The following is the experiment by which the authors prove that ſuch is the ſecret progreſs of the phænomenon:—If well waſhed oxide of ſilver be interpoſed between the two waters, the negative wire, near which the hydrogen gas ought to manifeſt itſelf, produces no efferveſcence, and the oxide is in part reduced on the poſitive ſide: the reaſon of this, ſay theſe authors, is, becauſe the galvanic fluid charged with hydrogen loſes it in traverſing the oxide, the oxygen of which takes it up to re-form water.

C. Cuvier lately read in the Inſtitute an intereſting paper on foſſil bones, from which the following is an extract:—Bones which have belonged to ſome animal different from any of thoſe now exiſting on the ſurface of the globe have been found under the earth, in great abundance, in all countries. The ſoil of Siberia is full of ſuch bones; and there is ſcarcely a diſtrict in Germany, Italy, France, England, Ireland, and Spain, in which ſome of them have not been dug up. The foſſil bones found on the banks of the Ohio have been long known. Some of them were found by Dombey in Peru, and the Spaniards brought a whole ſkeleton from Paraguay. It is even probable that ſuch remains of the antediluvian world are to be found in Africa and New Holland.

Such

Such bones are diſcovered not only in the moſt modern ſtrata, but even in the middle of rocks. The foſſil bones of ſome of the mammalia are found in the neighbourhood of Paris in prodigious banks of gypſum, which are covered with banks of petrified ſea-ſhells, &c. It is an important obſervation, that the older the mountainous ſtrata in which ſuch remains of mammalia are found, the more different are the animals from thoſe of the preſent world. I think I may almoſt with certainty affirm, that all the real foſſil bones which I have had an opportunity of examining with accuracy, belonged to none of thoſe kinds of animals now exiſting on the globe. It is only in regard to the teeth of ruminating animals that this aſſertion cannot be made with certainty. By attentive examination, and the aſſiſtance of my friends and predeceſſors, I have been able to determine from their remains twenty-three ſpecies of animals which, in all probability, do not at preſent exiſt.

1ſt, The foſſil bones which approach near to thoſe of the Indian elephant, but which are, however, different from them: 2d, The elephant of the Ohio: 3d, The rhinoceros with a lengthened head: 4th, The megatherium, of the claſs of the ſloth, found in Paraguay: 5th, The bear of the Gailenreuther cavern: 6th, A ſecond ſpecies of bear, ſometimes ſimilar to the former: 7th, A kind of animal from the ſame cavern, forming a middle ſpecies between the wolf and the hyæna: 8th, The foſſil bones of the great elk: 9th, Several kinds of large foſſil tortoiſes: 10th, The ſo called crocodile of Maeſtricht: 11th, The ſingular flying amphibium, of which Collini has given a figure: 12th, Another amphibium, or kind of whale, mentioned by Collini. Beſides the above twelve kinds of animals, deſcribed by others, I was the firſt who determined eleven other kinds; viz. 13th, The animal of Simore, in Languedoc, approaching near to the elephant of the Ohio: 14th, A kind of tapir different from that now exiſting: 15th, A gigantic tapir: 16th, A kind of river horſe of the ſize only of a ſwine: 17th—22d, Six varieties of a ſpecies which, in conformation, ſtands between the rhinoceros and the tapir; of theſe, one kind was as large as the horſe, while the reſt were merely of the ſize of the rabbit; all theſe were found in the gypſum of Paris. 23d, In the laſt place, I found lately, near Honfleur, the bones of a ſpecies approaching near to the crocodile. I do not include here three claſſes of uncertain bones. The firſt claſs are ſimilar to thoſe of animals now exiſting; ſuch as the tiger, hyæna, and the deer. The ſecond claſs are like the bones of ruminating animals, whales, &c. from Verona, Gibraltar, Orleans,

Orleans, Dalmatia, &c. The third clafs are ftill uncertain; as it is not known whether they are real foffil bones of the urus, buffalo, and arnis. From this quantity one may judge what may be hoped from the united refearches of all naturalifts, when it is confidered that thefe fpecies of animals, now loft, were collected or determined in the courfe of two years by one man, who employed no other means for that purpofe than his own zeal and the affiftance of his friends. The moft celebrated foreign naturalifts, my colleagues in France, thofe in France as well as in foreign countries who poffefs cabinets, and the keepers of public collections, have all been fo good as to affift me with their advice, and to communicate to me the facts which were known to them. By the degree of perfection to which my work has been brought, I flatter myfelf that I am entitled to the fupport of all the learned in Europe. I am now in poffeffion of more than 300 drawings: 50 copper-plates are finifhed, feveral others are begun, and I expect, before the work is publifhed, to enrich it with important matter, which this notice may procure.

ELECTORAL ACADEMY OF MUNICH.

In the fitting of April 20th, the following prize queftion, propofed by the Philofophical Clafs for 1801, was again propofed for 1803, as no fatisfactory anfwer had been received:

Are the azotic gafes produced by fo many means totally unlike, and in fo many different ways, perfectly the fame in all their chemical properties and fundamental principle (fimple azote) as that of the atmofphere? And, Has the nitrous acid the fame azote for its acidifying principle as the azote of the atmofphere?

The following have alfo been propofed for the year 1803 by the fame Clafs:

To determine, by chemical analyfis as well as fynthefis, whether manganefe be an effential component part of every kind of fteel; and particularly of caft fteel, prepared according to Clouet's method?

The Hiftorical Clafs, at the fame time, propofed the following queftion for 1802:

In what writings is any mention to be found of the Bavarian hiftory, from the origin of the Bavarian nation to the 15th century? who were the authors of them, and what are their hiftorical authority and importance?

Anfwers to the two queftions of the Philofophical Clafs muft be tranfmitted, before the 1ft of November 1801, to the fecretary of the academy J. Kennedy. The prize is the ufual gold medal of the value of fifty ducats.

XVII. *Intel-*

XVII. *Intelligence and Miſcellaneous Articles. June* 1801.

GALVANISM.

MR. BOLTON, of Birmingham, has ſucceeded in procuring ſuch a ſpark by the galvanic pile as to be able to explode by its means a mixture of oxygen and hydrogen gaſes. His pile conſiſted of 1500 pairs of plates.

Mr. Cruickſhank has alſo ſucceeded in exploding the ſame ingredients by means of the galvanic ſpark. He employs a galvanic battery of his own invention. It conſiſts of troughs made of baked wood, with notches at ſhort diſtances, ſawn in the ſides oppoſite to each other, to receive pairs of ſquare metallic plates, zinc, and ſilver, ſoldered together, and introduced with cement compoſed of reſin and wax. Three pairs of plates, with the intervening cells, occupy about an inch and a tenth of the trough, and the cells are ſo well ſecured with cement that no water can paſs from one to another. One trough is about 26 inches in length, 1·7 inch deep, and 1·5 inch wide, and contains 60 pairs of plates. A galvanic battery may be compoſed by connecting ſeveral of theſe troughs together. When the machine is employed, the interſtices or cells between the plates are filled with water, with ſolutions of ſalts or alkalies, or with dilute acid: it gives ſtrong ſhocks and ſparks, viſible in the day-time; and is found to be eaſily kept in order, and in conſtant action, when that is wiſhed.

C. Fourcroy has juſt publiſhed the following notice:—"Among the new facts with which the ſcience of nature is daily enriched, none is ſo remarkable, or deſerves more the attention of philoſophers, than that relating to the inflammation of iron by galvaniſm. The apparatus for the experiment, made at the French National Inſtitute in the ſitting of the firſt Claſs on the 10th of June, before the Count of Leghorn, conſiſts of eight plates of zinc and eight plates of copper from 10 inches to 7½ inches in diameter, and from a line and a half to two lines in thickneſs, placed upon each other, and ſeparated two and two by pieces of cloth of the ſame ſize, well moiſtened with a ſaturated ſolution of muriate of ammonia. The two pieces of metal at the extremities of this apparatus, the zinc and the copper, were made to communicate by means of two ſilver wires, at the extremity of one of which was a bit of very fine iron wire rolled in a ſpiral form, the free point of which projected beyond the ſilver wire. At the moment of contact, the iron becomes red, and emits very bright ſparks. Sometimes it inflames

with

with a real deflagration in the atmofpheric air. This laft effect always takes place in oxygen gas, and has a perfect refemblance to the inflammation which iron experiences when immerfed in that gas after a piece of lighted tinder has been attached to it.

" In the air the wire often becomes red, fufes into globules, is vaporized at the fame time that it emits bright fparks, and the portion of the wire next to that which has been fufed becomes brittle like the oxide of that metal. Inftead of forming the communication with wires, if the branches of a pair of fciffars (*pair de cifeaux*) be employed, as is frequently done for trying the piles, there is excited at the extremity of the one which touches the zinc, a bright fpark, accompanied with a decrepitation.

" The communicating wire when immerfed in hydrogen gas, and in carbonic gas, is alfo luminous; but it is only rednefs or incandefcence, as the wire does not change colour, and ftill retains its ductility. This incandefcence is manifefted when the experiment is made under mercury with gas and conductors very dry; the effect therefore is not owing to the water decompofed on the conducting wires, but to two caufes united.

" The motion of the galvanic fluid reddens the iron; and the air, particularly the oxygen gas in which it is immerfed, inflames it, and burns with decrepitation or deflagration.

" Small parcels of zinc placed on the laft plate, and touched by a brafs wire communicating with the lower plate, are fometimes reduced to powder or into fmoke at the moment of contact, and a very fenfible decrepitation is then produced, but without inflammation. This phænomenon is not fo conftant as the inflammation of the iron wire.

" This inflammation does not take place, unlefs the plates of copper and zinc be from 10 to $7\frac{1}{2}$ inches, at the leaft, in diameter.

" It is moft remarkable, that piles compofed of thefe large plates give only feeble fhocks, and effect only very flowly the decompofition of water; while if each of the plates be divided into four, and if thefe fmall plates be placed one above the other, with pieces of cloth moiftened with an ammoniacal folution interpofed between each pair, they produce a commotion four times as ftrong, and a much fpeedier decompofition of water, without exciting an inflammation of the air. Thus, the galvanic power which ignites metals rifes in a ratio different from that which decompofes water, and excites mufcular movements.

" The firft of thefe powers follows the fize of the metallic plates

plates piled on each other, and the ſecond, the number of the plates, and their ſuperpoſition; the firſt increaſes with the ſize of the plates without increaſing by their number; the ſecond increaſes with the number without ſenſibly increaſing by the diameter of each of them, at leaſt, ſo far as has been tried.

"It is not proved that the galvanic effects are the ſame as thoſe of electricity, notwithſtanding the identity hitherto admitted by very eminent philoſophers between theſe two fluids. It even appears that the more experiments and diſcoveries are multiplied, the more this pretended identity diſappears, or, at leaſt, is weakened. The piles of large plates which inflame iron give no effect, or almoſt none, with the moſt ſenſible electrometers, when the upper plate of zinc is taken from the lower plates by means of ſilk ſtrings, as is done with the electrophorus. We obtained nothing by applying the electrometer of Sauſſure. We tried to produce, by a ſtrong electrical apparatus, the chemical effects produced by galvaniſm; viz. the ſolution of metallic oxides; the precipitation of their ſolutions; and the decompoſition of acids; but the attempt was not ſucceſsful."

A SINGULAR PHÆNOMENON.

A very curious phænomenon was obſerved on the 24th of May, after a ſtorm, in the neighbourhood of Raſtadt. A tub, which had been left in the open air during the rain, having become filled with rain water, there were obſerved on the ſurface of it a great many moleculæ, ſimilar to ſulphur in a ſtate of fuſion, which made it be preſumed that the water muſt be ſtrongly impregnated with ſulphureous matter, and, conſequently, be very inflammable. On trial this was actually found to be the caſe: a ſtick immerſed in it readily inflamed when brought near a very weak fire.

During this ſulphureous rain, a heavy ſtorm of hail ravaged a part of the ſame country ſituated beyond the ſmall rivers Kunſig and Schutter. The hail-ſtones were of the ſize of an egg.

COUNT RUMFORD.

In the biographical ſketch of this gentleman, inſerted in our laſt number, we mentioned his having founded a biennial premium of the value of 60l. to be adjudged by the Royal Society of London to the author (reſiding in Europe) of the moſt uſeful diſcovery reſpecting heat or light.

We take the preſent opportunity of mentioning another circumſtance, of which we were then ignorant, but which ought to be generally known. The Count has alſo founded a like premium of equal value for ſimilar diſcoveries made *in America*, to be adjudged by the American Academy of

Arts and Sciences. The fund for this premium is 5000 dollars in the American three per cent. ſtock, which was transferred to the Academy.

MANUFACTURE OF GUNPOWDER.

We have to requeſt that our readers will have the goodneſs to correct the following *errata* in Mr. Coleman's paper on this ſubject given in our laſt Number, as they materially affect the ſenſe:—Page 359, line 21, for *paſſed* read *preſſed:* p. 360, l. 23, for *if ſparks* read *if no ſparks:* p. 365, l. 4, for *ſulphate* read *ſulphite*; line 13, after *united with a ſmall*, read, *proportion of carbonic acid, ſulphate of potaſh, a very ſmall quantity*, &c.

Mr. Coleman informs us that the *gloom* is not in a heated ſtate when the powder is taking in and out of the ſtove, and that it is furniſhed at the ſame time with a copper and other coverings. He approves, however, heating the ſtoves by means of ſteam-tubes, as mentioned in the note, p. 360.

ANTIQUITIES.

The Babylonian bricks, received by the Eaſt India company from Bagdad, are of two kinds; the one dried in the ſun, the other kiln-burnt or baked in a furnace. Dr. Hager is now engaged upon a work on the Perſepolitan inſcriptions, as they have hitherto been called, found impreſſed on theſe bricks. The ſubject is extremely curious and intereſting, and promiſes no little gratification both to the linguiſt and the antiquary.

Other valuable articles, beſides thoſe arrived from Aſia, are expected from Perſia, ſent by colonel Malcom.—An ORIENTAL MUSÆUM will ſhortly be opened at the Eaſt India-houſe for their reception.

LONGEVITY.

In the community of Pommiers, the department of Iſeres, lives a carpenter, who enjoys full health and ſtrength at the age of 115 years. His eldeſt ſon is 81; his ſecond ſon 80; his only daughter 65. The father is now the ſtouteſt and healthieſt perſon of the family.

BLEACHING.

The next and ſucceeding Numbers of the Philoſophical Magazine will contain a tranſlation of a new work, juſt publiſhed in France, entitled, "*An Eſſay on Bleaching; with a Deſcription of the new Method of Bleaching by Steam, according to the Proceſs of* C. CHAPTAL, *and on its Application to the Arts: by* R. O'REILLY, *of the Academy of Bologna, Member of the Lycæum of the Arts, &c.*

We expect to be able to compriſe the whole in three or four Numbers.

XVIII. *An Essay on Bleaching; with the Description of a new Method of Bleaching by Steam according to the Process of* C. Chaptal; *and on its Application to the Arts. By* R. O'Reilly, *of the Academy of Bologna, Member of the Lycæum of the Arts, &c.*

THE art of bleaching is one of those connected with the first ideas of civilization. The theory on which it is founded was entirely unknown to the antients; but the Egyptians were acquainted with the detersive quality of some kinds of clay, and the effect produced by the atmosphere, moisture, and light, on the stuffs exposed to their action.

Health and cleanliness rendered it necessary to devise quicker means than these; and the property of soap and leys of ashes were therefore soon discovered.

In the present age, the arts, following science with close steps, have taken advantage of processes and detersive menstrua, the existence of which was before unknown: these discoveries have succeeded each other with such rapidity, that the last six years have effected a complete revolution in the art of bleaching.

This art divides itself very naturally into two quite distinct branches, which we shall avoid confounding. One of them comprehends the bleaching of animal substances; the other, that of vegetable matters. We shall treat of these subjects separately, as well as of the different menstrua and detersive substances generally employed.

Bleaching of Animal Substances.

The substances produced by the animal kingdom, which are more particularly employed as vestments, differ essentially from those of the vegetable kingdom. It is on a knowledge of the most striking traits, which form the line of demarcation between the two kingdoms, that the art of bleaching is founded.

Vegetables serve as nourishment to the animals and insects the spoils of which we employ. Animalized by their organs they acquire other properties. *Azote*, in particular, seems to be their most distinguishing character: it is scarcely found in vegetable substances. To this principle we may add the existence of sulphur and phosphorus, which form so many

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sources for those pestilential exhalations with which the decomposition of animal matters, by putrid fermentation, is always accompanied.

The affinity of aggregation of these substances, or that law of adhesion which keeps their moleculæ together, is weaker than in the vegetable kingdom; for this reason they are so easily dissolved and destroyed by acids and alkalies, and hence the readiness with which aëriform fluids are produced.

The bleaching of animal substances requires the concurrence of alkalies, soap, ammonia, and sulphurous acid. We shall here confine ourselves to an examination of wool and silk, as the animal substances most generally employed, and which it is of importance that manufacturers should be acquainted with the method of bleaching in the most œconomical and most expeditious manner.

Of Wool.

Wool is a kind of hair with which the bodies of several animals are covered. It is composed of filaments or tubes filled with an oily or medullary substance. The sides of these tubes are perforated with a multitude of small pores, which communicate with the longitudinal tube. By chemical analysis wool gives a great deal of oil and carbonate of ammonia: caustic alkaline leys destroy it entirely; and it is to the facility with which it dissolves in alkalies that we are indebted for the noble discovery, made by C. Chaptal, of the *soap of wool.* Wool experiences no change in boiling water: this observation is of great importance, in regard to the art of which we are now treating; it alters very little when preserved in a place well aired; acids have very little action on it; when exposed to a strong heat it enters into fusion. All these facts united prove that wool is a semi-oleaginous substance. The grease with which it is covered when on the body of the animal, and from which it is freed by scouring, serves to confirm this assertion.

An examination of these chemical facts is necessary for understanding the principles which ought to direct the artist in the bleaching of this substance. The little action which acids have upon wool, and its unalterability in water, even when aided by caloric, render it necessary to have recourse to alkaline or saponaceous leys; but its solubility in these salts shows that great prudence and caution must be employed. In regard to acids, none have been hitherto used but the sulphurous acid obtained in the gaseous state by combustion.

Of the Bleaching of Wool.

In the preliminary operations to which wool is subjected, it is customary to leave a little of its grease to secure it from insects. Wool is often freed from the grease by the farmers when they wish to sell it at a high price; but in the subsequent manipulations it is greased or oiled before it is combed, spun, &c.; and as this fat matter attracts dust, it dirties and thickens the stuffs. The first kind of bleaching to which wool is subjected, is to free it from these impurities. This operation is called *scouring*. In manufactories it is generally performed by means of an ammoniacal ley, formed of five measures of river water and one of stale urine; the wool is immersed for about twenty minutes in a bath of this mixture heated to fifty-six degrees; it is then taken out, suffered to drain, and then rinsed in running water: this manipulation softens the wool, and gives it the first degree of whiteness; it is repeated a second, and even a third time, after which the wool is fit to be employed. In some places scouring is performed with water slightly impregnated with soap; and, indeed, for valuable articles this process is preferable, but it is too expensive for articles of less value.

Fulling the cloth adds still to the whiteness, and if a new degree be necessary it must be procured by the action of the sulphurous acid; that is to say, of the fumes of sulphur in a state of combustion, or that acid vapour condensed and combined with water.

Sulphuring is generally performed in an arched or very close chamber, constructed in such a manner that the articles to be exposed to the action of the sulphur can be suspended on poles. The chamber being filled, a certain quantity of sulphur is put in a state of combustion on flat dishes having a large surface with very little depth: the entrance is speedily shut, and all the interstices around the door are carefully stopped to prevent the access of the atmospheric air. The acid generated by the combustion of the sulphur penetrates the stuffs, attacks the colouring matter, destroys it, and effects the bleaching. The stuffs are left in the stove some time after the deflagration has ceased. This time varies from six to twenty-four hours. They are then taken out, and made to pass through a slight washing with soap, to remove the roughness they have acquired by the action of the acid, and to give them the necessary softness.

A simple description of this process shows how imperfect it is. At first the acid of the sulphur acts only on the surfaces, and does not penetrate them. This aërial immersion is not ſufficient; the gas cannot introduce itſelf to a ſufficient depth into the ſtuffs, and the ſuperficies only is whitened. By taking advantage of the intimate knowledge which we have of the nature of this acid, we have diſcovered a proceſs much ſimpler, more œconomical, and more agreeable to the principles of ſcience.

The ſulphurous acid, or that acid generated by the imperfect combuſtion of ſulphur, differs from the ſulphuric acid (oil of vitriol) by its containing leſs of the acidifying principle, and by being, as we may ſay, the mean term between ſulphur and the ſulphuric acid. As we are deſirous that our work ſhould be underſtood in manufactories, we ſhall ſpeak only very briefly of the chemical properties of the ſulphurous acid, and ſhall proceed to the method of preparing it.

Sulphurous acid gas unites very eaſily with water, and in this combination it may be employed for bleaching wool and ſilk. The ſulphurous acid in this ſtate of liquidity may be prepared by making it traverſe water in an apparatus nearly ſimilar to that uſed for preparing oxygenated muriatic acid. The moſt œconomical method of obtaining it is, to decompoſe ſulphuric acid (oil of vitriol) by the mixture of any combuſtible matter capable of taking from it a part of its oxygen. In exact experiments of the laboratory, where the chemiſt is deſirous of having great purity, it is obtained by means of metallic ſubſtances, and particularly by mercury; but for the purpoſe of which we are treating, where great œconomy is required, we would recommend the moſt common ſubſtances. We ſhall therefore give the following proceſs:

Take chopped ſtraw, or ſawduſt, and introduce it into a matraſs; pour over it ſulphuric acid, applying at the ſame time heat, and there will be diſengaged ſulphurous acid gas (vapour of ſulphur), which may be combined with water in the following apparatus, and by the following method:

Place long necked matraſſes on a furnace, and make them communicate with a tubulated flaſk into which a little water has been put to abſorb the ſmall portion of ſulphuric acid (oil of vitriol) that may paſs without being decompoſed through this firſt reſervoir. Care muſt be taken to apply a ſmall ſafety-tube, one of the extremities of which muſt be immerſed ſome lines in the water, to guard againſt abſorption. A tube with a double bending conducts the acid into flaſks or other veſſels, where it muſt at length combine with the water.

We would propoſe uſing, inſtead of the tubulated flaſk, a cylinder of lead, or of fir, or any white wood, hooped with varniſhed

varnished iron (to prevent rusting) of a pretty considerable height, terminating at top with a Wolf's bottle, the bottom of which must be taken out, and which is to be placed in a collar formed in the leaden cylinder; care being taken to cement it with a luting of wax to render it impermeable to fluids. This capital of glass will enable the operator to see the quantity of air bubbles disengaged from the surface of the water, and thus to appreciate the progress of the saturation, while the weight of this narrow and high column of water pressing on the bubbles of sulphurous acid gas, in proportion as it is disengaged from the extremity of the tube at the bottom of the cylinder, will facilitate its combination with the water, and accelerate its solution in that fluid. That nothing may be lost, two or three of these cylinders can be united in the same way as is done with a series of Wolf's bottles. A cock adapted to the bottom of each cylinder will facilitate the discharge into the immersing tubs.

The apparatus which we would employ for the immersion of woollen and silk stuffs in leys of sulphurous acid are perfectly similar to that which we shall describe hereafter for immersion in oxygenated muriatic acid, and which we have constructed according to the principles of Rupp *. It was by reasoning upon his apparatus with C. Widmer, of Jouy, that we conceived the design of the present one, which is now making at the manufactory of Essone. Let us suppose an oblong box, divided in the middle by a partition, and on each side of it a large reel, on one of which the stuff is rolled up: in each angle are placed rollers, over which the stuff is conveyed before it passes the partition, and traverses a like number of rollers, which conduct it to the other reel. The object of this disposition is to cause the stuffs to pass through the bleaching ley, and to expose to its action the greatest surface possible.

To turn these reels, an axis or column of glass passing through a collar of leather is employed. One of the extremities of this axis, which is square, is inserted into the axis of the reel, while the other is adapted to a handle, which gives it a rotary motion. By this disposition there is no need for employing any metallic substance internally. To prevent the dispersion of the gas, the covering of this apparatus is furnished with a border which fits exactly into the box, and of which an inch, at least, ought to be immersed into the detersive liquor.

* For an account of Mr. Rupp's process and apparatus here alluded to, see Manchester Transactions, vol. v.; or Philosophical Magazine, vol. ii. —Edit.

For bleaching woollen stuffs we propose the following method:—The stuffs are first to be scoured by a slightly alkaline ley in the proportion of a pound of potash to 50 pounds of wool; the ley must be heated to the temperature of 30 degrees: the old process, by means of stale urine, already mentioned, may be also employed. Urine is preferred, because it holds in solution only a small quantity of salt incapable of hurting the wool. When the grease is dissolved, and the wool has been perfectly rinsed, it is to be washed in warm soapy water: this part of the scouring process is performed sometimes in the fulling-mill, sometimes with beaters, and sometimes by treading in the tub. In all these cases the stuffs must be freed from grease by repeated washings before they are sulphured. If a very bright whiteness be required, it will be proper to expose them to heat a second, and even a third time, always in water a little soapy, made with two ounces of that substance for each pound of wool. It will be better to repeat this operation, turning the stuff for half an hour at each immersion with a stick, than to run the risk, by too strong a ley, of injuring the quality of the wool. After the stuff has been carefully rinsed it is carried to the tubs to be immersed in liquid sulphurous acid, or sulphur water, as the workmen term it: the pieces are rolled upon the reels, and are drawn through the sulphurous acid by turning them until it is observed that the whiteness is sufficiently bright. They are then taken out, and left to drain on a bench covered with cloth, lest they should be stained in consequence of the decomposition of the wood by the sulphurous acid: they are next washed in river water, and Spanish white is employed if it should be judged necessary. This operation is performed by passing the pieces through a tub of clear water in which about eight pounds of Spanish white have been diluted. To obtain a fine whiteness, the stuffs, in general, are twice sulphured. According to our process, one immersion and reeling for two or three hours is sufficient. Azuring or blueing is performed by throwing into the Spanish-white liquor a solution of one part of Prussian blue to four hundred parts of water, shaking the cloth in the liquid and reeling it rapidly.

The operation is terminated by a slight washing with soap, to give softness and pliability to the stuffs. The final operations of drying, stretching, pressing, &c. are foreign to the processes which are the object of this essay.

Before venturing thus to recommend the use of the liquid sulphurous acid, we made a great many experiments on spun wool and woollen stuffs, and always with the most complete success.

Of Silk.

Silk is a diaphanous matter spun by a caterpillar, and formed of a substance contained in its body, which becomes hard in the air. This insect inhabits warm climates, being indigenous in Asia: it was naturalized in Europe about the time of the downfal of the Roman empire.

The filaments prepared by the silkworm are rolled up in a cod or ball. In the state in which we find it, it is covered with a yellow varnish, which destroys its brilliancy and renders it rough. Silk by chemical analysis gives carbonate of ammonia and oil; water at a boiling heat produces no effect upon it; alcohol makes it experience no change, but concentrated alkaline leys attack and dissolve it.

To give splendour to silk, it must be freed from its varnish. This covering is soluble in alkaline leys. Silk is scoured by means of soap, which ought always to be chosen of a good quality for fear of staining it, and sometimes with diluted muriatic acid. Silk by being scoured with soap loses a fourth of its weight. The matter disengaged from it is exceedingly fœtid: if a skain of silk be not washed in abundance of water after being scoured, it will become hot in a few days, putrid fermentation will take place, and small white worms will be produced, which will devour the glutinous and saponaceous matter that remains in the silk. The liquor in which it is boiled putrefies, and becomes useless. Macquer has very properly observed, that if the yellow varnish can be precipitated to the bottom of the soapy liquor before putrefaction takes place, the soap may be recovered, and the dyer will thus make a considerable saving.

Even when the best soap is used, it is generally suspected that it injures the whiteness of the silk. The splendour of the Chinese silks is brighter than that of the European, and the Chinese employ no soap in their operations. We remember that the Academy of Sciences proposed a prize for a method of scouring without soap, which was gained by Rigaud, who performed it by a slight alkaline solution. Colomb even dissolved the varnish of silk in water, notwithstanding the opinion entertained of its insolubility in that liquid. He exposed the raw silk for nine hours to ebullition, and freed it from the varnish with the loss of a fourth of its weight.

Notwithstanding the whiteness which silk acquires by these different operations, it must be carried to a higher degree of splendour by exposing it to the action of sulphurous

 acid

acid gas in a close chamber, or by immersing it in that acid in a liquid state.

Of the Bleaching of Silk.

To obtain the complete bleaching of silk it is subjected to several operations. The first tends to deprive it of the gum and colouring matter which externally cover its filaments; the second, to give it a just degree of whiteness: sometimes the scouring is several times repeated; it is then baked, blued, and sulphured.

It is freed from the gum by a ley of soap and soft water, in the proportion of from twenty-five to thirty pounds of the finest kind of soap for a hundred pounds of silk. The boiler is then exposed to the action of the fire, and the heat is so far kept down by a little cold ley, as to maintain, as uniformly as possible, the temperature of about 90 degrees of Fahrenheit. The silk is turned, to expose all the parts of the skains to the action of the bath. The skains are then twisted on the wringer to free them from the ley. They are put into bags of coarse cloth in packets of about twenty-five pounds.

The baking, as the workmen term it, though a boiling, is performed by throwing all these bags into a kettle of fresh ley composed as the preceding, making it boil for two or three hours, and stirring it often with a batton lest the silk should adhere to the bottom: it is then taken from the bags, after which it is opened and spread out. When the skains have been suffered to drain they are again wrung, and then rinsed in a stream of water. When they have been well washed and beat in the running water, they are examined, to see whether there be any spots not dissolved which may render it necessary to repeat the operation.

To give it whiteness, a soapy ley is prepared of four ounces of soap for each pound of silk, diluted with water till it form a good lather when well stirred and beaten. The same heat is maintained as in the preceding operations, and never that of boiling water; the silk is pressed for half an hour at least, and after being turned for another half hour it is removed; and, not unfrequently, it is *baked* before it is subjected to the operation of sulphuring.

This *white baking* is performed in a ley similar to that above described, and in bags like those employed for boiling the silk in its raw state. This baking finishes the bleaching with soap. The silk being taken from the bags is wrung, and rinsed in running water. If an azured white be required, it is made to pass through blue; after being azured, and when

when the silk is dry, it is then sulphured, and the bleaching is complete.

All these processes are exceedingly destructive: those which I am about to propose will make a total change in the method of bleaching silk. I have already mentioned the prize granted by the Academy to Rigaud for scouring by means of a slightly alkaline ley, and the success obtained by the abbé Colomb in having succeeded to dissolve the varnish of silk by the action of boiling water at a very high temperature: these incontestable facts furnish more than the necessary proofs of the goodness of our method.

Take a solution of caustic soda, so weak as to mark only a fourth of a degree at most of the areometer for salts, and fill with it the boiler of the apparatus for bleaching with steam. Charge the frames with skains of raw silk, and place them in the apparatus until it is full; then close the door, and make the solution boil. Having continued the ebullition for twelve hours, slacken the fire, and open the door of the apparatus. The heat of the steam, which is always above 250 degrees, will have been sufficient to free the silk from the gum and to scour it. Wash the skains in warm water, and, having wrung them, place them again on the frames in the apparatus, to undergo a second boiling. Then wash them several times in water, and immerse them in water somewhat soapy to give them a little softness.

The last degree of bleaching is effected by making the skains to pass through sulphurous acid, making use of the process and apparatus before recommended for bleaching wool, and which supplies here the place of sulphuring. The incalculable advantage of this process in comparison of any other, consists chiefly in the possibility of following its operations progressively, and without running the risk of injuring the quality of the silk by too violent leys.

Of the Bleaching of Vegetable Matters.

The characters and properties of vegetable substances are widely different from those we have described. As organic matters, they contain oxygen, hydrogen, and carbon; but azote, which acts so important a part in the animal kingdom, is rarely found in them, and much less phosphorus and sulphur.

The substances found in the interior of plants are, like those observed in the interior of organized bodies, the result of vegetable secretion. The nourishment of vegetables is derived from the bosom of the earth, and this combination of principles

ciples, abforbed by the roots, with the juices affimilated in their vafcular veffels, produces new compounds.

The deftruction of plants exhibits phænomena which have very little refemblance to thofe exhibited by the diffolution of animal bodies; but the laft refult is always the natural deftruction of the combination of their conftituent principles, the union of hydrogen and oxygen forms water, and the combination of oxygen and carbon forms carbonic acid. It is on thefe principles and modifications, applied to the treatment of vegetable matters, that the art of deftroying colour is founded; it is a decompofition begun and checked in proper time, or the deftruction of fome principles in order to preferve others.

To bleach vegetable fubftances requires the concurrence of feveral menftrua or deterfive fubftances; fuch as foda, oxygenated muriates, calcareous fulphuret, and foap. There are feveral proceffes for depriving hemp, flax, and cotton, of their colour, which may be claffed in the following order:

1ft, Bleaching in the open air, with the affiftance of alkali and foap.

2d, Bleaching by water alone.

3d, Bleaching by the oxygenated muriatic acid, fubftituted for the action of the atmofpheric air; and this method is divided into four diftinct proceffes: the firft confifts in employing the oxygenated muriatic acid alone; in the fecond, potafh is mixed with this acid to condenfe the gafeous vapour and deftroy its fuffocating odour; for the third, oxygenated muriates diffolved in water are employed; and in the fourth, fulphuret of lime is united with this acid.

4th, Bleaching by the fteam of alkalino-cauftic water, where the air and folutions of oxygenated muriates coincide alternately with the action of the fteam.

Of Hemp and Flax.

If hemp and flax be examined immediately after they are pulled, we obferve an union of fibres cemented together, which form filaments; thefe fibres are moiftened by the fap, and the ftalks, formed of bundles of filaments, are enveloped in a femi-ligneous fubftance, and covered with a very thin bark. The fap of textile plants differs from thofe of ligneous plants; it approaches near to extractive matter; it is neither faponaceous, nor refinous, nor aqueous, but it poffeffes fomething of all thefe properties: it is foluble in water like the fap of wood, it precipitates itfelf in flakes by the action of oxygenated muriatic acid, but thefe two kinds of fap are diftinguifhed

by

by one very ſtriking character: that of trees almoſt always contains tanning principle, or gallic acid; that of textile plants never poſſeſſes any. The ſap, therefore, is nothing elſe than real vegetable chyle; a nutritive juice, compoſed of water, mucilage, and ſugar, with ſome portions of carbon, phoſphorus, and lime.

Theſe preliminary obſervations are indiſpenſably neceſſary for comprehending the theory of the operations to which hemp and flax are ſubjected. Deprive theſe plants of their ſap as ſoon as they are pulled, decompoſe the extracto-mucilaginous matter, which occaſions the aggregation of their filaments, and you will have performed the firſt operation, which is called *watering*. The hemp or flax, tied up in bundles, is immerſed in ſtagnant or ſpring water, in which the bundles are preſſed down by means of ſtones. Well water and brackiſh water muſt be carefully avoided, as well as that which flows over gypſeous ſoil. Such water accelerates putrefaction, and hurts the quality of the hemp and flax. This is perfectly agreeable to the principles of chemiſtry; it is thus that a little ſalt accelerates animal putrefaction, while a great deal tends to prevent it. The portion of ſaline ſubſtances taken up by the water haſtens corruption by extending the putrid fermentation, which ought to operate only on the juices, even to the filaments, which it blackens and ſpoils.

The fibres of flax are ſeparated by letting them remain in ſtagnant water until the mucilaginous membranes which connect them are deſtroyed by putrefaction. During its immerſion their ſap is decompoſed and diſſolved, the bark ſeparates from the ligneous body, and the fibres are inſulated. Some days are ſufficient for the proceſs of watering.

To aſcertain the period of watering, which always varies according to the kind of plants, the degree of their maturity, and the nature of the ſap, a handful of the flax is taken from the pond, and broken and rubbed between the fingers: if the ſtalks are ſtill green, but brittle, and break with the leaſt effort, the bundles muſt be taken out: a longer immerſion might extend the decompoſition even to the fibrous texture. The putreſcence decompoſes the water; there is formed carbonated hydrogen peſtilentially fœtid; the fiſhes die, and the air becomes infected. In countries where a great deal of hemp and flax are cultivated, there are laws which forbid theſe ſubſtances from being watered in rivers and other ſtreams.

The hemp and flax, when taken from the water, are ſpread out on the graſs to dry. During the fermentation and decompoſition

composition which thence result, there is a speedy combination of oxygen and carbon. Exposure on the grass facilitates the escape of the carbonic acid into the atmosphere. The plants become of a whitish gray colour, which is called a flaxen gray.

It is known that a ley very slightly alkaline may be substituted with advantage for this long and noxious operation: it is therefore certain that a chamber of from 20 to 30 feet in length, into which the steam of alkalino-caustic water of the strength of *one-fourth* of a degree only is introduced, will be sufficient to produce the same effect as watering, on an immense quantity of hemp and flax suspended on basket-work, in less time and with less expense than are required for the different manipulations of watering. The losses occasioned by the negligence of workmen, who, by suffering the hemp and flax to macerate too long, give time to the decomposition to reach the filaments, which renders them brittle and occasions a considerable waste, will also be avoided. In our process the artist can follow every moment the progress of his operation, and stop it at the favourable period.

Hemp and flax, after being watered, must be dried in a kiln or stove. A fibrous skeleton which exhibits a number of small tubes, the interior of which is composed of a fibrous tissue, and the exterior of a ligneous, will then be obtained: one of these must be preserved, and the other rejected. This is the object of the subsequent operations of beating, heckling, &c.

The ligneous tissue, or this bark, as the workmen call it, is thrown away as useless, and a certain portion of the fibres of the hemp and flax, which still adheres to it, is thus lost, notwithstanding the care of the workmen during these different manipulations.

In the neighbourhood of mills, where the operations of beating, heckling, &c. are performed, I have seen heaps of that substance thrown away: it cannot be converted into manure, on account of the long time required for its decomposition; and I have often lamented the loss of a matter so valuable, and which might so easily be employed for some useful purpose. By macerating it in water, and subjecting it to the other operations of a paper manufactory, it may be converted into pulp proper for the fabrication of every kind of paper*: it might even be previously bleached, or bleached in the state of pulp, by the different processes which are the

* In Britain this substance is often so made use of.—EDIT.

object of this essay. The price of rags is already high enough, besides their scarcity; and Belgium, the ci-devant Britanny, Auvergne, Alsace, &c. are every year covered with heaps of this substance, which the paper-makers might procure at a very low price, and which would afford a rich mine to be worked by the industrious artist.

Hempen and linen cloth, when they come from the hands of the weaver, are charged with flour paste called *dressing*, employed by the manufacturers to aid the tension of the threads during the weaving: some manufacturers immerse their cloth in tubs, or expose them in running water, or boil them, to free them from this substance. These are bad methods, which betray absolute ignorance of the proper principles. The best is to immerse the cloth from forty-eight to fifty hours in a tub filled with soft water, at the temperature of from 60° to 75°: the kind of fermentation which ensues is sufficient to decompose the paste, and is never strong enough to attack the filaments of the thread: the cloth is then to be rinsed in running water, by the help of a fluted cylinder, which entirely frees it from that amylaceous substance.

This operation gives to cloth a first degree of bleaching, which arises merely from the destruction of a part of the colouring matter during the fermentation, which opens the threads of the cloth, slackens and softens their tissue, and swells their fibres: it may be seen that it has reached its proper term by observing all these phænomena, and when the colour of the cloth is uniform throughout.

After the cloth has been completely rinsed in running water with the cylinder, it remains of a grayish white colour: the tint which opposes its perfect whiteness arises from extracto-resinous matter which remains combined with the filaments, and from which they must be freed. This is the operation properly called bleaching, whatever may be the operation employed for accomplishing it. These different processes will be described in the course of this work.

Of the colouring Matter of Hemp and Flax.

Before we proceed to a description of the different processes for bleaching, it is of importance that we should say a few words respecting the colouring matter of flax. This subject has been fully treated of by the celebrated Kirwan, from whose experiments it is abundantly proved that the colouring matter extracted by the action of alkalies is a peculiar resin, which differs from pure resin by being insoluble in essential oils, and in having some resemblance to lacks. Having procured some of this substance, by separating it from what the

the workmen call *dead ley*, by ſaturating the alkali with acids, and in that manner obtaining it in the form of a greeniſh precipitate, which he carefully waſhed, he made the following experiments to determine the action of alkalies upon it:

Eight grains of it were digeſted in a ſolution of cryſtallized ſoda ſaturated at the temperature of 60° of Fahrenheit: the ſolution inſtantly aſſumed a dark brown colour. Two meaſures of this ſolution, weighing each 275 grains, were not entirely diſſolved by this ſubſtance; but two meaſures of a ſolution of potaſh diſſolved the whole of it.

One meaſure of cauſtic ſoda, the ſpecific gravity of which was 1·053, diſſolved almoſt the whole of it, leaving only a white reſiduum.

One meaſure of cauſtic potaſh, the ſpecific gravity of which was 1·030, diſſolved the whole of it.

One meaſure of an alkaline ſulphuret, the ſpecific gravity of which was 1·170, diſſolved the whole matter.

One meaſure of ammonia diſſolved alſo a portion of this ſubſtance.

Though theſe experiments were ſufficient to ſatiſfy Kirwan's doubts, he thought it neceſſary to repeat them with the ſaline ſubſtances uſually employed in bleaching as well as with ſoap.

He diſſolved, therefore, an ounce of common ſoda, and as much Dantzic potaſh, each in ſix ounces of diſtilled water: eight grains of the green matter were put into a meaſure of an ounce of each ſolution, and then digeſted for three hours and a half in a heat equal to 180° of Fahr. The diſſolving power of the Dantzic potaſh was ſuperior to that of the ſoda; for, an ounce of the ſolution of ſoda was ſtill required, and half an ounce only of the ſolution of potaſh, to diſſolve the whole of the ſubſtance.

An ounce of white ſoap was diſſolved in 18 ounces of diſtilled water. The ſolution was turbid, and it could not be rendered tranſparent but by heating it almoſt to the point of ebullition, and then the operation was difficult; for when the liquor, by chance, began to boil, it was thrown to the diſtance of more than three feet from the matraſs. Three ounces of this ſolution were required to diſſolve eight grains of the colouring matter.

In order to compare the reſpective ſtrength of theſe ſolutions, it muſt be obſerved, that an ounce of the ſoda of the ſhops contains only 114 grains of pure ſoda: ſuppoſe the ſolution to have been made in ſix ounces of water, each ounce of water will contain 19 grains of pure alkali, while an an ounce of the like solution of Dantzic potash will contain 50 grains.

The detersive force of lime was tried without success; three ounces of water, saturated with lime, produced scarcely any effect on the colouring matter: these three ounces contain at most three grains of pure lime.

Description of Apparatus.

Fig. 1. (Plate II.) the new apparatus proposed by the author for preparing liquid sulphurous acid, and which may serve also for distilling oxygenated muriatic acid. A, a section of the furnace, which is a sand bath, and contains three flasks (as may be seen in the horizontal section fig. 2). Each flask is furnished with a bent tube *a*, for pouring in the sulphuric acid; and from it the liberated gas passes by the tube *b* into the receiver B, which is made of lead. This receiver has five necks (vide fig. 2.): three of them receive the tubes connected with the three flasks, one receives a safety-tube *c*, intended to prevent absorption, and the 5th the bent tube *d*, which connects it with the series of tall Wolfs C, D, &c.

Fig. 3. shows the way in which it is proposed to alter Mr. Rupp's apparatus. The stuff is made to pass over rollers in the corners, &c. of the box in going from one reel to another, and the axes come through leather collars in the side instead of the top of the box. The engraving represents a vertical section.

Fig. 4, a boiler and steaming chamber. A, the boiler, charged with stale urine, rendered caustic by the addition of quicklime *. The ammonia thus disengaged passes through the tube B into the chamber C, which is furnished with reels and rollers for winding the stuff, and thus exposing it to the action of the vapour. At the corner *a*, the uncondensed vapour can pass into the worm-tub D to be condensed, and returned to the boiler by the tube *b c*. Or it may be received into the tub E by shutting the cock at *c*, and opening the cock *n*. The opening into the chamber, *i. e.* the door, is on the top, and shuts air-tight. With this apparatus, vapour or steam of any kind may be employed for the purpose of bleaching.

[To be continued.]

* For this method of applying ammonia to the purposes of bleaching, the world is indebted to Mr. Crooks, of Edinburgh, who, a considerable time ago, took out a patent for it for England. The same gentleman having, along with Mr. Turnbull, improved the process, and extended the principle to the use of fixed alkalies also, assisted by the action of the steam of boiling water, patents have since been taken out in their joint names for England, Scotland, and Ireland. Of this invention we gave an account in our ninth volume.—EDIT.

XIX. Re-

XIX. *Researches respecting the Preparation of the Citric Acid. By Professor* PROUST.

ONE of my friends, Don Antonio Hernandez del Valle, secretary to the consulship of the Havannah, wrote to me in the year 1795, during his residence at Cadiz, before he embarked, to request some information respecting the best method of preserving lemon juice during long voyages; a process in which no one had ever yet properly succeeded. As his acquaintance with chemistry inspired him with a design to make experiments on this subject, he desired me to make some researches, that he might compare them with those he proposed to undertake in regard to this acid as soon as he should reach the place of his destination.

What I am going to say on the subject will make no addition to our knowledge on the nature of the acid of lemon-juice, since the indefatigable Scheele has left nothing to be wished for on this subject; I only intend to reduce to fixed data his formula for the extraction of this acid, and to ascertain whether the substances which oppose its preservation are of such a nature as to be capable of being separated by means that depend less on the art of our laboratories.

The lemon juice I employed had been clarified by filtration; and it had been kept for a year in a cellar, covered with a little oil, according to the usual method of the shops.

I. Spirit of wine mixed with this juice in a pretty large quantity, did not render it turbid even after being kept 24 hours.

Having evaporated about three pounds of it, in a gentle heat, to the consistence of syrup, I observed, as Scheele had done, that the citric acid announced no disposition to crystallize even when carried by evaporation nearly to the consistence of extract. The reason of this, no doubt, was, that this acid, which is very crystallizable, requires, however, but little water for its crystallization.

Lemon juice, by evaporation, assumes the colour and disagreeable odour of the extract of plants; when redissolved in water, it reproduces a juice of a taste which still participates of that of extracts. In a word, evaporation, which gives no hope of the possibility of separating the principles which alter it, adds to it the inconvenience common to all extracts, which is, that their solution in water never brings back the juice to that taste which it before had in the plants.

Dubuisson, in a supplement to his *Art du Distillateur*, says, that the evaporation of lemon-juice in a gentle heat makes it it depofit mucilage, and puts it into a ftate of being preferved. I obferved nothing of this kind; nor was I furprifed on that account, as mucilage and extractive matter are not of a nature to be feparated by fuch means. The latter, in particular, is not among the number of thofe which, forming a pellicle, abandon their folvent in confequence of the infolubility they acquire by becoming faturated with oxygen. Lemon juice thus prepared will keep well, no doubt; but where? In our cellars, and not in the hold of a fhip proceeding towards the equinoctial.

It is cuftomary, as I have been informed by Don Hernandez, to boil the lemon juice pretty ftrongly before it is put on board; but, befides the burnt fmell it contracts, it ferments ftill in the bottles, and makes them burft when the fhips approach the line.

II. The concentration of lemon juice by congelation, propofed by Georgi, is attended with no better fuccefs. It brings it to the confiftence of fyrup from being a more powerful acid, efpecially if it be reduced to one-eighth of its volume. But this procefs neither deftroys the mucilage nor the extract; and befides, its not being practicable in the countries where the lemon tree grows, becaufe it is a native of hot climates, it may be readily conceived that this fyrup will not ftand the heat experienced in fea voyages any more than that prepared by means of fire.

III. Dr. Brugnatelli announces that lemon juice diluted in fpirit of wine frees itfelf in the courfe of a few days from part of its mucilaginous matter; and he adds, that, after the alcohol has been feparated by diftillation, the acid is obtained as pure as it is when concentrated. It may be readily believed that by this procefs the object is not entirely accomplifhed; for I fhould afk the author, what has become of the extractive part found by Scheele in lemon juice?

I was defirous of trying whether it was poffible to render it pure by means of charcoal powder, fo much extolled, and which has given occafion to fo much difpute in Germany; but I found that this procefs was attended with no real effect.

It follows from this review, that, except the formula of Scheele, no method has yet been found of feparating the mucilage and extractive fubftance of lemons, and that we muft adhere to it until a fimpler one will be difcovered.

IV. Lemon juice, evaporated to the confiftence of fyrup, and diluted in feven or eight times its volume of fpirit of wine, becomes turbid, and depofits a matter fomewhat brownifh, clammy, and which diffolves completely in water. This is pure mucilage.

This fpiritous mixture, diftilled in a retort, leaves the juice at the same degree of consistence, and with the same colour; and though it has lost the mucilage it cannot be yet rendered crystallizable by concentration, because its extractive matter, soluble in water, remains in it. The juice employed in these experiments gave about five or six degrees of Baumé's areometer. When dried as much as possible, without altering it, it produced 48 grains per ounce of dry matter.

V. Four ounces of white chalk were exposed to heat, with a pound of water, in a silver bason. It was afterwards saturated by pouring lemon juice successively into it as long as an effervescence was produced. When this point was obtained, about an ounce of juice was added, in order to be certain that the earth was completely saturated. For this process 94 ounces were required.

When the mixture had cooled it was decanted from off the citrate, which occupied the bottom of the bason. It was then washed three or four times with cold water in order to separate all the remainder of extractive matter, and there were obtained by these means seven ounces and half a dram of white calcareous citrate, pulverized and light.

The liquid separated from the citrate added to the water employed in the washing was evaporated to a certain point, by which means there were obtained also $3\frac{1}{2}$ drams. The product of the citrate was consequently 7 ounces 4 drams; and by adding half a dram, which, according to my estimation, remained in the extract of the liquids evaporated, there were obtained altogether 60 drams and a half of this citric salt.

VI. As the citric acid, by uniting with the chalk, expelled the carbonic acid, the question now is to know the amount of the latter, in order to ascertain the quantity of the citric acid which replaced it.

Analysis of this Chalk.

A hundred parts, converted into lime by calcination, were reduced to $56\frac{1}{2}$. The loss of acid and water was therefore $43\frac{1}{2}$ per cent. A hundred parts of the same chalk, dissolved by nitric acid, lost only from 40 to 41 of carbonic acid. Consequently, there is about three per cent. of water in this earth. The nitric acid separated also about three of argil slightly ferruginous. The quintal of chalk may then furnish the following result:

Argil - -	3
Water - -	3
Carbonic acid -	$40\frac{1}{2}$
Lime - -	$53\frac{1}{2}$
Total	100

In

In 4 ounces or 32 drams of chalk, then, we have the following quantities, a few fractions excepted:

Argil	- -	1
Water	- -	1
Carbonic acid	-	$12\frac{3}{4}$
Lime	- -	$17\frac{1}{4}$
	Total	32

It is now evident that the earthy base furnished to $60\frac{1}{2}$ of citrate by 32 drams of chalk, was $17\frac{1}{4}$ drams of lime, or $18\frac{1}{4}$ including the argil.

It is also evident that the citric acid, which assumed the place of the $12\frac{3}{4}$ drams of carbonic acid, amounted to $41\frac{1}{4}$ drams. If to these $58\frac{1}{2}$ drams of pure citrate, 2 drams of water and argil be added, we shall have for the whole product $60\frac{1}{2}$ drams.

From these proportions it will be found by calculation that it must contain about $30\frac{2}{3}$ of lime, mixed with a little argil, in a quintal of citrate; but, having calcined a hundred parts of this citrate, it left $31\frac{1}{2}$ of lime, a proportion very near to the former; and if we deduct from this lime about $1\frac{1}{2}$ of argil, we shall have in the quintal of citrate,

Lime - -	30	100
Citric acid -	70	

But the real quantity of acid will be less by all the water with which it may be united in the citrate. This, however, I did not examine.

The citrate of chalk, as Scheele has remarked, is very little soluble in water, and the solution has no striking savour. It is not rendered turbid by spirit of wine, and it produces no change either on turnsole paper or on the solution of sulphate of potash The fluoric, phosphoric, and boracic acids make no impression upon it; but the oxalate of potash and the oxalic acid precipitate from it the lime.

The extractive ley contains, besides mucilage and extract, malate of lime, which spirit of wine immediately precipitates from it, if it has been concentrated by evaporation. Extract of this ley has the colour, smell, and savour, common to the extracts of plants. If it has been concentrated only to the consistence of syrup, it speedily becomes covered with mouldiness.

The colour of lemon juice is not changed by a few drops of the nitrate of iron, because excess of the acids redissolves the gallate, or combination of iron with the astringent principle; but if this excess be taken away by potash, the vinous colour, but weak, makes its appearance, which shows that the astringent principle is only in small quantity.

The citrate of lime kept under water, exposed to the sun during the heat of summer, becomes putrid, and the water is covered with a stony crust, which is carbonate of lime. The citric acid, like the other vegetable acids, is destroyed by putrefaction. Its carbonaceous part united to the oxygen of the water, which is decomposed, and thus transformed into acid, reproduces chalk: this putrefaction is always accompanied with an escape of bubbles, which are only carbonaceous hydrogen.

VII. *Decomposition of the Citrate of Lime by Sulphuric Acid.*

To expel the carbonic acid completely from 4 ounces of chalk, it was necessary to employ 20 ounces of diluted sulphuric acid (of 19 degrees of Baumé's areometer). This acid is made by mixing three parts of water with one of common oil of vitriol: if the latter is not well concentrated, the water must be diminished, and, by some trials, the diluted acid may be brought to the required point.

To separate the citric acid united to a base of four ounces of chalk, it is evident that the above quantity of sulphuric acid must be sufficient. This quantity, therefore, amounts to five times the weight of the citrate, or 500 per cent. of this earthy salt.

I heated to ebullition six ounces of citrate with two pounds of water, and added 30 ounces of my sulphuric acid of 19°: after being exposed to ebullition about seven minutes, taking care to stir the mixture with a spatula, the whole citrate was found changed into a calcareous sulphate. The mixture being then strained through filtering paper, and left to evaporate, deposited sulphate; and four successive evaporations and filtrations were necessary to free it entirely from its earthy deposits.

The separation of this sulphate may be abridged by mixing the liquor, evaporated to the consistence of bright syrup, with a certain quantity of spirit of wine; and this is even the process which ought to be followed on all occasions when it is required, without having a very large quantity of citric acid, to obtain it as pure as possible.

The consistence of bright syrup is not, however, the point at which the citric acid can crystallize, it must be carried to that of baked syrup, because this acid takes up very little water in its crystals. By two crystallizations I obtained $3\frac{1}{2}$ ounces, or 28 drams, of pretty large crystals. The two drams wanting

wanting to complete the thirty, which, according to the proportion before eſtabliſhed, ought to be produced by ſix ounces of citrate, remained in the mother water. But, as it appeared to me that there could not be more than half a dram in this reſiduum, it is evident that the citric acid will be, as I have before indicated, from two to three below 70 per cent.

VIII. Though the citrate of lime be white and well waſhed, it always retains fixed in it a little extractive matter, the colour of which is found again, after its decompoſition, in the liquors. It thence happens that it is difficult to obtain the cryſtals white without two new cryſtallizations at leaſt. The citrate of lime, in this reſpect, exhibits the ſame phænomena as the other earths and earthy ſalts, which readily adhere and fix themſelves to the colouring parts. The citrate, which may be ſeparated from the juice of verjuice by chalk, is, in particular, attended with this inconvenience:—if it be not immediately ſeparated from the liquor, it aſſumes a violet colour, which cannot be taken from it by repeated waſhings.

Four ounces of lemon juice employed in the ſucceeding experiments, evaporated in the ſun, left 48 grains of dry reſiduum. But the citric acid, having been found to be 34, the extract, gum, and a little malic acid, formed together 14 grains. Theſe 48 grains, of different principles, were then diluted in 3 ounces 7 drams and 24 grains of water; that is to ſay, they formed a ninety-fourth of the lemon juice.

IX. *Conſequences.*

It follows, from theſe reſearches, that mucilage and extractive matter, as Scheele diſcovered, are the corruptible or fermentable principles of the lemon juice; and as none of the recipes propoſed for its concentration are capable of depriving it of theſe principles, it is neceſſary to have recourſe to the method of that author. This method will be very practicable on a large ſcale, but it will require baſons of ſilver or fine tin. It will be abſolutely neceſſary to proſcribe from the laboratory earthen veſſels varniſhed with lead, but not ſtone ware, becauſe the lead which enters into their coating is ſo far vitrified as to be proof againſt any attack. One can hardly believe that the ſyrup of lemons commonly ſold in the ſhops does not contain oxide of lead. Hepatic water gives to theſe ſyrups a dark brown colour. This is ſufficient to convince us that either lead or copper is preſent.

Let us now conſider ſeparately each of the principles of our lemon juice in regard to fermentation.

Strictly ſpeaking, none of them is capable ſeparately of paſſing to ſpiritous fermentation, and not even to the acetous.

The extractive part of this juice tends very rapidly to mouldiness. Notwithstanding this, when they are found naturally mixed with saccharine juices, such as that of grapes, apples, cherries, elder berries, &c. they pass very well to a new state, which to them, if it be not that of spiritous fermentation, is, however, a state which ensures common preservation to all the principles. Let us take, for example, the juice of gooseberries, one of those juices which, on account of their excess of acid, produce only bad wine, poor in spiritous product.

This juice is composed of mucilage, gelatine, extract, sugar, citric and malic acid, &c. If it be made to ferment during warm weather it goes on but faintly, because it does not contain a sufficient quantity of sugar, which is the basis of spontaneous movement; but if this deficiency be supplied by adding from one to two ounces per pound, it may be brought to produce real wine; but *green wine* indeed, because the acid principle, which predominates in this juice, will not allow us to expect any thing else. In a word, the juice of gooseberries may serve to represent the juice of those grapes which have been deprived of sweetness and maturity by a rainy and cold season.

In this wine, and all those of the same kind, it appears that the primitive acid is not altered, or at least is less sensibly altered, by fermentation; so that, if the quantity of citric acid it contains before fermentation be appreciated, it may be found entire after the fermentation is over: and it is very probable, also, that the gummy and extractive parts will no longer be found, or will be found in a very inferior proportion.

Now, if instead of checking the spiritous fermentation of the juice of gooseberries, it be speedily brought to the acid fermentation, I have no doubt that it might be possible to obtain vinegar of gooseberries, the mucous and acetified extractive parts of which would be as little susceptible of further alteration as those which enter into the composition of every kind of vinegar, which, in my opinion, support very well the heat of the line.

According to these ideas, it would be proper to prepare lemon juice for fermentation by the addition of a small quantity of sugar, to carry this fermentation to its maximum of acescence, and to subject the vinegarized juice first to a chemical analysis, if possible, and then to a trial at sea. Who knows but the citric acid might be found entire after the fermentation, as is the case with tartar? and, whether freed from the greater part of those principles which, as has been already ſeen, form an obſtacle to its cryſtallization, it might not be poſſible to complete its purification either by concentration alone, or by the aid of a little ſpirit of wine? Experiments of this kind ought to be undertaken in a warm country, and on a ſomewhat large ſcale, if it be required to obtain more certain reſults than thoſe which I was able to obtain in Caſtille.

As the citric acid, when cryſtallized, poſſeſſes a very active acidity, it appeared to me of importance to compare lemonade made with theſe cryſtals with that made by uſing the freſh juice. I therefore firſt took the juice of a lemon, and endeavoured, by repeated trial, to diſcover what quantity of it in weight it would require to make a large glaſs of lemonade well ſeaſoned with ſugar. The quantity requiſite was about eight or nine drams.

We have already ſeen that an ounce of juice employed for experiments contained about 34 grains of citric acid, with a ſmall portion of malic acid. I therefore made a glaſs of lemonade, of the like ſize, with the ſame doſe of ſugar and 54 grains of citric acid. The lemonade was of ſuch a nature that thoſe called in to compare them could find no difference, except that there was ſomething more agreeable in the latter than in the former. At firſt they could not tell in what this difference conſiſted; but each of thoſe preſent having taſted them ſeveral times, it was at length agreed that the firſt lemonade has a ſlight harſhneſs not obſerved in the lemonade made from the citric acid.

This difference was aſcribed, and very properly, to the ſmall quantity of aſtringent principle in the lemon juice. The addition, indeed, of ſome drops of iron in freſh lemon juice, ſaturated afterwards by potaſh, made it aſſume that vinous colour which is obſerved in old lemon juice.

It is to the aſtringent part of the lemons, without doubt, that we muſt aſcribe that contraction of the abdomen which people very often experience after drinking lemonade. Hence it follows, that in diſeaſes where this contraction is to be apprehended, lemonade made with citric acid ought to be preferred.

I ſhall conclude this memoir with the means of preventing an accident which may take place in the proceſs followed in regard to the citric acid.

If more ſulphuric acid than is neceſſary to ſaturate the baſe of the citrate has been employed, when this acid has concentrated itſelf by evaporation, it will react on the citric acid, and proceed ſo far as to ſeparate ſome carbonaceous principles; the mixture, becoming blacker and blacker, will refuse to give crystals. This excess may be remedied by throwing a little chalk into the mixture, after being heated, and then filtrating it to separate the sulphate of lime which has been formed. With a little practice it will be easy to fix the point at which the sulphuric acid is nearly saturated, in order that the citric acid may not be neutralized also.

XX. *Conjectures respecting the Origin of the American Nations* *.

WHETHER America, called also the West Indies and the New World, was known to the antients, is a question which, after long being an object of research, has never yet been decided. The Egyptian priests, as we are told by Plato, gave an account to Solon, the Athenian legislator, of a certain island called Atlantis, which was situated at the distance of a few days sail from Spain beyond the strait of Gibraltar. This island, according to the information given by these priests, was greater than Libya and all Asia, properly so called, taken together; and so powerful, that it had reduced under its dominion all Libya as far as the Tuscan sea, till it was at length swallowed up by a flood and violent earthquake, which continued twenty-four hours. Diodorus Siculus also speaks of a large island to which the Phœnicians were driven while cruizing along the eastern coast of the Atlantic. He says also that the Tuscans, who at that time were powerful at sea, were desirous of sending thither a colony, but were prevented by the Carthaginians, who wished to preserve this island to themselves as a place of refuge in case of necessity, and for that reason endeavoured to conceal it from the whole world.

Had the large Atlantic island been mentioned by no other writer besides Plato, the whole account might have been considered as a fabrication or an allegory; but the testimony of Solon, or at least of the Egyptian priests, gives it a certain air of authenticity. In regard to Diodorus Siculus, his information,

* From *Neue Nordische Beytrage*, by professor Pallas, vol. iii. Respecting the author professor Pallas adds the following note:—"I have thought it necessary to publish this almost forgotten and not unimportant essay of the late professor H. Fischer, of the Petersburgh Academy, which was first made known in the St. Petersburgh *Historical Calendar*, because it has been misapplied by a writer, who has been guilty of other plagiarisms from his works, without mentioning the real author, to whom he has been indebted for many of the observations he has given out as his own. It is hardly necessary to say, that this paper of professor Fischer, which was first published in 1771, forms the foundation of Scheerer's work on the Peopling of America, published in the French language.

formation, as mentioned in his work, was taken merely from tradition or fabulous relations, which will not bear critical examination. But even though this account were true, the iſland of Diodorus might be conſidered as one of the Canary iſlands, or perhaps Ireland or Britain, as the ſhip is ſaid to have been driven thither by a ſtorm.

It is not, however, our intention to dwell on this ſubject, as our object is to examine at what time and from what place the Americans were conveyed to that country which they now inhabit. In the firſt place, then, one of the three following poſitions muſt be admitted as true: The Americans are aborigines, that is, original inhabitants who have always been in poſſeſſion of the country; or they have emigrated thither from ſome other part of the globe; or they have ſerved to people our old world with their colonies. Were we not aſſured of the contrary by the Scripture, the firſt and laſt of theſe poſitions might be defended as well as the ſecond. Among the Pagan philoſophers, the diſpute reſpecting the creation or eternity of the world was never decided; and many of the nations of antiquity, ſuch, for example, as the Athenians, boaſted of being deſcended from no other people. In regard to the third poſition, the Mexicans actually believed that the Spaniſh kings were deſcended from their firſt ſovereign Quezalkoal, and conſequently they had made themſelves maſters of Spain ſeveral hundred years before the diſcovery of America. This, however, does not agree with what is recorded in hiſtory; and the Mexicans, in this reſpect, were dupes to the ſame vanity as many other nations, who pretend that all the ſciences, knowledge, inventions, and political inſtitutions in the world were tranſmitted by them to the reſt of mankind. To give only one inſtance, many of the learned in Europe have imagined that Pythagoras communicated his idea of the tranſmigration of the ſoul, and the Egyptians their political conſtitution, to the Indians; though Pythagoras and all the other Greek philoſophers derived their wiſdom from the Indians, and by no means communicated theirs to them. Whether the Indians had their learning and political knowledge from the Egyptians, or the latter from the former, is a queſtion which many of the moderns think ſcarcely worthy of an anſwer; becauſe they have read accounts given in Greek works, or the accounts of the Roman authors collected from the Greek writers, who pretend that the Egyptians were in every thing the predeceſſors and inſtructors of the Indians.

I have mentioned the firſt and third poſition, not becauſe I conſider them as true, but only to ſhow that, however falſe

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an opinion may be, it will ſtill find defenders: the ſecond poſition, therefore, alone remains to be examined, viz. that the Americans were tranſplanted to their preſent country from ſome other part of the world.

Not only the divine revelation, by which we are expreſsly taught that the firſt men originated in Aſia, but the natural indolence, dulneſs, and want of all the arts and ſciences among the Indians—compared with the genius, livelineſs, and induſtry, of the nations in other parts of the world, leave no doubt that the Americans never went out of their own country to a foreign one; and, on the contrary, that foreign nations viſited them. But what nations, and how? Was it on purpoſe, or by accident? Theſe are difficult queſtions, the ſolution of which would require more than common knowledge of the languages in every part of the world; of the features of the natives, and their religion, manners, cuſtoms, and uſages. It is not requiſite, however, that one ſhould be acquainted with all the languages in the four quarters of the globe; it would be ſufficient, at firſt, that one ſhould be able to compare the languages on the weſtern coaſt of Africa with thoſe of the different countries of America, ſuch as Brazil, &c. But, though this would require great labour, it is not impoſſible that a vocabulary containing ſome hundred words in all the known languages of the world might be collected. Condamine coincides with my opinion when he ſays, that this, perhaps, is the only method of diſcovering the real origin of the Americans. Such a vocabulary would be much fitter for the purpoſe than the Lord's prayer, which has been tranſlated into the languages of ſo many ſavage nations; for, as the ſavages have few or no words expreſſive of moral or metaphyſical things, how can this prayer be properly tranſlated into their languages? Beſides, in learning any thing, people ought always to begin with the eaſieſt part, and to conclude with the moſt difficult; but here the order preſcribed by nature is reverſed.

In regard to ſuch a vocabulary, if, among ſome hundred words, a few ſhould be found ſimilar both in ſound and ſignification to one of ſome other language, one ought not thence to conclude that theſe two languages were the ſame. Who, for example, will ſay that the Latin and Greenlandic languages have an affinity, becauſe the Greenlandic word *ignach* has the ſame meaning as the Latin word *ignis*, fire*? On

* The ſame thing might be ſaid of the Shanſcrit, which contains a great many words that both in ſound and in meaning have a ſimilarity to the Latin. For example, *dendha*, dens, a tooth; *yuga*, jugum, a yoke; *juncta*, junctus, juncta, junctum, joined; *nau*, navis, a ſhip; *navīga*,

On the other hand, there are people who, though they find many words in the languages of two nations which have considerable similarity and the same signification, will not acknowledge the similitude. These, however, are in the wrong, because they do not take into consideration the way in which different nations pronounce their words, either by shortening or contracting them; and do not reflect that every nation has in its alphabet peculiar characters which others have not, and which they cannot pronounce; from which there must naturally follow a perceptible variation in the sound of two words of the same meaning.

Such a general collection of words might require, perhaps, one or more centuries; and if no other way can be found for discovering the origin of the Americans, our researches by this method will, in all probability, prove fruitless; for history, or rather tradition, affords us no light in this respect, and, in my opinion, historians have never given themselves much trouble respecting it. There is however another method of attaining to the proposed end; that is, by comparing the manners, customs, and mode of life among the Americans, with the manners and customs of other nations. It is indeed true, that two nations very remote from each other may have a great similarity in their manners, customs, &c. without being sprung from the same stock; but when singular practices, which appear to be contrary to nature, are found among different nations, they must either have been invented there, or been borrowed from others. The first case seems not very probable, for it can hardly be comprehended how such singular ideas could have arisen among individuals, and much more among different nations; it is therefore probable that these people have communicated their singular manners and customs to each other by their common intercourse.

We shall therefore examine the origin of the Americans on these principles, and consider, as briefly as possible, their singular mode of life, together with the most remarkable of their manners and customs, so far as they coincide with those of the old world.

1. *Singular Form of Government.*

In the East Indies, the Samorin, that is, the sovereign of the kingdom of Calicut, was succeeded not by his own son but by the son of his sister. This manner of succession is common also in all the states of Malabar. The princes do

viga, navita, navicularius, a shipmaster; *nava*, novem, nine; *sapta*, septem, seven; *tri*, tres, three; *dui*, duo, two; *adja*, hodie, to-day; *vidhava*, vidua, a widow; *nò*, non, no; *sua*, suus, his, &c. See Fra Paolino's *Voyage to the East Indies*, p. 316.—EDIT.

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not marry princeſſes, but the daughters of nairs; and therefore their children are not princes, but nairs. The princeſſes are generally given in marriage to bramins: all the children produced by ſuch marriages are princes, and capable of ſucceeding to the throne. This princely race forms the royal family, which takes the precedency of all the reſt. After the king's death, the oldeſt prince always ſucceeds him in the government. By this method, no diſputes ariſe in regard to the ſucceſſion, and young ſovereigns are never ſeen. In all the countries inhabited by negroes, from Senegal to the Rio Volta, the king is always choſen from the royal family; but his children are uniformly excluded from the ſucceſſion, which in all caſes goes to the female branch.

In America, and the iſland of Hayti, now called St. Domingo, the principalities were hereditary; but when the cacic died without heirs, his poſſeſſions devolved to his ſiſters' children, to the excluſion of the brothers' children.

On the death of the chief of the Iroqueſe, his dignities always fall to the children of his mother's ſiſter.

Theſe cuſtoms are followed alſo by the Hurons, the Natches, and the Indians on the Miſſiſſippi. They ſay that one can depend with more certainty on the ſiſter's ſon being of the royal blood, than on the king's ſon, or the ſon of his brother.

2. *Interring the Dead.*

We find inſtances both in antient and modern hiſtory of wives and ſlaves being interred along with the body of a deceaſed prince or great man. Herodotus, ſpeaking of the Scythians on the Boryſthenes (Dnieper), ſays, that on the death of their king, one of his concubines, his cup-bearer, cook, purveyor, valet, &c. together with horſes and golden cups, were interred along with him. We are told the ſame thing by Lucian. The Romans, at the funerals of great men, ſacrificed a number of priſoners, who were obliged to fight in ſingle combat till none of them remained. Cæſar relates, that among the Gauls, the Soldurii ſhared with their patrons in all the conveniences of life and the bitterneſs of death. In another place he ſays, that the cuſtom of burning the ſervants and deareſt clients of great men at their funerals, together with other things, had ceaſed not long before that period. The antient Danes, to ſhow their reſpect for the dead, cauſed wives to be buried alive with their huſbands. We are aſſured by Dalin the hiſtorian, that the ſame practice prevailed alſo in old Sweden. We are informed by De Guignes that it was cuſtomary among the Honi-Re, a Turkiſh nation, to inter with their huſbands thoſe wives who had brought

brought them no children; and even at preſent, the women in the Eaſt Indies ſometimes burn themſelves along with their deceaſed huſbands. Marco Polo relates, that, when the chan of the great Moguls was conveyed to the place of interment, all thoſe who met the proceſſion on the road were put to death, in order that they might ſerve the great chan in the other world. In the barrows, which were the burying-places of the old Moguls, there are found ſometimes around the body, lying in the middle of them, other bodies, which probably were put to death at the funeral. It was cuſtomary among the Jakuts, whoſe anceſtors ſerved in the armies of the Mogul chans before they were ſubjected to the Ruſſian government, that one of the favourite domeſtics of the deceaſed ſhould burn himſelf, with every mark of joy, in a particular fire made for the purpoſe, that he might ſerve his maſter in the other world. This practice muſt have been cuſtomary, alſo, among the Mantchew Tartars; for Duhalde ſays, that Schnu-tehi, the founder of the family now on the throne of China, after he had loſt his ſon and princeſs, required that thirty perſons ſhould expoſe themſelves to voluntary death in order to appeaſe the ſouls of the deceaſed; and that Cham-hi, his ſucceſſor, had taken a great deal of pains to aboliſh this cuſtom. Among the Afgans, a piratical people on the borders of Perſia, and the inhabitants of the Philippine iſlands, a ſimilar cuſtom prevailed. At the interment of the kings of Whidah and Benin, a great many perſons of both ſexes are thrown into the grave alive. Theſe kingdoms lie on the weſtern coaſt of Africa, which of all countries in the old world are neareſt to the eaſtern coaſt of America.

In the iſland of Hayti, at the interment of the cacic, many perſons of both ſexes, but in particular ſome of his wives, were buried alive with him; and they often contended among themſelves for having this honour.

The Caribs ſtill put to death their ſlaves on the deceaſe of their maſters. This deteſtable cuſtom was conveyed from theſe iſlanders to the Mexicans and Peruvians, and even to the Natches on the Miſſiſſippi.

3. *Cutting off the Hair as a Mark of deep Mourning.*

This was a very old cuſtom among the heathens, which God, through Moſes, forbade the children of Iſrael to imitate. At firſt, the hair of dying perſons was cut off, for it was ſuppoſed that their ſouls would otherwiſe not be received into the kingdom of Pluto. Of this we have two celebrated examples in Alceſtes and Dido. In the courſe of time the relations alſo cut off their hair as a mark of ſorrow.

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The Scythians on the Borysthenes, according to the testimony of Herodotus, cropped their hair on the interment of their kings. This offering to the dead is often mentioned both by the Greek and Latin poets; for such is the name given by Ovid to this ceremony, when he says that Hecuba left her tears, together with her gray hairs, on the grave of her son Hector, as an offering to the dead. Petronius, speaking of the well-known matron of Ephesus, says that she placed the hair torn from her head on the breast of her deceased husband. Busbek, ambassador from Ferdinand king of Hungary to Soliman the Turkish sultan, says, that tufts of human hair are found on the graves of most of the Servians, as a mark of the sorrow of the relations for the loss of the deceased. Though the Servians are not now heathens, but Christians, and, consequently, these tufts of hair can no longer be considered as an offering to the dead; yet constant experience shows, that in all the changes of religion which take place among nations, some remains of the old religion are always retained.

Instances of this practice may be found even in modern times. In the year 1716, one of the Chinese embassy, having died at Samarow-jam, a small town at the mouth of the river Irtish, his oldest domestic cut off a lock of hair from his head, and threw it into the funeral pile as an offering to the deceased. The mataram, supreme prince of the island of Java, when he caused his rebellious brother to be interred with great funeral pomp, as a token of his grief cut off his hair. The Caribs in the Antilles crop their hair when in mourning, and the women cut it off entirely. The women in Virginia strew their hair around the burying-ground, or throw it upon the grave. The Brazilian women shave their heads, and their mourning is not at an end till their hair has grown again. When the Apalachites, a people of Florida, are desirous of expressing their sorrow for the death of a relation, they cut off a part of their hair: at the death of their prince they shave their heads entirely, and do not suffer their hair to grow again till the body has been deposited in the earth, which is never done till the expiration of two years.

The Iroquese of both sexes testified their grief also by cutting off their hair. The women, on this occasion, durst not go out of their huts till their hair had grown again; but as this required a long time, they at present, with the permission of their relations, cut off only a small portion, which they strew over the graves of their deceased husbands. It is here to be observed, that the women in Canada consider it as the greatest indignity that can be offered to them if any one cuts off their hair;

hair; for in this condition they dare not appear in public. Among the men, ſhaving the beard is uſual; as was the caſe with the ambaſſador from the Turkiſh ſultan Bajazet to Tamerlane.

4. *Deſtroying the Habitations and Huts of the deceaſed.*

The antient Moguls were accuſtomed to tear to pieces and deſtroy the tents of their deceaſed officers. The preſent Moguls, alſo, when their chan or his principal conſort dies, if they are private perſons, abandon their habitations; and the chief of the tribe leaves his camp, and never ſuffers himſelf to be ſeen during the whole period of mourning. Among the Telengutians, the huts of the deceaſed are deſtroyed. The Jakutians formerly removed from the huts in which any one died, and entirely abandoned them. The Telengutians are a race of the Urats or Oelòts, who together are called Calmucks; and the Jakutians, as far as can be concluded from their language, are of Tartar extraction. Both of them may have inherited this cuſtom from the Moguls. The Perſians have an averſion to the habitations in which their fathers have died, and never approach them. No one, alſo, will reſide in the houſes or palaces of the great officers put to death by order of the ſovereign, or ſchah; for this would be conſidered as an unfortunate omen of a ſimilar fate; and therefore ſuch houſes generally ſtand empty, and ſoon fall into ruins. No ſooner has a Laplander breathed his laſt, than his neighbours drag out the body and deſtroy the hut, which they afterwards abandon. On the death of the king of Whidah, on the weſtern coaſt of Africa, his palace is deſtroyed, and another, according to the taſte and pleaſure of the new ſovereign, is erected.

Among the Caribs it is cuſtomary alſo to deſtroy the hut in which the father of a family has died, and to build another in ſome other place: nor does any one ever think of rebuilding the former one. In Peru, the apartment inhabited by a deceaſed inca was cloſed up by means of a wall.

This averſion to the habitations of perſons deceaſed ariſes from a ſuperſtitious notion, prevalent among the pagans, that the deceaſed in the other world follow the ſame occupations which they exerciſed during life, and that therefore they have occaſion for every thing they before poſſeſſed. For this reaſon, their furniture, utenſils, and tools, are thrown into the grave along with them. Should any of theſe articles be withdrawn or withheld, the ſpirit of the deceaſed, according to the idea of theſe people, would have no reſt, but torment and frighten the living by its appearance. They conſequently chooſe

choose rather to remove to a diſtance, and to leave to the reſtleſs ſpirit the whole hut, in which they imagine it reſides, or elſe they deſtroy it. The very thought, therefore, of a deceaſed perſon is diſagreeable to theſe people; his name is never uttered; and if any perſon of the tribe has the ſame name, he is obliged to lay it aſide, and to aſſume another. In this manner, a deceaſed perſon among them is like one who never was in the world; his hiſtory and genealogy cannot, therefore, be far extended.

5. *Huſband aſſuming the Place of his Wife when delivered of a Child.*

We are told by Strabo, that the men in the northern part of Spain, after the delivery of their wives, went to bed, and ſuffered themſelves to be nurſed by them. This cuſtom ſtill exiſts in ſome of the provinces of France bordering on Spain, where it is called making a *couvade.* The ſame thing is related by Diodorus Siculus of the Corſicans, and by Apollonius Rhodius of the Tibarenes, a people inhabiting the coaſt of the Pontus Euxinus, in Aſia Minor. Marco Polo, ſpeaking of a province which in the French tranſlation is called Arcladam or Ardandam, ſays that the women left their bed as ſoon after delivery as poſſible, and that the men then took their place, where they remained for forty days, and nurſed the new-born child. This cuſtom is ſaid to be uſual, alſo, among the Japaneſe.

When the Carib women in Guiana are delivered, the men bind up their head and place themſelves in bed, as if ſeized with the pains of labour. They are then viſited by their neighbours, who conſole them by all thoſe means uſual among theſe people. This cuſtom muſt always be ſtrictly obſerved; for, even when engaged in war, as ſoon as they hear of the delivery of their wives they muſt return home. We are told by Labat, that the father of the child, on this occaſion, muſt obſerve a ſtrict faſt for thirty or forty days; but he adds, that this ceremony is practiſed only in regard to the firſt-born, otherwiſe, ſays he, the poor huſbands, who have five or ſix wives, would be obliged to keep more faſts than the Capuchins. This account is confirmed by Fermin in his deſcription of Surinam, but he ſays nothing of the ſtrict faſting which muſt be obſerved by the father of the child. Piſo, a Dutch phyſician, ſays, that the women among the Brazilian ſavages, when they find the pains of labour approaching, go out into the woods to cut the umbilical cord of the child with a ſhell, which they boil and eat; and that the huſbands, in the mean time, go to bed and uſe the beſt food

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they can procure, under a pretence of repairing their loſt ſtrength. We are told the ſame thing by captain Woods Rogers, who ſays that the Brazilian women, at the time of their delivery, go out alone into the woods, and when delivered waſh the child; while the men place themſelves in bed for twenty-four hours, where they are attended in the ſame manner as if really ſuffering from the pains of labour.

Lafitau denies that the men indulge themſelves on this occaſion, and is of opinion that this practice is a religious ceremony, which muſt be performed for ſix months with the ſtricteſt faſting, and other acts of mortification almoſt inſupportable; and that it ought to be conſidered as a kind of penance for the ſin of our firſt parents. If this be true, the notion of original ſin muſt be diffuſed throughout the whole world, and have been conveyed from the old to the new continent: but this I ſhall not here examine. He, however, agrees with Labat in ſaying that this ſtrict faſting is obſerved only in regard to the firſt-born child; but, inſtead of ſix months, as above mentioned, Labat makes the duration of it to be only thirty or forty days.

[To be continued.]

XXI. *Reſearches reſpecting the Laws of Affinity.* By C. Berthollet, *Member of the French National Inſtitute.*

[Continued from p. 74.]

XIII. On the Precipitation of Metallic Solutions by other Metals.

1. WHEN metals are precipitated by ſubſtances which do not ſeize upon their oxygen, the precipitates retain a portion of the acid, and often ſome of the precipitant. Of this we have a ſtriking inſtance in the precipitate of the oxygenated muriate of mercury by the alkalis and lime. On expoſing the precipitate to a ſufficient heat, one portion of mercury, more or leſs conſiderable, according to the nature of the precipitate, is reduced, another is ſublimed, and forms a muriate, not merely becauſe the muriatic acid is combined with a portion of the oxide of mercury, as I ſuppoſed, (*Memoirs of the Academy*,) but becauſe the expanſive force of the heat, and the tendency to the combination of the muriatic acid, acting upon the oxide of mercury, cauſe, as we may ſay, a new partition of it to be made: the precipitate by ammonia retains a portion of the ammonia; the precipitate of the

the muriate of iron by potash, retains part of the potash. Facts of this kind may be collected in great number. There is no doubt, therefore, but that the observations which have been made upon the precipitations of substances which lose their solubility, cannot be applied to the metallic precipitates, which vary according to all the circumstances which are capable of modifying the powers brought into action, at the moment of their successive precipitation, and which will deserve a particular examination in another memoir. But when the metals are mutually precipitated from their solutions, their reciprocal affinity for oxygen has a great effect in the action that takes place; and sometimes the precipitate is found in the metallic state. If another force were not joined to the affinity of the precipitating metal for oxygen, it would naturally follow, from the principles established in this memoir, that the oxygen would divide itself between the two metals which are in competition, according to the action they exert upon it. It is therefore necessary to examine what may be the force which determines the precipitation in the metallic state.

2. The affinity of mercury, gold, and silver, for oxygen, is very weak: the mutual affinity which still remains between the parts of these metals when they are in fusion, as mercury is at the temperature of the atmosphere, is sufficient to prevent their combination with oxygen in the state of gas; but heat, by dilating the particles of the mercury, diminishes the force of their mutual affinity sufficiently to enable them to combine with oxygen; while a superior degree of heat, by the difference of dilatation which it produces in the mercury and in the oxygen, will separate them: heat, then, contributes to this combination by diminishing the mutual affinity of the parts, but at length, by augmenting this difference, it renders their combination impossible. As the force of cohesion in mercury is sufficient to prevent oxidation, this very force will tend to effect its deoxygenation, with the assistance of a metal which will act directly upon the oxygen. It is a force analogous to that which produces crystallization and precipitations. (Art. V.)

3. The particles of a metal have not only a mutual affinity, but likewise an affinity for those of other metals: hence proceed the amalgams and mixtures. It is only necessary to put copper in contact with mercury to effect a combination between these two metals. Thus, when a metal opposes its action to a metallic solution, part of the metal may act upon the oxygen and upon the acid, while the other tends to combine with the metal of the oxide. Let us see whether we can discover,

discover, in the precipitation of the mercury, silver, gold, and copper, in the metallic state, the influence of these two forces, that is to say, the mutual affinity of the particles of one and the same metal, and the affinity of one metal for another.

4. When a piece of copper is put in a solution of mercury in nitric or in muriatic acid, the copper becomes instantly white, and the mercury is revived, but combined with the copper. If, instead of copper, a plate of clean iron be plunged in the same solution, after several hours the liquid appears disturbed, and at length a precipitate is formed; but with the muriatic solution in particular, this precipitate is partly in the state of an oxide, and very probably retains a portion of acid.

If the affinity of one metal for oxygen were the sole cause that produced the precipitation of another metal, the iron ought to act with greater efficacy than the copper; for it is known to have a stronger affinity for oxygen: but its action is slow, difficult, and incomplete, while that of copper is instantaneous. It is seen by the manner in which the indecomposable acids are retained by the oxide of copper and the oxide of iron, when these combinations are exposed to the action of heat, that there can only be a very small difference between the affinities of these metals for the acids. There is consequently no doubt that the affinity of the copper for the mercury, with which it has actually combined, must have greatly contributed to its precipitation in the metallic state; but in the experiment with iron, the mutual affinity of the particles of mercury must alone have decided, though with difficulty, the reduction of the mercury; a portion was also precipitated in oxide, and probably retained a portion of acid, as the whole would have done, if the affinity of the iron for oxygen had been the sole agent; and the portion precipitated in the metallic state did not combine with the iron.

5. If a solution of silver be precipitated by copper, the precipitate, which is in the metallic state, is not pure silver, but a combination of silver with a small portion of copper: it could not take the copper from the plate itself, which was plunged in the solution; it must therefore have precipitated with it out of the solution: the mutual affinity of these two metals decides their deoxygenation. By means of this force, two combinations are effected, as often happens: one, that of the acid with the oxide of copper; the other, that of the silver with a portion of the copper. The action of the acid upon the oxide of copper, and that of silver upon copper, are thus put in equilibrio.

6. In like manner, if a plate of copper be plunged into a solution of gold, the gold which is precipitated, shows, by its

 deeper

deeper colour, that it has combined with copper, and the solution retains but a small part of the copper lost by the plate. If a plate of iron be put in this solution, the gold which is precipitated seizes, perhaps as strongly as in the former case, a part of the iron, or at least its precipitation is determined by the affinity of the iron for the gold, at the surface of which this last combines. For the gilding is a combination of the two metals at the surface of contact: when the first stratum is formed, the precipitation is afterwards capable of continuing by the mere force of the mutual affinity which the particles of gold have for each other, and which makes them to cohere.

7. What I have just stated is proved in the precipitation of copper by iron. When a solution of copper is decomposed by a plate of iron, and the copper attached to the plate is separated, it is perceived, by the brown colour of the interior surface, that the copper is not there pure, but contains some iron. After this first stratum the copper continued to precipitate by contracting an adherence with itself, and afterwards with those coats which are successively formed: the affinity, then, for the iron began the effect, which was continued by that of the copper for itself.

8. Phosphorus precipitates several metallic solutions, as has been explained by Sage and Bouillon (*Journal de Physique* 1781). Though it has a strong affinity with oxygen, yet what has just been explained relative to precipitation by the metals, ought to be applied to its action. Pelletier has proved that phosphorus has the property of combining with metals, so that a part of that which is put in action is capable of combining with oxygen, while the other acts equally upon the metal. There are some metallic solutions which are not affected by phosphorus; in others the metal is precipitated in oxide, which doubtless retains part of the acid of the solution, or of the phosphoric acid which is formed; in others the metal is at length reduced. Gold, silver, copper, and mercury, are among those which resume the metallic state. On considering the observations which have been made on this precipitation, it appears that copper and silver are precipitated by combining with a small portion of phosphorus: thus, in precipitating twelve grains of silver, three grains of phosphorus are consumed; but only about three grains of phosphoric acid, in a gelatinous state, are obtained: now, only one grain of phosphorus is necessary to produce this quantity of acid; consequently, more than two grains must have combined with the silver. A part only of the mercury, thus treated, resumes the metallic state; the rest preserves the state of an oxide, and combines with the phosphoric acid. Here the

the force of cohesion is weak, and no combination is made with the phosphorus; hence the effect is but partial, as when iron is used. (No. 4.)

Though the affinity of gold for oxygen is much inferior to that of copper, its precipitation is not so quickly effected, and a portion is precipitated in the state of oxide; probably because it has little disposition to combine with phosphorus; and it is the combination of copper with phosphorus that determines the precipitation of the latter metal. Some of the observations which I have here presented, require the accuracy of experiment for their entire explanation: but all appear to me indubitably to prove that it is the force of cohesion which tends to recombine the particles of one individual metal, and the mutual affinity of some metals which decides their precipitation in the metallic state; so that this state is more or less sudden and complete, according to the force with which these causes are capable of acting *.

XIV. On the resulting Affinity.

1. The result of the action of several affinities in the same substance, I denominate the *resulting affinity*: for instance, the nitric acid is composed of oxygen and azote; this acid combines with potash; it acts upon potash by an affinity resulting from that of the oxygen and of the azote. The reciprocal mutual action of the potash is likewise a force resulting from that exerted by it upon each of the substances which compose the nitric acid.

2. All bodies existing upon the earth have an affinity for each other. If there be exceptions, the number can be but very small. I may therefore reason from this, and apply to all substances that which observation has made known relative to affinities and their modifications. If this application be not forced, if it accounts for properties which cannot be directly established upon experiment, the considerations which I present in this article may throw some light upon several phænomena, which are owing to a chemical action still undetermined.

3. In the definition of *resulting affinity*, I have supposed that the affinity of a compound substance is derived from those of the substances which compose it. It is necessary to examine what circumstances may modify the elementary affinities, and to ascertain the changes which must arise in the affinity resulting from them.

* Fabroni has published some very interesting observations on the mutual action of metals. (*Journal de Physique*, Brumaire, an. 8.)

4. The chemical action of substances is weakened in proportion to their saturation. (Art. II. No. 10.) It must be concluded, therefore, that the resulting affinity must be a less quantity than the elementary affinities when alone: for the latter have experienced a commencement of saturation; but other circumstances may increase the action of the resulting affinity, or may augment the weakness it derives from saturation.

5. If one of the substances that combine change from a solid to a liquid state, it acquires the advantages possessed by solvents; and its affinity, before disguised by the solid state, becomes active; so that the resulting affinity may, on this account, be much more considerable than the elementary affinities appeared to be. Thus, when sulphur is dissolved by potash, the sulphuret which proceeds from it exerts a strong action upon oxygen gas, as soon as it has been rendered liquid by the addition of water, or has attracted sufficient humidity from the air: because it has by that means lost its force of cohesion, as it would by igneous fusion; and because the potash likewise exerts an action upon the oxygen, though much weaker than that of the sulphur, since it cannot alone overcome the elasticity of the gas. The action of the sulphur is diminished by the sum of that attraction which it exerts upon the potash, and upon the water which serves as a solvent to the sulphuret; but it gains much more by the liquidity which it acquires, than it loses by this saturation. Strictly speaking, all those substances the solidity of which is overcome by a solvent, do act by virtue of a resulting force or affinity.

6. Circumstances contrary to the preceding produce an opposite effect; and when substances, by combining, become solid, or more disposed to crystallize, this circumstance must be added to the loss of force arising from the saturation. Potash, for example, and nitric acid, have both the property of dissolving in alcohol, and yet alcohol does not dissolve nitrate of potash; that is, the force of cohesion which belongs to that combination, and which, with water, produces its crystallization, has modified the elementary affinities into the resulting affinity. What confirms this explanation is, that salts which are not crystallizable in water, because they oppose only a feeble cohesion, have, in general, the property of dissolving in alcohol; but in such a manner, that they are capable of crystallizing in that fluid, because the weaker action of the alcohol cannot overcome, except to a certain point, the force of cohesion, of which they are not entirely destitute.

The limited ſolubility of nitrate of potaſh in water ariſes from the ſolubility of the potaſh, as well as of the nitric acid, by water, being greater than by alcohol.

7. Bodies act in proportion to the quantity of them which exiſts within the ſphere of action. (Art. IV.) Hence we deduce, that an action much ſtronger than that of the component parts may reſult from a combination, when the components, or one of the two, paſs from the elaſtic to the liquid ſtate; for they then carry into the ſphere of activity a more conſiderable quantity, the action of which may conſiderably exceed the force loſt by the ſaturation. Thus potaſh cannot overcome the reſiſtance which proceeds from the elaſticity of the oxygen and azotic gaſes; but if theſe two be combined, in order to form nitric acid in the liquid ſtate, they act upon the potaſh in a quantity much greater than they could have applied when in the elaſtic ſtate; and the reſult of their action, though weakened by a commencement of ſaturation, is found to be much more conſiderable than if the azote and oxygen had continued in the elaſtic ſtate.

8. The affinity of a ſubſtance which enters into combination with a compound ſubſtance, concurs with the elementary affinities of the latter, to maintain its compoſition againſt the action of foreign ſubſtances, in proportion to the degree of ſaturation which it produces. Thus iron eaſily carries off oxygen from azote, or rather, it ſhares it, or takes a portion; but as ſoon as the nitric acid is combined with potaſh, iron can no longer ſeparate its oxygen at an ordinary temperature; but at a higher temperature the difference of dilatation ſufficiently deſtroys the reſulting affinity of the potaſh to cauſe the iron to combine with the oxygen. In the oxygenated muriatic acid, the ſur-oxygen, which is feebly retained by the muriatic acid, paſſes eaſily into other combinations; but though it is preſent in a much greater proportion in the oxygenated muriate of potaſh, it is carried off with much more difficulty by oxygenable ſubſtances. Phoſphate of lime is not decompoſed by charcoal even at a great degree of heat; but if it be in the ſtate of acidulous phoſphate, the portion of acid, which may be conſidered as in exceſs, is capable of being decompoſed by charcoal, becauſe not prevented by a ſufficiently large maſs of the baſe; and it is this part alone which affords phoſphorus, when, in order to obtain this ſubſtance, we uſe phoſphate of lime reduced to an acidulous phoſphate by the ſulphuric acid.

9. The contrary takes place when, inſtead of a ſaturating ſubſtance, which ſerves to ſtrengthen the reſulting affinity, one

one is added that tends to form a combination into which one of the constituent parts must enter. For example, when sulphuric acid is added to a mixture of water and iron, this acid favours the decomposition of the water, because it tends to combine with the metal, and with a portion of oxygen; a tendency concurring, with that of the metal, against the affinity which forms the combination of oxygen with hydrogen.

10. From the preceding remarks we conclude, that the properties of the resulting affinity of compound substances may be reduced, 1. To the advantages of liquidity, and under this point of view it is necessary to apply to it the theory of solvents (Art. IX.): 2 To the disposition to solidity, which produces contrary effects, which must be explained by the force of cohesion (Art. V.): 3. Lastly, to the concentration of elastic substances. The observations presented in No. 7. and 8. prove that, in those compounds in which elastic substances are concentrated, there are established, by a change of constitution, affinities which may be considered as new; an additional force has accrued, to which we may apply the inverse of what has been stated relative to the effects of elasticity (Art. VI.) The distinctive character of the complex affinities treated of, (Art. XII.) compared with those which result from the composition of the substances of which I now speak, is, that in the first but very little change obtains in the constitution of the component parts; so that, when the force of cohesion or of elasticity does not intervene, we may consider them in the same manner as they have been considered in Art. XII. No. 1., whereas a new force is established in compounds in which elastic substances are condensed; a power which may be considered as analogous to that of the cohesion which obtains on the mixture of different substances that determine the combinations that are formed, or which require to be overcome by the forces opposed to it.

11. Caloric, by augmenting elasticity, destroys the affinity of substances, of which the constituent parts have an unequal dilatation, conformably to what has been stated in Art. VII.

12. Observation further shows us, that when the resulting affinity is not sufficient to prevent the decomposition, it sometimes renders it very slow and tedious. To this slowness of action, to these progressive changes of constitution, to the different degrees of saturation which take place, must be ascribed most of the phænomena observable in vegetation, fermentation, the animal œconomy, and, in general, among all bodies which contain condensed elastic substances.

ſubſtances *. This ſubject will require ſtill further explanation.

13. The reſulting affinity ought always to be conſidered as a ſingle force, while the ſubſtances from which it is derived remain in combination: but when a ſeparation takes place, it is neceſſary to conſider the elements of which it is compoſed; for the reſult will then be conformable to what has been explained in the diviſion of ſubſtances, in proportion to the oppoſite powers which act upon them.

14. It often happens that a ſubſtance acts partly by a reſulting affinity and partly by its elementary affinities. When a metal is diſſolved by the nitric acid, one part of the acid exerts a reſulting affinity, and another acts by its elementary affinities; ſo that the oxygen of the latter part is divided between the metal and the azote, and the oxide which is formed is diſſolved in the undecompoſed acid.

15. It is obvious, from what has juſt been explained relative to reſulting affinity, that a falſe idea may be adopted of the properties of a body, when we confine ourſelves, as is too often done, to the determination of its conſtituent parts, without paying attention to the other conditions of its conſtitution, if among thoſe conſtituent parts there chance to be ſome whoſe ſtate has undergone a conſiderable alteration. A quantity of oxygen gas does not poſſeſs the ſame chemical power when it is in the elaſtic ſtate, as when it exerts a reſulting force in its combination with azote, hydrogen, carbon, ſulphur, or a metal. For example, the oxygen does not exert the ſame action, and has not the ſame reſulting affinity, in the ſulphuric and the ſulphurous acid: though in the ſulphuric acid a ſmaller proportion of ſulphur is combined, yet it adheres much more ſtrongly than in the ſulphurous acid, and, being more condenſed, it exerts a much more powerful chemical action †. We ought not to confound the oxygen gas which is held in ſolution by water, with the oxygen which, by its combination with hydrogen, forms this liquid: the difference cauſed between them by the ſtate of condenſation, produces two ſubſtances very different in their chemical action. It is therefore neceſſary, either to conſider the whole conſtitution of a body, in order to explain its chemical properties, or to content ourſelves with

* I have often reſorted to this change of conſtitution in the chemical explanations which I have had occaſion to give, and particularly in the lectures of the National School, where I defined the reſulting affinity by the name of *collective affinity*, and diſtinguiſhed it from *elementary affinities*.

† I have obſerved the effects of condenſation in a memoir on the ſulphurous acid. (*Annales de Chimie* 1789.)

establishing those properties by experiment; for we must pay attention to all the circumstances of chemical action, to explain the results of that action, or we must confine ourselves to their establishment or confirmation.

XV. *Recapitulation.*

1. We have frequently remarked that the action of a substance is diminished in proportion as it approaches a state of saturation; and this diminution of force was applied to explain several chemical phænomena. It was affirmed that a metal could only take a definite portion of oxygen from the nitric acid, because, when the oxygen in the acid is diminished, the remaining portion is too strongly combined with the azote. The property of carrying off only a portion of oxygen from certain metallic oxides was attributed to hydrogen; it was admitted that when a substance attracts humidity from the air, its dissolving force comes to an equilibrium; so that, according to the degrees of desiccation of the air, the substance may either carry off or give out water to it. It was shown that the resistance experienced in expelling the last portions of a substance from a combination, either by the action of an affinity or by that of heat, is much greater than at the commencement of the decomposition, and sometimes such, that its entire decomposition cannot be effected. Thus it was ascertained that oxygen could be but partially disengaged from the oxide of manganese by the action of heat. The combinations which are formed when forces are opposed, do not therefore depend upon the affinities alone, but upon the proportions of the substances which act. I have therefore only applied to *all* the phænomena of chemistry, what has been unavoidably admitted in *several* of them from observation. I have only deduced the immediate consequences.

2. These are, that substances act in proportion to their affinity, and to the quantity of them existing within the sphere of activity; that the latter may counterbalance the former affinity; and that the chemical action of each power is proportionate to the saturations it produces. I have defined by the word *mass*, or *chemical mass*, the quantities determined by a like degree of saturation, and consequently, relative to the capacity of saturation: when two substances are in competition in order to combine with a third, each of them obtains a degree of saturation proportionate to its mass. The subject of the combination also divides its action in proportion to the masses, and by varying the latter the results will also be varied.

3. I have

3. I have confidered all the forces which, by their concurrence or oppofition to the mutual affinity of the fubftances brought into action according to the preceding principle, may have an influence upon chemical combinations and phænomena. They may be reduced to the following heads: the action of folvents, or the affinity which they exert according to their proportion; the force of cohefion, which is the effect of the mutual affinity of the parts of a fubftance or combination; the elafticity, whether natural or produced by heat, which ought to be confidered as an affinity of caloric; the efflorefcence, the caufe of which may be attributed to an affinity which is not yet determined, and which acts only under very rare circumftances; gravity likewife exerts its influence, particularly when it produces the compreffion of elaftic fluids; but it may always, without inconvenience, be confounded with the force of cohefion.

4. I have attempted to afcertain whether it were poffible to determine the relative affinity of two fubftances for a third; I have obferved that for this purpofe it would be neceffary to difcover in what proportions this third would be divided with a given quantity of each of the two firft, or rather, would divide its action; I have pointed out the infurmountable obftacles that would be met with in the means that muft neceffarily be employed to prove this divifion of action, and the changes of conftitution which would attend it.

5. As all the tables of affinity have been conftructed upon the fuppofition that fubftances poffefs different degrees of affinity, which produce the decompofitions and combinations refulting from their mixture, independently of the proportions and other conditions which contribute to the refults, thefe tables can only give a falfe idea of the degrees of chemical action of the fubftances arranged in them.

6. Elective affinity is in itfelf an erroneous expreffion, fince it fuppofes the union of one entire fubftance with another, in preference to a third, while there is only a divifion of action, fubjected to other chemical conditions.

7. The action of two, three, or a greater number of fubftances is fubject to the fame laws; and the refult depends on their affinity, on their proportion, or on the degree of their faturation, and the concurrence or oppofition of the forces they exert.

In all cafes of perfect liquidity, mutual faturation takes place, and the refult is a fingle combination, in which all the forces are counterbalanced, while there is neither precipitation nor difengagement of elaftic matter; but as the action is divided when there is an oppofition of forces and a difference

ence of saturation, some substances are retained in the new combination less strongly than before the mixture; they may consequently yield to the powers of cohesion, elasticity, or other affinities which they might otherwise have resisted.

8. The force of cohesion, hitherto considered merely as an obstacle to solution, not only limits the quantities of substances which may be brought into action in a liquid, and consequently modifies the conditions of the saturation which follows, but is the power which causes the precipitations and crystallizations that take place, and determines the proportions of such combinations as quit the liquid: it is this force which sometimes even produces the separation of one, without its forming any combination with another substance, as we have remarked in some metallic precipitations. I distinguish insolubility from the force of cohesion, because the one is relative only to the action of the solvent, and the other is the effect of the mutual affinity of the parts of a substance or combination, considered absolutely.

Elasticity acts by producing effects opposite to those of cohesion, which consist in either withdrawing some substances from the action of others in a liquid, or in diminishing the proportion which exists within the sphere of activity; but when all the substances are in the elastic state, their action is subjected to the same conditions.

If tables were formed which would represent the disposition to insolubility or volatility in the different combinations, they would serve to explain a great number of combinations which take their origin from the mixture of different substances, and from the influence of heat.

9. Caloric acts upon bodies like the other solvents, when it is not in a state of *radiant caloric*, because in this case it is not in combination. It should exceed the greatest part of the force of cohesion, in order to render a body liquid; other affinities also may concur with it to produce this effect, in the same manner as itself concurs with the action of other solvents. It is not distributed among bodies in proportion to their weight, or to their bulk, when it produces the degrees of temperature indicated by the thermometer, in the same manner as an acid does not take up an equal quantity of the different alkalis, to attain the same degree of saturation; and were tables of specific caloric constructed, they would be similar to those of specific acidity or alkalinity. The latter, however, would represent the whole saturation to a certain assumed point, because pure acids and alkalis might be employed; but the specific calorics could only be determined

mined from an unknown point of saturation to another point, the bodies submitted to experiment being already combined with a quantity of caloric. The results, which may be obtained between two points of the scale of the thermometer, have no known connection with the total quantities. To attempt to form a conclusion of one from the other, would be the same as to pretend to determine the comparative solubility of the muriate of soda, and the nitrate of potash in water, by experiments made only at or towards the point of ebullition or of congelation. In the former case we should say that three parts of water would be required for the solution of one part of muriate of soda, and only half a part would be necessary to dissolve one part of the nitrate of potash; in the latter, that much less water would be required to dissolve the muriate of soda than to dissolve the nitrate of potash *.

The force of cohesion in a body on its taking the solid state obliges a part of the caloric to separate; in the same manner as when a salt crystallizes, it abandons part of the solvent, or even a part of the acid, or of the alkali, with which it might be combined.

10. It may be said that the affinities may really be represented by the tables of capacity; since they may afford the measure of the action of one substance upon another, when a common term of saturation is found, such as neutralization for the acids and the alkalis, and thermometric temperature for caloric; but nothing could possibly be concluded for chemical action at another term of saturation, and more particularly for another constitution, and for all the circumstances in which the forces of elasticity and cohesion might not be introduced.

11. Having considered all the affinities which may jointly produce chemical action, I next examined how, in the compounds, they may result from their constituent parts, in order to acquire a conception how the varied powers, which produce all the chemical phænomena, can be derived from one single property of simple bodies. The observations presented on this subject have shown, that what principally distinguishes compound substances, whose action is considered as simple, is, the condensation of the constituent parts, on which a new affinity depends; an affinity very different from that which the same parts possess in the elastic state: the elementary

* This consideration alone, that specific caloric has no known relation to the quantity of caloric combined in a body, shows that the experiments by which Rumford has lately pretended to prove that caloric is not a constituent part of bodies, cannot lead to such a conclusion.

affinities

affinities are modified by the ſtate of ſaturation, by the force of coheſion, or by the variations of elaſticity: the reſulting affinity may undergo, by combination, a new degree of ſaturation which tends to ſupport the compoſition, or may be weakened by other tendencies to combination with one of the conſtituent ſubſtances.

12. The conſiderations which I have preſented reſpecting the modifications of chemical action, do not, however, prevent us from uſing the term *affinity* to denote the whole chemical power of a body exerted in a given ſituation, either by its preſent conſtitution, its proportion, or even by the concurrence of other affinities; only we muſt avoid conſidering this power as a conſtant force; for it would be erroneous to infer from its preſent effects, in any inſtance, what they would be under other conditions.

[To be continued.]

XXII. *A Treatiſe on the Cultivation of the Vine, and the Method of making Wines.*

[Continued from p. 19.]

V. The Method of taking the Wine from the Vats, and the proper Period for that Purpoſe.

AT all times agriculturiſts have conſidered it as a matter of great importance, to be able, by unerring ſigns, to diſcover the moſt favourable period for taking the wine from the vats; but here, as in other things, they have fallen into the very great inconvenience of general methods. This period ought to vary according to the climate, the ſeaſon, and the nature of the wine propoſed to be obtained, and of other circumſtances, which muſt always be kept in view.

It will be proper for us, therefore, to lay down principles rather than to preſcribe methods; for, in our opinion, this is the only way to make ourſelves maſters of the operations, and to bring together the whole of thoſe phænomena, the knowledge and compariſon of which become neceſſary before any deciſion, founded upon certainty, can be given.

Some agriculturiſts have ventured to determine a fixed period for fermentation; as if it ought not to vary according to the temperature of the air, the nature of the grapes, the quality of the wine, &c. Others conſider as a ſign that the wine is fit to be removed from the vats, the ſinking down of the vintage, being certainly ignorant that almoſt the whole of the

the wines of the North would lofe their moft valuable qualities, if their removal of the vats were delayed till that time.

There are fome countries where it is judged that the fermentation is completed, when the wine, after being put into a glafs, exhibits no foam at the top, and no air-bubbles at the fides of the glafs. In other places it is thought fufficient to fhake the wine in a bottle, or to pour it from one glafs into another feveral times, to afcertain whether there exifts any foam. But befides that all new wines give more or lefs foam, there are many in which that mark of effervefcence ought to be preferved, in order that they may not lofe one of their principal properties.

In fome countries, a ftick is immerfed in the vat, and fpeedily drawn out; the wine is then fuffered to drop from it into a glafs, to fee whether a circle of foam is formed in it, which is called *faire la roue*. Some thruft their hand into the refufe, and, applying it to their nofe, judge, by the fmell, of the ftate of the vat: if the fmell is mild, they allow the wine to ferment fome time longer; if it is ftrong, it is removed from the vats.

Some agriculturifts, alfo, confult only the colour in order to regulate the period of removing the wine from vats. They fuffer it to ferment till the colour becomes fufficiently dark: but the coloration depends on the nature of the grapes; and muft in the fame climate, and produced from the fame foil, does not always fhow the fame difpofition to acquire colour; which renders this fign exceedingly variable and very infufficient.

It thence follows, that all thefe figns, taken feparately, cannot exhibit invariable refults; and that, if we wifh to reft on fixed bafes, recurrence muft be had to principles.

The object of fermentation is to decompofe the faccharine principle: the more abundant, therefore, this principle is, the fermentation muft be brifker, or continued for a longer time.

One of the infeparable effects of fermentation is, the production of heat and carbonic acid gas. The firft of thefe refults tends to volatilize and to difperfe the flavour and fmell, which forms one of the principal characters of certain wines. The fecond carries outwards, and caufes to be loft in the air a fluid, which if retained in the beverage would render it more agreeable and pungent. From thefe principles it follows, that weak wines, but of an agreeable flavour, require little fermentation; and that colourlefs wines, the principal property of which is to be brifk, ought to remain fcarcely at all in the vats.

The moft immediate product of fermentation is the formation

tion of alcohol, which refults immediately from the decompofition of the fugar. When the grapes, therefore, are very faccharine, fuch as thofe of the fouth, the fermentation muft be brifk, and long continued; becaufe thefe wines, being deftined for diftillation, ought to produce immediately all the alcohol that can refult from the decompofition of the whole of the faccharine principle. If the fermentation be flow and weak, the wines remain lufcious, and do not become warm and agreeable till they have long worked in the vats.

In general, grapes abundant in the faccharine principle muft ferment a long time. In the Bordelois, the fermentation is fuffered to work itfelf to an end: the wine is never removed from the vats till the heat has fubfided.

According to thefe principles and others, deduced from the theory before eftablifhed, we may draw the following confequences:

1ft, The muft ought to remain in the vats the lefs time according as it is lefs faccharine. Light wines, called in Burgundy *vins de primeur,* cannot bear the vat above from fix to twelve hours.

2d, The muft ought to remain the lefs time in the vats, according as it is propofed to retain the acid gas, and to form brifk wines: in that cafe, it is thought fufficient to tread the grapes, and to put the juice into the cafks after it has been left in the vat twenty-four hours, and fometimes without having been in the vat at all. In this cafe, the fermentation, on the one hand, is lefs tumultuous; and, on the other, the gas can with lefs eafe be volatilized; which contributes to retain that highly volatile fubftance, and to make it one of the principles of the liquor.

3d, Muft ought to be left in the vats lefs time, according as it is propofed to obtain wine lefs coloured. This condition is of great importance in regard to brifk wines, one of the moft valuable qualities of which is their want of colour.

4th, Muft ought to remain in the vats lefs time, according as the temperature is warmer, and the mafs more voluminous, &c.: in that cafe, the brifknefs of the fermentation makes up for its fhortnefs of duration.

5th, The muft ought to remain in the vats lefs time, according as it is propofed to obtain wine of a more agreeable flavour.

6th, The fermentation, on the other hand, will be longer, according as the faccharine principle is more abundant, and the muft thicker.

7th, It will be longer if the wines are deftined for diftillation; in which caſe, every thing ought to be ſacrificed to the production of alcohol.

8th, The fermentation will be longer, according as the temperature has been colder when the grapes were collected.

9th, The fermentation will be longer, according as the wine is required to be more coloured.

From theſe principles it may be conceived why in one country the fermentation in the vat terminates in twenty-four hours, while in others it continues for twelve or fifteen days; why one method cannot be generally applied; and why particular proceſſes may be attended with errors, &c.

Gentil admits as an invariable ſign of the neceſſity of removing the wine from the vat, the diſappearance in regard to taſte of the ſweet and ſaccharine principle. This diſappearance, as he obſerves, is only apparent, but the ſavour of the little that remains is concealed; the alcohol, the ſavour of which predominates, terminates its decompoſition in the caſks. It is alſo evident that this ſign, which is not at all applicable to white wine, cannot be employed for wines deſtined to remain luſcious.

The ſigns deduced from the ſinking down of the head or refuſe, and the coloration of wines, are attended with the like inconveniences, and we muſt return from them to the principles above eſtabliſhed. This is the only method of avoiding error.

A provident agriculturiſt will always prepare his caſks, on the approach of the vintage, in ſuch a manner that they may be ready to receive the wine as it comes from the vat. The preparation given to them is as follows:

If the caſks are new, the wood of which they are compoſed retains an aſtringency and bitterneſs, which may be tranſmitted to the wine; and theſe faults may be corrected by pouring warm water and ſalt water into them ſeveral times in ſucceſſion. Theſe liquors muſt be well ſhaken, and ſuffered to remain in them till they penetrate the texture of the wood, and extract the pernicious principle. If the caſks are old, and have been frequently employed, one end of them is opened: the ſtratum of tartar, with which the inſide is covered, is ſcraped off, and they are waſhed with warm water or with wine.

In general, the moſt uſual methods of preparing the caſks are confined to the following:

1ſt, Waſh the caſk with cold water, then pour into it a quart of ſalt water in a ſtate of ebullition; ſtop the bung-hole, and ſhake it in every direction: empty it, let the water drain well off; then take two quarts of fermenting muſt, and, having boiled and ſkimmed it, pour it boiling hot into the caſk; cloſe it and again ſhake it, after which ſuffer it to drain off.

2d, Warm wine may be employed inſtead of the above preparations.

3d, An infuſion of the flowers of the peach-tree, &c. may alſo be uſed.

When the caſks have acquired any bad quality, ſuch as muſtineſs, &c. they muſt be burnt: it is poſſible to conceal theſe defects, but there is reaſon to fear they might reappear.

The antient Romans put gypſum, myrrh, and various aromatic ſubſtances into the caſks into which their wines were removed from the vat. This is what they called *conditura vinorum*. The Greeks ſometimes added a little bruiſed myrrh and argil. Theſe ſubſtances not only perfumed the wine, but ſerved alſo to clarify it.

When the caſks are properly prepared, they are depoſited on caſk-ſtands, and thus raiſed ſome inches from the ground, both to prevent the action of putrid humidity, and for the more convenient drawing off the wine which they contain. They muſt be arranged in parallel rows in the cellar, with ſufficient room between for a perſon to examine whether any of them leaks.

In the caſks thus prepared the wine is depoſited: when it is thought to have remained a ſufficient time in the vat for this purpoſe, the tap of the vat, which is raiſed ſome inches above the ground, is opened, and the wine is ſuffered to run into a reſervoir, generally conſtructed below, or into a veſſel placed on purpoſe to receive it: the wine is immediately drawn from the reſervoir and carried to the caſks, into which it is introduced by means of a funnel.

The liquor which floats over the depoſit of the vat is called in Burgundy *ſurmoût*. This *ſurmoût* is carefully drawn off, and put into caſks capable of containing 30 gallons, or into half caſks of 15. This *ſurmoût* forms a lighter kind of wine, more delicate and leſs coloured.

When all the wine which the vat can furniſh has been drawn off, nothing remains but the head, which has ſunk down almoſt to the depoſit. This refuſe is ſtill impregnated with wine, and retains ſuch a quantity, that it may be extracted by means of the preſs. But as the head, which has been in contact with the atmoſpheric air, for the moſt part contracts a little acidity, eſpecially when the vintage has remained a long time in the vat, it muſt be carefully ſeparated, in order to be preſſed by itſelf; by which means it will produce very good vinegar.

When

When the depoſit in the vat has been preſſed, the vine that flows from it is put into the caſks with the reſt; after which the preſs is eaſed, and the refuſe is cut quite round, to the thickneſs of three or four inches, with a ſharp ſhovel; that which has been cut off is thrown into the middle, and again ſubjected to the preſs: the operation of cutting is a ſecond time repeated, and the cut matter is preſſed as before.

The wine ariſing from the firſt *cutting* is the ſtrongeſt; that ariſing from the third is harder, harſher, greener, and more coloured.

Sometimes a firſt cutting is thought ſufficient, eſpecially when the refuſe is deſtined for the acetous fermentation. The product of theſe different cuttings is often mixed together in ſeparate caſks, in order to obtain wine coloured and pretty durable; and in ſome places it is mixed with common wine when it is required to give to the latter colour, ſtrength, and a ſlight aſtringency. In Champagne, the wine of the firſt preſſing is mixed with that ariſing from ſucceeding cuttings.

The wine of the preſs is the leſs coloured according as it is preſſed more weakly and more ſpeedily. Theſe wines in Champagne are called *gray wines.* The wine ariſing from the firſt and ſecond cutting is called *œil de perdrix*; and that ariſing from the third and fourth, *vin de taille:* the laſt is the moſt coloured, but it is ſtill agreeable.

The refuſe, when ſtrongly preſſed, acquires ſometimes the hardneſs of ſtone. It is applied to various uſes in commerce.

1ſt, In ſome countries it is diſtilled in order to make a ſpirit, which is called *eau-de-vie de marc.* In Champagne it is known under the name of *eau-de d'Aixne*; but it has a bad taſte. This diſtillation is advantageous, eſpecially in countries where the wine is highly generous, and where the preſſes do not preſs very cloſely.

2d, In the neighbourhood of Montpellier, the refuſe is put into caſks, where it is carefully trod upon; and it is then preſerved for making verdigris *.

3d, In other places it is rendered acid by carefully airing it, and the vinegar is then extracted by ſtrong preſſure. The expreſſion may even be facilitated by moiſtening it with water.

4th, In ſeveral cantons the cattle are fed with the refuſe: as it comes from the preſs, it is broken with the hands in order to divide the lumps; it is then thrown into caſks, where it is moiſtened with water, and it is covered with earth mixed with ſtraw: this covering is about 7 or 8 inches in thickneſs. When bad weather prevents the cattle from going out into the fields, about 6 or 7 pounds of this refuſe

* See Philoſophical Magazine, Vol. IV.

is ſoaked in warm water with bran, ſtraw, turnips, potatoes, and oak or vine-leaves, which have been preſerved on purpoſe in water: a little ſalt may be added to this mixture, which is given to the cattle in a tub evening and morning. Horſes and cows are fond of this food; but it muſt be given to the latter in moderation, becauſe it would cauſe their milk to turn four. The refuſe of white grapes is preferred on account of its not having been fermented.

5th, The ſtones contained in the grapes ſerve for feeding poultry: oil, alſo, may be extracted from them.

6th, The refuſe may be burnt to obtain alkali: 4000 pounds of refuſe yield 500 pounds of aſhes, which give 10 pounds of dry alkali.

VI. Of the Method of managing the Wine in the Caſks.

The wine depoſited in the caſks has not reached its laſt degree of preparation. It is turbid, and ſtill ferments; but, as the movement of it is leſs tumultuous, this ſtate of it has been called the *inſenſible fermentation.*

Soon after the wine has been put into the caſk, a ſlight hiſſing is heard, which ariſes from the continued diſengagement of the carbonic acid gas that eſcapes from every point of the liquor; foam, which paſſes over through the bung-hole, is formed at the top, and care is taken to keep the caſk always full, that the foam may eſcape, and that the wine may diſgorge itſelf. For a ſhort time it will be ſufficient to faſten a piece of paper on the bung, or to lay a tile over it.

In proportion as the fermentation decreaſes the maſs of the liquid ſinks down; and this depreſſion is carefully watched, in order to pour in more wine, that the caſks may be always kept full. There are ſome countries where this operation is performed every day for the firſt month, every four days during the ſecond, and every eight till it is drawn off. This is the method practiſed in regard to the delicious wines of the Hermitage.

In Champagne, the *gray wines* are ſuffered to ferment in the caſks ten or twelve days; and when they ceaſe working up, the caſks are cloſed by means of the bung, leaving a ſmall vent-hole at one ſide of it. This vent-hole is cloſed eight or ten days after with a wooden peg, which may be taken out at pleaſure. When the caſks have been cloſed, freſh wine muſt be poured in through the vent-hole, every week for twenty-five days; then every two months as long as the wine remains in the cellar. When the wines have not ſufficient body, and are too green, which is the caſe when the ſeaſon has been damp and cold; or if they are too luſcious, which is the

caſe

case when the season has been too dry and warm, the casks are rolled five or six times twenty-five days after the wine has been made, to mix well the lees; and this operation is repeated every eight days during a month: by these means the wine is improved.

The fermentation of the wines of Champagne destined to be brisk is continued very long: it is believed that wine can constantly be brisk, provided it be put into bottles between the time of the vintage till the month of May; and that, the nearer to the time of the vintage, the better it foams. We are assured also that it always foams if put into bottles between the 10th and 14th of March. Wine never begins to foam till six weeks after it has been put into bottles. Mountain wine foams better than Champagne: when wine is put into flasks between June and July it foams little, and not at all if bottled in October or November, after the vintage.

In Burgundy, when the fermentation in the cask has slackened, the casks are closed, and a small hole is made in them near the bung, which is closed with a peg. This peg is drawn out from time to time to suffer the remainder of the gas to escape.

In the environs of Bourdeaux it is customary to begin pouring in new wine eight or ten days after the wine has been put into the casks. A month after, the bung is put in, and new wine is poured in every eight days: at first, the bung is put in very gently, and it is gradually driven in closer without incurring any danger.

The white wines are drawn off about the middle of December, and they are then sulphured. The white require more care than the red, because they contain more dregs, and are more disposed to become oily.

Red wines are not drawn off till the end of March or beginning of April. The latter easier turn sour than the white, which renders it necessary to keep them in cooler cellars during the hot weather.

Some people, after the second drawing off, turn the barrels with the bung on one side, and thus keep the wine hermetically sealed, without having need to pour in new wine, as there is no loss. The wine then is not drawn off but every year at the same period, until it is found convenient to drink it. As the processes every where followed are nearly the same, we shall not multiply details, which would be only repetitions.

When the fermentation has ceased, and the mass enjoys perfect repose, the wine is completely made. But it acquires new qualities by clarification; and by this operation is preserved from the danger of turning sour.

This clarification is effected ſpontaneouſly by time and repoſe; and there is gradually formed a depoſit at the bottom of the caſk and on the ſides, which frees the wine from every thing not in abſolute ſolution in it, or which is in it in exceſs. This depoſit, called the lees, *fæces*, is a confuſed mixture of tartar principles, analogous to fibrous matter and colouring matter.

But theſe matters, though depoſited in the caſk, and precipitated from the wine, are ſuſceptible of being ſtill mixed with it by agitation, change of temperature, &c.; and in that caſe, beſides injuring the quality of the wine, which they render turbid, they may communicate to it a new fermentation, which makes it degenerate into vinegar.

To obviate this inconvenience, the wine is drawn off into other veſſels at different periods; all the lees which have been precipitated are carefully ſeparated; and every thing exiſting in it in a ſtate of incomplete ſolution is diſengaged from it by ſimple proceſſes, which we ſhall hereafter detail. By means of theſe operations it is cleanſed and purified, and deprived of all thoſe matters which might determine acetification.

Every thing that relates to the art of preſerving wines may be reduced to *ſulphuring* and *clarification.*

Sulphuring of Wine.

1ſt, To ſulphur wine is to impregnate it with a ſulphurous vapour obtained by the combuſtion of ſulphured matches.

The method of compoſing theſe matches varies conſiderably in different places; ſome mix with the ſulphur aromatic ſubſtances, ſuch as powder of cloves, cinnamon, ginger, Florentine iris, flowers of thyme, lavender, marjoram, &c. and melt the mixture in an earthen veſſel over a moderate fire. In this melted mixture, rags of cotton cloth are dipped in order to be burnt in the caſks. Others employ ſulphur alone, which they melt over the fire, and dip rags in it in the ſame manner.

In the method of ſulphuring caſks there is alſo conſiderable variety. Sometimes the match is ſuſpended at the end of an iron wire; it is then lighted, and put into the caſk intended to be filled with wine; the caſk is then ſtopped, and the match is left to burn: the internal air becomes dilated, and is expelled, with a hiſſing noiſe, by the ſulphurous gas: two, three, or more matches are burnt in this manner, according as may be thought neceſſary. When the combuſtion is terminated, the ſides of the caſk are ſcarcely acid; the wine is then poured into it. In other countries, two or three pailfuls of wine are poured into a good caſk; a ſulphured

phured match is then burnt in it; and when the combuſtion is finiſhed, the caſk is ſtopped, and ſhaken in every direction. After being left at reſt for an hour or two, it is unſtopped, more wine is added; it is then again ſulphured, and the operation is repeated till the caſk be full. This is the proceſs uſually followed at Bourdeaux.

At Marſeillan, near the commune of Cette, in Languedoc, a kind of wine is made of white grapes called *mute wine*, which is employed to ſulphur others. The vintage is trod and preſſed without giving it time to ferment; it is then put into caſks filled one-fourth; ſeveral matches are burnt over it; and the caſks are ſtrongly ſhaken, until no more gas eſcapes through the bung-hole when opened. A new quantity of wine is then added, matches are again burnt over it, and the caſks are ſhaken with the ſame precautions. This operation is repeated till the caſk is full. This wine never ferments, and for that reaſon is called mute wine (*vin muet*). It has a ſweetiſh ſavour, a ſtrong ſulphurous odour, and is employed for mixing with other wine. Two or three bottles of it are put into a caſk. This mixture is equivalent to ſulphuring.

Sulphuring firſt renders wine turbid, and gives it a bad colour; but the colour is reſtored in the courſe of time, and the wine becomes clear. This operation whitens the wine a little. Sulphuring is attended with the very valuable advantage of preventing it becoming acetous. Though it be difficult to explain this effect, it appears to me that it cannot be conceived but by conſidering it under two points of view:

1ſt, By the help of the ſulphurous gas the atmoſpheric air is diſplaced, which otherwiſe would become mixed with the wine, and determine acid fermentation.

2d, Some atoms of a violent acid, which oppoſes and overcomes the development of a weaker acid, are produced.

The antients compoſed a kind of maſtic with pitch, a fiftieth part of wax, and a little ſalt and incenſe, which they employed for burning in their caſks. This operation was denoted by the words *picare dolia*, and the wines thus prepared were known under the names of *vina picata*. They are mentioned by Plutarch and Hippocrates.

It was, perhaps, in conſequence of this cuſtom that the fir was conſecrated by the antients to Bacchus: at preſent, an agreeable perfume is communicated to weakened red wine by making it remain over a ſtratum of the ſhavings of fir. Baccius ſays that the caſks ought to be pitched (*picare dolia*) during the dog days.

[To be continued.]

XXIII. *Researches on Alumine. Read Dec. 18, 1800, in the Society of Physics and Natural History at Geneva.* By Theodore de Saussure.

[Concluded from p. 36.]

On the different Degrees of the Desiccation of pure Alumine in its different States.

ALUMINE, precipitated by ammonia and by the carbonate of ammonia, exhibits itself under two very different aspects, according to the quantity of water in which the aluminous salt is dissolved, though the weight of the precipitates be the same when they are dried in a temperature of from 65 to 75 of Fahrenheit.

If the quantity of water does not exceed what is necessary for the solution of the aluminous salt, a white earth is obtained, light, friable, exceedingly spongy, and which adheres to the tongue. I shall distinguish it by the name of *spongy alumine.*

But if the aluminous salt is dissolved in a very large quantity of water, there is obtained, after the precipitate has been dried at the above temperature, a transparent mass*, yellow and brittle, which when in fragments is somewhat voluminous, breaks or splits in the hand as sulphur does in the like case; it has a smooth and conchoid-formed fracture, without any earthy aspect, does not adhere in any manner to the tongue, and neither swells up nor resolves itself into water: it presents a volume of only a tenth or a twelfth of what the same weight of the spongy alumine does, and resembles gum arabic or dried jelly. I shall give it the name of *gelatinous alumine.*

* Opacity is not, then, essential to alumine, but when, in this or in the gelatinous state, it has been exposed to a violent heat. I do not know whether it was in this state that it was considered by Fourcroy, when he says, in his *Système des Connoissances Chimiques*, that alumine appears opaque in its ultimate moleculæ; that it reflects the light entirely; and that it communicates that property to stones, into which it enters in a large quantity. But there are many exceptions which destroy this *general rule.* I shall remark, that alumine, considered either in its spongy state or in that of its complete desiccation, appears opaque only by the division of its parts. With a good microscope, which magnified 200 times, I observed gelatinous alumine in fine powder, after being exposed to a heat expressed by 170 degrees of Wedgewood's pyrometer. It was transparent in its smallest moleculæ, though the powder of alumine had experienced neither agglutination nor fusion. The sapphire, the topaze, the cymophane, and the ruby, contain more alumine than is found in any opaque stone or rock at the surface of the earth; and yet these gems are transparent! By being too eager to establish *general rules*, we fall into confusion.

If

If ammonia be employed to precipitate gelatinous alumine, it is not neceffary to dilute the folution with fo large a quantity of water as when the carbonate is ufed, becaufe the difengagement of the carbonic acid contributes to give to the precipitate a fpongy appearance. But liquid ammonia highly concentrated can itfelf furnifh a *fpongy alumine*, when the folution of alumine is much concentrated, becaufe the elements of the precipitate have not fufficient room to float freely in the liquor, and to difpofe themfelves in fuch a manner that the light may not be refracted in paffing from one molecula to another.

Spongy alumine and gelatinous alumine, dried at the temperature of the atmofphere, contain the fame quantities of water, as I fhall foon prove. But the former, on account of its minute divifion, abandons, at the firft degrees of incandefcence, all the water it can contain; while the latter, more compact, retains a part at the higheft degree of heat that our furnaces can produce.

A hundred parts of fpongy alumine lofe in weight, at a red heat, lower than that which makes filver enter into fufion, fifty-eight parts; and it does not lofe a greater quantity at 130 degrees of Wedgewood's pyrometer, a heat capable of fufing iron.

A hundred parts of gelatinous alumine, at the firft degrees of incandefcence, lofe forty-three parts of their weight; and only forty-eight parts and a quarter at 130 degrees of Wedgewood's pyrometer.

To demonftrate that fpongy alumine and gelatinous alumine, when dried at a temperature between 10 and 20 degrees of Reaumur, contain the fame quantities of water, I diffolved in nitric acid 100 parts of gelatinous alumine, dried at a temperature between 15 and 20 degrees of Wedgewood's pyrometer, affifting the folution by mixing it with potafh at a fufing heat. The purified alumine was precipitated with the precautions already prefcribed for obtaining this earth under the *fpongy* form. It was then dried at a temperature between the 15th and 20th of Wedgewood's pyrometer, and it weighed then only twenty-five parts. A hundred parts of gelatinous alumine, dried at the firft degrees of incandefcence, retain, then, about fifteen parts of water; which agrees with the refults above announced.

I have entered into thefe details, which are doubtlefs minute, only becaufe great errors may have been committed in chemical analyfes by eftimating, as hitherto appears to have been the cafe, the quantity of alumine by the weight of this dried earth obtained at that red heat which generally indicates the firft degrees of incandefcence. This method is exact only when the alumine is in the spongy state: it is liable to an error of fifteen hundredths when it is in a gelatinous state; and in that case, nothing can be done but to dry it at a temperature between the 65th and 90th degree of Reaumur, and to diminish its weight in the ratio of 58 per cent.; or, what is still better, to effect its solution, and precipitate it in the spongy state. If this earth, then, dried at the temperature of the atmosphere, does not lose at a red heat about 58 hundredths of its weight, it may be presumed that it is pure.

Considerations on the Application of gelatinous Alumine to Pyrometry.

Gelatinous alumine experiences, at a heat successively augmented, losses of weight which, at equal intervals of heat, follow a decreasing progression; to know the law of which would be very important, because they might serve for estimating, in a precise manner, the different degrees of heat. I ascertained, by repeated experiments, made with care, that the quantity of water it loses is invariable; that is to say, that when the earth has attained its *maximum* in regard to loss of weight at a certain degree of heat, the continuance of the heat at that degree has no influence in producing any further desiccation. Though the experiments I made in other respects, to obtain some information on the possibility of applying gelatinous alumine * to pyrometry, were far from affording me satisfaction, I shall describe them with all their imperfections. They will be of some use to those who may have perseverance enough to pursue these researches.—A hundred parts of gelatinous alumine in powder, and dried at the temperature of from 65 to 88 degrees of Fahrenheit, lose at the temperature of

Degrees of Fahrenheit.	Wedgewood's Pyrometer.	Parts of Water volatilized.
144·5 -	- - -	- 12·2
257·0 -	- - -	- 19
369·5 -	- - -	- 23·7
482·0 -	- - -	- 27·2
	13 -	- 42·3
	29 -	- 45
	85 -	- 46
	106 -	- 47·5
	133 -	- 48·25
	170 †	- 48·25

These

* As spongy alumine abandons all the water it contains at a slight incandescence, it can be employed only for lower degrees.

† The shrinking of pyrometric cylinders, and, in general, of argils, by heat, is ascribed to the expulsion of water. This opinion is true beyond a doubt

These experiments were each made on 50 grains only, and with a balance which I cannot warrant to have been free from an error less than a quarter of a grain. They are far, therefore, from that degree of precision which is necessary to determine the law of the progression in question.

These results, in regard to the uniformity of their progress, do not agree with Wedgewood's pyrometer: but I must observe, that this instrument is too uncertain to be employed for determining the law of desiccations.

C. Necker, to whom I am indebted for the use of that which I employed, exposed to the same heat, and for the same time, eight pyrometric cylinders in a crucible of platina. He saw with me that they indicated 127—126—111—107—98—96—93—90 degrees of their scale. Some of them were vitrified; others remained in the state of porcelain, or changed their form more or less; others experienced none of these accidents. These results arise from the inequality of the mixture of which the paste of the cylinders is formed. It can hardly be supposed that two artists, though furnished with the same formula, can be able to make similar cylinders, because of the different degrees of the pulverization of the silex, which will never be the same, and will always have a great influence on the result. C. Gazeran obtained this equality, which he even surpassed, only by laborious and multiplied trials, though founded on an analysis of Wedgewood's cylinders*.

It is here seen, that if the property which alumine possesses at low temperatures, of losing only a determinate quantity of water at a constant degree of heat, continues unimpaired at a more elevated heat, it is possible that, by employing for

a doubt in regard to low temperatures; but I think it in a great part erroneous, in regard to the shrinking of pyrometric clay at a temperature above the 29th degree of that instrument. The experiment on which I found this idea is as follows:—I weighed, with a balance sensible to the eighth of a grain, the pyrometric piece of the last experiment. Before put into the fire, it weighed $32\frac{1}{2}$ grains. I took it out at the 29th degree, and it had then lost $2\frac{1}{2}$ grains. After that term to the 170th of the same scale it did not sensibly change its weight, and yet during that interval it had lost more than the fourth of its volume. This shrinking, therefore, does not arise merely from the expulsion of the water, but rather, and almost exclusively, from the new combinations or modifications which the earthy elements of the argil experience at a high temperature.

At the 170th degree, the platina crucible containing the alumine gave, at its exterior surface, proofs of very great emollition, and almost of fusion. This surface, in some of its parts, exhibited a confused crystallization similar to that exhibited by Carrara marble when polished. The platina covering, though very thick, sunk down, and was slightly fused in some places.

* Philosophical Magazine, Vol. IX. p. 155.

each

each experiment about 200 grains of alumine, and a balance ſenſible to the twentieth of a grain, as great exactneſs will be attained as that given by Wedgewood's pyrometer in its ſtate of perfection; but it is ſeen, alſo, that theſe obſervations cannot be extended beyond the 130th degree of that pyrometer, becauſe at a higher the loſſes in weight of the alumine are little or not at all ſenſible in ſmall quantities.

The method I propoſe would be particularly uſeful when it were wiſhed to determine the degrees comprehended between the 257th degree of Fahrenheit and the weakeſt incandeſcence; degrees not comprehended in Wedgewood's ſcale, and which cannot be, on account of the dilatation experienced by argil before it attains to a red heat. I ſhall here mention ſome precautions which ought to be employed in order to make theſe obſervations with exactneſs.

1ſt, The deſiccation of gelatinous alumine at the temperature of the atmoſphere is uncertain: it may not be equal in all the parts of the earth; it is proper then to pulverize it, and to ſet out from a fixed degree of deſiccation. For that purpoſe, a ſmall part muſt be expoſed to a heat of 257° F. by putting it together with that thermometer into a glaſs tube, cloſed at one of its extremities, and immerſed in a ſand-bath heated by an Argand's lamp, the heat of which is graduated at pleaſure. The loſs of weight ſuſtained by the alumine, dried at the temperature of 257°, is to be deducted in all operations performed with earth dried at the temperature of the atmoſphere. The dried earth may be preſerved in a bottle with a ground ſtopper.

I have indicated the 257th degree of Fahrenheit as the loweſt term, becauſe, at degrees lower than that of boiling water, the loſs of weight in the alumine dried at the temperature of the atmoſphere takes place with great ſlowneſs.

To deſiccate two drams and a half I employed

Nine hours in a heat of	144° F.
Two hours - -	257
Half an hour -	482

The termination of this proceſs may be readily perceived when the tube which contains the alumine ceaſes to be obſcured by the vapours that eſcape.

2d, In operations at degrees lower than incandeſcence, it is proper to weigh the earth at the moment when it comes from the fire, becauſe at the end of an hour or two it takes from the atmoſphere a quantity of water, which may produce an error of one or two hundredths.

XXIV. *Some Account of the Life of the late Dr.* Joseph Black.

THIS eminent chemist was born at Bourdeaux, in France, in the year 1728. His parents were both natives of Great Britain, and at an early age he was brought over to this country, and educated for the medical profession at the university of Glasgow. Dr. Cullen being at that time lecturer of chemistry, Black became one of his favourite pupils, was allowed the free use of his laboratory, and assisted him in his experiments; by which means he acquired a decided taste for this branch of natural philosophy. In 1754 he took the degree of doctor of physic in the university of Edinburgh, where he had studied for some time; and the choice which he made in regard to the subject of his inaugural dissertation gave a proof of his attachment to chemical pursuits. It was *De humore acido a cibis orto et magnesia alba*. The principles of the doctrine which he brought forward in this thesis he afterwards fully explained in a paper read the next year before a society in Edinburgh, and published in the second volume of *Essays Physical and Literary*, 1756; containing experiments on magnesia alba, quick-lime, and alkaline substances. In this paper, by an ingenious and philosophical series of researches, he evidently proved the existence of an aërial fluid, which he called *fixed air*, the presence of which gave mildness, and its absence causticity, to alkalies and calcareous earths. This noble discovery certainly paved the way to all that important knowledge respecting aërial bodies which has done so much honour to the names of a Cavendish, a Priestley, and a Lavoisier, and which have made chemical philosophy assume an entirely new form.

In the year 1756, on the removal of Dr. Cullen to Edinburgh, Dr. Black became professor of medicine and lecturer on chemistry in the university of Glasgow. Next year he enriched the science of chemistry with the curious doctrine of *latent heat*, in which he explained, in what has been hitherto reckoned a clear and satisfactory manner, the connection of heat with fluidity, the phænomena of freezing and boiling, and the manner in which they affect the thermometer. These discoveries, the result of great natural sagacity and experimental skill, certainly laid the foundation of all those important facts relating to this part of chemistry which were afterwards brought to light by several of the most eminent philosophers of the present period, and would alone be sufficient to give celebrity to the name of Black. His reputation,

putation, indeed, was now raised so high, that a vacancy having taken place in the chemical chair of Edinburgh, by the removal of Dr. Cullen, in 1765, to another department, Dr. Black was looked up to as the only man capable of sustaining, in this branch of science, the superiority which that celebrated school of medicine had acquired in all others. He was therefore elected to succeed Cullen, and for many years discharged the duties of the office with universal approbation, being much admired for the care, perspicuity, and elegance, with which he communicated instruction in his lectures, and his neatness and accuracy in performing experiments. Very complete manuscript copies of his lectures were taken by many of his students, particularly in the early part of his teaching, when they contained a great deal of matter then little known to the chemical world; and these copies, read with avidity by the lovers of this science, have greatly contributed to secure to him the honour of those discoveries, and that original mode of reasoning, which he scarcely ever made public in any other form.

After his election to the chemical chair, he published nothing but a paper on the Effect of Boiling upon Water, in disposing it to freeze more readily, printed in the sixty-fifth volume of the Philosophical Transactions for 1774; and An Analysis of the Water of some Hot Springs in Iceland, in the Philosophical Transactions of Edinburgh for 1791. The latter contains some observations, highly interesting to the chemist, on the formation of the siliceous stone deposited by these wonderful springs; and has long been considered as a model of neatness and accuracy in the analysis of mineral waters. Two of his letters on chemical subjects have been published by Crell and Lavoisier.

Dr. Black was long a strenuous opposer of the new theories in chemistry; but he at length became an avowed convert to the principles of the French chemists, and did not hesitate to make amends by his applause for his former opposition. He never distinguished himself as a practical physician. His manners were simple, his temper cold and reserved, and his habits of life adapted to his own convenience. He was never married; and died suddenly, in his sixty-second year, on the 6th of December 1799, his health having been in a declining state for some time before. He was a member of the Philosophical Societies of London and Edinburgh, and, by the solicitation of Lavoisier, had the distinguished honour of being chosen one of the eight foreign members of the Academy of Sciences of Paris.

XXV. *On*

XXV. *On the Means to be employed for multiplying Fiſh. By* C. Nouel, *Member of the Jury of Inſtruction at Rouen* *.

Permit me to call your attention, and that of your readers, to the advantages which might reſult to France by encouraging the multiplication of fiſh; a branch of public œconomy too much neglected, notwithſtanding the experiments of our neighbours, and the ſucceſs they have obtained. It is an unexplored mine preſented to national induſtry. What products might we not expect, if our patriotic efforts, directed towards it, ſhould have for their object an increaſe of the natural productions of our rivers; the reſtocking our pieces of water, ponds, and lakes, rendered uſeleſs by long neglect! Two methods, which might be adopted with equal facility, would conduct to this reſult. The firſt conſiſts in conveying from the lakes to the rivers, and from the rivers to the lakes, fiſh found only in one of them; the ſecond, in introducing into freſh water, as it were inſenſibly, and by means of artificial ponds, fiſh produced in ſalt water, giving the preference to thoſe ſpecies which by their habits and manner of living might be fitteſt for this kind of naturalization.

We have already had inſtances of fiſh being conveyed from one river to another, or from a river to a lake, and *vice verſa*. This method has been employed with ſucceſs in Germany in regard to the ſhad, with which ponds and pieces of ſtagnant but clear water, with a bottom of ſand and gravel, preferred by the ſhad to all others, have been peopled. In the year 1779 Dr. Bloch wrote me from Berlin that this experiment had been attended with complete ſucceſs. It is not above fifty years ago that Mr. Copland † conveyed perch into the Ken-loch and the river Urr, where they have thriven remarkably well; as has been the caſe with the trout taken from the river Leven and depoſited in Loch Long, in the county of Renfrew. The carp, which is a fiſh peculiar to warm climates, has been ſucceſſively introduced into the rivers and ponds of Pruſſia, Denmark, and England. Linnæus ſays poſitively that this fiſh formerly was not known in Sweden; and in my opinion it is ſtill unknown in Livonia,

* Tranſlated from the *Moniteur* of July 17th. Though the objects propoſed in this eſſay are applied by the author excluſively to France, it contains however a great many curious facts applicable to any other country, and therefore we have thought proper to make no alteration in the form in which the author has given it.—Edit.

† Mr. Copland of Collieſton.—Edit.

unleſs

unlefs it has been conveyed thither within thefe few years. The frefh-water gourami in the Ifle of France, where it has multiplied prodigioufly, came originally from Bengal. It was M. Poivre, that philofophic adminiftrator, who had the honour of enriching the rivers of this ifland with a fifh which in goodnefs and fhape may be compared to the fhad. That fmall fifh, the brilliant gold and filver colours of which all admire, the Chinefe dorado, was brought to Europe from the northern part of China. If fo much was done for a ufelefs fifh, valued merely on account of its fhining robe, by making it traverfe the feas to embellifh, in compliance with fafhion, our halls and our cabinets, why fhould we not do the fame to obtain fifh ufeful to man, which would recompenfe our troubles and our facrifices? The Romans, fated with victories and triumphs, received from tributary Afia the rareft fpecies of fifh to make a figure on their tables at their feafts. What the Romans did for the luxury of the rich, let us do for the general good, for the utility of the poor; and let us diftribute to every river in France the beneficent germs of a new fecundity, which will double their productions and their produce.

Our rivers do not contain more than about twenty indigenous fpecies, and fome migratory fifhes, which at certain periods of the year afcend to a certain diftance from their mouths, or, like the falmon, fwim towards their fources as far as they can. The fmall rivers poffefs ftill fewer fpecies; the greateft part even are confined to the tench, the trout, eels, and fome fmaller fifh of little value. How advantageous would it be to introduce into thefe rivers a multitude of foreign fifh, which in thefe waters would find aliment more agreeable to their tafte, and which would enjoy a temperature as analogous to their wants as favourable to their reproduction?

The Seine, which I fhall take as an example, nourifhes many fpecies of falmon and cyprini; but how many other fifh of the fame kind might be propagated in it! If the Seine poffeffes the falmon, it wants the thymallus, the umber of Auvergne, the lavaret, the murena of Germany, the grilfe of Scotland, the pala of Swifferland, the ferra of the lake of Geneva, &c. Why fhould not the carpio of the lake di Guarda, the *fchwarz-ritter* (charr) of the lakes of Berchftoldgaden, an excellent kind of falmon, highly praifed by baron de Moll, a naturalift of Salzbourg, fucceed in France, if that bottom, which they are moft attached to, were procured for them, at the foot of the Ardennes or the Vofgues? Why might they not be afterwards gradually introduced

troduced into our ſmall rivers? Can it be believed that the numerous tribe of the trout kind, the white, red, black, yellow ſpotted; the whitling, charr, bull, phinnoc, par, ſparling, &c. which ſwarm in the rivers in Scotland, would refuſe to ſupply our colonies with their ſpecies? No. There can be no doubt that they would bring thither that fecundity, abundance, and riches, which render them ſo valuable to their native ſtreams. The caſe would be the ſame with the *boudelles* and *büglings* offered to us by the lakes of Swiſſerland; the gudgeon, the cyprinus ballarus, and the ſalmo umbla, bred in the rivers of lower Germany. Let us open, then, with theſe countries a philoſophical and liberal exchange of the beſt fiſh of France for thoſe of which we wiſh to be poſſeſſed.

The ſecond method of multiplying the number and quantity of the natural productions of rivers, would be, as already ſaid, to convey into the freſh waters thoſe fiſh produced in ſalt water.

Nature herſelf gives us examples, and we have nothing to fear if we take it as our guide. Fiſh, originally produced in ſalt water, have voluntarily eſtabliſhed themſelves in freſh, where they have loſt all remembrance of the tumult of the waves amidſt which thoſe of their ſpecies play and ſport. Several lakes of Scotland poſſeſs ſalmon, which, abandoning their erratic taſte for a calm and ſettled life, have there become gradually naturalized. The ſalmon of the rivers Cluden and Nith, as well as thoſe of the Dee, are evidently indigenous, as is proved by their external form. The ſturgeon, the ſterlet, and different kinds of ſalmon, which Pallas obſerved in the Kama, reſide there, according to this naturaliſt, without interruption, and never deſcend to the Caſpian ſea. This celebrated traveller found the ſea-dog in the lake Baikal, though it is never caught in the Eniſſei nor in the lower Angora. He ſuppoſes, indeed, that it has been conveyed into that lake in conſequence of ſome conſiderable variation in the level of the globe, or by ſome other extraordinary event. On one hand, we ſee the *foudre*, a ſalt water fiſh, inhabit at preſent the Seine, and loſe itſelf in the banks of Tournidos, twenty-four miles above Rouen: on the other, Liancourt found the herring in the Elk, Potowmack, Hudſon's river, and the Delaware, rivers of North America; and, according to Twiſs, the ſame fiſh is caught in the freſh water lakes of Ireland: it is found in prodigious ſhoals in the baſons of Loch Lomond and Loch-Eck, in Scotland; it aſcends alſo the river Forth along with the ſalmon, and even to a very great diſtance from the ſea. In Pruſſia, it has been ſeen in the Oder, in the environs of Stetten, at the diſtance of more than ninety miles from the mouth of that river; and I have been often told by the fiſhers of Mark and Enckhuyſen, that the herring is found in the river Vollenhoven on the other ſide of the Zuyder Zee, eſpecially towards the end of the fiſhing ſeaſon.

There is no doubt, then, that theſe different ſalt water fiſh might be eaſily naturalized in freſh water; and that the caſe would be the ſame in regard to many other ſpecies, if proper care were taken, after their removal, to beſtow on them that attention neceſſary to enſure ſucceſs to the experiment. We have a proof of this in the ponds of Eaſt Frieſland. The large plaice, tranſported thither from the North Sea, have multiplied by myriads; and they now people thoſe pieces of water which before were totally unproductive. While encouraged by thoſe examples, is there any reaſon to doubt of ſucceſs? Has not the induſtry of man, ſeconded by perſeverance, obtained reſults far more aſtoniſhing than thoſe which might be expected from ſuch experiments? By care and attention he has been able to naturalize birds of paſſage, produced in diſtant latitudes, and which are now domeſticated. Diveſting themſelves of their ſavage and free ſtate, the ſtork, the gooſe, the duck, and the ſheeldrake (*anas tadorna*), have increaſed, in the courſe of time, the number of our poultry and the inhabitants of our farm-yards. The rabbit has forgot its paternal burrows, the pigeon and the turtle-dove have deſerted the hoſpitable hollows of the oak to inhabit among us; and from this amiable bird, to that ſuperb animal which ſhares in the labours of man, how many living beings have exchanged their manners for habits and wants which we have forced them to adopt? Man, the ſovereign of nature, has not confined his dominion to that which he exerciſed over animals; and though the domain of the vegetable kingdom ſeems placed beyond the limits of his power, trees and vegetables of every kind have been ſubjected to trials and experiments, the ſucceſs of which ſeems almoſt miraculous. Guided by the ſpirit of invention, and enlightened by genius, art has every where triumphed. What has been done, therefore, for the ſurface of the earth, by collecting in different points vegetables brought from every part of the globe, and aſtoniſhed at living together, let us do alſo for the population of our internal waters.

In the year 1799 I had the honour of reading, in one of the ſittings of the National Inſtitute, a memoir on the means and advantages of naturalizing the herring, a ſalt water fiſh, in the waters of the Seine, near its mouth, &c. The account of the proceſſes for accompliſhing this end, which I there pointed out, are not ſuſceptible of analyſis, and therefore cannot be introduced into this eſſay; it will be ſufficient for me to ſay, that the report of Lacepede, Cuvier, and Teſſier, was entirely in their favour. At preſent, I am ſtill more convinced of the efficacy of the means which I then propoſed; and I have no doubt that, if artificial ponds were formed on the edges of rivers, the experiment would be attended with complete ſucceſs. Every man who catches a fiſh, ſays Dr. Franklin, draws from the water a piece of money. Let not the maxims and example of this philoſopher be loſt to poſterity; let them rather produce fruit, like ſtrong and vigorous ſeed ſown in a fertile ſoil. Having obſerved in New England that the herrings aſcended from the ſea into one river of that country, while a ſingle individual was never ſeen in another river, ſeparated from the former by a narrow tongue of land, and which communicated alſo with the ſea, this philoſopher took the leaves of ſome plants on which the herrings had depoſited their ova, already fecundated, and conveyed them to the river which was deprived of the annual viſit of theſe fiſh. The ſucceſs of this experiment ſurpaſſed his expectation; the ova were completely productive, and the following year the river was peopled with a numerous ſhoal of herrings, which ſince that time have continued to frequent it.

This fiſh is not the only one which I wiſh to ſee naturalized in freſh water; to the herring I ſhould add ſeveral ſpecies of the pluronectes, ſuch as the brill, the barbue, and other flat fiſh, which, poſſeſſing traits of the family of the flounder, have alſo ſimilar wants and habits: I ſhould add alſo the mullet, the goby, the whiting, the gar-fiſh, and perhaps one or two ſpecies of the gurnet. I would pay the greateſt attention poſſible to the nature of the water proper for each ſpecies. This happy choice is the principal condition, and that which could enſure ſucceſs; but I would ſelect in particular for this colonization the fiſh found in lakes, which, though little known, are more numerous than is commonly ſuppoſed, and ought to be ſo.

At the epoch of the grand revolutions of the globe, when a part of the primitive earth emerged from the middle of the ocean, and pieces of water were formed without any current, the ſpecies of fiſhes were variouſly diſperſed. Every lake in Swiſſerland and Bavaria poſſeſſes ſome ſpecies ſo peculiar to it as not to be found in any neighbouring lake. Confined within their narrow baſons, theſe inſulated ſpecies lead a melancholy vegetative ſort of life, almoſt exiled from the world.

world. It is therefore through a very juſt predilection for theſe fiſh, priſoners in their lakes, that they ſhould be the firſt employed for the execution of my plan.

This plan, indeed, would be attended with two advantages, beſides the increaſe of proviſions, which would at length be the reſult of it. 1ſt, The increaſe in individuals, as in ſpecies, would neceſſarily introduce œconomical ways of preparation, to render the uſe of theſe fiſh more general and more extenſive. Many of thoſe conſumed freſh, would be ſalted, pickled, or dried, with ſucceſs. The Scots grilſe is exported to diſtant countries. Salmon, ſmoked after the manner of the Livonians, is in great requeſt at Hamburgh, though there are fat ſalmon in the Elbe. The gudgeon would be dried, as is practiſed in the Iſle of Oëſel; the plaice, the brill, and the ſole, according to the Dutch method of Katwyk, imitated on the banks of the Volga in drying the bream, &c. The *boudelle* would be pickled along with the ſhad. Pallas ſays that the latter is very proper for being ſmoked; and on this occaſion he mentions the Mardouan-Tſchouvaſches, who dry in the open air ſuch of theſe fiſh as they are not able immediately to conſume. All fiſh of the ſalmon kind, the ſparling excepted, and many of the genus of the cyprinus, would be ſuſceptible of different kinds of preparation, which would give them an additional value in commerce.—2d, If ſociety in general, on the one hand, gained an increaſe of proviſion; ſcience, on the other, would derive great advantages in regard to the improvement of phyſical knowledge. More ſpecies being collected, they would be leſs apt to eſcape the eye of the obſerver, who would thus be better able to examine every thing intereſting in theſe animals in regard to their organization, nutrition, multiplication, and habits, and to whatever conſtitutes their harmonies and contraſts. We are little acquainted with the induſtry of fiſhes; they are too far beyond our reach. We do not, however, preſume, as was ſaid very juſtly by Bonnet, that all their employment is confined merely to eating each other.

Let us procure, then, theſe fiſh: it is well known that in Germany fiſh are tranſported alive to a diſtance of ſixty miles and more. Let us place theſe adoptive ſpecies in convenient ponds, where they will forget their lakes; where they will find their accuſtomed food, tutelary ſhelter, and thoſe aquatic herbs the ſhade of which they were fond of in the days of their infancy, and which will invite them to reproduce in their turn. Hot beds are formed for vegetables; let us form a new kind for fiſhes. A moderate ſum will be ſufficient to enable

enable us to collect a great many species; and we shall soon be paid, with interest, for our expenses and sacrifices. Fishery is the agriculture of the waters: the fishes themselves will be at the trouble of sowing the seed, and man will have nothing to do but to collect the harvest.

XXVI. *Some Account of the natural Productions of the Island of Ceylon, particularly in the Environs of Columbo. By a Gentleman now resident on the Island.* 1800 *.

THE grain and fruits which are common to the peninsula are found in Ceylon.

Of rice there are four kinds, three of which are cultivated on the mountains, and do not require continual inundation. That this nutritious and wholesome article is not superabundant in the kingdom of Candy, arises from the imperfections of its government. If its growth were properly encouraged, this country, instead of having recourse to Bengal for supplies, might be enabled to export large quantities of this grain.

The cocoa-trees are very numerous within the district subject to the British government, and from whence the coasts of Malabar and Coromandel are supplied with spirits distilled from their fruit. In Candy this tree cannot be cultivated, from the great number of elephants which inhabit the woods, and are forbidden to be destroyed by order of the king.

The areka-tree is seen in every part of the island, and a clandestine trade is carried on with the Candian country, in the nuts which it yields. These, with such as are produced in the part subordinate to the British government, form a considerable branch of commerce.

This tree finds an enemy in the government of Candy, which discourages its cultivation; but the soil is so favourable to its growth, that it may be said to flourish, in spite of the elephant that tramples on it, and man who neglects to preserve it.

The coffee which is produced here, approaches in flavour to that of Moca.

Though the quantity of sugar-cane planted at Calitura is very small, and is only employed to procure spirits, it is sufficient to prove that, if this necessary article were encouraged, it might be produced in sufficient quantities to supply the demands of this island, and supersede the necessity of importing

* From the *Asiatic Annual Register*, 1800.

it from Bengal and China. The natives, however, draw a ſmall portion of ſaccharine juice from the buds of the tree called *kitoul* (the *carriotta* of Linnæus), the pith of which is but little inferior to the ſago of the eaſtern iſles.

The pepper plant flouriſhes here, but its fruit is not equal to that of the Moluccas: at the ſame time it may be conſidered as an important article of commerce.

The *cardamum* grows only at Matura, and a few other parts; and is inferior to that which is produced on the coaſt.

Though the cultivation of the ſweet potatoes is very ſimple, the quantity produced is not more than ſufficient for home conſumption.

The *margora* or *agedorac* (melia of Flora Zeylanica) is conſidered as one of the moſt valuable plants that Ceylon can boaſt of. It is eſteemed as an admirable ſuccedaneum for the quinquina; and its leaves are ſo obnoxious to moths and deſtructive inſects, that they will preſerve woollen cloths, linen, and books, from being infeſted by them.

Fruit-trees are in great abundance, though their produce is not in general admired by Europeans, who are accuſtomed to thoſe of a ſuperior flavour. The fruit of Ceylon is however, in general, ſuperior to that of the peninſula, particularly its lemons, oranges, and *pompel-mos*.

The *goraka* is a pulpy fruit, whoſe flavour is blended with an agreeable acid. It is of a round ſhape, and deeply indented. The peal is employed as a culinary article by the natives. The tree that bears it exudes a yellowiſh reſin, which produces a tolerable varniſh. This tree has been generally confounded with the *gockat*-tree, that diſtils the *gamboge*, and from which ſeveral hundred weight of this gum might be annually drawn. There is alſo a great variety of trees which grow ſpontaneouſly in the woods: they bear different fruits, though generally more or leſs of an acid taſte, and much uſed by the people of the country in the confectionary, which forms ſuch an important article in their entertainments.

The *nux vomica*, which muſt be ranked among the poiſonous plants, is a native of this iſland; but is applied to no uſe whatever. In the ſame claſs may be placed the *palma chriſti*, from whence the caſtor oil is extracted; which forms a ſmall article of trade.

The *banè* is a kind of pulſe, and might be rendered an article of very great utility. The ſtem of this plant is from three feet and a half to four feet in length, and furniſhes a flax, which is twiſted into a long rope. It is particularly employed by fiſhermen for their nets and lines, from the extraordinary

extraordinary quality it possesses of never decaying or rotting in water. It appears to be deficient in elasticity; but that may arise from its never having been sufficiently steeped. From some experiments which have been made, its strength appears to be in the proportion of five to four with European cordage.

The district of Matura produces six different kinds of shrub, on which insects deposit the *laca*. The description of this insect by Roxburgh, in the second volume of the Asiatic Researches, is very correct. The Ceylon *laca* is the same as that which is found in Pegu; but, though it is found in great abundance on the shrubs where it is deposited, the inhabitants collect no more than is necessary for their particular use.

The plantations of cinnamon abound with a plant which delicacy forbids us to describe. It is called *kaudura* by the Cingalese, and has received the scientific denomination of *nessentbes distillatoria* by the botanists. It is inaccurately represented by Burman, and in Pennant's View of Hindustân. It has been equally considered and examined by the antiquarian, the man of letters, and the botanist. It flourishes beneath the shade of the cinnamon-tree, whose culture it interrupts.

The trees and plants in Ceylon are very numerous. In the district of Columbo alone, there are not less than three hundred species. Many of them appear in the very inadequate catalogue of Palus Hermanus; from whence they have been transferred, without any distinctive description, to the Thesaurus Zeylanicus of Burman, and so on, to the Flora Zeylanica of Linnæus, and other botanical works. Indeed, of one hundred Cingalese names given by Hermanus, and adopted by Burman and Linnæus, there are not ten in use among the natives; and the rest are almost unintelligibly rendered in the German orthography.

Of the timber used in domestic articles, &c. thirty-nine of the most remarkable species have been collected. Among them the *kaloumidirié* is distinguished by very fine black and yellowish veins; the Europeans call it *caleminder*. The *kadbumbirié* has the same streaks as the former, but not quite so large. Very beautiful articles of furniture are made of them both.

There are also the satin wood, called *bourouth*; the *tekka*, or *teak*, employed for masts, and every kind of shipwright's and carpenter's work; the *jack*, one of the bread-fruit trees, the wood of which, when fresh, is of a beautiful yellow, but changes in the course of time to a reddish hue; and the *nedoun*, or *nindow*, which is very ſtrong. The two laſt are employed in furniture and domeſtic uſes. To theſe may be added the *nuga gaba*, the ebony, &c.

The elephant muſt take the lead among the quadrupeds in every part of the world which it inhabits. In Ceylon there are two ſpecies; the one called *alleia*, which has no teeth, or at leaſt very ſmall ones; and the other called *aeta*, which has teeth of a conſiderable length. In the interior parts of the iſland they are very numerous; and there are a ſufficient number of them in the Engliſh poſſeſſions to do conſiderable miſchief to every kind of agriculture.

The royal tiger is not an inhabitant of this iſland; but the leopard is very common, and ſome of them have been taken that meaſured five feet in length.

There are two kinds of wild cat, one of which is not generally known, or, at leaſt, has been very imperfectly deſcribed.

The wild buffalo is found in the foreſts, and is as furious as that of Bengal.

The wild boar is equally dangerous with the buffalo, and the woods alſo abound with them.

There is the *axis*, or Ganges deer, and a ſtag whoſe colour is gray, tinged with a ſhade of red. It bears a greater reſemblance to the hart of Corſica, than to any other of its claſs.

Of monkeys, there are three peculiar kinds, with long tails, and pouches under the chin. The hair of one is of a reddiſh hue, and that of the other two is very long: the one is white, and the other black; but all of them have long beards, which ſpread over their cheeks. They are very ſagacious, well-tempered, and tractable, as well as full of trick and amuſing playfulneſs.

The ſloth is not very common; it is from ſeven to eight inches in length, and is born with a thick covering of hair.

The *pangotin* is very common in Ceylon, and called *kabal-vaeïa*. It is accurately deſcribed by ſeveral naturaliſts; but the print of it, in Buffon, is ill deſigned. It is there repreſented as walking on its fore-feet, in common with other quadrupeds; whereas it actually walks on the *metatarſus*, turning the toes downwards. This animal can never be preſerved alive, from the impracticability of providing a ſufficient quantity of ants (which are its only food) to ſuſtain it.

There is alſo the *viverra ichneumon*, which, by the Europeans, is called *mongoos*. It has been generally believed that this animal inſtinctively applies to the medicinal aid of a certain plant, which acts as a counter-poiſon when it has been bit by a ſerpent. The natives, however, are not acquainted

quainted with any plant that poſſeſſes this ſalutary quality. It is, nevertheleſs, aſſerted by them, that the *mongoos* has been ſeen to attack the *cobra di capello*; when, though ſeverely bitten, it has killed the ſerpent, and eaten a part of it, without any viſible effects of poiſon.

Of ſquirrels there are two ſpecies. One, which is called *laéna*, has a red noſe quite flat, and long black tail, which is only found in the woods; the other, called *dandu la na*, with yellow longitudinal ſtreaks, frequents gardens, where it deſtroys every kind of fruit.

The hares are large, but inferior, as a food, to thoſe of Europe. There are otters, but they are very rare, and ſeldom ſeen. The porcupine is to be found every where in the woods, and may be readily tamed into all the familiarity of a domeſtic animal.

There are two ſpecies of rats, which infeſt the houſe and the garden: one of them is called the *muſk-rat*, which is ſo well known in the peninſula.

There is one of four ſpecies of bats known here, which is called the *flying fox*; its French name is *rouſſette*: it is well known in the peninſula, and feeds only on fruit.

The birds are among the moſt beautiful productions of this iſland; but their prevailing haunts are in the eaſtern parts: the number of them is comparatively ſmall in the vicinity of Columbo. Not more than thirty ſpecies of them have been aſcertained ſince the Engliſh have become its inhabitants. Among theſe are the pelican, the flamand, the great and ſmall Greek pigeon, the *rollieu* of Mindanao of Briſſon; a beautiful cuckoo, with variegated plumage, called *kouroulongſia*; the maynat; two fly-catchers, with two long feathers in the tail, the one with a black head and white body, the other with a blue head and reddiſh back; and an abundance of woodpeckers, with golden plumage.

Among the fiſh which have yet been obſerved, and are not generally, if at all, known, is a ray, with a projecting ſnout like that of a dog, and of a brown colour, with a green tinge on the upper ſide. The fiſhermen appear to have a knowledge of the cramp-fiſh.

The number of ſerpents is very great, and the larger part of them are of a poiſonous nature; nor can they be generally known, as none of them exactly correſpond with the prints of Ruſſel.

The *cobra di capello*, which is a well known and moſt formidable reptile, is a native of Ceylon. It has a broad neck, and a mark of dark brown on the forehead; which, when viewed

viewed in front, has the appearance of a pair of ſpectacles; but, being regarded from behind, is like the head of a cat. Its back is of a gray colour, and has ſome duſky ſpots on the belly. No other kind of this ſerpent has been ſeen here. The natives conſider it as an object of veneration, and do not ſuffer it to be deſtroyed. It loves to inhabit dilapidated buildings.

The largeſt of all the ſerpents is the *pimpboura*. The writer of this memoir has ſeen one preſerved in ſpirits, of eight feet and an half in length, and thirteen inches in circumference, which was quite young. It is this ſpecies that is accuſed of ſwallowing bullocks and buffaloes. But, however that may be, the Cingaleſe aſſert, in the moſt poſitive manner, that there are ſerpents which are ten inches in diameter, and that ſome have been taken with a hog in their belly. Nay, it was declared, with equal ſolemnity, that one of them had been opened, in which was found the horn of a buffalo.

The moſt curious ſerpent of this iſland is the *potanga*, which is ſaid to grow to a moſt enormous ſize. One of them, when only four feet and a half in length, and half an inch in diameter, had ſeven young ones in it. Theſe two ſpecies are remarkable for two ſhort thick prickles, contiguous to the anus.

There is alſo the *depatnaïa*, a third kind of the *anguis* of Linnæus. Some have deſcribed it as poſſeſſing two heads. It appears to conſider its tail as a defence, from the violence of its motion whenever it is attacked.

The fiſhermen caught an extraordinary ſerpent, ſome time ſince, at ſea, of the length of fifty-ſeven inches and a half, of which there does not appear to be any deſcription in any work of natural hiſtory; though Pennant's View of Hinduſtân contains an account of one that bears ſome ſmall reſemblance to it.

Of the lizard tribe, the crocodile is the moſt conſiderable; it is the inhabitant of all the lakes and rivers in Ceylon, but is ſeldom ſeen in the vicinity of the ſea. There are two kinds of *laguna*; one of them is ſeven feet long, and is ſuppoſed to be the ſame as that which is ſo well known on the coaſt of Coromandel. There is alſo a ſmall lizard with a prickly back, like the camelion: to which may be added a ſmall ſpotted lizard, which, from its meaſured and tuneful cry, has acquired the name of the *ſinging lizard*; and the real camelion.

The toads are not of a large ſize, like thoſe of Bombay.

The inſects are innumerable. The genus of the *ſcarabæus* is the moſt abundant, but that of the *mantis* of Linnæus is the moſt curious. The ſhapes it produces are very various and extraordinary. One of them, of which Colonel Agnew made

made a drawing, is called the *animated leaf*, from the resemblance of its wings to the leaf of a tree.

There are five species of the golden-coloured *coreinelle* of Linnæus.

A grasshopper, with black, prickly, tuberculous horns, terminated by two large yellow knobs.

A spider, whose venom and bite are as potent and dangerous as those of a serpent: fortunately, this insect is very rare.

A black hairy scorpion, about four inches in length.

Of butterflies there are about twenty species, some of which are well known.

The *phalæna*, a species of which is to be found in a treatise published in France on foreign butterflies.

The *termes*, or what is called the *white ant*, infests this island as well as the peninsula.

Lastly, There are a great number of ticks found on different animals, such as the rat liguana, water birds, pangolin, &c. The tick found on the rat is remarkable for the extraordinary manner in which it moves, having its mouth and belly turned upwards.

The shore of Trincomalée abounds in shells; but they are all mentioned in Rumplici's work on Conchology.

With respect to pearls, it may be observed, that the shell in which they are found is a mytilus, and not an oyster. The description of it is very correctly given in the Asiatic Researches. All banks are not equally productive of the pearl; for, though the shells in which it is generally found are very plentiful on the Chilau banks, there is very seldom found a single pearl in them; whilst, further up the gulph, a pearl is found in almost every shell of a certain size that is opened.

There are the common crystallizations of sapphires, rubies, topazes, kouroundous, tourmalines, and rock crystals.

Romé de l'Isle has given a description of a precious stone that unites two distinct colours; and such a stone is said, and generally believed, to have been found by the adigar, or prime minister, of the king of Candy, on his return from an embassy to Columbo: it unites the colours of the sapphire, the ruby, and the topaz. The account adds, that it was instantly presented to the king.

The soil around Columbo is a brittle clay, with a mixture of ferruginous particles. It is generally covered with a sand, whose fertility is equal to that of the richest earth. On the sea shore, and in some distinct parts, there are hillocks of a dark gray earth, which appear to compose a stratum immediately beneath that already mentioned.

There

There is every reafon to fuppofe that there are extinguifhed volcanoes in Ceylon, from the fpecimens of volcanic ftores which have been collected at Trincomalée. This opinion is fupported by the account, that there is a lake near the fummit of Adam's Peak, whofe height is conjectured to be 1500 fathoms above the level of the fea. It received this name from the Portuguefe; but the Cingalefe call it *Sanamalé*. According to the tradition of the country, it was Buddah, the founder of the government, and to whom the inhabitants pay almoft divine honours, who left the mark of one of his feet on this mountain, while the impreffion of the other was found in Siam.

TABLE *of Obfervations on the general ftate of the Atmofphere in Columbo, which proves the unexampled uniformity of its Climate, both as to its temperature and the regular denfity of the Air. The variation of the barometer in twelve months is only* 0·36 *of an Englifh inch, and that of Fahrenheit's thermometer only* 13 *degrees.*

COLUMBO, Ifland of CEYLON.

Months.	BAROMETER.				THERMOMOMETER.			
	Highest Point.	Lowest Point.	Difference.	Mean.	Highest Point.	Lowest Point.	Difference.	Mean.
Nov. 1798 .	30.160	29.940	0.220	30.053	82. 0	77. 0	5. 0	79.41
December . .	30.128	29.988	0.200	30.057	81.50	75. 0	6.50	78.77
Jan. 1799 .	30.114	29.988	0.076	29.952	80.75	75. 0	5.75	78.29
February . .	30.090	29.940	0.150	30.020	82.50	76. 0	6.50	79.93
March . . .	30.114	29.914	0.200	30.020	86. 0	80. 0	6. 0	82.71
April	30.124	29.920	0.204	30.004	85.50	79.50	6. 0	82.71
May	30.062	29.912	0.150	29.959	86. 0	80.50	6.50	83.28
June and July	No obf	ervatio	ns . .	. . . .	. . .	. . .	. .	. . .
Auguft . . .	30.064	29.976	0.880	30.030	84. 0	82. 0	2. 0	82.67
September .	30.070	29.940	0.130	30.013	82.50	78.25	4.25	80.40
October . . .	30.070	29.970	0.092	30.027	82.50	80.25	2.25	81.12
November .	30.080	29.900	0.180	29.979	83.50	79.50	4.50	80.83
December . .	30.150	29.800	0.350	30.002	82.50	73.50	9.50	79.90
Average for 12 Months,	30.160	29.800	0.360	29.980	86. 0	73. 0	13.0	79. 5

XXVII. *Me-*

XXVII. *Memorandum respecting the Hunting Establishment of Tippoo Sultaun, at Seringapatam; with an Account of the Chetas sent to his Majesty, and now kept in the Tower, London**.

THE principal amusement followed by Tippoo Sultaun, at Seringapatam, for several years, was to hunt antelopes with chetas †. His predilection for this diversion was manifested in the precautions taken to preserve the game, and the attention paid to render the sport as perfect as possible. A considerable tract of ground to the south-west of Seringapatam, and called the *rumna*, was exclusively appropriated for the maintenance of the game, and guarded with the utmost vigilance. There were several hunting bungalows ‡ in different parts of the rumna for the sultaun to retire to after the fatigues of the day. To each of these was attached a small establishment of servants, who were responsible for the care of the buildings and gardens §. The number of chetas in Tippoo's possessions at the period of the capture of Seringapatam amounted to sixteen; the greater part of them were well trained. Each cheta had an establishment of four men ‖, one cart, and four bullocks; and the whole were under the superintendance of a meer shikar, or chief huntsman, with a certain number of assistants.

Whenever Tippoo determined to take the amusement of hunting, one day's notice was generally given to the huntsmen, to prepare the chetas and bullocks; and on the evening preceding the day appointed for this amusement, six or eight chetas were carried out to some village near the spot of the rumna fixed on as the rendezvous for the hunters. At day-break the following morning, the sultaun, accompanied by one or two of his sons, and ten or twelve favourite noblemen, proceeded to the rumna. On these excursions he was attended by a few horsemen, and some officers called Mootafurrikas,

* *From the same.*

† A species of spotted tiger, and known, in the relations of travellers, under the name of hunting leopard.

‡ A name used in India for a small light building.

§ Each of these gardens contained four small but neat buildings, regularly disposed, and fronting each other; the ground between them being laid out in walks of cypress trees. The ground adjacent to the buildings was also laid out in gardens; and the whole was surrounded by a thick hedge, through which there were entrances and gates.

N. B. The sultaun chose whichever of the buildings he preferred, and the party took the others.

‖ One huntsman, two keepers, and one bullockman.

furrikas, (independent officers, not belonging to any corps,) who were constantly attached to the sultaun's person, and remained near him on all occasions, both at the palace and in the field. Very little state was observed, and no persons were present but those who received particular invitations. The sultaun generally reached the rumna about six o'clock, and then immediately the hunt took place as follows:

Each cheta was carried on a light cart, drawn by two bullocks regularly trained for the purpose. The huntsman of each cheta was seated on his respective cart, and the other attendants ran close to it on foot. The carts followed each other in regular succession, the meer shikar conducting the leading cart. The cheta was hood-winked, and all the spectators and sportsmen kept close to the carts, and endeavoured to preserve silence in order not to alarm the game.

The huntsmen followed any direction across the country which they thought proper. On discovering a herd of deer, they proceeded with more caution, and endeavoured to take up such a position as should oblige the antelope, when chased, to run up hill, or over broken ground; in either of which cases, the probability of success is much in favour of the cheta. When they arrive within four or five hundred yards of the game, the men on foot turned the cheta's head towards the antelope, uncovered the cheta's eyes, and then let him loose.

The great aim of the cheta is to place himself exactly behind his prey; and the skill and caution he displays in attaining his object, constitutes one of the principal beauties of this diversion. The cheta continues to be very cautious till he is within two hundred yards of the antelope; he then gets bolder, begins to run, and follows his prey with the greatest rapidity for about three or four hundred yards, when he is either successful, or gives up the chase. In the latter case, he generally moves about slowly, and prowling, till his keeper comes up: the cheta then suffers himself to be hood-winked, and conveyed back to the cart. If the cheta has been successful, after seizing the antelope, he holds it by the neck with his mouth, in such a manner as not to hurt it, and keeps the prey down on the ground in this position until the keeper arrives: he is then hoodwinked; the throat of the antelope is cut, and a leg or two given to the cheta as his reward; after which he is carried back, without any difficulty, to the cart. If it should be wished, however, the antelope may be taken alive* from under the cheta, who,

* This is seldom practised, and requires management and confidence in the huntsman.

when

when hoodwinked, is perfectly manageable. The ſpectators keep at a proper diſtance till the huntſman has covered the eyes of the cheta, but they may always chooſe their ground in ſuch a manner as to ſee the whole of the hunt.

A cheta will run two or three times in a day, and often is ſucceſsful in every chace. He always ſelects the largeſt buck of the herd, though it ſhould not be in ſo favourable a poſition for his purpoſe as many other ſmaller deer. In large herds, two or four chetas are let out, and then the ſport is highly diverſified and intereſting.

After hunting until ten or eleven o'clock, the ſultaun retired with the party to the next bungalow, where he paſſed the remainder of the day, and in the evening returned to his palace in Seringapatam.

A Deſcription of the Cheta.*

The cheta is the animal mentioned by Tavernier, Bernier, and other eaſtern travellers, under the name of the *hunting leopard.* It differs, however, from the leopard properly ſo called, in the following particulars:

Firſt, in ſhape.—It is of a long make, narrow deep cheſt, and ſlender waiſt. Its legs alſo are very long in proportion to the body; in which particular, as well as in its general form, it bears a greater reſemblance to the gre-hound than to its *cogeners* of the feline tribe.

2dly, The ſize of the cheta's head is ſmaller in proportion to its body than that of the leopard, or of moſt other quadrupeds. The colour of the iris is of a deeper yellow than in the leopard, and its face is diſtinguiſhed by a dark line reaching from the corner of the eye to that of the mouth on each ſide.

3dly, The hair on the throat, breaſt, belly, and the under ſide of the tail, is much longer than on the other parts of the body; it is of a duſky white colour, with few or no ſpots. The hair on the upper part of the neck, and on the ſhoulders, is alſo ſomewhat longer than on the body, though not ſufficiently ſo to entitle the cheta to the ſpecific name of *Felis Zubata*, which Linnæus has given it.

4thly, The ſpots on the cheta, inſtead of being diſpoſed in circles like thoſe of the leopard and panther, are each diſtinct. The body and limbs, excepting where the long hair extends, are thickly covered with theſe ſpots, varying in ſize, of a dark colour, and a round or oval ſhape, on a light

* This deſcription was written by J. Fleming, Eſq. of the Bengal Medical Eſtabliſhment; and the other parts of the memorandum, by Capt. Sydenham.

tawny

tawny brown ground. The ears, which are short and round, are each marked behind with a broad dark bar; and the tail, which is long, slender, and somewhat bushy at the end, is marked with four such bars from the tip upwards.

5thly, The last and principal difference between the cheta and leopard is in respect to disposition. The leopard is incapable of being tamed, and always retains its fierce malevolent habits. The cheta is easily broken in, and trained for the chace. I have never seen one, however, that could be said to be thoroughly tamed. It still retains some share of its natural ferocity and treachery, which it betrays by its restlessness, the obliquity of its movements, and the duplicity of its looks. It suffers no one to approach it familiarly but its keeper, and even he caresses it with caution and diffidence. It must be led to the chace chained and hoodwinked; and all that can be expected from it, even when it has been carefully trained, is, that it should return quietly to its keeper when the chace is over.

The size of a full grown cheta is as follows:

	Ft.	In.
Length from the nose to the tail	3	8
Length of the tail - -	2	3
Height at the shoulder -	2	4
Height at the rump -	2	3

Mr. Pennant's description of the cheta (Hist. of Quadr. vol. i. p. 284) is tolerably correct; but his figure is a very bad one, and conveys a very erroneous idea of the shape of the animal.

The chetas presented to his majesty by the court of directors, were caught in the woods near Rydroog. They are about three years old *, were trained at Seringapatam, and have been frequently hunted by Tippoo Sultaun.

Their daily food is six pounds of mutton, with as much water as they can drink. This allowance is sometimes varied to three fowls. A *massala*, or mixture of spices, is given to them once a day with their food, and serves to keep them in health and spirits.

Each cheta has two keepers; and one cart, with two trained bullocks, was sent at the same time as a specimen of the carts used at Seringapatam. The cart sent to his majesty was actually one of the sultaun's, and has frequently been used by him; and the bullocks were also part of his hunting establishment.

* Now about *five*.

XXVIII. *Pro-*

XXVIII. *Proceedings of Learned Societies.*

FRENCH NATIONAL INSTITUTE.

THE Inſtitute, in the public ſitting of July 4, propoſed the following queſtions as the ſubject of prizes:

PRIZE QUESTIONS.

Mathematics.—To determine the means, as far as poſſible, for leſſening the lee-way of a ſhip of war when ſailing on an oblique courſe, by combining together the manner moſt favourable for that purpoſe, the form of the keel, the draught of water, the poſition of the main beam, and ſtability.

In the year 1793 the Academy of Sciences propoſed this as the ſubject of a prize for 1795; it was ſuppreſſed before any paper was received in anſwer to it: but the Claſs of the Mathematical and Phyſical Sciences, being deſirous to fulfil the engagement contracted by the Academy, and conſidering, beſides, that this ſubject is of great importance for the navy, have thought they could not do better than to propoſe it again.

The Claſs are too ſenſible of the difficulty attending this problem to require or to hope for a ſolution from theory alone, but, without preſcribing rules in that reſpect, they invite learned navigators to treat the queſtion principally by means of obſervations, deduced either from their own experience or taken from thoſe journals in which the commanders of veſſels give an account, at the concluſion of a campaign or the end of a voyage, of the circumſtances which have occurred in regard to the rate of ſailing of their reſpective ſhips.

The prize will be a gold medal of the value of a chiliogramme, and will be decreed in the public ſitting of Meſſidor 5, an. 11 (July 4, 1803). The anſwers will be received till the 1ſt of Germinal, an. 11, (March 22, 1803,) and not beyond that period.

Phyſics.—The Claſs of the Phyſical and Mathematical Sciences of the Inſtitute, charged with propoſing, for the year 9, the ſubject of a prize, think it their duty to adopt a queſtion the ſolution of which muſt accelerate the progreſs of an intereſting part of natural hiſtory. The ſcience of organized bodies conſiſts, in a particular manner, in a knowledge of their organization, which is diſtinguiſhed into internal and external. The external ſigns, called *characters*, the firſt ſtudied and the firſt known, are of uſe to indicate the internal organization, from which they are derived, and which always ought to have an influence on their exiſtence. Theſe two parts of the ſcience intimately connected, tend mutually to

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throw light upon each other. Thus anatomy furnishes zoology with the bases of its grand divisions; it affords it the means of characterizing, with precision, the different classes and families of animals, and of explaining the causes of their manners and habits, and of the mode in which they feed.

The philosophy of vegetables ought to render the same service to botany. By the exertions of Grew, Malpighi, Liewenhoek, Duhamel, Bonnet, Sennebier, and other respectable philosophers, it has been already enriched with a great number of insulated observations, which may serve as guides in future researches. It has exhibited to us in those of C. Desfontaines, the difference which exists in the disposition of the ligneous and utricular parts of the monocotyledon and dicotyledon plants. This labour, which has enabled the science to make a great progress, deserves to be followed in the subdivisions of these two grand classes, and in the plants known by the name of *acotyledons*, composing the cryptogamia system of Linnæus. We must assure ourselves, by studying the internal organization, whether the latter ought to continue to form a third division, or whether they ought to be joined to one of the other two. The science has still a great interest to determine the internal structure of vegetables composing the grand families acknowledged by all botanists. It ought to verify, whether each of them has a peculiar internal organization, common to all the plants of its order, and different from that of the other families. It will endeavour to discover their affinity determined according to their external characters, and confirmed in the same degree by inspecting their internal organs. It will examine what cause determines the union or separation of the sexes; the existence or non-existence of the corolla; the unity or plurality of its parts; the number and relative situation of its sexual organs: in a word, the characters of the first line, derived from the essential organs, are invariable in all the known families. These grand external differences are the consequence only of a concealed composition, which it is necessary to unveil. The first discoveries pave a way to new ones, and the secondary differences will successively become objects of attention when the first have been confirmed.

From these considerations, the class, circumscribing their views, reduce their question to the following:

To establish the general relations which exist between the internal and external organization of vegetables, particularly in the grand families of plants, generally acknowledged by all botanists.

The authors are requested to accompany their descriptions with drawings, carefully representing the organs described; and

and to confine themselves to a small number of families, multiplying the examples in each. They ought, above all, to insist on the relations and differences of the families distinguished by characters of the first value; and they must avoid reducing their labours to compilations from the authors who have written on the same subject.

The prize will be a gold medal of the value of five hectogrammes of gold; it will be decreed in the public sitting of Messidor 15th, year 11, (July 4, 1803). The answers will be received till the 1st of Germinal, (March 22,) year 11, and not beyond that period.

The Class of the Moral and Political Sciences proposed the following question:

To compare the geographical knowledge of Ptolemy, in regard to the interior of Africa, with those transmitted to us by later geographers and historians, excepting Egypt and the coasts of Barbary, from Tunis to Morocco.

The prize will be five hectogrammes of gold struck into a medal: it will be determined in the sitting of Vendemiaire 15th, year 11, (7th October, 1802). The answers will be received till the 15th Messidor, year 10, (July 4th), 1802), and not beyond that period.

General conditions to be observed by the candidates for the prizes whatever be the subject.

No paper transmitted in answer to the questions must bear the name of the author, but be distinguished only by a device: a sealed note may be attached to it, containing the device, and the name and address of the author. This note will not be opened by the Institute except in the case of the piece having gained the prize.

The answers may be transmitted to the Institute, sending the packet containing it post paid. They may be addressed also, post paid, to one of the secretaries of the Class at Paris, or be delivered into his hands: in the last case, the secretary will give a receipt for it. The Institute informs the competitors that it can return no memoirs, drawings, or machines, transmitted to them; but the authors will always be allowed to have copies of the memoirs and drawings, and models of the machines. A commission of the Institute will deliver the gold medal to the bearer of the receipt; and, in case there is no receipt, the medal will not be delivered but into the hands of the author, or some one properly authorized to receive it.

The following account of the mathematical labours of the Class of the Mathematical and Physical Sciences during the third quarter of the year 9, was read by Delambre:

Memoir on achromatic glasses, adapted for the measurement of angles; and on the advantages which may be derived from *double refraction for the accurate measurement of small angles: by C. Rochon.*—After an interesting historical notice, the object of which is, 1st, To claim the invention of achromatic glasses for the learned Morehall, who, about the year 1743, found means to destroy the aberration of sphericity and refrangibility by employing substances of different refracting powers: 2d, To call to remembrance what we are indebted to the learned researches of Euler on this subject, C. Rochon announces that he has improved the instrument described in his Researches on Mechanics and Physics, printed in 1783.

Beccaria has shown that rock crystal may be cut into prisms in such a manner as not to produce double refraction. C. Rochon has taken advantage of this discovery to substitute a prism of that kind in the room of two variable prisms of glass which he employed in his first construction.

A new improvement enabled him to obtain the measure of angles greater than the diameter of the sun by means of two prisms of rock crystal producing double refraction; when, on again examining Euler's theory on the aberration of glasses, he found that it was possible by these means to measure by his instrument angles of a more considerable extent; so that at present it can be conveniently employed for determining the respective distances of ships, and the greater or less variations of these distances: an advantage obtained but imperfectly by Ramsden's instrument, which is much used in the English and Spanish navies.

Decisive experiments have proved to C. Rochon the advantages of his instrument over those of the celebrated English artist. He admits the great difficulty that may sometimes occur in constructing the instrument, to those who are not well acquainted with the method of cutting rock crystal. He, however, hopes that this difficulty will be surmounted; and C. Narci, attached to the agency of the mines, has already constructed the instrument with all that degree of precision which can be desired.

On the co-relation of geometrical figures: by L. N. M. Carnot.—The object of this work is to give a more clear theory of positive, negative, and imaginary quantities; and to furnish more general and certain rules for the changes which a formula established on a primitive system of points and lines may experience, and of which some parts change their respective positions. Means are proposed, also, for giving the enunciation of geometrical problems a technical form, in order to shorten them, and render the application of them easier.

To illustrate his method, and show the use that may be made

made of his principles, the author applies them to a great number of theorems and propofitions, feveral of which are remarkable for their fimplicity and elegance. What he fays of chords; the new idea he gives of fines; and the addrefs with which he has found means to render fenfible to the eyes, in one figure, the principle relations that exift between the fine and the cofine of two angles, and the fine and cofine of their fum, or their difference, will be in particular diftinguifhed.

Memoir on the theory of the moon.—C. Laplace has collected in this memoir the moft interefting refults of his analytical calculations refpecting the theory of the moon. The equations which he found for the mean longitude, the apogeum and the node, and the happy manner in which he employed the inequalitities, either in longitude or latitude, to deduce from them the oblate form of the earth, are already known. He now announces a determination no lefs curious, that of the parallax of the fun. Mayer made a fimilar calculation; but, befides that the analyfis of that great aftronomer was lefs profound, he was far from having fo great a number of obfervations to enable him to determine the precife value of the inequality which the parallax may give. He found it therefore about $\frac{1}{11}$ too fmall; whereas C. Laplace has attained precifely to the fame quantity as Lexell and Lalande deduced from paffages of Venus, that is to fay, 8″ 6. An aftronomer, therefore, without going out of his obfervatory, by uniting analyfis with obfervation, might have determined what has coft fo many voyages to countries fo different in climate. We muft however obferve, that this method would have required much more time, and that much fewer perfons would have been in a ftate to appreciate the juftnefs of the refult. There is no reafon, therefore, to regret the long voyages undertaken, nor even to prevent people from braving fuch dangers, when an opportunity occurs. Too many different means cannot be employed to eftablifh truths which, on the one hand, are fufficiently aftonifhing to juftify, to a certain point, the incredulity of thofe who refufe to admit them, becaufe they do not comprehend the demonftrations; and, on the other hand, are fo delicate that one can never be certain of knowing them with the utmoft precifion.

Trigonometric tables.—C. Prony has read to the Clafs a memoir on a work called *Opus Palatinum de Triangulis.* Thefe tables, the moft complete that ever appeared in regard to trigonometric lines in natural numbers, were not calculated in all their parts with the fame exactnefs. It was foon found that the tangents and fecants of the laft degrees had

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need of considerable corrections; it was vaguely known that these corrections had been ordered, but it was not certain that they had been executed.

C. Prony had the good fortune to meet with a copy of the *Opus Palatinum*, in which the tangents and secants of the last degrees were as exact as the rest. The title of the book was augmented by the following words: *recens emendatus à Bartolomæo Pitisco, Silesio*, &c. The seven last degrees have been calculated anew, which rendered it necessary to reprint eighty-six pages, which may be known by some differences in the paper and type; the latter being more used, and the former less beautiful, than in the rest of the volume. C. Prony's memoir contains the formulæ necessary for fixing the quantity of the errors, and tables of comparison, which prove the exactness of the corrections of Pitiscus.

Trigonometrical tables of Borda, published by Delambre.— These tables are merely logarithmic. The decimal division of the circle for which they have been constructed, is, without doubt, more convenient than the sexagesimal division. The celestial signs, each consisting of 30 degrees, which divide the circumference into twelve parts, while each degree is subdivided into 60 minutes, and the minute into 60 seconds, deviate too much from the simple progress of the arithmetical system, which proceeds invariably by tens, not to give frequent rise to very great inconveniences in practice.

Histoire Celeste Françoise. This important collection published by Lalande contains observations of the stars, made at the military school in 1783 by Dagelet; and observations of every kind, made at Toulouse by C. Darquier and Hadancourt in the space of seven years, beginning at 1791. But the most considerable part of this volume is the astonishing collection of 50,000 stars, the fruit of the vigils and assiduous labour of eleven years of Michel le François Lalande, the nephew, happily seconded for three years by C. Burckhardt. It may readily be conceived how useful this labour may be in regard to comets, which in future will not ascend in any part of the heavens without being surrounded by stars well known, and by help of which their motion and positions may be every moment determined. It is no less evident that these observations, compared with those made or which may be afterwards made at different times by different observers, will, sooner or later, give rise to interesting remarks on the changes that take place in the heavens on the new stars that from time to time appear, and on those which lose themselves, or at least change their splendour and light.

Memoir containing the solution of a mechanical problem *proposed by d'Alembert: by C. F. Nieuport.* The object of this problem is to determine the direction of the force which would keep in equilibrium and immoveable a body of any figure whatever, traversed by a slack and flexible thread having its extremities attached to two fixed points.

The analysis of Nieuport conducts to a result of which d'Alembert had only a faint idea; that is to say, he concludes that in all cases the direction of the force divides into two equal parts the angle formed by the direction of the two parts of the thread which are without the body.

It results also from this analysis, that if the groove which affords a passage to the thread be of a curvilineal figure, the solution will not be more complex, and the equation will always retain the same form. This d'Alembert did not venture to assert.

Demonstration of a geometrical theorem on estimating the solidity of the hemispherical arch of Viviani: by C. Tedenat, professor of mathematics in the Central School of Aveyron.—On reading the Integral Calculus of Lacroix, published a few years ago, he conceived the idea of determining algebraically, by a method of Euler, the solidity of that part of a hemispherical arch of which Viviani determined only the surface.

In the second volume of the Memoirs of the Institute for the year 6, it is seen that C. Bossut had announced to the Class the solution of the same problem, of which he gave merely the result, promising to give the calculation on some other occasion. This he indeed did some time after, at the end of the second volume of his Integral Calculus: two solutions of the problem may be seen there; the second of which is exceedingly simple.

C. Tedenat, having read in the above memoir this extension, which may be given to Viviani's problem; a circumstance not before mentioned by any geometrician, was desirous of proving that he himself had made the same remark, and with that view sent to the Institute the solution here announced, and which, in regard to the definitive result, is agreeable to that of Bossut.

Longitude of Florence.—C. Lalande read a memoir on the longitude of Florence, the position of which was very uncertain. He has learned from new observations received from Ciccolini, and which he has calculated, that the difference between the meridians of Paris and Florence is 0 h. 35′ 40″.

Secular motion of Venus.—This memoir was also by Lalande, who has found by the last inferior conjunction of this planet, that the epoch of the longitude is exact as well as the equation of the orbit, and that there is no change to be

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made in this reſpect in the laſt tables. In theſe calculations, C. Lalande has kept in view the perturbations which Venus experiences by the action of Jupiter and that of the earth, according to the formulæ which he gave himſelf in the Memoirs of the Academy of Sciences.

Natural Hiſtory.—C. Jurine has made ſome curious obſervations on the puce monocule, called commonly the water flea (*monoculus*), a ſmall cruſtaceous animal which abounds in ſtagnant water, and which ſometimes has given riſe to reports of ſhowers of blood, becauſe the eggs, with which it is full in the ſpring-time, give it a red colour, ſo that the water where there are a great many of theſe inſects, ſeems really to be mixed with blood.

The ableſt naturaliſts, Swammerdam, De Geer, Schæffer, and Otto Frederic Muller, have ſucceſſively ſtudied this animal; but Nature is inexhauſtible even in her leaſt productions, and C. Jurine, of Geneva, aſſociate of the Inſtitute, has ſtill diſcovered, reſpecting this inſect, a number of curious particulars which had eſcaped theſe learned naturaliſts.

The moſt ſingular fact diſcovered by C. Jurine is, that a female which has had intercourſe with the male, tranſmits the influence of it to her female deſcendants; ſo that they all lay eggs, without being obliged to couple, till the ſixth generation; after which their young periſh in moulting. Another ſpecies carried this influence to the fifteenth generation. It is well known that Bonnet made ſimilar obſervations in regard to *pucerons*. Theſe generations produced without copulation are leſs abundant, and ſucceed with leſs rapidity, than thoſe in which the males have had a ſhare.

THE FREE ECONOMICAL SOCIETY OF PETERSBURGH.

In an extraordinary ſitting of the Society on the 16th of April, which was attended by a great number of the principal members, there was read the following

Letter from his Imperial Majeſty:

"All inſtitutions eſtabliſhed for the benefit of my ſubjects ſhall always be objects of my particular attention, and therefore the Free Economical Society may rely upon having my ſupport and protection. I conſider their labours, both in regard to their object and conſequences, as worthy of reſpect; and, to promote their influence on the general good, I have ordered the imperial treaſurer to pay to the Society yearly the ſum of five thouſand roubles. In regard to changing the preſent impreſſion of its medal, it is my opinion that none can be fitter for that purpoſe, or more agreeable to

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the feelings of the Society, than the head of its first founder, by whom it was approved and confirmed; and therefore I consider it proper that it should be retained as a memorial to posterity, and even for the honour of the institution.

I remain your well wisher,

" April 13th, 1801. ALEXANDER."

The Society, after this letter was read, voted their most respectful thanks, to be communicated in writing, to his imperial majesty, for his having been graciously pleased to assure them of his protection, and for the annual sum promised to enable them to prosecute their labours; that a complete collection of their transactions should be presented to his majesty, and that these resolutions should be published.

The Society has proposed the following

Prize Question:

A great many experiments have been already made on the preparation of sugar from white beets both in Russia and in other countries; and a variety of opinions and facts in regard to this subject, which however are, in part, contradictory, have been published. As this subject is considered to be of great importance, the Society require a dissertation, in which shall be shown:

What has been hitherto discovered with certainty in regard to the preparation of sugar from the beet-root: what, on the other hand, is doubtful; and, in particular, what is properly the kind of beet which ought chiefly to be chosen for that purpose: in what soil, and in what manner, it can be best cultivated: how sugar can be obtained from it with most advantage: and, whether there is reason to expect that the sugar procured from it can be sold in any of the provinces at a cheaper rate than the common sugar?

The prize for the best paper on this subject is a gold medal of the value of 30 ducats. The papers must be transmitted to the Society, with the usual forms, before the month of March 1802; and may be written in the Russian, German, or French languages.

XXIX. *Intelligence and Miscellaneous Articles. July* 1801.

ASTRONOMICAL NOTICES.

I. C. CAIGNE, notary, Rue de la Harpe, No. 237, is commissioned to pay the sum of 600 francs to the first astronomer, French or foreign, who shall discover a comet between this

this period* and the end of the year 1801, provided it be not visible to the naked eye, and that its appearance be confirmed by another astronomer; in France, for example, by one of those at Paris, Toulouse, Marseilles, Montauban, Viviers; in Germany, by one of those at Gotha, Berlin, Vienna; in Italy, by one of those at Milan; and in England, by the astronomer royal, Greenwich.

To find a comet it is not necessary to be an astronomer, nor is it required that its place should be exactly determined; it will be sufficient to indicate nearly the hour at which it appeared, at what height above such or such a star, or at what distance from the meridian; which is very easy. There are so many amateurs who look at the heavens, that there is reason to hope some of them will employ this degree of attention by considering that comets are at present the only desiderata in astronomy, and that they may be found by a common telescope mounted on a quadrant or parallactic machine of wood, which any one may construct by consulting the rules of astronomy. LALANDE.

II. On the 12th of July, at ten in the evening, C. Bouvard discovered a small comet near the head of the Great Bear. Its right ascension was 111° 15′, and its northern declination 69° 30′, at 11^h 58^m of true time. It was small and round, had no tail, and was somewhat nebulous. C. Bouvard has told me that it was seen by C. Mechain at a quarter past ten, and by C. Messier at half after ten. I do not yet know who will be entitled to the 600 francs which Caigné, the notary, has been commissioned to deliver to the person who should discover a comet. LALANDE.

III. The following notice respecting this comet was transmitted by C. Mechain, to the minister of the interior:

"Paris, at the National Observatory,
July 13, 1801.

"The interest which you take in the re-establishment of the observatory, and the powerful means you procure to us to enable us to put it into such a state as to vie with the most celebrated observatories of Europe, render it my duty to communicate to you the discovery I made yesterday evening about ten o'clock. I observed a new comet in the northern part of the heavens below the pole, between the constellations of the Giraffe and the Great Bear, and very near the head of the latter. This comet was not visible to the naked eye, it was even very faint in the telescope: it had no tail

* This notice is copied from the *Magazin Encyclopédique*, 1st Messidor (19th June).

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or train, and appeared only as a nebulous ſtar of not more than two or three minutes diameter; a little more luminous towards the centre than the edge, which was diffuſe, or not well defined.

"According to my obſervations, this comet at 12 hours mean time had 111 degrees 14 minutes right aſcenſion, and 69 degrees 31 minutes northern declination. This period was very nearly that of its lower paſſage of the meridian, where its altitude above the horizon was 28½ degrees. It appears to deſcend towards the ſouth about 3½ degrees in 24 hours, and is proceeding rapidly towards the eaſt. I ſhall follow it attentively; and, when I have made a ſufficient number of obſervations to determine its orbit, I ſhall have the honour of tranſmitting to you the reſult of my reſearches.

"If you think this notice of the appearance of a new comet worthy the attention of the Firſt Conſul, it belongs to you to preſent it to him.

"This is the third comet which I have diſcovered at the National Obſervatory ſince I entered it, after having terminated the portion of the meaſurement of the meridian, with which I had the honour of being charged; and it is the twelfth altogether that I have found without the aſſiſtance of any perſon ſince I have been employed on this part of aſtronomy.

"C. Bouvard, aſſiſtant of the Board of Longitude, who reſides alſo in the obſervatory, and who purſues with zeal the courſe of the daily and fundamental obſervations, diſcovered yeſterday the ſame comet nearly at the ſame time as myſelf, and without our having had any communication on the ſubject. MECHAIN."

IV. The comet diſcovered on the 12th by three aſtronomers at the ſame time, is a ſingularity, of which we have no example: it is the twentieth of C. Meſſier, the twelfth of Mechain, and the fourth of Bouvard. It was ſeen on the 18th near the ſtar Lambda, in the paw of the Great Bear; having moved at the rate of four degrees per day, and acquired a little increaſe of light. As it is proceeding towards the ſouth, it is probable that it will ceaſe to be viſible to us in eight days on the back of the Lion.

I had the pleaſure of finding in my 50,000 ſtars, that which was near the comet at the moment when it was diſcovered.

The notary has written to the Board of Longitude to know to whom he ought to pay the 600 francs depoſited in his hands; and has received for anſwer, that he muſt wait till it is known whether the comet has been diſcovered in any other country. July 20th. LALANDE.

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CHEMICAL NOTICES.

Professor Lampadius has offered some speculations, accompanied with experiments, respecting the possibility of decomposing the earths and fixed alkalies. The following observations deserve attention:

1. The caustic strontian earth, barytes, and lime, are decomposed in the strongest white heat, by combining them with carbon; the first is particularly attracted by coal, and forms azote, water, and carbonic acid, during that process. The decomposition of those bodies, also, proceeds under the blowpipe.—2. Earths possess much affinity for oxygen, which is proved by the excellent experiments of Humboldt, in decomposing the pure argillaceous earth by oxygen gas; and it appears, from the following facts, how great the influence of oxygen is upon the earths.—3. The *fermentatio fossilis* of the porcelain earth, according to some mineralogists, is formed by the fossil fermentation of the fieldspar; but it continues to be in this way decomposed, when it is further exposed to the action of the air, by which means it is also prepared for the intended use, losing thus its sandy particles, and becoming soft, and fit for being worked.—4. The oxidated argillaceous earth is with more difficulty dissolved in acids than the deoxydated. Pure argil, which he happened to keep in combination with oxygen gas and water for six months, was not perfectly soluble in sulphuric acid. The solution, however, proceeded, as soon as the earth, after being dissolved by caustic lye in a silver crucible, was precipitated by acetous acid; by which it seems probable, that the caustic fixed alkali deprives the argillaceous earth of its oxygen in a red heat. Hence it may be explained why the sapphire is soluble in acids, after being burnt with kali, &c.—5. It deserves to be attended to, and proved by further experiments, what the late Mr. Girtanner has conjectured of the oxidation of earths.—6. The earths are formed in plants and animals from elements, which they receive with their nutriment, and through the mediums with which they are surrounded. The interesting experiments of the ingenious Vauquelin on the formation of the calcareous earth in hens, are known to every chemist. The earths contained in plants are the same, even when they grow in different soils, from which, of course, they do not originate.—7. Earths are also formed in the atmosphere, which appears from the late observations of stony masses having fallen from the atmosphere. If we dare acknowledge hydrogen, oxygen, and azote, as the elements of the earths, that phænomenon will be easily explained. From these remarks we may conclude,

conclude, that the analyſes, which have hitherto been made of terreous ſubſtances, are very little to be depended on. Profeſſor Lampadius is at preſent much engaged in experiments to aſcertain the nature of ſiliceous earth; which he conceives to be nothing but argillaceous earth in the higheſt degree of oxidation, and which is changed into argillaceous earth by treating it with deoxidating ſubſtances. It ſeems, therefore, probable, that ſeveral foſſils, which, according to their external or oryctognoſtic ſigns, appear to be ſiliceous, are changed in the hands of chemiſts into argillaceous earth! Though conſcious of the boldneſs of this aſſertion, the profeſſor obſerves, that in different analyſes of the ſame ſubſtances he has ſometimes obtained a greater, ſometimes a leſs, quantity of argillaceous or of ſiliceous earths, which he aſcribes to the above circumſtance. On the whole he thinks, that earths as well as fixed alkalies are compoſed of azote, hydrogen, and oxygen.

Mr. Lambe has proved, by ſeveral experiments, that the precipitate formed upon mixing muriate of lime with muriate of magneſia is carbonate of lime, which ariſes from the muriatic acid not having the power to ſeparate the laſt portion of carbonic acid from carbonate of magneſia, when affuſed on that ſubſtance to convert it into a muriate.

C. Vauquelin, in a late paper on the combination of metals with ſulphur, divides them into three orders: 1. Metals and ſulphur, or ſulphurets properly ſo called: 2. Metallic oxides and ſulphur, which ought to be called ſulphurated metallic oxides: 3. Metallic oxides with ſulphur and hydrogen. Theſe triple combinations he calls *metallic hydro-ſulphurated oxides*. It is obvious, and chemiſts ſhould remember the fact, that the action of the different acids upon ſuch compounds muſt be altered and modified according to the claſs to which they may belong.

MAN IN THE SAVAGE STATE.

A great deal has been ſaid in the journals of the ſavage child found in the department of Aveyron; and ſuch diſcoveries cannot fail of being intereſting to mankind, eſpecially if they could lead to means for civilizing and reſtoring to ſociety theſe unfortunate beings, whom nature ſeems to have cut off from the rank of men to place them among the number of irrational animals.

Such are the ideas ſuggeſted by examining the young man found

found about a year ago in the iſland of Madagaſcar, now exhibited in Toulouſe. He is of the uſual ſize, that is to ſay, about five feet eight inches in height; he is pretty ſtout, and well made in all his parts, and ſeems to be between twenty and twenty-five. The colour of his ſkin is the ſame as that of all the Europeans; which gives reaſon to think that he had been caſt upon the above iſland by ſome ſtorm during his infancy, and found means to preſerve his exiſtence by devouring whatever he could find; for he ſwallows ſtones, iron, and every thing that falls into his hands. He eats raw fleſh with unexampled avidity, flowers, herbs, and even dogs and cats, dead or alive, if given to him; but he has a great averſion to bread and dreſſed victuals, and, in general, for every thing baked, boiled, or roaſted; and this he teſtifies every time they are preſented to him, by convulſive movements and tearing his own ſkin: in a word, he always appears to be in a ſtate of ſuffering; his head is in a continual ſtate of motion, leaning alternately to either ſhoulder; he twiſts his hands, or employs them in pulling the ſkin of his breaſt with an air of grief truly affecting. His manner of ſwallowing is alſo worthy of remark: he does not exerciſe this function like other men, but, having turned the meat for a few moments in his mouth, he throws it violently into his gullet, into which it ſeems to deſcend with pain. He ſeems not to underſtand any thing ſpoken to him, and only emits a faint cry from his throat when he wiſhes to have food. Yet this being, ſo voracious, ſo well formed, and who is neither deſtitute of beard, nor hair on thoſe parts uſually covered, ſeems in other reſpects not to be a man: women have no attractions for him; and his keeper aſſerts that he never could diſcover the leaſt movement in his parts of ſex.

Such is the ſtate of this unfortunate being, who has nothing human but the form, and who in judgment and underſtanding ſeems inferior to the greater part of animals. It is ſuppoſed that the Dutch captain in whoſe ſhip he was brought to Europe, uſed him very ill: he is, indeed, exceedingly timid, and ſeems to have no other ſentiments than thoſe of hunger and fear. The leaſt threatening motion of his keeper frightens him ſo much as to produce a total change in his phyſiognomy: he can neither laugh nor weep; and employs the ſame cry to expreſs his joy when food is preſented to him, his deſire when he ſees it, and his pain when ſtruck. It has hitherto been impoſſible to accuſtom him to wear clothes; and, in order that he may be exhibited to the curious, a ſkin is faſtened around his loins: even this cover-

ing

ing he seems to bear with impatience, and makes every effort to tear it off. As long as he is permitted he remains lying on the ground naked, with his head low, and in a posture which appears to be extremely constrained.

VOYAGES OF DISCOVERY.

I. His majesty's ship the Investigator, of 22 guns, which had been preparing for some months before, sailed from the Nore on Monday the 20th of July, on a voyage of discovery to the south-west of New Holland. She was to have sailed some time ago, but it was thought advisable to procure first the protection of the French government, to prevent the object of the voyage from being defeated by any of the common accidents of war; and some delay was occasioned before the necessary papers were procured. The Investigator is commanded by lieutenant Flinders, to whom the world is indebted for several discoveries made in that quarter; having been sent from Jackson's Bay, and sailed round that country known by the name of Van Diemen's Island, passing through the strait which separates it from New Holland, to which he gave the name of Bass's Strait. He is now to examine the whole coast of New Holland; to discover what large bays, but especially what rivers are to be found there; as it is natural to suppose that so large an island, or, more correctly speaking, so extensive a continent, (being considerably larger than all Europe,) must have many such, which may enable him to penetrate far into the interior.

Persons versed in astronomy, natural history, mineralogy, &c. and able draftsmen, accompany the expedition.

II. The following is an extract of a letter from captain Baudin, now on a voyage of discovery, dated on board *le Geographe*, Isle of France, March 20th:

"We entered this port yesterday; and I embrace the opportunity of a Swedish vessel, just about to sail, to inform you of our arrival at this colony, after a passage of four months and two days, from Teneriffe. We have been alternately distressed by contrary winds and calms; yet no kind of malady has appeared on board either of the two vessels, and all, without exception, have enjoyed perfect health. Our voyage, very uninteresting in regard to geography, has been highly interesting in regard to natural history: we have collected more than two hundred new and hitherto unknown objects, which to connoisseurs will occasion as much astonishment as pleasure."

NATURAL HISTORY.

The following ſingular phænomenon, which muſt be intereſting to thoſe fond of obſerving nature, has been communicated in a letter from Sileſia:—Laſt year, a gooſe, like the other animals of her ſpecies, on the cauſeway of Schauris, not far from Wartenberg, placed herſelf on a neſt in the ſpring, as if with intention of laying, but produced no eggs. She, however, remained in the neſt during the whole hatching-ſeaſon; and completed that period, but without having laid. This gooſe, being killed in the autumn following, thoſe who had obſerved her during the hatching-time were much aſtoniſhed when ſhe was opened, to find in her bowels two young ones completely hatched, perfectly formed, and preſſed towards each other. They were both dead; their bodies, like thoſe of other young geeſe, were covered with yellowiſh down; and they had feathers in their wings an inch in length. Near them was a large egg perfectly hard.

GRAND JUNCTION CANAL.

An epoch of ſingular importance to the internal commerce of the kingdom in general, and particularly of the metropolis, is, the opening of this canal, which took place with great formalities on the 10th of July. This ſtupendous monument of Britiſh ſpirit was undertaken and finiſhed during the courſe of the war, at an expenſe of nearly a million ſterling. It unites the trade of the north, north-weſt, and north-eaſt, and midland parts of this iſland, with Paddington, now become *the weſtern port of London.*

TO DESTROY BLACK BEETLES.

On the cover of our laſt Number we printed a requeſt from a correſpondent to be informed whether any effectual method was known for getting houſes cleared of that kind of vermin vulgarly called *black beetles*. A conſtant reader deſires us to inform him, that if he will take ſome ſmall lumps of unſlacked lime, and put it into the chinks or holes from which they iſſue, it will effectually deſtroy them; or, that he may ſcatter it abroad on the ground, if they are more numerous there than in the holes.

XXX. *Account of the improved Pump invented by Mr.* ROBERTSON BUCHANAN, *Engineer, No. 57, Piccadilly.*

THE many fatal accidents which happened to ſhips from the choking of their pumps, made it an important object, in naval affairs, to find ſome machine for freeing ſhips from water not liable to ſo dangerous a defect. The chain pump, having been found leaſt exceptionable in this reſpect, was adopted in the Britiſh navy; but, as Mr. Townſend obſerves, "the chain pump itſelf is not free from imperfections. If the valves are not well fitted to the cylinder, through which they move, much water will fall back; if they are well fitted, the friction of many valves muſt be conſiderable, beſides the friction of the chain round the ſprocket wheels, and of the wheels themſelves." To which may be added the great wear of leathers *, and the diſadvantage which attends the ſurging and breaking of the chain. "The preference, therefore, which has been given to chain pumps over thoſe which work by the preſſure of the atmoſphere, muſt have ariſen from this one circumſtance, that they have been found leſs liable to choke.

"In point of friction, of coolneſs, and of cheapneſs, the ſucking pump has ſo evidently the advantage over the chain pump, that it will not fail to gain the preference whenever it ſhall be no longer liable to be choked with gravel and with chips †."

Buchanan's pump, which, like the common pump, acts by the preſſure of the atmoſphere, is not liable to the defects incident to other pumps upon that principle, being eſſentially different from any now in uſe.

The conſtruction of this pump will be eaſily underſtood from the following ſhort deſcription:

Fig. 1. (Plate III.) is a vertical ſection of the pump, as made of metal, in which A is the ſuction-piece, as it is commonly called; B, the inner valve; C, the outer valve. The valves are of the kind called clack valves; their hinges are generally made of metal, as being more durable than leather; and, requiring no boxes, are peculiarly ſimple in their conſtruction. D, the working barrel; E, the piſton; G, the ſpout.

Fig. 2. is a ſection, by the line a b, of fig. 1. ſhowing how

* See Captain Inglefield's Narrative.

† Townſend's Journey, vol. i. p. 171.

the lower valve B may have its ſockets formed in the flanche at the lower end of the working barrel, and therefore requiring no box. The outer valve is alſo conſtructed in the ſame manner.

The piſton E, being raiſed in the working barrel D by any of the methods practiſed with the common pump, rarefies the ſpace between the piſton and the valve B, which valve opens upwards; the exterior atmoſphere, at the ſame time, by its preſſure on the ſurface of the water in the well, forcing the water to aſcend in the ſuction-piece A, to reſtore an equilibrium. On the return of the piſton, the valve B, by its own gravity and the increaſed weight brought upon its upper ſurface, cloſes the upper orifice of A; while the valve C, by the ſame increaſed weight acting on its inner ſurface, is forced out towards b, allowing whatever is contained between the valve B and the piſton E to paſs into the ſpout G, from whence it cannot return into the working barrel; for, the moment the piſton begins again to aſcend, the valve C, by its own gravity and by the preſſure of the atmoſphere, is forced back into its firſt poſition, and ſhuts up the communication between the ſpout and the working barrel. A few ſtrokes of the piſton exhauſt the ſuction-piece A of all the air it contains, driving it off through the valve C; the water, in the mean time, riſing in A till it paſs the valve B, and, by ſucceſſive ſtrokes, be diſcharged through the ſpout G.

It will be readily perceived that this pump, ſo far as we have deſcribed it, agrees exactly with the *common ſuction-pump* as to *its prime principle,* the water being raiſed to the height at which it is delivered *by the preſſure of the atmoſphere alone*; but that it poſſeſſes alſo important advantages in point of conſtruction. In ſhort, it has all the deſirable properties of the common pump without any of its diſadvantages, beſides poſſeſſing not a few good qualities which are peculiarly its own.

The principal object of its invention was to remove the imperfection of *choking*; and in attaining this important end, a variety of collateral advantages have alſo been produced, which enhance its utility.

The points in which it differs eſſentially from the common pump, and by which it excels, are, *that it diſcharges the water below the piſton, and has its valves, which are of the moſt ſimple and durable conſtruction, lying near each other, and of eaſy acceſs, without the disjunction of any part of the machine.*

The advantages of this arrangement are: that the ſand, or other matter which may be in the water, is diſcharged without

without injuring the barrel or the piston leathers; so that, besides the avoiding of unnecessary tear and wear, the power of the pump is preserved, and not apt to be diminished or destroyed in moments of danger, as is often the case with the common and chain pumps: that the valves are not confined to any particular dimensions, but are made capable of discharging every thing that can rise in the suction-piece, *without danger of being choked*: that if there should happen upon any occasion to be an obstruction in the valves, they are both *within the reach of a person's hand*, and may be cleared at once, without the disjunction of any part of the pump. Besides, it occupies very little space in the hold, and thus saves room for stowage.

But this is not all: the pump under consideration may be *instantaneously converted into an engine for extinguishing fire*, as it commands at will all the advantages which result from the principles on which *forcing pumps* are constructed. This is obtained by simply screwing an air vessel H on the top of the spout G, while the mouth of the spout is furnished with a stopple, fig. 3. made for receiving such pipes and hose as are common to fire engines. This stopple is elliptical and tapered, and, being introduced transversely, upon being pulled back becomes immediately tight.

These parts being provided, all that is necessary to make the pump act as a fire engine, after having been used as a sucking pump, is to plug up the spout with the stopple. When not wanted to act as a forcing pump or fire engine, these parts are not necessary.

The advantage to a ship of having a pump, which, as occasion requires, may either be used for raising water or extinguishing fire *, is too obvious to require comment. It may however be observed, that in its latter capacity it may also be useful on ship-board for many common purposes, such as washing the decks and sides, or for wetting the sails in light winds. For those purposes clean water may be applied in various ways, but perhaps the most simple is by the stop-cocks, used in many ships for sweetening them.

But this pump is not confined to nautical uses alone; its adaptation extends to the raising of water in all situations, and with peculiar advantage where it happens to be mixed with sand, or substances which destroy other pumps; as, for instance, in alum works, soap works, mines, quarries, the clearing of foundations: and in its double capacity it will be very convenient in gardens, bleaching grounds, on West India estates, (combining a still-house pump and a fire

* Fire engines, when wanted, are often out of repair.

 engine,)

engine,) in ſtable and farm yards, and in all manufactories, or other places, where there is a neceſſity for raiſing water, and the riſk of fire.

With all theſe advantages it is a ſimple and durable pump, and may be made either of metal or wood at a moderate expenſe.

No particular mode being eſſential in the working of this pump, it may, according to choice or circumſtances, be wrought by all the methods practiſed with the common pump. In many caſes, however, it may be advantageous to have two of them ſo connected as to have an alternate motion; in which caſe, one air veſſel, and even one ſuction-piece, might ſerve both.

Its principles admit of various modifications; but as what is already mentioned may be ſufficient to indicate its ſuperiority over the common and chain pumps, and the advantages likely to reſult from its general uſe, a further detail is unneceſſary. We cannot, however, diſmiſs this article without mentioning that we have ſeen two certificates reſpecting its utility at ſea, which deſerve particular notice. One of them, dated the 23d of June laſt, is from captain William Murray, of the Prince of Wales exciſe yacht, of 20 guns, who had one fixed on board that veſſel in the year 1794, which was found to anſwer ſo well, that he has ſince had a ſecond and third one: he finds that the piſton leathers are not in the leaſt hurt by ſix years uſe, and recommends the pump highly to veſſels which carry corn, or ſuch ſubſtances as are apt to choke or injure other pumps. The other certificate, dated the 14th of July laſt, is from captain Hurſt, of the Britannia of Glaſgow, but then in the Thames. He ſtates, that one of theſe pumps was fixed on board his veſſel in April 1800, and had anſwered its purpoſe in the moſt complete manner, and gives one particular inſtance in the following words:—" When at ſea, about ſix weeks ago, a quantity of coffee, by ſome means, had got into the ſhip's well. Upon trying the common pump, it was ſoon rendered almoſt uſeleſs by the coffee preventing, in a great meaſure, the valves from acting. I then tried the patent pump, which, with the greateſt facility, completely diſcharged the coffee from the well." He then adds: " The piſton leathers are ſtill as good as when the pump was firſt fixed, nor had I ever occaſion to give any part of the pump the ſmalleſt repair. I well know the great advantage of having a pump not liable to choke, having, during the voyage before yours was put on board, been nearly loſt in the Britannia, laden with corn, from the choking of the pumps. As an engine for extinguiſhing fire, as far as relates to the force, quantity

quantity of water difcharged, &c. I have given it fair trial; from which I have no hefitation in faying, that fhould an occafion of real danger from fire unhappily arife, it is my opinion the patent pump might be of the greateft utility."

XXXI. *Refearches refpecting the Laws of Affinity.* By C. Berthollet, *Member of the French National Inftitute.*

[Continued from p. 142.]

On the Influence of the Proportions in Complex Affinities.

1. In my refearches on the laws of affinity I have afcertained the principal refults prefented by complex affinity, when the force of cohefion or that of elafticity is fufficiently ftrong to produce that change of bafe which has been afcribed to the fuperiority of the divellent affinities over the quiefcent affinities. But I avoided entering into the neceffary details for determining the changes which may arife from different proportions of the fubftances brought into action, when the force of cohefion is not fufficiently great to caufe the effects of this difference to difappear. I promifed (Art. XII. No 6.) to return to this fubject, which I fhall now proceed to do.

According to the theory explained (Art. V. No. 5.), all fubftances exert a mutual action while they are in the liquid ftate; fo that in a folution, for example, of fulphate of potafh and muriate of foda, thefe two falts are not diftinct, while there is no caufe to determine the feparation of their combination; but there exift in this liquid fulphuric acid, muriatic acid, foda, and potafh. I fhall, however, continue to make ufe of the ordinary language, which after this notice can produce no ambiguity.

2. I begin with mixtures in which a confiderable force of cryftallization muft determine the combinations which are formed.

Experiment A. Equal parts of nitrate of lime and fulphate of potafh were mixed: after the feparation of the fulphate of lime firft formed, the liquid, by fucceffive evaporations, yielded only nitrate of potafh and fulphate of lime. After the laft evaporation, however, fome cryftals of fulphate of potafh were procured; there remained only a very fmall quantity of uncryftallizable liquid, which precipitated with carbonate of foda and with nitrate of barytes; fo that it confifted of a little fulphuric acid and lime, and very probably a larger portion of nitrate of potafh.

The quantity of fulphate of lime which was depofited in the courſe of the evaporation was much more conſiderable than would have been obtained from the ſimple ſolution of this ſalt and water; ſo that its ſolubility was augmented by the action of the other ſubſtances.

B. Two parts of ſulphate of potaſh and one of nitrate of lime, gave firſt ſulphate of potaſh and ſulphate of lime; and, by ſucceeding evaporations, nitrate of potaſh and the two ſulphates, the proportions of which continued to decreaſe to the laſt cryſtallization. There remained only ſome drops of the liquid uncryſtallized, which did not precipitate with carbonate of ſoda, but did with nitrate of barytes: hence they were probably formed of ſulphate of potaſh and a ſmall portion of nitrate of potaſh.

C. Two parts of nitrate of lime, and one of ſulphate of potaſh, yielded, during the firſt evaporation, a ſmall quantity of ſulphate of lime, and, by cooling, nitrate of potaſh: the other evaporations only produced nitrate of potaſh. In the latter, however, ſome cryſtals of ſulphate of lime were perceived at the ſurface of the liquid. The reſidue, which was abundant, was ſeveral times ſubmitted to evaporation and cooling, but did not afford cryſtals of any ſalt. This uncryſtallizable reſidue, treated with alcohol, formed an abundant depoſit, which, having been diſſolved in water, ſcarcely afforded any precipitate with nitrate of barytes. It contained, therefore, little or no ſulphuric acid, and conſiſted of pure nitrate of potaſh: the portion diſſolved by alcohol was nitrate of lime, with a ſmall portion of nitrate of potaſh. The uncryſtallizable reſidue was therefore compoſed of nitrate of potaſh and nitrate of lime.

In this experiment we ſee that the ſulphate of lime was rendered much leſs ſoluble than in the preceding experiments; but that a conſiderable quantity of nitrate of potaſh loſt the property of cryſtallizing by the action exerted on it by the nitrate of lime.

3. In theſe three experiments ſulphate of lime muſt have been formed, becauſe the lime and ſulphuric acid coming in contact, would ſeparate on account of the inſolubility which belongs to their combination.

The ſulphate of lime in the experiments A and B, was rendered much more ſoluble than it naturally is, by the action of the ſubſtances which were in ſolution; but in the experiment C, its ſolubility was not ſenſibly increaſed, probably becauſe the nitrate of lime and the nitrate of potaſh, which formed the uncryſtallizable liquid, mutually experienced a degree of ſaturation, which conſiderably weakened their action upon the ſulphate of lime.

4. From

4. From these considerations, I shall proceed to deduce, first, the theory of the uncrystallizable residues found in evaporated solutions of salts: it will be confirmed by the succeeding observations.

Saline substances exercise upon each other an action which increases their solubility, an effect that has been particularly established by Vauquelin. (*Annales de Chimie*, tom. xiii.) This mutual action varies in the different salts. It has, however, been thought, that salts with an earthy base do not increase the solubility of the nitrate of potash, though these in reality increase it the most. There is in this respect a difference in the effect produced by the salts, which depends on their nature; but this difference is in general very small, compared with that which proceeds from the force of crystallization.

D. Equal parts of nitrate of potash and sulphate of potash afforded by evaporation, successively, and in proportion to their solubility, sulphate of potash and nitrate of potash, without leaving any uncrystallizable liquid; but the same experiment being made with nitrate of soda and sulphate of soda, both of which have only a slight tendency to crystallize, and are nearly of equal solubility, only a small quantity of sulphate of soda was separated by crystallization; all the rest remaining liquid, without any crystallization. A mixture of muriate of soda and sulphate of alumine having been submitted to the same proof, it was clearly perceived that the two salts had become more soluble; but they were entirely separated by alternate evaporation and cooling. Substances, therefore, which possess a considerable force of crystallization, though rendered more soluble, separate on account of their insolubility, and leave very little or no uncrystallizable residuum. But the mutual action of salts, which have only a feeble disposition to crystallize, counterbalances their force of crystallization, so that there then remains much liquid which cannot crystallize; particularly when the residuum contains a substance in itself uncrystallizable; as in experiment C, where, by the proportions employed, there was found a superabundance of nitrate of lime, which by its action upon the nitrate of potash reduced a considerable quantity of that salt into an uncrystallizable liquid. How came it, then, that the most learned chemists, Lavoisier, Fourcroy, Vauquelin, Guiton, and the Commissaries of the Academy of Sciences, among whom myself was one, could have been led, by the experiments made upon the proof of saltpetre, to believe that the nitrate of lime exerts no action upon the nitrate of potash, nor increased its solubility? (*Annales de*

Chimie, tom. xi. xiii. xv. xxiii.) It was becaufe, in the experiments that were made, a folution of nitrate of potafh was put to digeft upon dried nitrate of lime. The latter neceffarily caufed a divifion of the water, upon which it has a ftrong action. It would therefore have precipitated a confiderable quantity of nitrate of potafh, if this effect had not been compenfated, or nearly fo, by the folubility which it imparted to that falt; but if the folution had been evaporated, there would have been feparated by cryftallization much lefs nitrate of potafh than was contained in the liquid, and an uncryftallizable refiduum would have been left, fimilar to that of experiment C. The proof, therefore, which was confidered as conclufive, induced an error refpecting the chemical phænomenon. Hence it follows, that when the mother waters of the faltpetre works are decompofed by potafh, the nitrate of potafh obtained confifts not only of that which has juft been formed, but alfo of that which was rendered uncryftallizable by the falts with an earthy bafis.

5. I made mixtures of cryftallized fulphate of foda and nitrate of lime. Here the fulphate of foda, and the nitrate of foda which might proceed from the operation, differed little in point of folubility, and had a cryftallizing power lefs confiderable than the fulphate and nitrate of potafh.

E. Equal parts of cryftallized fulphate of foda and of dry nitrate of lime gave by evaporation only a fmall quantity of nitrate of foda. The uncryftallizable refidue, which was abundant, did not precipitate with muriate of barytes, but did with oxalic acid.

F. Two parts of fulphate of foda, and one part of nitrate of lime, afforded, after evaporation, a greater quantity of nitrate of foda than the preceding experiment: the uncryftallizable refidue did not precipitate with oxalic acid, but did with muriate of barytes. To compare the two laft with the experiments A, B, and C, it muft be obferved that the cryftallized fulphate of foda contains more than half its weight of water of cryftallization. Even fulphate of foda was not formed in experiment F, as fulphate of potafh was in experiments A and B, becaufe fulphate of potafh has a force of cryftalliztion much greater than fulphate of foda.

The refidue of experiment E did not contain a quantity of fulphuric acid perceptible by the muriate of barytes; but was formed of nitrate of foda and nitrate of lime, which probably, by their mutual action, fo much exhaufted their diffolvent power as not to prevent the feparation of the fulphate of lime No. 3.

In experiment F the refidue was not precipitated by oxalic acid,

acid, but by the muriate of barytes; ſo that this reſiduum was compoſed of ſulphate of ſoda and a greater proportion of nitrate of ſoda, which mutually prevented their cryſtallization, as in experiment D.

6. *Experiment* G. Equal parts of nitrate of potaſh and ſulphate of ſoda gave by ſucceſſive cryſtallizations, 1. Sulphate of potaſh, and ſome ſmall cryſtals of nitrate of potaſh; 2. A little ſulphate of potaſh, and a greater proportion of nitrate of potaſh; 3. Small cryſtals of nitrate of potaſh, and much nitrate of ſoda: there was an uncryſtallizable reſidue, notwithſtanding the care which had been taken to obtain the utmoſt cryſtallization: this reſidue was formed of nitrates and ſulphates; for it precipitated abundantly with the nitrate of barytes, and, after drying, it flowed on ignited charcoal. This experiment ought to be compared with experiment F.

H. One part of nitrate of potaſh, and two of ſulphate of ſoda, gave, 1. Sulphate of potaſh; 2. Sulphate of potaſh, and ſome needles of nitrate of potaſh; 3. Sulphate of potaſh in ſmall priſms, ſuſpended from a pellicle formed by nitrate of ſoda, fine cryſtals of nitrate of potaſh and nitrate of ſoda: the reſidue contained nitrates and ſulphates.

In theſe two experiments, the leaſt ſoluble ſalt of thoſe which were formed, viz. the ſulphate of potaſh, was the firſt which was cryſtallized. When the proportions had been thus changed, the action of the nitric acid on the potaſh reſumed its ſuperiority, and nitrate of potaſh was formed, though the liquid ſtill contained ſulphuric acid.

In the ſecond, the more abundant ſulphuric acid gave riſe to a greater quantity of ſulphate of potaſh; but, after the firſt cryſtallization, more nitrate of potaſh was formed, though there would have been a ſufficient quantity of ſulphuric acid to cauſe a complete change of baſe, if this exchange could have been made as has been imagined. The reſidue was formed, even in experiment G, of ſulphate of ſoda and nitrate of ſoda; and probably of a ſmall quantity of ſalt with baſe of potaſh.

7. *Experiment* I. Equal weights of nitrate of potaſh and muriate of lime were mixed together: by evaporation there were, 1. Nitrate of potaſh; 2. Muriate of potaſh, in which was found a little nitrate of potaſh: the reſidue gave with the ſulphuric acid an abundant precipitate of ſulphate of lime, and vapours of muriatic and nitric acid were diſengaged.

K. The experiment having been made with two parts of muriate of lime, and one of nitrate of potaſh, an abundant cryſtallization of muriate of potaſh was produced, with no

appearance

appearance of nitrate: the residue, treated as in the preceding experiment, gave analogous results.

L. A mixture of equal parts of muriate of potash and nitrate of lime, afforded, 1. Nitrate of potash, mixed with a little muriate of potash; 2. Muriate of potash, which was mixed with a small quantity of nitrate of potash. The uncrystallizable residuum was dissolved in alcohol; there was a separation of nitrate of potash, which was fused upon ignited charcoal, but contained a little muriate of potash, as was seen by the test of the solution of silver. The sulphuric acid showed that the part dissolved by the alcohol contained muriatic acid, nitric acid, and lime.

In the above experiments, in which substances were employed whose combinations could not have a considerable force of crystallization, and differed but little among each other in this respect, it is evident that the formation of the salts obtained by crystallization depended on the proportions of the substances which mutually acted among each other. In experiment I, which might afford nitrate and muriate of potash, as these two salts differed little in their solubility, which, however, is rather the least in the latter, the nitrate of potash was obtained by the first crystallization; but as in experiment K the muriatic acid existed in a greater proportion, muriate of potash only was then obtained; one part of potash with muriatic acid, nitric acid and lime formed the residuum. The proportions employed in experiment L differed little from those of I, and the results were nearly the same. Opposite combinations, therefore, are obtained according to the proportions employed, or according to the period of crystallization; that is to say, according to the proportions of the substances which remain in action when a sufficient force of cohesion does not exist in the combinations that might be formed. But according to the opinion adopted by chemists, the entire change of base, which it is affirmed must take place, may be judged of even by a first crystallization. If, for example, nitrate of potash be first obtained from the proportions which have been employed of muriate of potash and nitrate of lime, a conclusion is made, that an exchange of base has been effected between the muriatic and nitric acids. If other proportions had been employed which would have afforded muriate of potash, as in experiment K, an opposite consequence would have been drawn. Chemists have even gone further: from the conclusion respecting the change of base, for example, between the muriatic and nitric acids, a further inference has been made, that the combinations

tions oppoſite to thoſe which afforded ſuch a change, would not be at all affected by their mixture.

8. I have examined what change might be produced in the reſults by a ſubſtance which has the property of forming triple ſalts, ſuch as magneſia.

M. Equal parts of ſulphate of potaſh and muriate of magneſia afforded, 1. Sulphate of potaſh; 2. Sulphate of potaſh, a little muriate of potaſh, and a triple ſalt, compoſed of ſulphuric acid, potaſh, and magneſia: this ſalt forms fine rhomboids, which, by expoſure to the air, do not loſe their tranſparency: its ſolubility is nearly the ſame as that of the ſulphate of potaſh: 3. Muriate of potaſh and ſulphate of magneſia. The reſiduum contained ſulphuric acid, muriatic acid, potaſh, and magneſia.

N. Two parts of muriate of magneſia, and one of ſulphate of potaſh, afforded, 1. Sulphate of potaſh; 2. Muriate of potaſh, and the triple ſalt of the preceding experiment; 3. Muriate of potaſh, and ſulphate of magneſia: the reſiduum was analogous to that of the preceding experiment.

In experiment M, ſulphate of potaſh was obtained by two cryſtallizations; but in experiment N, where the muriatic acid was in a greater proportion, it was obtained on the firſt cryſtallization; the triple ſalt, which in ſolubility nearly approaches the ſulphate of potaſh, cryſtallized after the ſecond evaporation. When the proportion of ſulphuric acid was ſufficiently diminiſhed by theſe cryſtallizations, then the muriate of potaſh was ſeparated nearly according to the order of ſolubility; and laſtly the magneſia, which being ſtill abundant, cryſtallized with part of the ſulphuric acid. We ſee that a different opinion might have been formed in theſe two experiments, according to the period of the cryſtallization at which it might have been obſerved; and how erroneous the eſtabliſhed opinion is, that a complete change of baſes takes place on the mixture of muriate of magneſia and ſulphate of potaſh.

In experiment M, where the ſulphuric acid was preſent in greater proportion, ſulphate of potaſh was obtained in both the firſt cryſtallizations; but in experiment N, where the muriatic acid had more influence by its relative quantity, ſulphate of potaſh only was obtained in the firſt cryſtallization; the magneſia, for the moſt part, remained in the uncryſtallizable reſidue, becauſe it has no force of cryſtallization with the muriatic acid, and only a weak power with the ſulphuric; other ſalts which would cryſtallize in other circumſtances, are retained in the reſidue which oppoſes their cryſtallization. The difference obſerved between the reſults of theſe two experiments, and thoſe of the experiments A, B, and C, in which a deliquescent calcareous salt was put into action with the sulphate of potash, corresponds exactly with the difference of solubility which exists between the sulphate of lime and the sulphate of magnesia.

9. After having treated of saline substances in the preceding experiments, as if they formed separate or distinct combinations in a liquid, I shall now consider some effects which are owing to the mutual action which is in reality exerted by them all when they are mixed in this state.

O. An aqueous solution of acetite of lead was gradually poured into a solution of muriate of soda, till no more precipitate was produced. The liquid which remained above the precipitate strongly reddened blue paper, which effect was not produced by the mere solution of the acetite of lead, nor by the muriate of soda; but it assumed a deep colour with hydro-sulphurets, and afforded an abundant precipitate with the muriatic and sulphuric acids. During its evaporation a deposition was formed of a scarcely soluble muriate of lead, and also a crust which had not a crystalline appearance. Lastly, some fine crystals were obtained, which were an acetite of soda and an oxide of lead. On dissolving the saline crust, a deposition took place of muriate of lead with excess of oxide, analogous to that described by Vauquelin. (*Annales de Chimie*, tom. xxxi.) It was necessary to repeat the solution and crystallization several times before the deposition ceased; and the saline crust thus became divided into two substances, muriate of soda and muriate of lead.

If the muriatic acid remain engaged in the liquid together with the acetous, as both acids are volatile, the excess, which is but slightly engaged, and which may be expelled by the action of heat, must be composed of two acids. In fact, having distilled a mixture similar to the preceding, after having separated the deposition which was first formed, the liquid which passed into the receiver contained acetous and muriatic acid: this circumstance deserves particular attention, and serves to explain several phænomena.

10. C. Prieur has remarked that when lead was employed to purify a solution of silver mixed with muriatic acid, a part of the latter acid passed over by distillation. This takes place because the muriate of lead is soluble, and much so by the action of the nitric acid. The liquid is therefore composed of oxide of lead, muriatic acid and nitric acid. The oxide of lead divides its action upon the two acids, and both are subjected to the action of the expansibility produced by the heat.

If the sulphuric acid were to be retained, lead would be

an

an efficacious agent: 1. Becaufe the fulphate of lead is much lefs foluble than the muriate; 2. Becaufe the fulphuric acid is much lefs volatile than the muriatic acid.

Muriate of filver being much more infoluble than muriate of lead, filver is much better than lead for retaining the muriatic acid which happens to be in the nitric acid. Velter and Bonjour obferved, however, that muriatic acid always came over in diftillation, if the operation was made without the precautions indicated by thofe learned chemifts. To obtain a pure nitric acid immediately, it is neceffary to make the operation upon an acid little concentrated, that it may not hold in folution any muriate of filver, and to feparate the muriate of filver which precipitates before the liquid is fubjected to the action of heat, or, which is better, to precipitate, by a folution of filver, the muriatic acid from the nitrate of potafh; after which, by decompofing this nitrate, the nitric acid is obtained perfectly free from muriatic acid.

When muriate of filver remains in the folution, a very pure nitric acid may neverthelefs be obtained by diftillation, by fetting afide the firft portion which diftils over, till it is feen by the teft that no more muriatic acid is afforded. For, as the chemifts I have juft quoted obferved, the muriatic acid in this procefs affumes the nature of oxygenated muriatic acid, and is difengaged in this ftate at the beginning of the operation.

P. Sulphate of potafh having been treated with the acetite of lead in the fame manner as the muriate of potafh, fulphate of lead was precipitated. The liquid retained only a fmall quantity of oxide of lead. By the progrefs of evaporation fome cryftals of fulphate of potafh were obtained, though before the evaporation the acetite of lead produced no more precipitate; and, laftly, the acetite of potafh, which retained a fmall quantity of oxide of lead. The decompofition of the fulphate of potafh was much more complete than that of the muriate of foda.

In the experiments I have juft defcribed, we fee, then, that the decompofitions, or exchange of bafes, alfo follow the order of the folubilities of the combinations which may be formed; and that the only difference obferved in moft of the preceding experiments, arifes from the property poffeffed by the oxide of lead of forming triple combinations, which fometimes again feparate in combinations of different degrees of folubility, as happens with the muriate of foda and of lead. (Experiment O.)

11. The following experiment will confirm the truth that the

the force of cohesion produces a different effect, according to the properties of the solvent.

Q. I mixed an aqueous solution of plombate of soda with the water of sulphate of soda; a slight precipitate only was produced, though the sulphuric and muriatic acids, if added, would have produced an abundant precipitate: when the experiment was made with the muriate, the precipitate was much more abundant than with the sulphate of soda.

On the first view, these effects may appear to be contrary to the principles I have established. For the sulphate of lead is much less soluble than the muriate of lead; so that it might be expected that a more abundant precipitate would be obtained in the experiment made with sulphate of soda than with muriate of soda. This happens otherwise because sulphate of lead is much more soluble in soda, as I have ascertained, than muriate of lead with excess of oxide, such as is precipitated in the preceding experiments. And the precipitation is not a direct consequence of the force of cohesion, but arises from the excess of the force of cohesion beyond that of the solvent.

12. These observations may be reduced to the following results. In the complex affinities, or double affinities, the force of cohesion, when considerable, and differing much in its intensity among the combinations which may be formed, determines a change of bases, in such a manner, that the most insoluble combination is formed and separated independently of the proportions, which have an influence only upon the state of those substances which remain in solution. The result of a mixture of different saline substances may therefore be foretold from the mere consideration of solubility. In this case, the adopted theory of the quiescent and divellent affinities does not mislead us as to the principal result; that is to say, the formation of the insoluble salt. But, as it is not deduced from facts of a superior order, it will demand as many experiments as particular facts. The doctrine does not rest upon any foundation from which we can foretel the mutual actions of substances presented to each other; and again, it has the disadvantage of affording no indication respecting the properties which the remaining fluid portion ought to exhibit when subjected to evaporation or to the action of a new substance. Though this certain relation in the results may be productive of doubt as to the theory in the foregoing case, it is not the same when there is but a small difference between the solubility of the combinations that may be formed. The proportions of the substances, in

4 quantity,

quantity, then, determine the formation of the different salts, either by a first crystallization, or by crystallizations which, by subtracting some of the parts, must alter the proportion, and occasion a difference in the disposition of the remaining principles to crystallize in the successive formation of the salts. It is here that the application of the theory of the quiescent and divellent affinities may produce many errors, by leading us to conclude, from the commencement of the phænomenon, that the subsequent effects will be all of the same description, though in reality a succession of opposite combinations may be established, according to the forces which are made to act at the moment of their respective separations. The joint consideration of the difference of solubility, and of the proportions employed, or which vary at the different periods of an operation, must consequently be our sole guide in the explanation of the successive formation of different salts which have no great difference in solubility. It is true, nevertheless, that the mutual action of the substances themselves may produce some difference in the results, which would be indicated by the preceding observations.

All substances in a state of solution exert a mutual action, which increases their solubility. Hence the reason why it is difficult to obtain, by a first crystallization, each salt in a state of purity; except in the case where it differs considerably from the others in its force of crystallization. Hence arise the uncrystallizable residues which succeed the crystallizations wherein salts are found in the liquid, which possess but little force of cohesion. But here also the consideration of the proportions and of the solubility will serve to predict the existence and composition of any uncrystallizable residuum. While the substances are in solution, the action which they mutually exert renders it easy to expel an acid from a combination, though, according to the received opinion, it ought to assume the place of another, supposed to be weaker. Insolubility must not be considered as an absolute property, but merely as relative to the liquid in which a precipitation is made. Thus a combination insoluble in water, may lose this property when the water holds alkali in solution.

In all these experiments, and in several others which I have thought it useless to describe, I perceived no change of saturation, either after the mixture of the neutral salts, or after the separation of the precipitates or crystallizations which took place, except in the experiments P, Q, made with a metallic substance. This permanent state of neutralization, after the change of bases which took place, seems to indicate

indicate that the acids have conſtant relations of quantity, in the neutral ſalts they form, with different alkaline or earthy baſes. So that, if the ſulphuric acid, for example, exiſt in greater proportion in the ſulphate of potaſh than in the ſulphate of lime, the muriatic acid, with which it may make an exchange of baſe, will be found in the ſame ratio of quantity in the muriate of lime and in the muriate of potaſh; a concluſion that would not agree with the proportions which chemiſts have often attributed to the component parts of the different non-metallic ſalts. Guyton has already made ſeveral very juſt and important reflections on this ſubject, and quotes the obſervations of Richter, with whoſe work I am not yet acquainted. (*Annales de Chimie*, tom. xxv. p. 292.)

[To be continued.]

XXXII. *A Treatiſe on the Cultivation of the Vine, and the Method of making Wines.*

[Continued from p. 151.]

On the Clarification of Wines.

2d, BESIDES the operation of ſulphuring wines, there is another, no leſs eſſential, called *clarification*. It conſiſts, in the firſt place, in drawing off the wine from the lees, which requires certain precautions, and in then diſengaging it from all the principles ſuſpended or weakly diſſolved in it; ſo that nothing may be retained but the ſpiritous and incorruptible principles alone. Theſe operations are even performed before that of ſulphuring, which is only a continuation of them.

The firſt of theſe operations is called drawing off, tranſvaſation, defecation. According to Ariſtotle, this operation ought to be often repeated: *quoniam ſuperveniente æſtatis calore ſolent fæces ſubverti, ac ita vina aceſcere.*

In the different wine countries there are certain fixed periods of the year for this operation, eſtabliſhed, no doubt, on the conſtant and reſpectable obſervation of ages. At the Hermitage, the wine is drawn off in March and September; in Champagne, on the 13th of October, about the 15th of February, and towards the end of March.

Dry, cold weather is always choſen for this operation. It is certain that it is then only that the wine is in a good condition. Damp weather, and ſoutherly winds, always render

6 wine

wine turbid; and care muſt be taken not to draw it off while theſe prevail.

Baccius has left us ſome excellent precepts reſpecting the moſt favourable periods for the defecation of wine. He adviſes the weakeſt wines, that is to ſay, thoſe produced from fat covered ſoil, to be drawn off at the winter ſolſtice; moderate wines, in the ſpring; and the moſt generous, during ſummer. He gives as a general precept, not to draw off wine but when the north wind prevails; and he adds, that wine drawn off at the time of full moon is converted into vinegar!

The manner of drawing off wine can be a matter of indifference only to thoſe unacquainted with the effect of atmoſpheric air on that liquid: by opening the tap, or placing a cock at about four inches from the bottom of the caſk, the wine which runs off becomes aërated, and determines movements in the lees; ſo that, under this double view, the wine acquires a diſpoſition to become ſour. A part of theſe inconveniences has been obviated by drawing off the wine by means of a ſyphon; the motion is then gentler, and by theſe means one may penetrate to any depth at pleaſure, without agitating the lees. But all theſe methods are attended with faults, which have been completely remedied by the help of a pump, the uſe of which has been eſtabliſhed in Champagne and other wine countries.

To a leather pipe, of from four to ſix feet in length, and two inches in diameter, are adapted at each end wooden pipes, nine or ten inches in length, which decreaſe in diameter towards the ends, and are fixed to the leather pipe by means of a piece of packthread. The bung of the caſk intended to be filled is taken out, and one of the extremities of the pipe is put into it. A good cock is fixed in the caſk to be emptied two or three inches from the bottom, and into this is inſerted the other extremity of the pipe.

By this mechaniſm alone, the half of the one caſk is emptied into the other: for this purpoſe nothing is neceſſary but to open the cock; and the remainder may be made to paſs by a very ſimple proceſs, for which a pair of bellows about two feet in length, comprehending the handles, and ten inches in breadth, are employed. The bellows force the air through a hole formed at the anterior part of the ſmall end: a ſmall leather valve, placed below the ſmall hole, prevents the air from ruſhing out when the bellows are opened, and to the extremity of the bellows is adapted a perpendicular wooden pipe to convey the air downwards: this tube is fitted into the bunghole in ſuch a manner, that when the bellows are worked, and the air forced out, a preſſure is exerciſed on the wine, by which means it is obliged to iſſue from the one caſk, and to aſcend into the other. When a hiſſing is heard at the cock, it is ſpeedily ſhut: this is a ſign that all the wine has paſſed.

Funnels of tin plate, the tubes of which are at leaſt a foot and a half in length, that they may be immerſed in the liquor without cauſing any agitation, are alſo employed.

Drawing off wine ſeparates a part of its impurities, and conſequently removes ſome of thoſe cauſes which may alter the quality of it; but there ſtill remain ſome ſuſpended in the liquor, which cannot be caught but by the following operations, which are called *fining* of wine, or *clarification*: Fiſh-glue (iſinglaſs) is almoſt always employed for this purpoſe: it is unrolled with care, and cut into ſmall morſels, and it is then ſteeped in a little wine, where it ſwells up, becomes ſoft, and forms a viſcid maſs, which is poured into the wine. The wine is then ſtrongly agitated, after which it is left at reſt. Some whip the wine, in which the glue has been diſſolved, with a few twigs of birch, &c. and by theſe means occaſion a conſiderable foam, which is carefully removed. In all caſes a portion of the glue is precipitated with the principles it has enveloped, and the liquor is drawn off when the depoſit is formed.

In warm climates the uſe of glue is dreaded, and during ſummer its place is ſupplied by whites of eggs: ten or twelve are ſufficient for half a *muid**. The eggs are firſt beat up with a little wine; they are then mixed with the liquor intended to be clarified, and it is whipped with the ſame care. It is poſſible that gum arabic might be ſubſtituted for glue. Two ounces will be ſufficient for four hundred pots of wine. It is put into the liquor in the form of a fine powder, and the liquor is then ſtirred.

Wine muſt not be drawn off till it is completely made: if the wine is green and harſh, it muſt be ſuffered to ferment a ſecond time on the lees, and muſt not be drawn off till towards the middle of May; if it continues green, it may even be left till the end of June. It even ſometimes happens that it is neceſſary to convey back the wine to the lees, and to mix them ſtrongly, that the wine may again acquire that movement of fermentation which is neceſſary to bring it to perfection.

We are told by Miller that when Spaniſh wine becomes turbid by the lees, it may be clarified by the following proceſs: Put the whites of eggs, gray ſalt, and ſalt water, into a

* About a 72 gallon caſk Engliſh.

convenient

convenient veſſel; ſkim off the foam formed at the ſurface, and pour the compoſition into the wine caſk from which a part of the liquor has been drawn off: at the end of two or three days the liquor becomes clear, and acquires an agreeable taſte. After being ſuffered to remain at reſt for about a week, it is then drawn off.

To revive claret injured by floating lees, two pounds of calcined flints, well pounded, ten or twelve eggs, and a large handful of ſalt, are beat up with two gallons of wine, which are then poured into the caſk: two or three days after, the wine is drawn off.

Theſe compoſitions may be varied without end: ſometimes ſtarch is employed, and alſo rice, milk, and other ſubſtances, more or leſs capable of developing the principles which render the wine turbid.

Wine is clarified alſo, and its bad taſte is often corrected, by making it digeſt over ſhavings of beech wood, previouſly ſtripped of the bark, boiled in water, and dried in the ſun or in a ſtove: a quarter of a buſhel of theſe ſhavings will be ſufficient for a *muid* of wine. They produce a ſlight movement of fermentation in the liquor, which becomes clear in the courſe of twenty-four hours.

The art of *cutting wines* (couper du vin), as it is called, (correcting one wine by another—giving a body to thoſe wines which are weak—colour to thoſe deſtitute of it—and an agreeable flavour to thoſe which have none, or which have a bad one,) cannot be deſcribed. In theſe caſes, the taſte, ſight, and ſmell muſt be conſulted. The highly variable nature of the ſubſtances employed muſt be ſtudied; and it will be ſufficient for us to obſerve, that in this part of the management of wines every thing conſiſts: 1ſt, In ſweetening wines, and rendering them ſaccharine by the addition of *baked muſt*, concentrated with honey, ſugar, or another wine of a very luſcious quality. 2d, Colouring the wine by an infuſion of turnſole cakes, the juice of elder-berries, logwood, and mixing it with dark, and, generally, coarſe wine. 3d, Perfuming it by ſyrup of raſpberries, an infuſion of the flowers of the vine ſuſpended in the caſk, tied up in a bag, as is practiſed in Egypt, according to the teſtimony of Haſſelquiſt.

In the Orleanois, and other countries, a wine is made called there *vin rapé*. It is prepared ftom picked grapes, which are trod with wine or ley; placing in the preſs a ſtratum of vine-twigs and another of grapes in alternate order, or by infuſing the twigs in the wine. Theſe wines are made to boil ſtrongly, and they are then employed to give ſtrength and colour to the weak colourlefs wines of the cold and damp countries.

Though wine may work at all times, there are certain periods of the year at which fermentation feems to be renewed in a particular manner; and, above all, when the vine begins to bud, when it is in flower, or when the grapes begin to become coloured. At thefe critical moments, wine ought to be watched with particular care; and every movement of fermentation may be prevented by drawing off, and fulphuring it, as above indicated.

When wines are completely clarified, they are preferved in cafks, or in glafs. The largeft veffels are the beft, and they ought to be well clofed. Every body has heard of the enormous capacity of the tun of Heidelberg, in which wine is preferved for whole centuries, always improving in quality; and it is allowed that wine keeps better in very large cafks than in fmall ones.

The choice of fituation in which veffels containing wine ought to be depofited, is not a matter of indifference: on this fubject we find among the antients ufages and precepts which deviate for the moft part from our common methods, but which, in part, are worthy of attention. The Romans drew off the wine from the cafks to fhut it up in large earthen veffels glazed in the infide: this is what they called *diffufio vinorum*. It appears that for containing wines they had two forts of veffels, which they called *amphora* and *cadus*. The *amphora* was of a fquare or cubical form, had two handles, and contained twenty gallons of liquor. This veffel terminated in a narrow neck, which was ftopped with pitch or plafter to prevent the wine from exhaling. This we learn from Petronius, who fays, *Amphoræ vitreæ diligenter gypfatæ allatæ funt, quarum in cervicibus pittacia erant affixa cum hoc titulo—"Falernum opimanum annorum centum."* The *cadus* had the figure of the cone of a fir-tree; it contained one-half more than the *amphora*.

The moft generous wines were expofed to the open air in veffels well clofed; the weakeft were prudently placed under cover: *Fortius vinum fub dio locandum, tenuia vero fub tecto reponenda, cavendaque a commotione ac ftrepitu viarum*, fays Baccius. Galen obferves that the whole wine was put into bottles, after which it was expofed to a ftrong heat in clofe apartments; and in fummer it was expofed to the fun on the tops of the houfes, that it might fooner become mellow, and fit for drinking. *Omne vinum in lagenas transfundi, poftea in claufa cubicula multâ fubjecta flammâ reponi, et in tecta ædium æftate infolari, unde citius maturefcant ac potui idonea evadant.*

That

That wine may keep, and improve in quality, it ought to be put into veſſels depoſited in proper places, the choice of which is not a matter of indifference. Glaſs veſſels are the moſt favourable, becauſe, beſides their preſenting no principle ſoluble in wine, they ſhelter it from the contact of the air, from moiſture, and the principal variations of the atmoſphere. Care muſt be taken to ſhut theſe veſſels very cloſely with good cork; and to lay the bottles on their ſides, that the cork may not dry, and facilitate the acceſs of the air. For the greater ſafety, the cork may be covered with a coating of wax, applied by means of a bruſh; or the neck of the bottle may be immerſed in a mixture of melted wax, reſin, and pitch. Some people cover the wine with a ſtratum of oil: this proceſs is recommended by Baccius. The neck is then covered with an inverted glaſs tumbler, a veſſel of tin plate, or any matter capable of preventing inſects or mice from falling into the wine.

The veſſels moſt generally employed for keeping wine are caſks, which for the moſt part are made of oak. They vary in ſize, and are known by different names, ſuch as pipes, hogſheads, &c. The great inconvenience of caſks is, that they not only preſent to the wine ſubſtances which are ſoluble in it, but that they are affected by the variations of the atmoſphere, and afford a paſſage both to the air which endeavours to eſcape from them, and to that of the atmoſphere which penetrates them.

Glazed earthen veſſels have the advantage of retaining a more equal temperature; but they are more or leſs porous, and at length the wine in them muſt become dry. In the ruins of Herculaneum veſſels were found in which the wine had dried. Rozier ſpeaks of a ſimilar urn diſcovered in a vineyard in the territory of Vienne in Dauphiny, in a place where the palace of Pompey had formerly ſtood. The Romans remedied the poroſity of earthen veſſels by covering them with wax on the inſide, and pitch on the outſide: they covered alſo the whole ſurface with wax cloths, which they applied with great care.

Pliny condemns this uſe of wax, becauſe, he ſays, it made the wine turn ſour: *Nam ceram accipientibus v ſis, compertum eſt vina aceſcere.*

Whatever may be the nature of the veſſels deſtined to contain wine, a cellar ſheltered from all accidents muſt be choſen.

1ſt, The expoſure of the cellar muſt be northern: its temperature is then leſs variable than when the apertures are turned towards the ſouth.

2d, It muſt be of ſuch a depth that the temperature may be

 conſtantly

constantly the same. *In cellis quæ non satis profundæ sunt diurni caloris participes fiunt; vina non diu subsistunt integra,* says Hoffman.

3d, The moisture in it must be constant, without being too great: excess of moisture renders the papers, corks, casks, &c. mouldy. Dryness desiccates the casks, and makes them leak.

4th, The light ought to be very moderate: a strong light dries; darkness, almost absolute, rots.

5th, The cellar must be sheltered from shocks. Violent agitation, or that shaking occasioned by the rapid passage of carriages along the street, agitates the lees, mixes them with the wine, where they are kept suspended, and occasions acetification. Thunder, and all movement occasioned by shocks, produce the same effect.

6th, Green wood, vinegar, and all substances susceptible of fermentation, must be kept at a distance from a cellar.

7th, The reverberation of the sun, which, as it necessarily changes the temperature of a cellar, must also alter the properties of the wine preserved in it, ought also to be guarded against.

A cellar, therefore, must be dug to the depth of some fathoms below ground; its apertures ought to be directed towards the north; it must be at a distance from the street, highways, workshops, sewers, necessaries, &c. and ought to be arched at the top.

VII. Maladies of Wine, and the Means of preventing or correcting them.

There are some wines which improve by age, and which cannot be considered as perfect till a long time after they have been made. Luscious wines are of this kind, as well as all highly spiritous wines; but delicate wines are so apt to turn *sour*, or *oily*, that it is only by means of great precaution they can be preserved for several years.

The first of the principal kinds of wine known in Burgundy, is that of Volney, near Beaune. This wine, so delicate and agreeable, will not bear the vat above 12, 16, or 18 hours, and can scarcely be kept from one vintage to another.

The second of the principal kinds of wine in Burgundy is that of Pomard: it keeps better than the former; but if kept longer than a year, it becomes oily, spoils, and assumes the colour of the peelings of onions.

In every canton the wine has a fixed and known period of duration; and it is every where known that this period must be shorter or longer according to the nature of the season, and the care employed in the process of vinification. No one is ignorant

ignorant that the wine made from grapes collected in rainy weather, or produced in fat soil, is not of long duration.

The antients, as we are informed by Galen and Athenæus, had determined the epoch of age, or the period at which the different wines ought to be drunk:—Falernum *ab annis decem ut potui idoneum, et a quindecim usque ad viginti annos:* after that period *grave est capiti et nervos offendit.* Albani *vero cum duæ sint species, hoc dulce illud acerbum, ambo a decimo quinto anno vigent.* Surrentinum *vigesimo quinto anno incipit esse utile, quia est pingue et vix digeritur, ac veterascens solum fit potui idoneum.* Tiburtinum *leve est, facile vaporat, viget ab annis decem.* Lubicanum *pingue et inter albanum et falernum putatur usui ab annis decem idoneum.* Gauranum *rarum invenitur, at optimum est et robustum.* Signimum *ab annis sex potui utile.*

The care employed in drawing off wine, and mixing it with *mute* wine, contributes greatly to its preservation. Few kinds are shipped without this precaution. It is of importance then, for the prevention of all its alterations, that all these operations should be multiplied and repeated; and it is to this valuable practice we are indebted for the power of being able to send wine to all climates, and to subject it to all temperatures, without fear of decomposition.

Among the diseases to which wines are most subject, *oiliness* and *acidity* are the most common and most dangerous.

Oiliness is an alteration which wines often contract: they lose their natural fluidity, and become ropy, like oil.

The less spiritous wines turn oily; and weak wines, which have fermented very little, are the most disposed to this malady. Weak wines, made from grapes which have been picked, are also subject to it.

Wine turns oily in the best corked bottles. Of this there are too frequent instances in Champagne, where the wine of a whole vintage, when put into glass vessels, is exposed sometimes to this alteration.

Oily wines furnish by distillation but a little fat coloured and oily spirit.

This fault may be corrected several ways.

1st, By exposing the bottles to the air, and, above all, in a well-aired barn.

2d, By shaking the bottle for a quarter of an hour; then uncorking it, and suffering the gas and foam to escape.

3d, By mixing the wine with fish-glue and whites of eggs mixed together.

4th, By introducing into each bottle one or two drops of lemon juice, or any other acid.

From the nature of the causes which produce oiliness in wines, the phænomena exhibited by that malady, and the means employed to cure it, it is evident that this alteration arises from the extractive principle, which has not been sufficiently decomposed.

We find a similar effect in beer, in the decoction of gall-nuts, and in several other cases where the extractive matter, being very abundant, is precipitated from the liquor which held it in solution; and acquires the characters of fibrine matter, unless burned by a fermentation or precipitated by an acid.

Acescence of wine is however the most common malady, and, we may even say, the most natural, for it is almost a consequence of spiritous fermentation; but by knowing the causes which produce it, and the phænomena which accompany or announce it, means may be taken to prevent it. The antients admitted three principal causes of the acidity of wines:—1st, The humidity of the wine: 2d, The inconstancy or variations of the atmosphere: 3d, Commotions.

To know this malady exactly, we must call to mind some principles which can alone furnish us with light on this subject.

1st, Wine never turns sour until the spiritous fermentation is terminated; or, in other words, till the saccharine principle is completely decomposed. Hence the advantage of putting wine into casks before all the saccharine principle has disappeared; because the spiritous fermentation then continues, is prolonged, and removes every thing that can pave the way for acetous decomposition. Hence the practice of putting a little sugar into the bottle to preserve the wine without alteration; and hence the very general method of baking a part of the must at a slow and moderate heat, and of mixing some of it in the casks intended for embarkation. In some places of Spain and Italy all the must is baked; and Bellon says that the wines of Crete would not keep at sea unless the precaution were taken to boil them.

2d, The least spiritous wines are those which soonest become sour. We know, by experience, that when the season is rainy, if the grapes be little saccharine, which consequently give little alcohol, the wines readily turn sour. The weak wines of the north become sour with great ease; while the strong, generous, spiritous wines obstinately resist acidity.

It is however no less true, that the most spiritous wines furnish the strongest vinegar, though their acetification is more difficult, because alcohol is necessary to the formation of vinegar.

3d, Wine

3d, Wine perfectly free from all extractive matter, either in consequence of its being deposited naturally by time or by clarification, is not susceptible of turning sour. I have exposed old wine in uncorked bottles to the ardour of the sun of July and August for more than forty days without the wine losing its quality; only the colouring principle was constantly precipitated under the form of a membrane, which covered the bottom of the bottle. The same wine in which I infused vine-leaves, became sour in a few days. It is known that old wines, well purified, do not turn sour.

4th, Wine does not acidify, or become sour, but when in contact with the air: atmospheric air mixed with wine is a real leaven of acidity. When wine grows flat (*se pousse*) it suffers to escape, or exhales, the gas it contains, and the external air then enters to assume its place. Rozier proposes to adapt a bladder to a pipe inserted in the vessel, in order to ascertain the absorption of the air and the disengagement of the gas. When the bladder fills, the wine tends to flatten; if it empties itself, it is a sign of its turning sour.

When wine flattens, the cask suffers the wine to ooze through the sides, and if a hole be made with a gimblet, the wine escapes with a hissing noise and foam: on the other hand, when wine turns sour, the sides of the cask, the bung, and the luting, are dry, and the air rushes in with violence as soon as it is unstopped.

From this circumstance it may be concluded that wine shut up in very close vessels is not susceptible of becoming sour.

5th, There are certain times of the year when the wine turns more readily sour. These periods are, the moment when the sap rises in the vine, when it flowers, or when the grapes assume a reddish tint. It is during these periods, in particular, that precautions must be taken to prevent its becoming acid.

6th, Change in the temperature also promotes acidity, especially when the heat rises to 80 or 90 degrees. The degeneration is then rapid, and almost unavoidable.

The acidity of wine may be easily prevented by removing all those causes before mentioned which tend to produce this alteration; and when it has begun, it may be remedied by the means, more or less effectual, which we are going to mention.

Baked must, honey, or liquorice, are dissolved in wine in which acidity has manifested itself: by these means its sour taste is corrected, being concealed by the sweetish savour of these ingredients.

The

The little acid which has been formed may be feized by the means of afhes, alkalies, chalk, lime, and even litharge. This laft fubftance, which forms a very fweet falt with acetous acid, is exceedingly dangerous. This criminal adulteration may be eafily detected by pouring hydro-fulphuret of potafh (liver of fulphur) into the wine. There will be immediately formed an abundant and black precipitate. Sulphurated hydrogen gas may alfo be made to pafs through this altered liquor: this will produce a blackifh precipitate, which is nothing but fulphuret of lead.

The works of oinologifts abound with recipes, of greater or lefs value, for correcting the acidity of wine.

Bidet fays, that about a fiftieth of fkimmed milk added to four wine reftores it; and that it may be drawn off in five days.

Others take four ounces of the beft wheat, boil it in water till it burfts; and, when it has cooled, put it into a fmall bag which is immerfed in the cafk, fhaking it with a ftick.

Some recommend alfo the feeds of leeks, fennel, &c.

To fhow the futility of the greater part of thefe remedies, it will be fufficient to obferve, that it is impoffible to make fermentation proceed in a retrograde manner, and that it can at moft be fufpended; that the whole of the acid then formed may be feized, or its exiftence may be concealed, by fweet and faccharine principles.

But befides thefe alterations there are others, which, though lefs common and dangerous deferve to be noticed. Wine fometimes contracts what is called a tafte of the cafk. This malady may arife from two caufes: firft, when the wine is put into cafks, the wood of which is rotten or damaged; fecondly, when lees have been left to dry in the cafks into which new wine is put. Willermoz propofes lime water, carbonic acid, and oxygenated muriatic acid, to correct the bad tafte arifing from the cafk: others recommend mixing the wine with ifinglafs, drawing it carefully off, and infufing roafted wheat in it for two or three days.

A phænomenon, which has ftruck and embarraffed the numerous authors who have fpoken of the difeafes of wine, is what is called the *flowers of wine*. Thefe are formed in cafks, but particularly in bottles, in which they occupy the neck; they conftantly announce and precede the acid degeneration of wine. They manifeft themfelves in almoft all fermented liquors, and always more or lefs abundantly according to the quantity of extractive matter exifting in the liquor. I have feen them formed in fuch abundance, in a fermented mixture of molaffes and the yeaft of beer, that they

they precipitated themſelves in the liquor in pellicles, or numerous and ſucceſſive ſtrata. In this manner, I have obtained twenty ſtrata.

Theſe flowers, which I at firſt took for a precipitate of tartar, is, in my opinion, a vegetation, or real *byſſus*, which belongs to that fermented ſubſtance. It is reduced almoſt to nothing by deſiccation, and by analyſis exhibits only a little hydrogen and a great deal of carbon.

All theſe rudiments or commencements of vegetation, which develop themſelves in all caſes where an organic matter is decompoſed, ought not, in my opinion, to be claſſed with perfect plants: they are not ſuſceptible of reproduction, and are only a ſymmetric arrangement of the moleculæ of the matter, which ſeems rather directed by the ſimple laws of affinity than thoſe of life. Similar phænomena are obſerved in all decompoſitions of organic beings.

In the years 1791 and 1792, the whole product of the vintage was altered at the commencement by an acrid, nauſeous odour, which went off after a long-continued fermentation. This effect was owing to an enormous quantity of tree-bugs, (*punaiſes de bois*,) which had ſettled on the grapes, and which had been cruſhed in treading them.

VIII. Uſes and Virtues of Wine.

Wine has become the moſt uſual beverage of man, and is, at the ſame time, the moſt varied. Wine is known in all climates; and the attraction of this liquor is ſo ſtrong, that the prohibitory law reſpecting it, which Mahomet impoſed on his followers, is daily broken.

This liquor, beſides being a tonic and ſtrengthener, is alſo more or leſs nutritive: in every point of view, it muſt be ſalutary. The antients aſcribed to it the property of ſtrengthening the underſtanding. Plato, Æſchylus, and Solomon, all agree in aſcribing to it this virtue. But no writer has better deſcribed the real properties of wine than the celebrated Galen, who aſſigns to each ſort its peculiar uſes, and deſcribes the difference they acquire by age, climate, &c.

Exceſs in regard to the uſe of wine has at all times called forth the cenſure of legiſlators. It was cuſtomary among the Greeks to prevent intoxication by rubbing their temples and forehead with precious ointments and tonics. The anecdote of that famous legiſlator, who, to reſtrain the intemperance of the people, authorized it by an expreſs law, is well known; and we read that Lycurgus cauſed drunken people to be publicly exhibited, in order to excite a horror of intoxication in the

Lacedæmonian youth. By a law of Carthage, the uſe of wine was prohibited in the time of war. Plato interdicted it to young perſons below the age of twenty-two. Ariſtotle did the ſame to children and nurſes. And we are informed by Palmarius that the laws of Rome allowed to prieſts, or thoſe employed in the ſacrifices, but three ſmall glaſſes of wine at their repaſts.

But, notwithſtanding the wiſdom of laws, the hideous picture of intemperance, and the fatal conſequences with which it is attended, the attractions of wine have been ſo powerful among certain nations, that their fondneſs for it has degenerated into a paſſion and real want. We daily ſee men, prudent in other reſpects, gradually acquire the habit of indulging immoderately in the uſe of this liquor; and in their wine extinguiſh their moral faculties and their phyſical ſtrength.

Narratur et priſci Catonis,
Sæpe mero incaluiſſe virtus.

We learn from hiſtory, that Wenceſlas, king of Bohemia and of the Romans, having come to France to negotiate a treaty with Charles VI. repaired to Rheims in the month of May 1397, where he got intoxicated every day with the wine of the country, chooſing rather to forego every thing than not indulge in this exceſs *.

The virtue of wine differs according to its age. New wine is flatulent, indigeſtible, and purgative: *muſtum flatuoſum et concoctu difficile. Unum in ſe bonum continet, quod alvum emolliat. Vinum rarum infrigidat;—muſtum craſſi ſucci eſt, et frigidi.*

The antients confounded theſe words—*muſtum et novum vinum.* Ovid ſays, *Qui nova muſta bibant. Unde virgo muſta dicta eſt pro intacta et novella.*

Light wines only can be drunk before they have grown old. The reaſon we have mentioned in the preceding pages. The Romans, as we have obſerved, followed this cuſtom, and drank their wines in ſucceſſion: *Vinum Gauranum et Albanum, et quæ in Sabinis et in Tuſcis naſcuntur, et Amienum quod circa Neapolim vicinis collibus gignitur.*

New wines are not at all nouriſhing, eſpecially thoſe which are aqueous, and little ſaccharine: *corpori alimentum ſubgerunt pauciſſimum*, ſays Galen.

Theſe wines readily produce intoxication; and the reaſon of this is, the quantity of carbonic acid with which they are charged. This acid, by diſengaging itſelf from the liquor

* Obſervations ſur l'Agriculture, vol. ii. p. 192.

by

by the temperature of the ſtomach, extinguiſhes the irritability of the organs, and brings on ſtupor.

Old wines, in general, are tonic, and very wholeſome: they are ſuited to weak ſtomachs, old people, and in all caſes where ſtrengthening is neceſſary: they afford very little nouriſhment, becauſe they are deprived of their really nouriſhing principles, and contain ſcarcely any other than alcohol.

It is of ſuch wine that the poet ſpeaks, when he ſays:

> ——————— Generoſum et lene requiro
> Quod curas abigat, quod cum ſpe divite manet
> In venas animumque meum, quod verba miniſtret,
> Quod me, Lucane, juvenem commendet amicæ.

Oily thick wines are the moſt nouriſhing. *Pinguia ſanguinem augent et nutriunt*;—Galen. The ſame author recommends the wines of Therea and Scibellia as highly nouriſhing: *quod craſſum utrumque, nigrum et dulce.*

Wines differ alſo eſſentially in regard to colour. Red, in general, is more ſpiritous, lighter, and more digeſtible: white wine furniſhes leſs alcohol, and is more diuretic and weaker, as it has remained leſs time in the vat: it is almoſt always more oily, more nutritive, and more gaſeous, than the red.

Pliny admits four ſhades in the colour of wines—*album, fulvum, ſanguineum, rubrum:* but it would be too minute as well as uſeleſs to multiply ſhades, which might become infinite, by extending them from black to white.

Climate, culture, and variety in the proceſſes of fermentation, produce alſo infinite differences in the qualities and virtues of wine. To avoid fatiguing repetitions, we muſt refer to what we have already ſaid on this ſubject.

The art of tempering wine by the addition of one part of water was practiſed among the antients: wine of this kind they called *vinum dilutum.* Pliny, after Homer, ſpeaks of a wine which could bear twenty parts of water. The ſame hiſtorian informs us, that in his time wines ſo ſpiritous were known, that they could not be drunk: *niſi pervincerentur aqua et attenuentur aqua calida.*

The antients, who had very juſt and correct ideas reſpecting the art of making and preſerving wines, ſeem to have been unacquainted with that of diſtilling ſpirit from them: the firſt correct ideas reſpecting the diſtillation of wine are aſcribed to Arnaud de Villeneuve, profeſſor of medicine at Montpellier.

The diſtillation of wines has given a new value to this production. It has not only furniſhed a new beverage, ſtronger

ſtronger and incorruptible, but has made known to the arts the real ſolvent of reſins and of aromatic principles, and, at the ſame time, a mean as ſimple as certain for preſerving animal and vegetable ſubſtances from all putrid decompoſition. It is on theſe remarkable properties that the art of the varniſher, the perfumer, the maker of liqueurs, and others founded on the ſame baſis, have been ſucceſſively eſtabliſhed.

XXXIII. *Deſcription of the Table and the Paarlberg Mountains, in Southern Africa.* *By* JOHN BARROW, *Eſq.**

THE firſt appearance of ſo ſtupendous a maſs of naked rock as the Table Mountain, cannot fail to arreſt, for a time, the attention of the moſt indifferent obſerver of nature from all inferior objects, and moſt particularly intereſt that of the mineralogiſt. As a deſcription of this mountain will, with few variations, anſwer to that of almoſt all the great ranges in Southern Africa, it may not, perhaps, be thought too tedious to enter into a detail of its form, dimenſions, and conſtituent parts.

The name of *table land* is given by ſeamen to every hill or mountain whoſe ſummit preſents to the eye of the obſerver a line parallel to the horizon. The north front of the Table Mountain, directly facing the town, is a horizontal line, or very nearly ſo, of about two miles in length. The bold face, that riſes almoſt at right angles to meet this line, is ſupported, as it were, by a number of projecting buttreſſes that riſe out of the plain, and fall in with the front a little higher than midway from the baſe. Theſe and the diviſion of the front, by two great chaſms, into three parts, a curtain flanked by two baſtions, the firſt retiring and the others projecting, give to it the appearance of the ruined walls of ſome gigantic fortreſs. Theſe walls riſe above the level of Table Bay to the height of 3582 feet, as determined by captain Bridges, of the royal engineers, from a meaſured baſe and angles taken with a good theodolite. The eaſt ſide, which runs off at right angles to the front, is ſtill bolder, and has one point higher by ſeveral feet. The weſt ſide, along the ſea ſhore, is rent into deep chaſms, and worn away into a number of pointed maſſes. In advancing to the ſouthward about four miles, the mountain deſcends in ſteps or terraces, the loweſt of which communicates by gorges with the chain

* From *Barrow's Travels into Southern Africa*, a work highly worthy of the attention of every perſon fond of natural hiſtory.

that

that extends the whole length of the peninſula. The two wings of the front, one of the Devil's Mountain, and the other the Lion's Head, make, in fact, with the Table, but one mountain. The depredations of time and the force of torrents, having carried away the looſer and leſs compact parts, have diſunited their ſummits, but they are ſtill joined at a very conſiderable elevation above the common baſe. The height of the firſt is 3315, and of the latter 2160 feet. The Devil's Mountain is broken into irregular points; but the upper part of the Lion's Head is a ſolid maſs of ſtone, rounded and faſhioned like a work of art, and reſembling very much, from ſome points of view, the dome of Saint Paul's placed upon a high cone-ſhaped hill. Theſe three mountains are compoſed of a multitude of rocky ſtrata, piled on each other in large tabular maſſes. Their exact horizontal poſition denotes the origin of the maſs to be neptunian, and not volcanic; and that, ſince its firſt formation, no convulſion of the earth has happened in this part of Africa ſufficient to have diſturbed the nice arrangement of its parts. The ſtrata of theſe poſtdiluvian ruins not being placed in the order of their ſpecific gravity, might lead to the concluſion that they were depoſited in ſucceſſive periods of time, were it not for the circumſtance of their lying cloſe upon each other, without any intermediate veins of earthy or other extraneous materials. The ſtratification of the Cape peninſula, and, indeed, of the whole colony, is arranged in the following order:

The ſhores of Table Bay, and the ſubſtratum of the plain on which the town is built, compoſe a bed of a blue compact ſchiſtus, generally placed in parallel ridges in the direction of north-weſt and ſouth-eaſt, but frequently interrupted by large maſſes of a hard flinty rock of the ſame colour, belonging to that claſs of aggregated ſtones propoſed by Mr. Kirwan to be called *granitelles*. Fine blue flags, with whitiſh ſtreaks, are procured from Robben Iſland, in the mouth of Table Bay, which are uſed for ſteps, and for paving the terraces in front of moſt of the houſes.

Upon the ſchiſtus lies a body of ſtrong clay coloured with iron from a pale yellow to deep red, and abounding with brown foliated mica. Imbedded in the clay are immenſe blocks of granite, ſo looſely cemented together, that the conſtituent parts are eaſily ſeparated by the hand. The mica, the ſand, and indeed the whole bed of clay, ſeem to have been formed from the decompoſition of the granite. Between the Lion's Head and the ſea, are vaſt maſſes of theſe aggregated ſtones entirely expoſed. Moſt of them are rent, and falling aſunder from their own weight; others are com

pletely

pletely hollowed out, so as to be nothing more than a crust or shell; and they have almost invariably a small aperture on that side of the stone which faces the bottom of the hill or the sea shore. Such excavated blocks of coarse granite are very common on the hills of Africa, and are frequently inhabited by runaway slaves.

Resting on the granite and clay is the first horizontal stratum of the Table Mountain, commencing at about five hundred feet above the level of the sea. It is siliceous sand-stone of a dirty yellow colour. Above this is a deep brown sand-stone, containing calciform ores of iron, and veins of hematite, running through the solid rock. Upon this rests a mass, of about a thousand feet in height, of a whitish-gray shining granular quartz, mouldering away in many places by exposure to the weather, and in others passing into sand-stone. The summit of the mountain has entirely undergone the transition into sand-stone; and the skeletons of the rocks, that have hitherto resisted the ravages of time, are surrounded by myriads of oval-shaped and rounded pebbles of semi-transparent quartz that were once imbedded in them. Those pebbles, having acquired their rounded form by friction, when the matrix, in which they are still found buried, had not assumed the form and consistence of stone; and the situation of this stratified matrix on blocks of primæval granite, clearly point out a grand revolution to have taken place on the surface of the globe we inhabit. No organized remains, however, of the old world, such as shells buried in the rock, petrifactions of fishes, or impressions of plants, appear on the sides of the Table Mountain, as has been asserted.

To those whom mere curiosity, or the more laudable desire of acquiring information, may tempt to make a visit to the summit of the Table Mountain, the best and readiest access will be found directly up the face next to the town. The ascent lies through a deep chasm, that divides the curtain from the left bastion. The length of this ravine is about three-fourths of a mile, the perpendicular cheeks at the foot more than a thousand feet high, and the angle of ascent about forty-five degrees. The entrance into this deep chasm is grand and awful. The two sides, distant at the lower part about eighty yards from each other, converge within a few feet at the portal, which opens upon the summit, forming two lines of natural perspective. On passing this portal, a plain of very considerable extent spreads out, exhibiting a dreary waste and an insipid tameness, after quitting the bold and romantic scenery of the chasm. And the adventurer may perhaps feel strongly disposed to ask himself, if such be all the

the gratification he is to receive for having undergone ſo great a fatigue in the aſcent. The mind, however, will ſoon be relieved at the recollection of the great command given by the elevation; and the eye, leaving the immediate ſcenery, will wander with delight round the whole circumference of the horizon. On approaching the verge of the mountain—

"How fearful
And dizzy 'tis to caſt one's eyes ſo low!
The fiſhermen that walk upon the beach
Appear like mice; and yon tall anchoring bark
Diminiſhed to her cock. - - - - -
- - - - - - - - - The murmuring ſurge,
That on the unnumbered idle pebbles chafes,
Cannot be heard ſo high."

All the objects on the plain below are, in fact, dwindled away to the eye of the ſpectator into littleneſs and inſignificance. The flat-roofed houſes of Cape Town, diſpoſed into formal clumps, appear like thoſe paper fabrics which children are accuſtomed to make with cards. The ſhrubbery on the ſandy iſthmus looks like dots; and the farms and their incloſures as ſo many lines, and the more finiſhed parts of a plan drawn on paper.

On the ſwampy parts of the flat ſummit, between the maſſes of rock, are growing ſeveral ſorts of handſome ſhrubs. The *cenæa mucronata*, a tall, elegant, fruteſcent plant, is peculiar to this ſituation; as is alſo that ſpecies of heath called the *phyſodes*, which, with its cluſters of white flowers, glazed with a glutinous coating, exhibits in the ſunſhine a very beautiful appearance. Many other heaths, common alſo on the plains, ſeemed to thrive equally well on this elevated ſituation as in a milder temperature. The air on the ſummit, in the clear weather of winter, and in the ſhade, is generally about fifteen degrees of Fahrenheit's ſcale lower than in Cape Town*. In the ſummer ſeaſon the difference is much greater, when that well known appearance of the fleecy cloud, not inaptly called the *tablecloth*, envelops the ſummit of the mountain.

A ſingle glance at the topography of the Cape and the adjacent country, will be ſufficient to explain the cauſe of this phænomenon, which has ſo much the appearance of ſingularity. The mountainous peninſula is connected with a ſtill more mountainous continent, on which the great ranges run parallel to, and at no great diſtance from, the ſea coaſt.

* The general ſtandard of the three winter months at Cape Town may be reckoned at 50° at ſunriſe to 60° at noon. In the middle of ſummer it varies from 70° to 90°, but reſts for days together at 83° or 84°.

coaſt. In the heat of the ſummer ſeaſon, when the ſouth-eaſt monſoon blows ſtrong at ſea, the water taken up by evaporation is borne in the air to the continental mountains, where, being condenſed, it reſts on their ſummits in the form of a thick cloud. This cloud, and a low denſe bank of fog on the ſea, are the precurſors of a ſimilar but lighter fleece on the Table Mountain, and of a ſtrong gale of wind in Cape Town from the ſouth-eaſt. Theſe effects may be thus accounted for:—The condenſed air on the ſummit of the mountains of the continent, ruſhes, by its ſuperior gravity, towards the more rarefied atmoſphere over the iſthmus, and the vapour it contains is there taken up and held inviſible, or in tranſparent ſolution. From hence it is carried by the ſouth-eaſt wind towards the Table and its neighbouring mountains, where, by condenſation from decreaſed temperature and concuſſion, the air is no longer capable of holding the vapour with which it was loaded, but is obliged to let it go. The atmoſphere on the ſummit of the mountain becomes turbid, the cloud is ſhortly formed, and, hurried by the wind over the verge of the precipice in large fleecy volumes, rolls down the ſteep ſides towards the plain, threatening momentarily to deluge the town. No ſooner, however, does it arrive, in its deſcent, at the point of temperature equal to that of the atmoſphere in which it has floated over the iſthmus, than it is once more taken up, and "vaniſhes into air—to thin air." Every other part of the hemiſphere ſhows a clear blue ſky, undiſturbed by a ſingle vapour.

The Paarlberg, on the left of the paſs into the valley, is a hill of moderate height, and has taken its name from a chain of large round ſtones that paſs over the ſummit like the pearls of a necklace. Of theſe, the two that are placed near the central and higheſt point of the range are called, *par excellence*, the Pearl and the Diamond; and a particular deſcription of them has been thought worthy of a place in the Philoſophical Tranſactions. From that paper, and Mr. Maſſon's deſcription, it would appear that theſe two maſſes of ſtone reſted upon their own baſes, and were detached from the mountain; whereas they grow out, and form a part of it. It has alſo been ſaid that their compoſition was totally different from the rocks that are found in the neighbouring mountain, which led a naturaliſt in Europe to obſerve, that theſe immenſe blocks of granite had probably been thrown up by volcanic exploſions, or by ſome cauſe of a ſimilar nature. It has been obſerved in the preceding pages, that the ſandſtone ſtrata of the Table Mountain reſted upon a bed of primæval granite, and that an infinite number of large ſtones

were

were ſcattered at the feet of the mountains along the ſea coaſt, from the Lion's Head to the true Cape of Good Hope. All theſe are preciſely of the ſame nature and the ſame materials as the Pearl and the Diamond; that is to ſay, they are aggregates of quartz and mica; the firſt in large irregular maſſes, and the latter in black lumps reſembling ſhorl: they contain alſo cubic pieces of feltſpar, and ſeem to be bound together by plates of a clayey iron-ſtone. All the ſtones of this deſcription appear to have been formed round a nucleus, as by the action of the air and weather they fall to pieces in large concentric laminæ. The Pearl is acceſſible on the northern ſide, but is nearly perpendicular on all the reſt. This ſloping ſide is more than a thouſand feet, and the perpendicular altitude about four hundred feet, above the ſummit of the mountain; and the circumference of its baſe is a full mile. Near the top it is quadriſected by two clifts, croſſing at right angles, in which were growing a number of beautiful aloes, ſeveral cryptogamous and other plants. A great part of the ſlanting ſide was covered with a ſpecies of green lichen. Down the perpendicular ſides were immenſe rifts, as if the maſs had been torn aſunder by its own weight. The Diamond is the higher block, but leſs bulky, and, being cone-ſhaped, is difficult and dangerous to aſcend.

XXXIV. *Obſervations on the Means of enabling a Cottager to keep a Cow by the Produce of a ſmall Portion of Arable Land. By Sir* JOHN SINCLAIR, *Bart. M.P.**

IN ſeveral parts of the kingdom, as in Lincolnſhire, Rutlandſhire, &c., which are calculated for grazing, it is not unuſual to give induſtrious cottagers as much land as will enable them to keep a cow, and ſometimes two, or more, beſides other ſtock; and it appears from the communications of Lord Winchelſea and others to the Board of Agriculture, from the publications of the Society for bettering the Condition of the Poor, and from a late intereſting work printed by Mr. Arthur Young †, that ſuch a ſyſtem is productive of the happieſt conſequences. It is ſuppoſed, however, to be totally inapplicable to an arable diſtrict. I truſt that ſuch an opinion will not be admitted without full conſideration.

* Drawn up for the conſideration of the Board of Agriculture and Internal Improvement.

† Intitled "An Inquiry into the Propriety of applying Waſtes to the better Maintenance and Support of the Poor."

 Indeed,

Indeed, ſo far as I can judge, this advantageous ſyſtem is to the full as well adapted for the one diſtrict as for the other. It requires unqueſtionably more labour on the part of the cottager, and of his family; at the ſame time, the occupation of ſo great an extent of ground is not ſo neceſſary in arable as in grazing countries; a circumſtance, in various reſpects, extremely material.

In arranging the following plan, (which the reader will pleaſe to conſider merely as furniſhing an outline, to be perfected by further diſcuſſion and experiment,) it is propoſed to keep in view the following principles:

1. That the cottager ſhall raiſe, by his own labour, ſome of the moſt material articles of ſubſiſtence for himſelf and his family.

2. That he ſhall be enabled to ſupply the adjoining markets with the ſmaller agricultural productions. And,

3. That both he and his family ſhall have it in their power to aſſiſt the neighbouring farmers, at all ſeaſons of the year, almoſt equally as well as if they had no land in their occupation.

It can hardly be queſtioned, that if it were practicable to have a number of cottagers of that deſcription in every pariſh, it would promote, in various reſpects, the intereſts of the public.

I. Extent of Land neceſſary.

Unleſs the experiment were fairly tried, it is impoſſible to ſtate exactly the extent of arable land requiſite to enable a cottager to raiſe the articles generally neceſſary for the ſuſtenance of himſelf and family; and to keep a cow, ſome pigs, and poultry. Much muſt depend on the natural richneſs of the ſoil; (though, under the management about to be propoſed, almoſt any ſoil would, in time, become fertile;) on the nature of the climate; on the ſize of the cow; on the induſtry of the cottager; on the age and number of his family, &c. But I ſhould imagine that three ſtatute acres and a quarter of good arable land, worth from 20*s.* to 30*s.* per acre, would be ſufficient. It is propoſed that the three acres ſhall be under a regular courſe of cropping. The quarter of an acre ought, if poſſible, to be converted into an orchard; where the cow might occaſionally paſture, and where a pond ought to be kept in good order, that it may have plenty of water at command. Were the land of a quality fit for lucerne, perhaps two acres and a quarter might be ſufficient.

II. *Stock*

II. Stock and Inſtruments of Huſbandry.

It is evident that ſo ſmall an extent of land as either two or three acres, under cultivation, excludes all idea of ploughing *; and, indeed, unleſs the cottager ſhall manage the whole in the ſimpleſt and cheapeſt manner, there is an end to the whole ſyſtem. It would require, indeed, four or five acres to keep a ſingle horſe, and the expenſe of purchaſing horſes, or even oxen, ploughs, and other inſtruments of huſbandry, muſt be far beyond the abilities of a cottager; whereas with a ſpade, a hoe, a rake, a ſcythe, a ſickle, and a flail, which are all the inſtruments really neceſſary, he is perfectly competent to the management of his little farm.

III. Courſe of Crops, &c.

The three acres propoſed to be cultivated ſhould be divided into four portions, each conſiſting of three roods, under the following ſyſtem of management:

	Roods.
Under potatoes two roods, under turnips one †	3
Under winter tares two roods, ſpring tares one	3
Under barley, wheat, or oats - -	3
Under clover, with a mixture of rye graſs ‡	3
Total	12 Roods.

Other articles beſides theſe might be mentioned, but it ſeems to me of peculiar importance to reſtrict the attention of the cottager to as few objects of cultivation as poſſible.

It is propoſed that the produce of the two roods of potatoes ſhall go to the maintenance of the cottager and his family §; and that the rood of turnips ſhould be given to the cow in winter and during the ſpring, in addition to its other fare.

The ſecond portion, ſown with tares, (the two roods of potatoes of the former year to be ſucceſſively ſown with winter tares, and the turnip rood with ſpring tares,) might partly be cut green, for feeding the cow in ſummer and autumn; but, if the ſeaſon will permit, the whole ought to be

* Ploughs might, perhaps, be hired; but, on the whole, the ſpade culture is infinitely preferable, and I would much rather ſee a cottager hire perſons to trench than to plough for him.

† I would alſo recommend a ſmall quantity of flax, where the culture and management of the plant was known, to employ the females, particularly in winter, and to ſupply the family with linen.

‡ Some recommend the proportion per acre to be at the rate of one buſhel of rye graſs to 12 lbs. of red clover; others, 14 lbs. of red clover to half a buſhel of rye graſs.

§ By Sir John Methuen Poore's experiments it was found that half a rood, or one-eighth of an acre, produced, for ſeveral years, as great a weight of potatoes as was ſufficient for a family of four perſons. Four acres anſwered for 131 perſons.

made into hay for the winter and ſpring feed, and three roods of clover cut green for ſummer food.

The third portion may be ſown either with barley, wheat, or oats, according to the ſoil or climate, and the general cuſtom of the country. The ſtraw of any of theſe crops would be of eſſential ſervice for littering the cow, but would be ſtill more uſeful, if cut into chaff, for feeding it.

The fourth portion, appropriated to clover and rye graſs, to be cut green, which, with the aſſiſtance of the orchard, will produce, on three roods of land, as much food as will maintain a cow and her calf for five months, namely, from the end of May, or beginning of June, when it may be firſt cut, to the firſt of November, beſides ſome food for the pigs. It is ſuppoſed that an acre of clover and rye graſs, cut green, will produce 20,000 lbs. weight of food for cattle. Three roods, therefore, ought to yield 15,000 lbs. weight. A large cow requires 110 lbs. weight of green food per day; a middling ſized cow, ſuch as a cottager is likely to purchaſe, not above 90 lbs.; conſequently, in five months, allowing 1320 lbs. weight for the calf and the pigs, there will remain 13,680 lbs. for the cow *. Were there, however, even a ſmall deficiency, it would be more than compenſated by the rood of land propoſed to be kept in perpetual paſture as an orchard.

IV. Mode in which the Family may be maintained.

It is calculated that three roods and eight perches of potatoes will maintain a family of ſix perſons for about nine months in the year; but, according to the preceding plan, it is propoſed to have but two roods under that article; for however valuable potatoes are juſtly accounted, yet ſome change of food would be acceptable, and the cottager will be enabled, from the produce of the cow, and by the income derived from his own labour, and from that of his family, to purchaſe other wholeſome articles of proviſion.

V. Manner in which the Stock may be kept.

It appears from the preceding ſyſtem of cropping, that ten roods of land, or two acres and a half, are appropriated to the raiſing of food for the cow in ſummer and winter, beſides the paſture of the orchard; and unleſs the ſeaſon ſhould be extremely unfavourable, the produce will be found not only adequate to that purpoſe, but alſo to maintain the calf for ſome time, till it can be ſold to advantage. It is indeed extremely material, under the propoſed ſyſtem, to make as

* Theſe calculations are merely given as data for experiment. It muſt depend upon the ſeaſon, whether the tares or the clover ſhould be made into hay.

much

much profit of the calves as poſſible, as the money thus raiſed will be a reſource, enabling the cottager to replace his cow when a new one muſt be purchaſed.

For the winter proviſion of the cow, which is the moſt material, becauſe ſummer food can be more eaſily procured, there is the produce,

1. Of about three roods of tares made into hay.

2. Of three roods of ſtraw, deducting what may be neceſſary for litter; and if dry earth be put in the cow's hovel, and removed from time to time to the dunghill, little or no litter will be neceſſary.

3. Of one rood of turnips.

The whole will be ſufficient for ſeven months in the year, namely, from the 1ſt November to the 1ſt June; and during the remaining five months, the paſture of the orchard, ſome of the winter tares, and the produce of three roods of clover and rye graſs, will not only ſuffice, but will furniſh a ſurplus for the calf, if it is kept for any length of time *, and ſome clover for the pigs.

The inferior barley, potatoes, &c. will of courſe be given to the pigs and the poultry.

VI. *Value of the Produce.*

The land thus managed will certainly produce, by means of the extra induſtry of the family, and at a ſmall expenſe, a moſt important addition to the income which the cottager may derive from his ordinary labour. For inſtance:

	per Ann.		
1. The orchard (after the trees become fruitful) will probably yield - -	£. 1	10	0
2. Three roods of turnips and potatoes -	4	0	0
3. Eighteen buſhels of barley, at 4*s*. -	3	12	0
4. The cow and calf † - - -	7	0	0
5. Hogs - - - -	3	0	0
6. Poultry and eggs - - -	2	0	0
Total	£. 21	2	0

Where

* In a pamphlet juſt publiſhed by Richardſon, Cornhill, on the Culture of Potatoes, price 1*s*. the following mode of applying the refuſe potatoes to the feeding of calves is ſtrongly recommended:

" Take two gallons of ſmall potatoes, waſh them clean, put them into a pot of boiling water ſufficient to cover them, and let them boil till the whole becomes a pulp: then add more water, and run the whole through a hair ſieve, which will produce a ſtrong nutritive gruel. At firſt uſe a very ſmall quantity, warmed up with milk, to make it palatable to the calf, and increaſe the quantity daily, till it becomes equal. A quart of potatoe gruel, and a quart of ſcald or ſkimmed milk, will be ſufficient for a good meal, which ſhould be given warm three times a day."

† According to Mr. Kent's calculations, a cow ſhould produce ſix quarts of

Where wheat can be raifed inftead of barley, the profit would be ftill more confiderable. Opinions will differ much regarding the value put on each article; but that is of little confequence, as the total cannot be accounted too high.

VII. Time required for cultivating the Land.

The quantity of land intended to be cultivated, will not materially interfere with the ufual labour of the cottager. It will only require to be dug once, and is then fit to be cropped. It is propofed that only nine roods fhall be annually cultivated, (the remaining three roods being under clover and rye grafs,) and nine roods may be dug in the fpace of about 558 hours, or at the rate of 62 hours per rood. This might be done at bye hours, (more efpecially when the family of the cottager fhall be fomewhat advanced, and confequently more able to furnifh affiftance); but fuppofing that the digging, manuring, harvefting, &c. will require twenty entire days per annum in addition to the bye hours, and allowing fixty days for Sundays and holidays, there will remain 285 days for the ordinary hand labour of the cottager, which, at 1*s*. 6*d*. per day, would amount to £.21 7*s*. 6*d*.; the earnings of the wife and children may, at an average, be worth at leaft £.4 per annum more. This is certainly a low calculation, confidering how much may be got during the hay and corn harvefts; but even at that moderate eftimate, the total income of the family will be as follows:

1. Produce of the farm	-	-	£.21	2	0
2. Labour of the cottager	-	-	21	7	6
3. Earnings of the family	-	-	4	0	0
		Total	£.46	9	6

VIII. Buildings.

It is impoffible to calculate the expenfe of building a cottage, as fo much depends upon its fize, the place where it is fituated, the materials of which it is compofed, the price of labour in the country, and a variety of other circumftances. On this important fubject, much ufeful information is contained in the firft volume of the Communications publifhed by the Board of Agriculture. But it is proper to obferve that no expenfive additional buildings will be neceffary in confequence of the propofed fyftem. A fhed or hovel for the cow cannot occafion any very heavy charge, and a fmall

of milk per day, worth 1*d*. per quart, equal to 3*s*. 6*d*. a week, or £.9 2*s*. per annum, fetting the profit of the calf againft the lofs fuftained when the cow is dry: but it is better to be rather under than over the mark.

barn,

barn, of the ſimpleſt and cheapeſt conſtruction, may be of uſe, not only for threſhing the crop, but alſo for ſecuring the hay, and making it to more advantage, in caſe the ſeaſon ſhould prove unfavourable: if the corn is put up in ſmall ſtacks, the barn may be made of very moderate dimenſions.

IX. Rent, and Balance of Income.

The rents of cottages and of land vary ſo much in different parts of the kingdom, that it is difficult to aſcertain an average. But if the cottage ſhall be ſtated at £.3 per annum, the land at 25*s.* per acre, and the orchard at 10*s.* the whole will not exceed £.7 15*s.* The cottager will alſo be liable to the payment of ſome taxes, ſay to the amount of £.1 5*s.* more. Hence the total deductions would be about £.9, leaving a balance in favour of the cottager of £.37 9*s.* 6*d.* Conſidering the cheap rate at which he is furniſhed with a quantity of potatoes, equal to ſeveral months conſumption, and with milk for his children, ſurely, with that balance, he can find no difficulty not only in maintaining himſelf and family in a ſtyle of comfort, but alſo in placing out his children properly, and laying up a ſmall annual ſurplus, that will render any pariſh aſſiſtance, whether in ſickneſs or old age, unneceſſary; and thus he will be enabled to preſerve that manly and independent ſpirit which it ſo well becomes a Britiſh cottager to poſſeſs *.

CONCLUSION.

Advantages of the propoſed Syſtem.

I ſhall now endeavour briefly to explain ſome of the advantages, which may be looked for with confidence from the propoſed ſyſtem.

In the firſt place, the land poſſeſſed by the cottager would be completely cultivated, and rendered as productive as poſſible. The dung produced by the cow, the pigs, &c. would be amply ſufficient for the three roods under turnips and potatoes; which would afterwards produce, 1. Tares, 2. Barley, and 3. Clover; with a mixture of rye graſs, in regular ſucceſſion, without any additional manure. The barley ſhould yield at leaſt eighteen buſhels, beſides three buſhels for ſeed; and if wheat or oats are cultivated, in the ſame proportion. The milk, deducting what may be neceſſary for the calf, and for the cottager's family, might be ſold in its original ſtate, if there ſhall be a market for it, or converted into butter,

* The different expenſe of fuel in the various diſtricts will, it is evident, greatly affect the annual ſurplus.

for

for the purpofe of fupplying the neighbouring towns or villages. Such cottagers, alfo, might certainly fend to market both eggs and poultry.

2. It is hardly poffible to fuggeft a meafure more likely to promote the benefit of a numerous and valuable body of people. The fyftem of keeping cows by cottagers, which has been found fo advantageous in the grazing diftricts, may thus be extended over the whole kingdom; and, indeed, if the above plan is found to anfwer, in place of four or five acres employed in feeding a fingle cow, it would be much better, even in the grazing counties, to reftrict the land to a fmaller quantity, under a tillage mode of management; for thus not only the cow, but alfo the cottager himfelf, and his family, would, in a great meafure, be maintained by a lefs furface of foil.

3. It is of infinite confequence to eftablifh the practicability of this fyftem, as the means of removing a moft unfortunate obftacle to the improvement of the country. It is well known to be the only popular objection to the inclofure of our waftes and commons, that, while uninclofed, a number of cottagers are enabled to keep cows by the means of their common rights, and that their cows difappear when the commons are inclofed. But if fo fmall a portion of land as $3\frac{1}{4}$ acres, when improved and properly cultivated, can enable a cottager to keep a cow even to more advantage than with a right of common; which can hardly be doubted, as he is enabled to provide winter as well as fummer food, there is an end to that obftacle to improvement. Indeed, if fufficient attention be paid to the principles above detailed, the fituation of the cottager, inftead of being deteriorated, would be materially bettered by the inclofure; and his rifing family would be early accuftomed to habits of induftry, inftead of idlenefs and vice.

I fhall conclude with afking, if any one can figure to himfelf a more delightful fpectacle than to fee an induftrious cottager, his bufy wife, and healthy family, living in a comfortable houfe, rented by himfelf, cultivating their little territory with their own hands, and enjoying the profits arifing from their own labour and induftry; or whether it is poffible for a generous landholder to employ his property with more fatisfaction, or in a manner more likely to promote, not only his own, but the public intereft, than in endeavouring to increafe the number of fuch cottagers, and encouraging, by every means in his power, the exertions of fo meritorious and fo important a clafs of the community.

London, May 1801. JOHN SINCLAIR.

Plan

Plan of the propoſed Cottage Farm, pointing out the Rotation of Crops in the different Lots.

Cottage.	The Orchard, or perpetual Paſture.	Pond.
Lot A. 3 Roods. 1. Year { 2 Roods Potatoes 1 Rood Turnips	Lot B. 3 Roods. 1. Year { 2 Roods Winter Tares 1 Rood Spring Tares	
Lot C. 3 Roods. 1. Year—Barley, Wheat, or Oats.	Lot D. 3 Roods. 1. Year—Clover and Rye-graſs.	

The Rotation of Crops for Four Years.

Year.	Lot A.	Lot B.	Lot C.	Lot D.
1	Potatoes and Turnips	Winter and Spring Tares	Barley, Wheat, or Oats	Clover and Rye-graſs
2	Winter and Spring Tares	Barley, Wheat, or Oats	Clover and Rye-graſs	Potatoes and Turnips
3	Barley, Wheat, or Oats	Clover and Rye-graſs	Potatoes and Turnips	Winter and Spring Tares
4	Clover and Rye-graſs	Potatoes and Turnips	Winter and Spring Tares	Barley, Wheat, or Oats

The rotation then begins as at firſt. Lot D might continue in natural graſs the firſt ſeaſon, to diminiſh the labour of that year.

The exact period when the different crops ſhould be dug for, or ſown, cannot be aſcertained, becauſe it varies ſo much in different counties, and depends upon the ſeaſons; but, according to the above rotation, the labour of digging for the various crops is diverſified as much as poſſible, ſo as not to interfere materially with the other occupations of the cottager. At no period would it be neceſſary for him to dig more than two roods in a month; and both he and his family will labour with much more ſatisfaction and diſpatch when they work for themſelves than for another. In caſe of neceſſity, the cottager might hire ſome of his neighbours to aſſiſt him in digging, which would be much better than hiring a plough. If a cottager under this ſyſtem could not work as a common daily labourer, he might, at leaſt, anſwer as a uſeful labourer by the piece.

XXXV. *Letter from Sir* HENRY VAVASOUR, *Bart. to the Right Hon. Lord* CARRINGTON, *P.B.A. on Field Gardening Husbandry.*

THIS communication, published by the Board of Agriculture as an appendix to Sir John Sinclair's Observations, (see the preceding article,) strongly confirms the practicability of a cottager being enabled to keep a cow by the produce of arable land only.

"My Lord, London, May 20, 1801.

"I have had the honour of mentioning in conversation, to your lordship, the advantages that appeared to me in cultivating land in the Flemish manner, or what is now called, about Fulham and that neighbourhood, the *field-gardening* husbandry. I have for some years encouraged my cottagers in Yorkshire in this mode of managing their small garths or gardens, which are in general from one to three acres; and I have now an opportunity of stating the husbandry of a poor industrious cottager's garth. As the man can neither read nor write, these particulars have been transmitted to me from his own mouth; and, as I saw his land almost every day during the last harvest, I can vouch that this account is not far from the truth.

	Produce.	Value.			A.	R.	P.
240	Bushels of potatoes - -	£. 24	0	0	0	2	0
60	Ditto of carrots - -	6	0	0	0	1	0
5	Quarter of oats, at 44s. per quarter	11	0	0	0	3	20
4	Load of clover, part in hay, part cut green	12	0	0	1	0	10
	Turnips - - -	1	0	0	0	0	20
	In garden-stuff for the family, viz. beans, peas, cabbages, leeks, &c. -	0	0	0	0	0	30
		£. 54	0	0*	3	0	0

Deduct rent	£. 9	0	0	including the house.
Seeds, &c.	3	0	0	
Value of labour	10	10	0	
	£. 23	2	0	

Produce before stated.	£. 54	0	0	
	23	2	0	
Profit	£. 30	18	0	if sold at market, exclusive of butter.

"His stock was two cows and two pigs: one of his cows had a summer's gait for twenty weeks with his landlord. The land was partly ploughed and partly dug with the spade, cultivated (the ploughing excepted) by the man, his wife, and a girl about twelve years of age, in their *spare* hours from their daily *hired* work, seldom a whole day off, except

* These sums are conformable to the prices of this year, but it is evident that in other seasons they must in general be lower.

in

in harveſt; made the rent in butter, beſides a little uſed in the family. The man relates that he thinks he clears, one year with another, from the three acres, about £.30. The daily wages his family earns, about keep them. It is very evident that this man clears from his three acres more than a farmer can poſſibly lay by from more than eighty acres of land in the common huſbandry of the country, paying for horſes, ſervants, &c.; and it muſt be obvious to every one how great the advantages muſt be to ſociety by cultivating land in this manner. It would have taken more than half the quantity of his three acres in paſture for one cow at graſs during half the year; whereas (excepting the ſummer's gait for one of his cows, as mentioned before) his ſtock of two cows and two pigs is kept and carried on the whole year. The family lives well, and a handſome ſum has been yearly ſaved to place out two ſons, and ſupply them with clothes, waſhing, &c.

"I am, &c. HENRY VAVASOUR.

"P. S. The man's name is Thomas Rook."

XXXVI. *Conjectures reſpecting the Origin of the American Nations.*

[Concluded from p. 129.]

6. *Arrows the Symbol of a general Proclamation.*

THESE arrows, which were blunt, were not feathered, and had a greater reſemblance to ſmall ſticks than to arrows. They were employed at firſt for foretelling future events. The names of the objects reſpecting which information was required were written upon two of them, and a third remained without writing; one arrow contained the things good or bad which had been obſerved, and another forbade them. All the three were put into a covered veſſel, and on drawing one of them out, the perſon who conſulted this kind of oracle knew what to do. If the thing was allowed, the perſon proſecuted his purpoſe; if it was forbidden, he purſued meaſures of a different kind: but if the arrow without writing was drawn out, it was believed that the proper period for engaging in the undertaking had not yet arrived. Theſe arrows, however, are not the kind here alluded to, but thoſe by which the aſſembling of a whole people was forbidden. They were much uſed, in particular, in the northern kingdoms. "When an army comes into the land," ſay the Norwegian laws, "or when any inſurrection takes place in the country, a meſsage stick shall be cut and sent through it." In Sweden, orders for summoning the magistrates to administer justice, as well as every other message, in the time of peace as well as war, were issued in the like manner. According to all appearance the art of writing was then unknown, and therefore such sticks were employed instead of circular letters. The same custom has been observed among the Moguls in Siberia, among the Ostiaks and the Tartars. Barlæus says, that the American savages of Chili, when they intended to make war on the Spaniards, sent an arrow, with a string fastened to it, to their neighbouring allies. If the chief received the arrow, it was a sign that he was resolved to support the war; he made a knot on the string, and sent the arrow to the next. The other chiefs did the same, and the messenger returned with his arrow, having the string full of knots. Le Gentil, who made a voyage round the round, says that the knots are of different colours, which not only denote the plan, but the place and day on which it is to be carried into execution. Don Antonio de Ulloa, however, says nothing of the knots being of different colours, but in other respects he coincides with the abovementioned writers.

7. *Tattooing on the Face and whole Body.*

Figures cut out in the skin of the human body were, according to the testimony of Herodotus, tokens of a noble birth. Ammianus Marcellinus says that the Huns cut out figures on the cheeks of their new-born male children, with a view, as he supposes, of preventing the growth of the beard. This, however, does not appear to have been the real cause; for the Huns, like their neighbours the Chinese, had from nature very little beard, and only a few straggling hairs on the cheeks and chin. We are informed by Claudian that the Picts, formerly a people of Great Britain, and the Geloni, a people of Greek extraction who inhabited on the Dnieper, made figures on their limbs with an iron instrument. This practice is very common in Siberia among the Tungusians, as we are expresly told by Gmelin the elder, in the account of his travels. In the small island of Meangis, not far from Mindanao, the men as well as the women cut out figures on their skin according to a certain pattern; they then put into the wounds finely pulverized gum, and afterwards rub over them a certain salve. Captain Dampier, who examined a Miangi prince, speaks highly of this kind of painting, and says that it is exceedingly beautiful, and that the flowers, leaves, &c. are so ingeniously executed, that they bespeak no small degree of art.

We are told by Lady Mary Wortley Montague, that the women in the neighbourhood of Tunis ornament their neck, face, arms, and ſhoulders, with flowers, ſtars, and figures of all kinds, which are burnt in with gunpowder; and that this is conſidered as a mark of extraordinary beauty. The women on the river Gambia, when young, form, on their neck, breaſt, and arms, with a hot needle, figures of all kinds, which have the appearance of flowers worked on ſilk, and which never are obliterated. In the kingdom of Widah, young maids are prepared for the ſervice of the great ſnake, which is their principal Fetiſh, or deity, by ſcratching out various figures, particularly of ſnakes, on their ſkin with an iron inſtrument, by which means their ſkin has the appearance of fine figured ſatin. This is a ſign that ſuch perſons are devoted to the great ſerpent.

The ſavages of the iſthmus of Darien, in America, form figures on their bodies in like manner. They make an outline of the figure they intend to paint, ſays Wafer, and prick it with a thorn till the blood guſhes out; they then beſmear the place with the colour moſt agreeable to them, and the figures cannot afterwards be effaced. This cuſtom was very prevalent in many countries of America, ſuch as Florida, Virginia, Louiſiana, and Canada, and even in the cold climate of Greenland. The women, according to Anderſon, ſew, with a thread which they have drawn through the foot of their lamps, between the eyes, on the cheeks, chin, and ears, all kinds of ſmall characters between the ſkin and the fleſh, the black marks of which, when the wounds have healed up, conſtantly remain, and have a reſemblance to the well-known figures which thoſe who viſit the holy ſepulchre cauſe to be formed on their arms.

8. *Scalping Priſoners, or Enemies who have been killed in Battle.*

This operation was performed in the following manner: The ſkin, being cut on the forehead, was torn off backwards to the ears and the hind part of the head. The ſkin, after a certain preparation, was made to aſſume a round form, then ſtuck upon the end of a pole, and carried about in triumph. A paſſage in Herodotus relating to this ſubject has been improperly tranſlated by Gronovius, for it alludes to the ſcalp taken from an enemy killed in battle. The Scythians freed it from the fleſh adhering to it by means of the rib-bone of an ox, and then gave it the ſame preparation as their leather in order to render it durable. A remarkable paſſage on this ſubject, alſo, occurs in Oroſius. Speaking of the Gimbric and

and Teutonic women, he says they defended themselves courageously against the Romans till the skin of their head was pulled over their ears, in which state they were left to their fate. It may naturally be asked where the Romans acquired this barbarous practice, of which no other instance is to be found in antient history. I am therefore inclined to think that the Cimbri had first treated the Roman prisoners in the same manner, and that the Romans, out of revenge, copied their example. The Cimbri may have inherited this practice from the Scythians their ancestors. We are told by Ammianus Marcellinus that the Alani, who lived beyond the Palus Mæotis, stripped the skin from the heads of their vanquished enemies, and suspended it from their horses as an honourable trophy of victory.

In North America this barbarous practice is exceedingly common, especially among the savages of Canada. The most remarkable circumstance here is, that some of those who are scalped survive the operation. Lafiteau asserts, that, during the course of his mission, he saw the wife of a Frenchman in Canada who was cured after the operation, and continued in good health.

9. *Putting to Death old and infirm Persons.*

Herodotus speaks of an Indian nation, whom he calls the Pagæi, who put to death and ate their old and infirm people, both male and female. The first inhabitants of Sardinia had a law, in virtue of which children were obliged to kill their parents when they had passed the age of 70. Hartknoch speaks of a like practice among the antient Prussians. It is well known, in regard to the northern nations, that old people, who had become useless on account of their great age, precipitated themselves, partly with their own consent and partly by compulsion, from a mountain into the sea. As long as a Hottentot is fit for labour, he is sure of life; but when he becomes old, and incapable of performing the usual occupations, a hut is built for him in a distant place, where he is left, and where he either dies of hunger or is torn to pieces by wild beasts. Kolben, who mentions this fact, having reproached them for this inhumanity, they replied, that the Dutch showed much greater cruelty to their sick; " for you leave them (said they) to perish gradually, amidst long and lingering pain; whereas we free them at once from all their torment." The Kamtschatkans and Jakutians do the same thing: they build huts for their sick in a forest, leave them there with some food, and pay no further attention to them.

The

The savage Americans of Brazil, according to Piso, put to death those who laboured under incurable diseases. When any person in the province of Terra Firma was sick, he was carried by his relations to the nearest mountain, where he was put into a hammock which was suspended from a tree, and the relations danced and sung around it the whole day. They then left food and drink to serve him for several days, and departed. If he recovered his strength so far as to be able to return home, they received him with every demonstration of joy; if he remained sick, they provided for him a new supply of food and water; but if they found him dead, he was immediately put into a deep hole made on the spot, with a little food and water.

10. *Virginity little valued among the Barbarians.*

Marco Polo, in his description of the eastern countries, says, that in the kingdom of Thibet it was not customary to marry a virgin. Married women carried their daughters to strangers, that they might cohabit with them during their stay in the country: and when a young girl separated from her lover, she requested from him some small present, as a memorial and a token that she had slept with him. This she wore as an ornament when she went abroad; and those who had the greatest number of such marks were always most esteemed. The same thing is related by Rennefort of the inhabitants of Madagascar, and by Gerber of the people of Taulistan.

In Brazil, the young women before they are married resign themselves, without shame, to the embraces of the unmarried men. Their relations frequently offer them to the first person that occurs; so that, according to the testimony of Leri, not a single virgin is found among those who enter into the state of marriage. The savages of Quito, according to Ulloa, are so foolish as to imagine, that if the person they have chosen for their bride has not before had intercourse with another man, it is an undoubted sign of her not being of great value. To their honour, however, it must be added, that when they once enter into the state of wedlock they abstain from all intercourse with other men; and among these people adultery is punished with death.

Among some savage nations, however, it is customary for the men to prostitute their wives. It is asserted by Muller that this is the case among the Tschukti; and Regnard gives the same account of the Laplanders. In Cumana, a district of the continent of South America, a woman does not lose her honour or reputation if she submits to the embraces of another

another man by the consent of her husband. But if she does so without his knowledge he has a right to put her to death.

These accounts might be considered as fabulous, were they not confirmed by different authors ancient and modern, laity as well as clergy, some of whom were eye-witnesses to what they relate. Herodotus, speaking of the Thracians, says that they permitted their daughters to have promiscuous intercourse with whomever they pleased. We are told by the same author that it was a law among the Babylonians, that all the women of the country should, once in their lives, expose themselves to the embraces of strangers in the temple of Venus. Each sat in a particular place, separated from the other by a rope stretched between them; and durst not move from her station till some one threw a piece of gold into her lap, and made her retire with him. The handsome women were soon engaged; but the ugly sometimes remained a long time, even three years, without being solicited by any one. On this occasion, the prophet Baruch, a much older writer than Herodotus, says, that the one were soon set at liberty, but that the others, who were obliged to remain sitting, were exposed to ridicule, because they had not been thought worthy of having their girdle unloosed. Strabo gives exactly the same account of this circumstance as Baruch and Herodotus do.

Another custom among the savages, no less singular, is what is called their marriage proof. In the kingdom of Congo, in Africa, young people of both sexes beat each other, in order to see whether they can endure each other. Both are equally at freedom to separate, in case they do not suit each other. Ulloa mentions a like custom among the Indians of Quito. I remember to have read somewhere that this custom prevailed formerly in the British isles, and that it is still practised in some parts of Ireland and Scotland.

Were I to enlarge further on this subject, a whole book might be formed of the manners and customs which the Americans have in common with the people of other quarters of the globe. But, that I may come nearer to the object in question, I shall here take a short view of the singular customs which the Americans have in common with the Chinese and the inhabitants of the western part of Africa exclusively.

II. *Comparison of the Americans with the Chinese.*

1. The Peruvians had four grand festivals in the course of the year; the principal of which was held at Cusko, the capital of the country, immediately after the solstice; the second and

and third were celebrated at the time of the equinoxes; the fourth had no fixed period. Theſe feſtivals of the Peruvians have a great ſimilarity to thoſe of the Chineſe, both in number and the times when celebrated; with this difference, that the Chineſe obſerve with great attention the four periods of the year, viz. the two ſolſtices and the two equinoxes.

2d, The Peruvian and Chineſe monarchs both aſſumed the title of Children of the Sun, from which deity they pretended to be deſcended.

3d, Within the city of Cuſko was a field which no one was allowed to cultivate but the Peruvian monarchs and their family. This affords a new reaſon for conjecturing that the Peruvians were a Chineſe colony; for the monarchs of China retained alſo a piece of land, which was ſet apart for them and their family.

4th, To this we may add, that the Chineſe and the Peruvian monarchs were inveſted with ſpiritual as well as temporal power, and that the political eſtabliſhments in both countries were excellent of their kind.

5th, The Creole ladies in Peru, according to the teſtimony of Frezier, are exceedingly fond of ſmall feet. Thoſe who have the ſmalleſt are reckoned more perfect than the reſt; and therefore their feet are confined, at a very early period, in narrow ſhoes. Who does not know that among the Chineſe women ſmall feet are accounted a great beauty? This cuſtom may have come alſo from China; though Frezier alludes only to the Creoles, and not to the original inhabitants of the country; for it may have been introduced before the arrival of the Spaniards in Peru; and, if that be the caſe, the Creole ladies received this cuſtom from the Indians, and the Indians from their anceſtors the Chineſe.

6th, The Peruvians had no writing, but inſtead of it they made uſe of their *quipu*; which word, properly ſpeaking, ſignifies knots, but, according to the more extenſive meaning, a reckoning, catalogue, or liſt of ſomething. The Chineſe, before the invention of their writing, made uſe alſo of ſuch knots to convey their ideas to diſtant places.

The Peruvian *quipu* were threads of different colours, each of which had its peculiar meaning; for example, yellow denoted gold; white, ſilver; red, warriors, &c. The Peruvians employed them chiefly for keeping accompts; in which they were ſo expert, that they could reckon as faſt with theſe threads, as the readieſt accomptant can in Europe with pen and ink. By this method they could calculate the number of the inhabitants in the whole country, according to their age and ſex: an account was kept, by means of theſe knots, of all the taxes which the inca received annually; they contained also the roll of all the warriors, and a list of the births, deaths, &c.

They denoted also certain words or modes of speech: when the inca, for example, sent an embassy to any foreign powers, the latter could comprehend the inca's meaning, though they did not understand the proper words. What some historians assert, that the Peruvians employed different coloured threads, with knots upon them, in the stead of our twenty-four letters, is entirely false. They could always express any thing, together with the circumstances of time and place, but never the meaning in literal words; much less were these knots a substitute for historical books. Garcilasso de la Vega, therefore, a descendant of these incas, did not compose his history from information preserved by means of these parti-coloured knots, but from the oral tradition of his predecessors.

In a word, these *quipu* were merely arbitrary; for they could be changed at pleasure, and arranged in a quite different manner. The incas, therefore, did not always adopt the same arrangement; but, according to the nature of the thing, changed one colour for another, suited to the meaning they had assigned to them. If the Peruvians, therefore, came originally from another quarter of the world, they are descended, in my opinion, from the Chinese. The distance between these two nations is, however, too great; whether they traversed the Pacific ocean, passed through the straits of Magellan, or, what amounts to the same thing, doubled Cape Horn. The last way is longer than the first, and by far too difficult and dangerous. Their passage through the Pacific ocean may have been occasioned by some accident; though, in my opinion, they did not all arrive at the same period. They might land on some of the islands which they found by the way, rest there for a time, and provide themselves with a further supply of provisions. It may, however, be objected, that the Chinese ships were made of too frail materials to hold out during such a long passage. But we have every reason to think that the Chinese vessels would, on the contrary, be sufficient for that purpose; especially as we know that the Russians who live on the Jakusk have proceeded with their paltry vessels from the Lena, past the Eissen and Tschuktschi Nos, as far as the mouth of the Anadir; which the largest and strongest built ships employed for the expedition sent out under the empress Anne, and which cost so much expense, could not have done. Who first peopled Solomon's islands, between Asia and America, which were discovered under the reign of Philip II., and, according to the testimony of Ulloa,

were

were found to be inhabited? The Americans had no ſhips; and conſequently it muſt have been done by the Chineſe, although the paſſage from China is much longer than that from America.

This conjecture receives conſiderable weight from Deguignes, who has diſtinguiſhed himſelf by his knowledge of the oriental literature and hiſtory; for he ſays expreſsly, that the Chineſe, about the year 458, carried on a great trade to America from the north-weſt part of California: and this opinion is adopted by Buache the geographer, who calls the country Quivara. If it be true, therefore, that the Chineſe diſcovered Quivara, it is poſſible that they or their deſcendants may have gradually proceeded along the coaſt to Peru, and that a part of them may have ſettled there. It is not improbable that Mango Capac, the firſt inca, and founder of the great kingdom of Peru, and his followers, were Chineſe.

This alſo may be taken into conſideration, that navigation among the different nations of the globe has never been on the ſame footing and in the ſame ſtate. The caſe is the ſame in this reſpect as with commerce, the arts, and the ſciences. They are conveyed from one nation to another, and, by their influence, convert ignorant ſavages into enlightened people, and civilized and poliſhed nations into rude barbarians. Who were more expert in navigation and trade than the Phœnicians? They founded important colonies both in Africa and Europe, and carried on a great trade on the Atlantic. The Egyptians coaſted along the whole peninſula of Africa, proceeding from the Red to the Ethiopic ſea; then round the Cape of Good Hope to the Atlantic; thence to the Mediterranean, and ſo back to Egypt. The Greeks had large fleets both for the purpoſes of war and of commerce. They deſtroyed the naval power of Xerxes, and by theſe means reſtored the freedom of their country: but the importance of theſe people has vaniſhed, and they muſt now groan under a foreign yoke till it ſhall pleaſe Providence to ſend them a deliverer.

12. *Compariſon of the Americans with the Africans on the weſtern Coaſt of Africa.*

Among the people of the Old World, who in their cuſtoms and manners bear a reſemblance to the Americans, of which ſome inſtances have been already given, we ought to comprehend, in particular, the inhabitants of the weſtern coaſt of Africa. They have more cuſtoms, &c. in common with the American nations than all the other people of the earth, and from them alone it would appear that the Americans are defcended. Of this I fhall here give a few proofs.

1ft, The Hottentot women, from the age of twelve, always wear thongs of fheep or calves fkin wrapped round their legs from the knee down to the ancle bone. The inhabitants of the Caribee iflands, in America, bind fimilar thongs around the legs of their women after the age of twelve, only with this difference, that the latter are of cotton. This difference is owing to the Hottentots having plenty of cattle and fheep, in which the Caribs are deficient. The women, therefore, alone wear fuch bandages on their legs; the reafon of which perhaps is, that the women go out to the fields and woods to labour, and confequently muft fecure their legs and feet from being pricked by briers and thorns.

2d, When a Hottentot widow intends to marry again, for each hufband with whom fhe is afterwards united fhe muft cut off a joint of one of her fingers, always beginning with the little finger. The Tucumans, a people of Brazil, have a fimilar cuftom; for on certain occafions, but of a different nature, they muft cut off one finger of the left hand. The Hottentot women cut off a joint when they marry again, but the Brazilians cut off their fingers on the death of their neareft relations.

3d, The Hottentot and the Carib women bend the limbs of their deceafed friends till they affume that form which they had in the mother's womb.

4th, The idolatrous negroes in Africa have almoft the fame religious ceremonies as the Americans, but it would be too tedious to enumerate them. Thofe defirous of making the comparifon may perufe the account of George Candidius, the Dutch clergyman.

I have concluded, from the cuftoms common to both nations, that the Peruvians are defcended from the Chinefe, though they are feparated by an extenfive ocean. If this be probable, the probability in regard to the inhabitants of the weftern coaft of Africa is ftill greater, for of all people of the earth thefe approach the neareft to the Americans. Thefe two people, however, are feparated by the Atlantic; but the breadth of it from Guinea to Brazil is not more than twenty degrees; and befides this, an eafterly wind generally prevails in that fea, which fometimes drives the European fhips to the coaft of Brazil. I am not, however, of opinion that America was peopled from China and the weftern coaft of Africa alone. As the fmall boats of the Laplanders, which can carry only one man, and which are employed for catch-

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ing seals, have a great resemblance to those of the Esquimaux Indians and the Greenlanders, there is some reason to conjecture that the northern part of Europe has also contributed to the peopling of America *.

XXXVII. *An Essay on Bleaching; with the Description of a new Method of Bleaching by Steam according to the Process of* C. CHAPTAL; *and on its Application to the Arts. By* R. O'REILLY, *of the Academy of Bologna, Member of the Lycæum of the Arts, &c.*

[Continued from p. 111.]

Of Cotton.

COTTON is a filamentous substance, or a kind of down, which envelops the seeds of the cotton plant. This plant or shrub comes from the east, and grows only in warm climates.

This substance, after being separated from the seeds, is always charged with a coarse colouring matter, which soils it, and renders it opake. The presence of this unctuous matter is proved by the slowness with which cotton absorbs water before it is scoured, and by the force with which it absorbs it after the operation; by which means, from being opake, it is rendered clear and transparent.

Cotton varies a great deal in its qualities, according to the different kinds, the climate where produced, and the culture employed. Its colour is sometimes yellow and sometimes white, but in general it is of a dirty yellow.

To bleach it, does not require the same preparations as hemp

* In a little known work intitled *An Account of the Islands of Orkney*, by James Wallace, M. D. and F.R.S. London 1700. 8vo. it is stated, p. 60 and 61, that North Americans and Greenlanders, called there *Finn-men*, have been sometimes driven in their small leather boats to the Orkney islands by the storms and currents. In the year 1682 a stranger of this kind arrived in his boat at the extremity of the island Eda, where a great number of the inhabitants assembled to see him; but, on a boat being sent out to catch him, he soon made his escape. About the year 1684 an American, perhaps the same person, made his appearance at the island of Westram. If it was possible for these savages to get to the Orkneys in such wretched vessels, the passage from thence to America would be much more possible in the worst vessels employed by the Europeans. Many of the fables related in regard to Tritons and Syrens, said to have been seen formerly on the coasts of Europe, might perhaps be explained by similar circumstances of Greenlanders or Esquimaux Indians, driven thither in the like manner. According to Dr. Wallace, an Indian canoe, with a paddle and arrows, driven on shore at the Orkneys, was preserved in the musæum of the college of Edinburgh. Another is preserved in the church on the island of Burra.

hemp and flax. The firſt operation conſiſts in ſcouring it in a ſlightly alkaline ſolution, or, what is better, by expoſure to ſteam in an apparatus we ſhall deſcribe hereafter *. It is afterwards put into a baſket, and rinſed in running water. The immerſing of cotton in an alkaline ley, however well it be rinſed, always leaves with it an earthy depoſit. It is well known that cotton bears the action of acids better than hemp or flax; that time is even neceſſary before the action of them can be prejudicial to it; and, by taking advantage of this valuable property in regard to bleaching, means have been found to free it from the earthy depoſit, by preſſing down the cotton in a very weak ſolution of ſulphuric acid, and afterwards removing the acid by waſhing, leſt too long remaining in it ſhould deſtroy the cotton.

Of the Oxygenated Muriatic Acid.

This acid is one of the moſt valuable diſcoveries of modern chemiſtry, for which we are indebted to Scheele. Berthollet is the firſt who applied it to bleaching, after having carefully examined its properties.

The muriatic acid is greedy of oxygen, and takes it from almoſt all its combinations: to its union with oxygen it is indebted for its deterſive property. Manganeſe, a metal comparatively of little value, preſents an immenſe reſervoir of oxygen, which the muriatic acid ſpeedily diſengages from it in the gaſeous form. This gas, combined with water, forms the oxygenated muriatic acid of the bleachers. Water thus ſaturated aſſumes a greeniſh-yellow colour, its odour has a ſuffocating acridity, ariſing from the emanation of the gas, which adheres little to the fluid in which it has been concentrated, and which every moment endeavours to eſcape.

This acid, then, is nothing but a combination of the muriatic acid and oxygen; but the latter principle adheres but weakly to the muriatic acid, as is ſeen by the decoloration effected by the oxygenated muriatic acid, which reſtores it to its primitive ſtate of ſimple muriatic acid.

All vegetable colours are attacked by this acid, and whitened with more or leſs celerity: this depends on their greater or leſs facility of combining with oxygen. The colouring matter undergoes a real ſlow combuſtion, which terminates by the formation of carbonic acid, which, eſcaping under the form of elaſtic fluid, produces what we call bleaching.

* The apparatus alluded to has been already deſcribed in the Philoſophical Magazine, Vol. V. p. 351, under the title, "*Account of a new Method of Bleaching Cotton.*"—EDIT.

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In whatever manner the oxygenated muriatic acid is procured, it is evident that the oxygen adheres to it only weakly; and it is on this property that the possibility depends of producing speedily in manufactories that action which the atmosphere produces but slowly, and of bleaching in a space of time proportionably short.

Oxygenated muriatic acid is produced by distilling together sulphuric acid, manganese, and muriate of soda, (common salt,) and condensing in water the acid gas which thence escapes. The apparatus and proportions of the ingredients will be treated of when we come to speak of the processes for bleaching with this acid.

Oxygenated Muriates.

Notwithstanding the little affinity which some earths and alkalies have for the oxygenated muriatic acid, means are found to combine them together, and to compose substances called oxygenated muriates. Of the earths, none but lime and magnesia can be conveniently converted into oxy-muriates; and the latter is even too dear to be employed. The oxy-muriate of lime is at present used at all the bleaching-grounds of Ireland. For the process of preparing it we are indebted to Tennant: he combines it with the oxygenated muriatic acid under the gaseous or liquid form; but the latter is preferable. Lime water saturated with oxygenated muriatic acid may be employed liquid; or, by supersaturating the mixture, the earthy moleculæ may be precipitated to the bottom of the apparatus: if the liquor, which is always surcharged with oxygenated muriatic acid, be then drawn off by means of a syphon, you will obtain a residuum saturated with that principle, the paste of which may be employed in the processes of bleaching. This oxy-muriate, under the concrete form, is sufficiently impregnated to form a bleaching ley when dissolved in water.

The alkalies of which such oxy-muriates may be formed are barytes, potash, and strontian. The first and the last are still too rare, and their price is too high, to suit that œconomy which the processes for bleaching require; but these substances have begun to be discovered in France. In regard to potash, we are already acquainted with the part it acts in condensing the oxygenated muriatic acid, and rendering it inodorous. To obtain the same results with oxy-muriate of lime, nothing is necessary but to saturate it in like manner.

The advantages obtained by these preparations are very important.

One is enabled to make these leys, and to send to a distance these muriates, which form the detersive substance, without fear of their losing their properties by the way. I have already mentioned the extreme volatility of the liquid oxygenated muriatic acid, and the almost impossibility of transporting it without the loss of nearly one-half of its strength; and however little it may be shaken in its passage, the acid gas will entirely escape. We shall show hereafter the method of preparing and employing these muriates in bleaching.

Of Potash.

The substance known in commerce under the name of *potash*, and which acts so important a part in the process of bleaching, is a saline matter produced by incinerating plants or wood, and lixiviating, concentrating, and calcining the ashes. The use of ley of ashes was known in the remotest periods; but the Germans were the first who taught us to concentrate the salt diffused throughout the water of the solution, and to which they gave the name it now bears, from the vessels employed in the fabrication of it, viz. *pot-ashes*, or potash.

Though potash be very common in nature, it is the vegetable kingdom which presents it to us in the greatest abundance. Chemists are divided in regard to the question, Whether this salt exists completely formed in the plants, or is produced by the union of certain principles during the combustion? It is sufficient for the bleacher to know how it is obtained, and to be acquainted with its most striking properties; for its chemical composition is entirely unknown.

The method of obtaining potash is as follows:—Burn herbs of every kind, except marine plants, or such as grow on the sea shore; then lixiviate the ashes and evaporate the solutions, by which means you will have a saline residuum: calcine this saline substance in a reverberating furnace, and the product will be potash. This substance, as soon as it is taken from the furnace, attracts the humidity of the atmosphere; or, to speak correctly, it endeavours to saturate itself with carbonic acid: in this state it forms what the bleachers call *mild alkali*; it is then more detergent than soap, and less so than caustic alkali. Potash is exceedingly soluble in water; it requires little more than half its weight to dissolve it. The potash of the shops is often adulterated with other saline substances, and commonly with the sulphate of potash, which is purchased, at a low price, by the makers of aquafortis, in glass-houses, &c. This salt degrades the quality of it, and, by its little solubility in water, retards the operation of bleaching. This fraud may be detected by one property; for, as sixteen parts of water are required to dissolve one of this sulphate, when the temperature of the atmosphere is 65° F., while one part is sufficient to dissolve a like weight of potash; one needs only boil together an equal weight of common potash and river water for some minutes, leave it to rest twenty-four hours, and then decant the clear ley; if the residuum be then washed with a fourth of the quantity of the water employed, and the clear liquor be poured off, the remaining deposit will be composed of foreign salts or heterogeneous matters, found there accidentally, or which have been employed in adulterating the potash.

We have mentioned the avidity with which potash absorbs the carbonic acid. As this principle diminishes its detersive force, it must be deprived of it by mixing it with twice its weight of lime; then lixiviating it, or, what is still better, pouring saturated lime water into a solution of potash also saturated, and until the lime water ceases to give a precipitate. It is on this property possessed by alkalies, of uniting with oils and fat matters, of rendering them soluble in water, and disengaging them from the substances with which they are mixed, that the theory of bleaching with soaps and alkaline mixtures is founded. This detersive force, however, must be moderated. Potash, even in the state of carbonate, attacks not only the colouring matter, but the substance, also, of flax, hemp, and cotton: being rendered caustic, its resolving force is increased; it is a dangerous enemy when its agency is abused, but a powerful auxiliary when employed with moderation.

It is by a prudent use of this matter that we propose to employ an alkalino-caustic lixivium in a steam-apparatus for bleaching the linen of public institutions: the ashes alone of their fire-places, where the fuel is wood, lixiviated and rendered caustic, will be sufficient for this operation, which will be attended with a degree of œconomy that no other process can counterbalance.

Though I recommend the use of caustic leys, I am far from recommending lime applied alone or mixed with alkalies. Ignorant manufacturers, imagining that it bleaches the cloth, make use of it imprudently, to the detriment of their manufactures, and excuse themselves by the example of enlightened men, who add lime to render the alkalies caustic; but every chemist knows that, notwithstanding this addition, there does not remain *a single atom of pure lime* in the alkalino-caustic liquor when it has been made with the necessary precautions.

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Of Soda.

Nature presents us with soda in still greater abundance than potash; and it is even found in a pretty pure state in Egypt, where it is collected at the bottom of the lakes. The combustion of plants, and the different kinds of *saltwort* or *soda* which grow on the sea-shore, furnish it in great abundance: it is from this plant that it takes its name. But modern chemistry has taught us how to obtain it in still greater profusion by the decomposition of sea salt (muriate of soda).

Its properties in regard to bleaching are nearly the same as those of potash, with this exception, that it does not unite itself to the oxygenated muriatic acid; in general, the action of soda, even when caustic, is much weaker; and it attacks cloth and stuffs much less than potash. We shall therefore make choice of it in preference for our process of bleaching with steam.

Soda is generally more mixed with heterogeneous matters than potash, and the fraud is more difficult to be detected. In this case, recourse must be had to repeated crystallizations. Kirwan, in his excellent memoir, recommends boiling the soda in three times its weight of water; suffering the solution to remain at rest; then filtering it, and boiling the residuum left on the filter with half the quantity of water, and making it again pass through the filter. Soda, being caustic, requires some days exposure to the air before it crystallizes. If it be of a bad quality, it will not form crystals in five or six days: if the contrary be the case, the salt is extracted, the mother water is reduced to one half, and it is again suffered to crystallize. This residuum is once more exposed, and this process is repeated till the whole of the crystallizable soda has been extracted. If the soda has been adulterated by a great deal of lime, it will be soon detected by dissolving an ounce of common soda in boiling water, and letting fall into it a drop of corrosive muriate of mercury: if the liquor assumes a brick colour, it contains a little lime: the quantity of this substance may be appreciated, in some measure, by the intensity of the yellow shades which its presence produces.

Of Soap.

The property I have already mentioned as inherent in alkalies, of combining with oils and fat animal matters, forms the basis of the process for making that detersive substance called *soap*. There is a very prominent line of demarcation between soap obtained by means of soda and that furnished by by potash. Soda gives a hard soap; potash, on the other hand, a soft kind. Pliny ascribes to the Gauls the invention of this valuable composition. The soap of our ancestors was formed of goat's grease mixed with the ashes of beech wood; and several improvements were successively introduced into the manufacturing of this substance, as chance, the mother of the most important discoveries, pointed out the necessity of them. The progress of the arts towards perfection has been very slow, on account of the prejudices of that ignorance which prevailed in the past ages. We have, however, now reached a period when the sciences and the arts, aided by their reciprocal resources, are advancing rapidly towards a certain degree of perfection.

In France, two kinds of soap only are made—hard soap, and soft soap: the first with soda and olive oil; the second with potash, and vegetable oils of less value.

In Hungary, soap is made of tallow and natron; as is the case in several parts of Germany and Russia. The Russians make a hard soap also with bad salt butter; but this kind is not much esteemed; its rancidity and the quantity of salt and caseous matter found in it degrade its quality. Wiegleb asserts that a very hard soap, which has a very agreeable smell of almonds, is made with yellow and white wax.

The English, as they have not vegetable oils in abundance, make soap only with tallow or fish oil, sometimes with kitchen-stuff or spoilt butter. They have four kinds. 1st, White soap, made with soda of Alicant, or the soda of Varech, and tallow. 2d, Marbled soap, made of tallow and kitchen-stuff. The marbled appearance does not arise from an oxide, as among us, but because a little of the ley is dispersed throughout the whole mass. 3d, A hard yellow kind of soap, composed of soda, tallow, and resin. This last substance is introduced only for the purpose of rendering the soap cheaper, but it certainly does not augment its detersive strength. The fourth kind of soft soap is formed of whale or fish-oil and potash.

It was long an object of research to discover substances which might be substituted for oil and tallow in the fabrication of soap. It was reserved for Chaptal to lay open this field by his important discovery of a process for saponifying wool, and converting into excellent soap rags of old cloth and worsted, the waste of carding, and the other refuse of cloth manufactories. This discovery gave rise to that of sir John Dalrymple, who supposed that, by a method similar to that of Chaptal, it would be possible to convert the muscular part of fat fish into soap; and some experiments, crowned with complete success, soon confirmed him in this idea.

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Those who wish to acquire information respecting the art of soap-making may consult the excellent work of Darcet, Pelletier, and Lievre, published a few years ago by the order of the French government.

Sulphuret of Lime.

Lime and sulphur are two substances which nature presents to us with profusion. They combime perfectly together. Their union is called *sulphuret of lime,* and they then form a very active detergent matter. Kirwan first observed that saline sulphurets, or the combination of an alkali with sulphur, might be employed with advantage in bleaching on account of their *detersive* properties, and even supply the place of alkalies. What Kirwan proposed was executed by Higgins in Ireland; and by analogy of reasoning he was led to the discovery of the detergent power of sulphurets of lime.

In whatever manner these substances are combined, the result is always the same; either in the dry way, by fusing them together, which produces a very strong and very solid sulphuret; or by uniting quicklime and sulphur, and pouring over them eight or nine times their weight of water; the heat alone of the lime while slaking will be sufficient to combine them: or, in the last place, by following the process of Higgins, which consists in boiling together slaked lime and sulphur. The last method is that which ought to be preferred for bleaching.

The liquor which results from this union of water, lime, and sulphur, is *liquid sulphuret of lime:* it is of a dark yellow colour, and has a harsh styptic taste; it emits an odour somewhat similar to that commonly perceived in sulphur and slaked lime. This emanation, however, is not of a noxious nature like that of the oxygenated muriatic acid.

Liquid sulphuret of lime loses its colour by exposure to the air, and speedily absorbs the oxygen of the atmosphere. These properties deserve the attention of the bleacher, as they will show the advantage of employing this solution as fresh as possible, lest the quality of it should be hurt; and they explain a part of the principles, according to which liquid sulphuret of lime exercises an action in the art of bleaching.

From the above observations the following practical principles may be deduced:

Sulphuret of lime, of all the alkaline compounds, is the most powerful solvent of the colouring matter of flax; caustic potash is the next; then caustic soda; then common potash; and, in the last place, common soda. Sulphur, if employed pure, stains cloth a little; but the stains may be easily removed

moved by the application of potash. The alkali arising from the combustion of plants is more powerful than the mineral alkali, as I have already observed. The alkaline sulphuret, which is formed by the combination of sulphur and soda, is far from possessing so detersive a quality as that made with potash.

Various Processes for Bleaching Hemp, Linen, and Cotton.

Having already spoken of the different methods hitherto pursued for bleaching vegetable substances, and examined the menstrua and detersive substances most used in the various processes, I shall proceed to a description of the different manipulations to which these matters are subjected in order to give them that degree of whiteness which is necessary to fit them for commerce.

Bleaching in the open Air.

The air with which the earth is surrounded is far from being homogeneous. Every thing volatilized on the surface of the globe; all the emanations of the earth, as well as the beneficent fluids, which assume the gaseous form, are confounded in this aëriform sea by which we are surrounded. It is an immense laboratory always in action, where the play of composition and decomposition is incessantly renewed.

Of the numerous properties of the atmospheric air, it will be sufficient if we mention only a few. About a fourth of this fluid is composed of a gas, which appears to be the acidifying principle: this is oxygen, which readily suffers itself to be absorbed by a great number of bodies, among which are carbon. This union with carbon forms carbonic acid, which is also an aëriform fluid.

Without calling in question those principles for which we are indebted to modern chemistry, mankind have at all times employed free air as the most convenient menstruum for bleaching. When tired with the slowness of its action, they assisted it by detersive leys, which abridged the process a little; and this union of boiling, and exposure on the grass, formed the whole of the antient art of bleaching. Formerly, when it was necessary to bleach cloth, it was customary to immerse it in pure water to free it from the dressing. This preliminary operation was sometimes hastened by a cold ley, the cloth was then rinsed in running water and spread out on a meadow, round which ran a stream of limpid water that served for watering the different pieces.

After being exposed in this manner for some time, the cloth was washed and boiled in a fresh ley; it was then again spread

ſpread out on the graſs; and this operation was ſeveral times repeated until the required whiteneſs was obtained. It was ſtill neceſſary to wind it through ſoapy water, not only to give it ſoftneſs and pliability, but to bleach completely the borders, which oppoſe the longeſt reſiſtance.

It was brought to its ultimate ſtate of whiteneſs by drawing it through whey or diluted ſulphuric acid. By this ſhort deſcription it may be ſeen that a conſiderable time was neceſſary before the abſorption of oxygen could take place: to haſten this operation of nature appeared impoſſible, until modern chemiſtry had demonſtrated that oxygen, ſolidified in various bodies, might be extracted and combined with water, to be afterwards applied to ſubſtances where its influence might be neceſſary.

Bleaching by Water alone.

I have already obſerved that, during the fermentation that takes place in the vats in which cloth is immerſed to free it from the dreſſing, the fibres aſſume the firſt tint of whiteneſs. It had been before remarked that the percuſſion of ſtampers in paper manufactories bleached, in ſome degree, the pulp impregnated with water; it was known that, by ſuffering hemp and flax to ferment a very long time, a greater degree of whiteneſs was obtained, but always at the expenſe of the fibrous tiſſue, deſtroyed by too long maceration. Taking advantage of theſe obſervations, Braſle, an artiſt of Amiens, found means to bleach hemp and linen by the action of water alone.

When the hemp was pulled, he watered it a little longer than uſual, having previouſly cut off the roots by laying the ſtalks on a board furniſhed with an inſtrument deſtined for that purpoſe. When the cortical tiſſue was attacked, and deſtroyed by the putrid fermentation, he removed the hemp from the water, and, by drawing it through a kind of heckle or comb, completely ſeparated the fibrous tiſſue, which, on account of its paralleliſm, was not hurt by the teeth of the inſtrument; while the reticular tiſſue of the bark or exterior covering, already half putrid, ſtuck on the points, and readily ſuffered itſelf to be ſeparated from the hemp. During this operation the hemp was immerſed ſucceſſively in water, between each ſtroke of the heckle, to facilitate the removal of the green matter above the bark. The whiteneſs which hemp aſſumes by this ſingle operation can hardly be conceived: it acquires a ſplendour and brilliancy which can never be communicated to it by the uſual proceſſes, but its ſtrength is alſo diminiſhed as well as the product by the too great progreſs of the fermentation; on the other hand, this hemp may be employed with great advantage in the arts. It is here proper to observe, that bleaching by water never gives complete whiteness, like the usual processes of the bleach-field. To finish the bleaching of hemp, it would be necessary to have recourse to the different means described in this essay.

Of Bleaching with the Oxygenated Muriatic Acid alone.

In this process oxygenated muriatic acid is substituted for the action of the air, and presents itself with advantage, because its oxygenating principle is not drowned in a chaos of different fluids, like the oxygen of the atmosphere; its action, too, must therefore be speedier. As I have already examined the principles of this acid, and its intimate nature, I shall now proceed to the application of it, and to a description of the best apparatus.

The matters which serve for the production of the oxygenated muriatic acid are manganese, common salt, (muriate of soda,) and the sulphuric acid. Manganese is a metallic oxide very much diffused throughout the surface of our globe, and which may be procured at a small expense. The greater part of it is brought to us from Macon, Saarbruck, and Hombourg in the ci-devant duchy of Deux-Ponts: it must be chosen well crystallized in small black brilliant needles; and it is necessary to avoid with care those blackish masses, which often contain heterogeneous matters, and, at any rate, the matrix of this mineral. In order to employ it with advantage, it should be pounded before the mixture is made for distillation.

The sulphuric acid (oil of vitriol) ought to be concentrated; that sold in the shops generally shows 60 or 66 of the areometer: it must be taken as nearly as possible at that term, in order to avoid errors in the proportions of the substances necessary for the distillation of the oxygenated muriatic acid; proportions founded on an uniform concentration.

The salt to be employed ought to be white, and well crystallized; it must also be dried, and the crystals, if large, must be pounded, in order to facilitate the mixture with the manganese.

The proportions generally observed are, one part (by weight) of manganese; two of sulphuric acid, diluted with a little more than its volume of water; and three of salt. The better these matters are combined together, the more easily will the acid gas be disengaged by the action of the sulphuric acid. It is proper also to remark, that the acid ought to be diluted in a leaden vessel; for, if other vessels were employed,

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they might break in consequence of the heat produced by the union of the acid in water. In some places these proportions vary. In England, the following are used:

Manganese	- -	30 parts.
Common salt	-	80
Sulphuric acid	-	60
Water	- -	120

Such is the ley employed at Manchester, where nothing is bleached but cotton cloth, and cotton and thread.

In Ireland, the proportions are:

Manganese	- -	60 parts.
Salt	- -	60
Sulphuric acid	-	50
Water	- -	50

This is the common ley of those who bleach linen cloth; and hence we may explain the great difference between these and the preceding proportions.

In Germany the doses vary a little, and approach near to the proportions used in the French manufactories. They are:

Manganese	- -	20 parts.
Salt	- -	64
Acid	- -	44
Water	- -	54

The necessity of distilling this acid on a large scale, has given rise to the invention of different kinds of apparatus more or less convenient. Berthollet has proposed matrasses with bent tubes, which convey the oxygenated muriatic acid to the pneumatic tub, in which the bubbles, traversing the water, are forced, by means of an agitator, to combine more or less with it. Pajot de Charmes recommends the use of tubulated retorts; but, besides these vessels being too dear, they do not answer the proposed end, since a portion of sulphuric acid not decomposed, and which injures the process, always passes into the water.

C. Widmer, at Jouy, has arranged his apparatus in such a manner as to lose the least gas possible during the condensation: he receives the gas under a capsule inverted at the bottom of the apparatus; above these are two *tours de goutiere* also inverted, then another capsule above these; then two more *tours de goutiere*, and then another capsule, which terminates the apparatus. The disposition of his tub is such, that he places around in his laboratory several distilling apparatuses, which are going at the same time.

Apparatuses constructed on similar principles are also in use at Glasgow and Manchester. Bourboulon-de-Bonneuil has likewise invented an apparatus, consisting of several matrasses, trăsses, ranged as in an aquafortis manufactory, the tubes of which are conveyed into a chamber containing concentrating tubs. His apparatus for the bleaching of paper is very ingenious, and deserves to be described. In the last place, others have arranged five or six large casks, like Wolf's apparatus, in such a manner as to make each cask perform the functions of a tubulated flask. The bleachers in Ireland employ a kind of leaden alembic capable of containing forty gallons of water; a capacity more than sufficient to contain the charge, and to favour the swelling which takes place by the reciprocal action of the matters during the distillation. This alembic, (see Plate IV.) of a conical form, and having a very broad base, rests in a balneum mariæ, in order that it may be subjected to a progressive heat; and the neck is of such a height, that any sulphuric acid which happens to rise may fall back. The cover is perforated to afford a passage to the handle of an agitator, which serves to stir the matters at the bottom of the alembic: this agitator is of iron as well as its arms; but the iron is covered with a pretty thick plate of lead, that the acid may not attack it: the handle goes through a leather collar, to prevent the escape of the gas. The sulphuric acid, diluted with water, is introduced into the leaden apparatus by means of a small glass or leaden funnel, the tube of which is bent to guard against the reaction of the gas. The apparatus is also furnished with a condenser, into which the gas is made to pass. This vessel has several shelves and an agitator. The latter goes through a leather collar in the top of the condenser, passes down through the shelves, and is furnished with arms between each of the shelves; by which means the gas in its ascent is exposed to the action of the liquid in a state of great agitation, and has a long way to travel through it. (See the Plate.)

I shall now speak of an apparatus which, in my opinion, is free from those faults which generally attend an apparatus of lead, which always becomes oxidated, and is at length destroyed. This apparatus * consists of a series of conical matrasses with long necks, furnished with bent funnels as well as tubes, both of glass, which are conveyed into a common reservoir. This reservoir ought to be perforated in such a manner as to leave room for the introduction of a tube of a larger size (two inches) communicating with the first condensing cask or cylinder, made of white wood, twenty inches in diameter, bound round by hoops made tight with screws, and completely water proof. Care must be taken to cover these hoops

* See Plate II. fig 1 and 2, given in our last Number; and the description, page 101 and 111.

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with a coating of japan, as it is called, or with oil paint, to prevent the oozings of the liquor from rusting them. The height of this cylinder must be seven or eight feet, and even more, if possible, in order to increase the pressure; and ought to have placed over it a large two-necked bottle deprived of its bottom, or a glass bell with two necks cemented to the upper edge of the cylinder. In one of these necks the large tube of the reservoir is introduced, and made to descend to the bottom of the cylinder. The air bubbles, as they are disengaged, being forced to traverse the fluid under a pressure equal to the height of the column of water, will combine with it until it be saturated; the second neck is also furnished with a bent leaden tube, the orifice of which is below the surface of the water; the superabundant gas passes through this tube, and, descending into the second cylinder of wood, similar in all respects to the preceding, saturates the water in it:—a third cylinder may be added, if judged necessary. By this arrangement the smallest portion of the gas cannot escape: care must be taken to apply a leaden cock at the bottom of each cylinder, in order to draw off the bleaching liquor as it is formed.

The residuums, after the distillation of the oxygenated muriatic acid, may be sold to earthen-ware manufacturers to be employed as a glazing for their coarse articles. The manganese contained in it gives it a blackish appearance, like that of bronze, which is far from being disagreeable to the eye. I have employed this glazing several times by way of trial; first fusing it with sand in a potter's furnace, throwing it into cold water to facilitate its division, and grinding it in a mill in order that it might be diffused in water. This glazing is attended with the advantage of being free from those dangerous qualities so common in all preparations made from the oxides of lead; but the most important object is the extraction of the soda from the sulphate of soda, which is formed in great quantity by the process, and remains in the residuum of the distillation.

The first point is, to convert the sulphate of soda into an alkaline sulphuret. Malherbe and Athenas have succeeded in this by employing iron as the intermediate substance: they mixed one part of charcoal dust with nine parts of the sulphate of soda, and exposed the mixture to the heat of a reverberating furnace: when the sulphuret entered into combustion, they added from three to five parts of old iron rendered as small as possible; and the whole being fused together, they obtained a black paste, composed of iron, soda, sulphate of iron, &c. This mixture was lixiviated, and filtered

tered through a basket filled with lime; it was then evaporated to dryness, and the residuum was calcined in a reverberating furnace. When soda of a superior quality is required, the washing and calcination must be repeated.

Dizé and Le Blanc decomposed the sulphate of soda, by means of the carbonate of lime, in order to neutralize the alkali, by saturating it, at a very high temperature, with carbonic acid. Their process consists in taking two parts of sulphate of soda, dried to deprive it of its water of crystallization, two parts of well ground chalk (carbonate of lime), and one part of charcoal powder, mixing them well in a muffled mortar, and then bringing the mixture to a white heat in a reverberating furnace: when the matter is fused it is stirred till the sulphur is consumed, and the ebullition and the jet of the flame produced by the hydrogen gas have ceased to appear. It is then taken from the furnace, and it may be lixiviated to obtain the soda very pure. In whatever manner the sulphate is decomposed, this object merits the greatest attention at bleachfields on account of the considerable degree of œconomy which results from the different manipulations. The ley of oxygenated muriatic acid will be obtained at little or no expense by bleachers, when they seriously set about extracting the soda from the sulphate formed during the distillation.

In whatever manner the muriatic acid gas may be distilled, the great object is to saturate the water with this aëriform fluid. Its action in bleaching is always stronger when employed alone than when in the state of combination with salts or earths, as in the subsequent operations of which I am about to speak. The volatility of the acid, however, is such, and the loss of the gas so enormous, that, when the thread or cloth is immersed, there is dissipated of it a quantity which may be estimated at about a *third*, at least, of the whole gas. The mixture of potash, indeed, renders the liquor inodorous; but besides that this salt is expensive, it greatly weakens the detersive quality of the liquor.

Rupp, of Manchester, has invented an apparatus for bleaching cloth exceedingly simple in its construction, of small expense, and which contains the liquor in such a manner as to prevent the escape of the oxygenated muriatic acid gas. A consideration of no less importance in the arrangement of this apparatus is, the impossibility of the vapour injuring the health of the workmen. I have witnessed, in a very large manufactory near Paris, the dreadful sufferings to which these unfortunate people were exposed by these suffocating vapours. I have seen them rolling on the ground through pain, and ſevere maladies are often the conſequence of theſe firſt effects of the oxygenated muriatic acid. In Rupp's apparatus I have found one great inconvenience: the cloth is rolled up on a vertical axis, and when there are ſeveral pieces on it, the edges are folded back merely by the weight of the ſtuff, and conſequently have leſs whiteneſs than the reſt of the cloth. In the improvements I have propoſed this inconvenience is avoided by the horizontal diſpoſition of the pieces, and by the manner in which I make them to be wound up in the inſide of my apparatus*. For the immerſion and bleaching of thread I would propoſe the uſe of Rupp's apparatus, with ſome trifling alterations. In regard to the deſcription of my apparatus, as it has been already given in ſpeaking of the ſulphurous acid, it is needleſs to repeat it here.

Before we proceed to the manipulations, I ſhall ſpeak of an inſtrument uſed for aſcertaining the deterſive force of the ley, and which Deſcroizilles, with great propriety, calls a Berthollimetre. I ſhall alſo examine the method propoſed by Rupp.

The proceſs of Deſcroizilles conſiſts in diſſolving indigo in dilute ſulphuric acid in the following manner:—A dram of the fineſt indigo is introduced into a matraſs with ſeven times its weight of ſulphuric acid at 66 degrees. The ſolution is facilitated by immerſing the matraſs into a balneum mariæ: the ſolution of indigo is then diluted in a flaſk containing 124 ounces of diſtilled water, until no traces of it remain in the matraſs; by which means the indigo then becomes mixed with the liquor in the proportion of one to a thouſand. The inſtrument afterwards ſerves to indicate the diſcolouring force of the oxygenated muriatic acid. The method of employing it may be ſeen in the memoir publiſhed by Deſcroizilles in the year 3.

The method pointed out by Rupp appears to me to be ſimpler, and calculated to avoid thoſe errors to which the ſulphuric acid always gives riſe: he adds acetite of lead to the ſolution of indigo until the lead is precipitated, and the indigo alone remains diſſolved in the acetous acid †.

The utility of theſe means for aſcertaining the ſtrength or exhauſtion of the oxygenated muriatic acid may be readily conceived. If a certain quantity of ſtuffs or thread put into an immerſing tub of a hundred cubic feet content, is found to have reduced the acid liquor from eight to ſix degrees of

* See Plate II. fig. 3. and 4. given in our laſt number.

† The author here details Mr. Rupp's experiments, which, having already been laid before our readers in our ſecond volume, we now omit. —EDIT.

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the Berthollimetre, there is reason to conclude that there has been an exhaustion of a fourth: the same reasoning may be applied by analogy to proofs by the acetite of lead.

Cloth is prepared for immersion in oxygenated water, by soaking in a ley of weak potash, and rinsing it afterwards in a large quantity of water in order to free it completely from the weavers' dressing and the saliva of the spinners. In England and Ireland, machinery is employed for rinsing and beating: in some places this operation is performed by means of planks to which an alternate motion is communicated; but this mechanism wears the stuffs, though it greatly accelerates the operation. In place of such planks, which are too long, in our manufactories we employ stampers, placed in very large conical tubs, the levers of which change their direction every stroke, passing successively over the whole quantity of cloth immersed. But the best method of all is beating by mechanism. For this purpose a circular platform, which performs its revolutions around a moveable axis, and is supported at the ends of the spokes by rollers of cast iron, is employed: the circumference of this wheel is notched to receive a catch, which makes it recede one notch every stroke by the motion of the mill-tree. This tree bears on its axis spokes that raise several wooden beaters, which, falling on the moveable platform covered with cloth and thread, rinse them completely: buckets attached to the water-wheel raise the water, and pour it into gutters that convey it under the beaters, which are thus abundantly watered.

Cotton and cotton cloth require in particular this preparation; otherwise the ley could not penetrate to the inside of the cotton, on account of the extracto-resinous matter contained in it, as we have already observed in speaking of that substance.

In several manufactories a ley of soap is used: but all this comes to the same thing; that is to say, the combination of the oily matters with the alkali, in order to render them soluble in water, and then to the combination formed between a part of the colouring matter and that saline substance; an union most essential for bleaching. It is in these leys, therefore, and in rinsing in running water, followed by pressing or wringing, to free the cotton from all filth, that the preparations which precede immersion in the oxygenated muriatic acid consist.

The apparatus must be arranged according to the objects to be bleached: the skains of thread must be suspended in the tub destined for them, and the cloth must be rolled upon reels in the apparatus. When every thing is thus disposed, the tubs are filled with oxygenated muriatic acid by introducing a funnel, which defcends to the bottom of the tub in order to prevent the difperfion of the gas. The cloth is wound, or the frame-work on which the fkains are fufpended is turned feveral times, until it is judged, by taking out a fmall quantity of the liquor from time to time, and trying it by the acetite of lead, that it is fufficiently exhaufted. The weakened liquor is then drawn off, and may be again employed for a new faturation.

It is neceffary to immerfe alternately in oxygenated muriatic acid and alkaline leys of from a degree to a degree and a half of the areometer. The number of thefe immerfions and leys varies according to the nature of the vegetable fubftances. Cotton may be bleached by two operations; thread and cotton by three; fine linen by four; and hemp by five or fix. Preffure alone, or wringing, will be fufficient inftead of rinfing, when the articles are taken from the tub, and before they are fubjected to the ley; it is even neceffary that the carbon, generated by the action of the alkali, fhould unite with the oxygen of the liquor to form carbonic acid, which, being afterwards expelled, forms the whole fecret of the art of bleaching.

[To be continued.]

XXXVIII. *Some Account of the Life of* Placidus Fixlmillner, *the Aftronomer.*

PLACIDUS FIXLMILLNER was born on the 28th of May 1721 at Achleiten, a village in hither Auftria, not far from Kremsmunfter. He received the rudiments of his education in the convent of Kremsmunfter, which was indebted to his uncle the abbot, Alexander Fixlmillner, for an excellent fchool and an obfervatory. Placidus conceived an early attachment to the mathematics, and took fo much pleafure in delineating mathematical figures, that his mother, out of derifion, called him the almanac-maker. After fome ftay at the above feminary he removed to Salzburg, where he completed his courfe of philofophy, and obtained in that faculty the degree of doctor. His tafte for the mathematics, however, became ftill ftronger. His father having afked him one day what prefent he fhould give him, he requefted Wolf's Epitome of the Mathematics; which he ftudied with the greateft pleafure and fatisfaction during fuch hours as he could fpare from his other avocations: but, having deftined himfelf for the convent, he was admitted a no-

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viciate at Kremsmunster in 1737, and next year he publicly took the vows before his uncle, the abbot Alexander.

After a stay of two years in the convent his *oheim* sent him again to Salzburg to complete his studies in jurisprudence and theology; but at the same time he applied with great assiduity to the mathematics, languages, history, and antiquities. He learned also to play on the harpsichord and organ; and made so much progress in music, that he composed several pieces both in the sacred and theatrical style. He disputed in some theological theses; obtained the degree of doctor in theology; and in 1745 returned to his convent, where he was consecrated to the priesthood.

About this time the *Ritterschule* having been established at Kremsmunster, Placidus was appointed professor of canon law; a department in which he had acquired great reputation at the university. This office he held for forty years, and resigned it only a short time before his death. Almost about the same period he was appointed dean of the higher school, and soon after principal regent over the young nobility; which places he retained also till his death. He possessed great knowledge of the canon laws, and on that account was often employed in processes and other affairs relating to the convent: he was likewise inscribed *Notarius apostolicus in curia Romana*.

In the year 1760 he published a theological work under the title of *Reipublicæ Sacræ Origines Divinæ*; but he acquired far more celebrity by his astronomical labours, both as an observer and a writer. The abbot Alexander Fixlmillner, a great friend of the sciences, and particularly of the mathematics, having resolved, in the year 1747, to form an establishment in his convent for promoting the latter, first set apart a spacious apartment for the purpose of containing mathematical and philosophical instruments. This paved the way for something further; and he determined, for the improvement of his conventuals in astronomy, to erect an observatory. Among those convents which for a long time have devoted their leisure and riches to the advancement of science and the good of mankind, none has distinguished itself more than that of Kremsmunster. This very old abbey is not the seat of infidelity and indolence, but a patron of the noblest branches of science. The observatory founded in 1748 was completed in 1758, and the superintendence of it was intrusted to Eugenius Dobler, a brother of the order.

Alexander's successor, the abbot Berthold Vogel, who long resided at Salzburg as professor of canon law and rector of the university, being well acquainted with Fixlmillner's great

great knowledge, particularly in the mathematics, appointed him in 1762 to be astronomer at Kremsmunster, with leave to retain his office as professor of canon law. He now applied with great zeal to render himself more fit for his new occupation, as he had not yet attended much to practical astronomy, and was even but little acquainted with those books from which he could obtain information on the subject. His great attachment, however, to this science, fine genius, and a desire of being useful to the institution in which he resided, and to the world, made him overcome every difficulty. The first book that fell into his hands was Lalande's *Exposition du Calcul Astronomique*, with which alone, without any oral instruction, he began to study and to make observations. This work, together with Vlacq's logarithmic tables, were for a long time his only sources and guides, till he at length obtained Lalande's large work on astronomy. Fortunately, a carpenter, named John Illinger, born in a village belonging to the abbey, though he could neither read nor write, was able, under the direction of Fixlmillner, to construct for him very neat mural quadrants, zenith sectors, transit instruments, and pendulum clocks. Other instruments were made for him by Brander of Augsburgh, and he procured achromatic telescopes from Dollond; so that by his activity the observatory at Kremsmunster soon became one of the most celebrated, and best supplied with apparatuses, in Germany. His principal assistants were Theod. Derfflinger, who afterwards became his successor, and Father B. Waller.

Fixlmillner now acquired a considerable rank among astronomical writers. In 1765 he published his *Meridianus Speculæ Astron. Cremifanensis*, in which he established the first elements of his observatory, and determined its longitude and latitude. In 1776 he published his second astronomical work, called *Decennium Astronomicum*, which contained the observations made by him at Kremsmunster from 1765 to 1775, and which is replete with important and useful information. His third work, on which he was employed towards the close of his life, and which was printed after his death, appeared in 1791. It contains a valuable collection of observations made between the years 1776 and 1791, together with a great many calculations and treatises, which still add to his celebrity in this department. Besides these, many important articles written by him are to be found in the *Journal des Savans*; Bernoulli's Epistolary Correspondence; the French *Ephemerides des Move*; the Astronomical Almanac of Berlin; the Astronomical Ephemerides of Vienna; and the Memoirs of the Royal Academy of Sciences at Paris.

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The important ſervice rendered to the ſcience of aſtronomy by Fixlmillner is well known to all aſtronomers. The great number of his obſervations of Mercury, at a time when they were rare, and difficult to be made, enabled Lalande to complete his accurate tables of that planet, for which the French aſtronomer publicly returned him thanks. Fixlmillner was one of the firſt aſtronomers who obſerved the orbit of the newly diſcovered planet Uranus. He was alſo the firſt who ſupported Bode's conjecture, that the ſtar 34, in the Bull, obſerved by Flamſtead in the year 1690, and which afterwards diſappeared, was the new planet. Fixlmillner was a man of ſo great application and activity that he not only made obſervations, but calculated them all himſelf, and deduced from them the neceſſary reſults. All his obſervations, of whatever kind, he calculated on the ſpot; and to avoid errors he always calculated them a ſecond time. To uncommon induſtry he united great penetration and deep reflection, as is proved by the great many excellent remarks and diſcoveries to be found in his works. It muſt here be added, that this able aſtronomer lived in a remote part of the country, at a diſtance from all literary helps, and from others who purſued the ſame ſtudies; that is to ſay, from all thoſe things which could animate his zeal; and yet he continued, till the laſt day of his life, a ſingular inſtance of perſeverance and attachment to his favourite ſtudy. But few men were ſo little ſubject to the imperious power of the paſſions. Simple in his manners, he poſſeſſed great equanimity and firmneſs, like the immutable laws of nature which he ſtudied. His wide extended celebrity did not render him proud: whatever was written or ſaid in his praiſe, he endeavoured rather to conceal than to publiſh. His cloſe application at length impaired his health, and brought on obſtinate obſtructions, which ended in a diarrhœa. He died on the 27th of Auguſt 1791, in the 71ſt year of his age, the 53d of his reſidence in the convent, and the 46th after his entering into the prieſthood.

XXXIX. *A brief Account of the Origin and Progreſs of Letter-preſs-plate or Stereotype Printing.*

HAD I liſtened to the ſolicitations of friends, I ſhould long before this time have publiſhed ſome account of an art to the advancement of which I had in ſome degree contributed, and in which, I may affirm, I was tolerably proficient upwards of twenty years ago: I might add, that the

idea

idea was truly my own—for ſuch was the fact—but in perfecting the invention I had the aſſiſtance and joint labour of another. At the time of the diſcovery I flattered myſelf that we were original; and, with thoſe ſanguine ideas which are natural to a young man, indulged the hopes of reaping ſome fame at leaſt from the diſcovery: nay, I was even weak enough to feel vexed when I afterwards found that we had been anticipated by a Mr. Ged, of Edinburgh, who had printed books from letter-preſs plates about *fifty years before!* The knowledge of this fact leſſened the value of the diſcovery ſo much in my eſtimation, that I felt but little anxiety to be known as a ſecond inventor; and but for the perſevering attempts of others to deprive Ged of the fame his memory ſo juſtly merits, and which he dearly earned, I might have ſtill remained ſilent.

It is not my intention at preſent to enter into a detail of particulars reſpecting the proceſſes connected with letter-preſs-plate or ſtereotype printing, nor would it be proper without previouſly obtaining the concurrence of Mr. Foulis, the gentleman who aſſiſted me in my labours. Much leſs is it my intention to enter into a hiſtory of printing in general; a few remarks, however, reſpecting its varieties may not prove unacceptable to ſome readers.

Impreſſing forms or images upon various ſubſtances, as clay and metals, by means of ſeals, ſtamps, dyes, punches, and the like, muſt have been an early invention: antique coins, antient bricks with inſcriptions on them, &c. are proofs of this. In this caſe, the body to be impreſſed muſt be in a ſtate comparatively ſoft and plaſtic, and the ſeal or other ſtamp is applied with ſuch a force as to make it leave its image IN *the ſubſtance* of the clay or metal. The tranſition from this to printing, which, in its ſimpleſt form, conſiſts in ſmearing over or daubing the prominences of a ſtamp with any coloured ſubſtance, that when applied to another body it may leave its impreſſion ON *the ſurface* of ſuch body, appears ſo ſimple, ſo eaſy, and natural, that it has been a matter of much wonder to the moderns that it ſhould not have been diſcovered for ſo many ages; not, indeed, till within theſe few centuries. This obſervation, however, does not apply with all its force to the Aſiatics; for in China the period of the diſcovery is ſo remote as to baffle any attempt that might be made to fix the æra of printing from blocks in that country.

Printing from blocks may be conſidered as the firſt ſpecies of printing properly ſo called. The end intended by this proceſs is obtained by cutting, upon a flat block of wood or metal, but commonly the former, the words or ſentences intended

tended to be multiplied by printing; and the cutting is managed in ſuch a manner, that the letters are left prominent, and preſent the original ſurface of the block, while every other part of the ſurface is cut down ſo much lower, that the paper, linen, or other material to be printed, when applied to the block or *vice verſa*, can come in contact with no part of the bottom of the inciſions, but only with the projecting places which preſent the letters. The block being provided, its ſurface is either applied to another flat ſurface covered over with a coloured compoſition, as is the practice with calico printers, by which means it receives a ſufficient charge to enable it to give off a portion of the colour, and, with the colour, its own form to the ſtuff to which it may then be applied; or the colour is diffuſed over its ſurface by means of a ball, commonly made of ſoft ſkin ſtuffed with wool, as is the practice with book-printers, in which caſe the coloured body gets the name of *printing ink*, and the paper receives the impreſſion by being applied to, and preſſed upon, the block. Were the block applied to the paper, the effect would be the ſame; but in practice it is found much more convenient to apply the paper to the block, for one reaſon among others—the paper is the lighteſt, and the eaſieſt taken up in the hand.

This kind of printing, from the beſt information that can be collected, appears to have been applied to the manufacture of playing cards long before any idea was entertained of multiplying copies of books by its means. Theſe cards had various kinds of figures upon them; and among others, we may obſerve in paſſing, one called the *devil*; and hence, probably, the antipathy expreſſed by many againſt all games with cards; and hence, too, may have come the opprobrious name given to them of *the devil's book*.

At length the idea of copying MSS. by means of blocks was taken up in Europe in the fifteenth century, and ſeveral books were ſoon executed in that manner, which may be called the firſt ſpecimens of European ſtereotype. It was a wonderful help to the propagation of truth; and the facility with which books could be thus multiplied, compared with the trouble of writing them, would have left little cauſe for wonder, had it induced men to be ſatisfied for a long time with this firſt ſtep in typography.

This method, however, continued but a ſhort time in practice till it ſuggeſted another. Cutting or engraving a block for every page, was a work accompanied with conſiderable labour and expenſe: to cut ſeparate letters on ſmall pieces of wood, which might be arranged afterwards in any manner wanted,

wanted, appeared to be a likely way of ſtill further reducing the price of *book-making*, as the ſame types might be afterwards employed for different works.

This advance in the art was alſo ſoon obtained, but ſtill printers were not ſatisfied. A great number of each particular letter was required to enable them to ſet up or compoſe (as putting the letters together is called) a ſingle ſheet of any work; each letter was to be cut and adjuſted with ſuch accuracy, as to make it ſtand exactly to the ſame height of every other letter; and all ſo as to range well with each other. If the cutting of *a ſingle alphabet* could be made to anſwer inſtead of ſo many, what a ſaving of labour! Can we wonder that the attempt was made? It ſucceeded, and gave riſe to a new art, that of the type-founder, as practiſed at this day.

In this art, the letters are firſt cut upon ſteel punches: theſe are afterwards hardened, that they may bear ſtriking into pieces of copper, in which they leave their impreſſion, which pieces, called *matrixes*, being furniſhed with a proper apparatus for forming the ſtalk or ſhank of the type, ſerve as moulds, from which any number of types may be caſt, every one exactly like its original punch.

Thus we ſee that book printing has been, in its progreſs, connected with arts very different in themſelves. At its firſt origin the blockcutter was the principal agent in producing the copy of the MS. Preſſmen were alſo neceſſary. In its next ſtep, the block-cutter turns letter-cutter, each like each other in height and body, that they might range properly in lines; a labour ſo prodigious that words cannot convey any idea of the mechanical patience it muſt have required! Another ſet of workmen now became neceſſary, a new buſineſs was formed, that of the compoſitor; the perſon who arranges the letters into words, lines, and pages. The third ſtage of the art was that in which moveable metallic types were employed, which embraces the arts of the punch-cutter, the ſinker and adjuſter of the matrixes, the mould-maker, (the mould, properly ſpeaking, is that part of the apparatus which forms the ſhank or body of the type; the letter formed by the matrix is called the *face*;) the type-founder, the compoſitor, and the preſſman.

This kind of printing is called *letter-preſs*, to diſtinguiſh it from another, which is radically different both in the mode of its production and in that of its working—we mean copper-plate work.

Engraving on metals is an art of great antiquity. Almoſt every kind of antient armour that has yet been found, as alſo many antique houſehold implements, are embelliſhed with engravings of leſs or more merit. We ſpeak not now of

ſculptures

ſculptures and carvings in metal, which are probably equally antient, but of engraving, properly ſo called, figures of flowers, animals, men, formed on ſurfaces more or leſs uniform, by inciſions or lines cut into them with graving tools. But though the origin of this art is ſo remote that it cannot be determined, that of taking impreſſions, or printing from ſuch engravings, appears to have been diſcovered ſubſequent to the art of letter-preſs printing. It is performed by rubbing over the plate with printing ink, and then cleaning its ſurface in ſuch a manner that the ink may ſtill remain in the inciſions. Moiſtened paper is then laid upon the plate, and both are paſſed through between rollers, with a piece of blanket or ſoft cloth on the back of the paper, which forces the latter into the inciſions, and brings it into contact with the ink left in them, a portion of which adhering to the paper, gives to it the forms engraved on the copper. This kind of printing, from the manner in which the impreſſion is obtained, is called *rolling-preſs*, and ſometimes *copper-plate printing*.

By the progreſſive ſteps which we have endeavoured briefly to enumerate, typography was brought to that ſtate of perfection to which it has attained. It is a curious fact, however, that all the improvements followed each other in ſuch quick ſucceſſion, that in a few years from its firſt invention in Europe, we find the printers in poſſeſſion of all our common modes of working, and producing ſpecimens of their art, which even now cannot be ſurpaſſed. Some of the early printed miſſals upon vellum are proofs of this.

But if we have reaſon to be ſurpriſed at the quick ſteps by which printing with moveable types was perfected, we have more cauſe to wonder why with the acquiſition of moveable types the art became ſtationary. The tranſition from ſolid pages, *cut at an expenſe and labour beyond the value of the intereſt of any capital that could be required to be ſunk in printing an edition of any work*, made it a deſirable object to deviſe means for making *the ſame letters* do over and over, not only for different ſheets in ſucceſſion of the ſame work, but for ſubſequent publications. Hence came the firſt moveable types; which, however, as we have already obſerved, were all *cut* ſingly. The ſucceſs which followed the attempts made to leſſen this labour of *cutting*, by making well formed letters *once cut* ſerve for ever, by the facility of multiplication which founding afforded, ought, one would think, inſtantly to have led to a further improvement. If founding could be applied to ſingle letters, *why not to pages*, to get rid of a ſacrifice of capital ſubmitted to at firſt, becauſe of the

the enormous expense of block cutting! Founding of pages, on the first view of it, promises many advantages in point of economy; and to science it holds out what can never otherwise be obtained—the possibility of procuring in a short time *immaculate editions*. From books cast into solid pages, no more copies would be printed than might be wanted for immediate sale; the money thus saved from being sunk in paper, to be piled up in warehouses for years, as at present, would serve as surplus capital to print other works; and thus the printer, his workmen, and the booksellers, would all be benefited; (for it would be easy to prove, did our present limits allow it, that not only the business of the pressmen, but of the compositors, would be materially benefited and increased by the general adoption of such an improvement) and all errors as soon as discovered could be rectified in the plates, to prevent them from appearing in after copies, instead of running through a large edition as at present.

Such considerations as I have just stated first led me to turn my thoughts to the improvement of the art of printing; and the more I thought upon it, the more I became convinced of its practicability. I communicated my ideas upon the subject to Mr. Foulis, printer to the university of Glasgow, my native city, and where I then resided, who furnished me with a page of types ready set up, or composed, for my first experiment, which had sufficient success to induce me to try others, and convinced Mr. Foulis of the possibility of producing plates, which would yield impressions not to be distinguished from those taken from types.

If I had seen some of the advantages which such a plan promised, Mr. Foulis saw and pointed out many more, of such a nature as could only present themselves to a regular bred practical printer. We agreed to prosecute the business together, and, if possible, to bring it to perfection, and in pursuance of this resolution performed, I may say, innumerable experiments, till we at last overcame every difficulty, and were able to produce plates, the impressions from which could not be distinguished from those taken from the types from which they were cast.

In the mean time we learnt that our art, or one extremely similar, had been practised many years before by Mr. Ged, as I have before observed; and soon after the world was favoured, by Mr. Nicholls, with an interesting pamphlet entitled "Biographical Memoirs of William Ged; including a particular account of his progress in the art of block printing*." The first part of the pamphlet, as the editor

* London: printed by and for J. Nicholls, MDCCLXXXI.

informs

informs us, was printed from a MS. dictated by Ged fome time before his death: the fecond part was written by his daughter, for whofe benefit the profits of the publication were intended: the third was a copy of propofals that had been publifhed byMr GED's fon in 1751, for reviving his father's art; and to the whole was added Mr. MORES's narrative of block printing.

From this publication it appears, that fo far back as the year 1725 Mr. Ged had begun to profecute plate-making. In 1727 he entered into a contract with a perfon who had a little capital but who on converfing with fome printer got fo intimidated that at the end of two years he had laid out only 22l. In 1729 he entered into a new contract with a Mr. Fenner, Thomas James a type-founder, and John James the architect; and fome time after a privilege was obtained from the univerfity of Cambridge to print bibles and prayer-books. But it appears that one of his partners was actually averfe to the fuccefs of the plan, and engaged fuch people for the work as he thought moft likely to fpoil it. A ftraggling workman who had wrought there informed Mr. Mores "that both bibles and common prayer-books had been printed, but that the compofitors when they corrected one fault made purpofely half a dozen more, and the preffmen when the mafters were abfent battered the letter in aid of the compofitors. In confequence of thefe bafe proceedings, the books were fuppreffed by authority, and the plates fent to the King's printing-houfe, and from thence to Mr. Cafion's foundery."

After much ill ufage, GED, who appears to have been a perfon of great honefty and fimplicity, returned to Edinburgh. His friends were anxious that a fpecimen of his art fhould be publifhed, which was at laft done by fubfcription. His fon, James Ged, who had been apprenticed to a printer, with the confent of his mafter fet up the forms in the night-time, when the other compofitors were gone, for his father to caft the plates from; by which means Saluft was finifhed in 1736. Of this work I have a copy, and, which is more fingular, the plate of one of the pages; and from it the fpecimen of Ged's work given with the prefent article was printed. This plate I firft faw in the hands of the deceafed Mr. John Murray, bookfeller, in the year 1782, but do not now recollect the way in which he faid it came into his poffeffion. Having about a year ago applied to his fucceffors in bufinefs, Meffrs. Murray and Highley, to requeft, if the plate could be found, that I might be allowed to take fome impreffions from it; they very politely infifted on my acceptance of what they had used for years as a flat weight to lay upon papers on the end of the desk. After what I have just stated, I need hardly add that the plate has received considerable injury, and that it would be unfair to judge by its present appearance of the degree of perfection to which Ged had brought the art. It is extremely probable too, that the forms from which he made his moulds were composed of worn types, which will always produce plates that may be said to be worn before they are used.

Besides the Saluft, I have another work printed some years after from plates of Mr. Ged's manufacture. The book is "*The Life of* GOD *in the Soul of Man*," printed on a writing pot, 12mo, and with the following imprint: "NEWCASTLE: *Printed and sold by* JOHN WHITE, *from plates made by* WILLIAM GED, *Goldsmith in Edinburgh*, MDCCXLII." It is a very neat little volume, and is as well printed as books generally were at the time.

Though we had reason to fear from what we found Ged had met with, that our efforts would experience a similar opposition from prejudice and ignorance, we persevered in our object for a considerable time, and at last resolved to take out patents for England and Scotland, to secure to ourselves, for the usual term, the benefits of our invention; for the discovery was still as much our own as if nothing similar had been practised before; Ged's knowledge of the art having died with his son, whose proposals for reviving it, published in 1751, not having been followed with success, he went to Jamaica, where he died. The patents were accordingly obtained; nay, they are even expired: and yet we hear people, who only began their stereotype labours *yesterday*, taking to themselves the merit of being the first inventors!—As to *benefits*, however, I have as yet reaped none, and Mr. Foulis I believe has reaped as few; for, owing to circumstances of a private nature, and which no way concern the public to know, the business was laid aside for a time; and having afterwards quitted Glasgow and removed to London, I soon found myself so much occupied with other concerns, that I have hardly had time even to think upon it since. I ought however to observe here, that its being suspended was not on account of any imperfection attending the art, or objections against its being a fit object to be prosecuted. On the contrary, several small volumes were actually printed from plates made by myself and Mr. Foulis, and the editions were sold to the trade without any intimation of their being printed out of the common way! We had heard whispers that our work could not possibly be such as would pass for *com-*

mon printing! The trade knew what we were at, and would *take care* of any thing done in the *new-fangled* way! The first essays, therefore, were in the lowest sense of the word common: one or two *histories**, and a cheap edition of The Economy of Human Life. We also printed a Greek volume, *Xenophon's Anabasis*, 1783, and had plates for several small volumes of the English Poets almost finished, but the latter were never put to press. Having preserved two or three of the plates made along with Mr. Foulis, I shall subjoin to the present account a specimen of one or two. They have been damaged by lying about for a number of years, and by a carriage of 400 miles; yet I shall offer no apology for their appearance.

Twice then had this art been invented and practised in Britain, when about three years ago DIDOT, the celebrated French printer, applied it to logarithmic tables, and afterwards to several of the Latin classics, and to various French publications, which he has executed with considerable accuracy. The press-work has been carefully attended to, and does great credit to the printer. Indeed, after what Didot has done, clamour and prejudice will attempt in vain in future to decry letter-press-plate, and his name will always be mentioned as a principal promoter of this useful art, the introduction of which will be marked as a singular æra in the history of printing. Some of his countrymen indeed (for I cannot suppose Didot would attempt it) wish to ascribe to him the whole merit of the invention, and to have it believed that it originated with himself. The facts I have stated show with how little justice this claim is made. It is true he may have discovered, for himself, the secret of the art; but it is hardly credible that he could be ignorant of Ged's progress and of ours, especially as it is well known that, when patents are obtained, a specification of the process is obliged to be put upon record, of which any one may obtain an office copy at a small expense.

Having stated what relates immediately to the invention of modern Stereotype, it would not be ingenuous were I not to state that claims have been set up in favour of a Dutchman as having practised the art even prior to Ged. The following extract, translated from *Niew Algemein Konst en Letter Bode* 1798, No. 232, will put our readers in possession of all we have yet met with respecting this printer.

* A kind of books technically so called such as *The Seven Champions of Christendom*; *The Twelve Cæsars*; *The History of Valentine and Orson*; *The French Convert*; and such scientific and classical performances, of which great numbers are annually exported to America.

"Above a hundred years ago, the Dutch were in possession of the art of printing with solid or fixed types, which in every respect was superior to that of Didot's stereotype. It may, however, be readily comprehended that these letters were not cut in so elegant a manner, especially when we reflect on the progress which typography has made since that period. Samuel and J. Leuchtmans, booksellers at Leyden *, have still in their possession the forms of a quarto Bible which were constructed in this ingenious manner. Many thousand impressions were thrown off, which are in every body's hands, and the letters are still good.

"The inventor of this useful art was J. Van der Mey, father of the well-known painter of that name. About the end of the 16th century he resided at Leyden. With the assistance of Muller, the clergyman of the German congregation there, who carefully superintended the correction, he prepared and cast the plates for the above-mentioned quarto Bible. This Bible he published also in folio, with large margins ornamented with figures, the forms of which are still in the hands of Elwe, bookseller at Amsterdam *: also an English New Testament, and Schaaf's Syriac Dictionary, the forms of which were melted down; and likewise a small Greek Testament in 18mo.

"As far as is known, Van der May printed nothing else in this manner; and the art of preparing solid blocks was lost at his death, or, at least, was not afterwards employed. The cause may readily be conceived; for, though this process in itself is very advantageous, it is far more expensive than the usual method of printing, except in those cases when such works are to be printed as are indispensably necessary, and of standing worth. The number of these, however, is certainly small; especially as we are acquainted with no instance in the annals of Dutch printing, that any dependance can be placed on the sale of 150,000 copies, as was the case with the brothers Guyot."

The publisher of the preceding notice supposes, nay, asserts, that the expense of stereotype precludes its use, ex-

* Should the present article chance to meet the eyes of Messrs. Leuchtmans or Elwe, the gentlemen mentioned in this extract as being possessed of some of Van der May's forms, they would confer a personal favour on the author of the present article, and at the same time a service to truth, if they would have the goodness to part with the plates or blocks of a few pages, and forward them to his address in London by any of the vessels which bear his Prussian majesty's flag, and which are daily passing between the two countries. By inspecting them, he thinks he could determine whether Van der May's process was the same that he himself has practised.

cept

cept in the caſe of ſtandard authors, whoſe works are ſure of an extenſive ſale: but, unhappily for his mode of reaſoning, exactly the converſe of this is the truth; for, if there wou'd be an advantage in applying the ſtereotype art to books of ra id ſale, there would be a ſtill greater one in the caſe of thoſe publications whoſe ſale may be leſs certain, as at the worſt there could only be the loſs of the plates, in place of that of the paper and preſswork of a whole edition, which, in almoſt every caſe, would amount to a much larger ſum. The expenſe, then, attending the proceſs (if, indeed, Van der May's was the ſame as ours) was not the cauſe of its being laid aſide in Holland. The probability is, that his art died with himſelf; for we find that Ged had "offers from Holland, repeatedly, either to go over there, or ſell them his invention *;" which would not have been the caſe had they been poſſeſſed of their own countryman's. A. T.

XL. *Communication from Profeſſor* M. A. Pictet, *of Geneva, (now in London,) on Flexible Stones, addreſſed to the Editor.*

Sir, Brompton Row, No. 45, Auguſt 20, 1801.

In reading lately in your very intereſting Journal (Vol. X. p. 83.) a deſcription of the *elaſtic quartz*, or *flexible ſand-ſtone*, from Brazil, I wondered that the author † had not mentioned a ſimilar phænomenon which has been obſerved in another ſtony ſubſtance, commonly as inflexible as any ſiliceous aggregate, but thoroughly different in point of chemical compoſition—I mean the table of *elaſtic marble*, which is ſhown at Rome as a great curioſity. A friend of mine, M. Fleuriau de Bellevue, from La Rochelle, who had ſeen it, gueſſed at the cauſe of its flexibility, and went ſo far as to render, by a particular proceſs, any given ſpecimen of Carrara marble as evidently flexible as the table in queſtion. He purſued at Geneva the ſeries of experiments which led him to that diſcovery, and read to our Society of Phyſics and Natural Hiſtory an account of the whole, which has been ſince publiſhed in La Metherie's *Journal de Phyſique*. The following are the leading facts:

That ſpecies of marble conſiſts, as you well know, in a confuſed aggregation of ſmall irregular cryſtals interwoven

* Biographical Memoirs of W. Ged, p. 16.

† Klaproth.

in all poſſible directions, and adhering to one another by a certain degree of coheſive force. He thought that if he could, by any proceſs, deſtroy that adherence, without altering much the ſolidity of the cryſtals themſelves, he might thus obtain a looſe, but entire, ſtony aggregate, which would become flexible on account of the relative mobility of the integrant cryſtals, but keep its ſolidity and preſerve its form in conſequence of their being deeply implicated and interwoven among themſelves.

According to that theory, he undertook a ſeries of experiments by expoſing ſlips of marble to the action of fire in ſand-baths of regularly graduated and well aſcertained temperatures: he thus found a point where the adheſion of the cryſtals was looſened, without any material alteration in their hardneſs. He gave to his friends ſome ſpecimens of Carrara marble thus rendered flexible. I have one of them in my poſſeſſion here in London, which may be ſeen by any perſon who ſhould yet entertain any doubts as to the poſſibility of the fact.

Now, a volcanic fire may have acted on a large maſs of marble nearly as my friend's furnace has done on his ſmall ſpecimens; and this explanation of the natural phænomenon I conſider as being as near to truth as moſt of our conjectures on ſimilar ſubjects can be.

I am, Sir, with true regard,
Your moſt obedient humble Servant,

Mr. Tilloch. M. A. PICTET, F.R.S. Lond. et Edinb.

XLI. *On the Velocity of Water Wheels. By Mr.* ROBERTSON BUCHANAN, *Engineer. Communicated in a Letter to the Editor.*

DEAR SIR, London, No. 75, Piccadilly, 14th Auguſt, 1801.

THE accompanying paper was read in May 1799, in a Philoſophical Society at Edinburgh. I offer it to you with diffidence, knowing that it contains things contrary to received opinions. Having, however, made no wilful error, if you think proper to publiſh it in your Magazine, it may induce thoſe who have leiſure and abilities to enter more fully into the inveſtigation of the ſubject.

I am, dear Sir,
Your very humble Servant,

Mr. Tilloch. ROBERTSON BUCHANAN.

THERE are many cafes in which it is of importance to know the proportion of power neceffary to give different degrees of velocity to a mill *. But as the conftruction of mills, and the purpofes they ferve, are various, it is perhaps impoffible to find any law of univerfal application. Mr. Banks, in his Treatife on Mills †, has drawn a conclufion, which he appears to confider as invariable, namely, that " when a wheel acts by gravity, its velocity will be as the cube root of the quantity of water it receives."

But if we fuppofe a wheel raifing water, by means of cranks and pumps, on Mr. Banks's principle, it might eafily, I think, be demonftrated, that, by reducing the velocity of the wheel to a certain degree, the wheel would raife more water than would be neceffary to move it at that velocity; a thing evidently impoffible.

In this view, it would feem there is no actual cafe in which Mr. Banks's conclufions will hold true. But, however they may apply to other mills, the experiments which I am going to mention feem to me to prove, at leaft, that they do not apply to cotton mills. On the ground of thefe experiments, made at different times, and with all the attention in my power, (and not from any abftract confideration,) have I prefumed to call in queftion an authority for which I entertain the higheft refpect.

In January 1796 I meafured the quantity of water the old Rothefay cotton mill required, 1ft, when going at its common velocity; and, 2dly, when going at half that velocity. The refult was, that the laft required juft half the quantity of water which the firft did. It is to be obferved, that in thefe experiments the quantities of water were calculated from the heads of water and apertures of the fluices.

From thefe experiments I inferred, " that the quantity of water neceffary to be employed in giving different degrees of velocity to a cotton mill, muft be nearly as that velocity."

I was fatisfied with this experiment, and the inference I drew from it, till fome gentlemen, well acquainted with the theory and practice of mechanics, expreffed their doubts on the fubject. I had then recourfe to another experiment, which I confidered as lefs liable to error than the former.

The water which drives the old cotton-mill falls, a little below it, into a perpendicular-fided pond, which ferves as a dam for a corn-mill. To afcertain, therefore, the propor-

* It was a fcarcity of water for the Rothefay mills which directed my attention particularly to this fubject.

† See Banks on Mills, p. 17, 18. 144, 145, 146.

tional quantities of water uſed by the old mill, nothing more was neceſſary than to meaſure the time the water took to riſe to a certain height in that pond; and accordingly, on the firſt of May 1798, I made the experiments noted in the following table:

1	2	3	4	Number of experiments.
46	46	24	23	Revolutions of one of the upright ſhafts per minute.
5	5	5	5	Riſe of water in the pond in inches.
6.58	6.57	14.45	15.0	Time in minutes and ſeconds.

The firſt and ſecond experiments were made with the mill at its common velocity; the third and fourth at nearly half that velocity.

The time which the mill required to uſe the ſame quantity of water in theſe experiments may be taken in round numbers; the proper velocity at 7 minutes, and half that velocity at 15 minutes.

The reſult of theſe experiments approaches very nearly to that of 1796. The difference may be accounted for by the ſmall degree of leakage which muſt have taken place at the ſluices on the lower end of the pond; and the time being greater in the third and fourth experiments, the leakage would, of courſe, be greater.

Mr. Smeaton * and others have proved, in a very ſatisfactory manner, that "the mechanical power which muſt be employed in giving different degrees of velocity to the ſame body muſt be as the ſquare of that velocity" But it appears to me that the reſult of the above experiments may be eaſily reconciled to this propoſition by conſidering what Mr. Smeaton ſays immediately afterwards:—"If the converſe of this propoſition (ſays he) did not hold true, viz. that if a body in motion, on being ſtopped, would not produce a mechanical effect equal or proportional to the ſquare of its velocity, or to the mechanical power employed in producing it, the effect would not correſpond with its producing cauſe." Now, it is to be obſerved, that Mr. Smeaton's experiments were made on the *velocity* of heavy bodies *free from friction* and

* See Smeaton on Mills, p. 18.

other

other causes of resistance; but in mills there is not only friction, but obstacles to be removed: and experiments made on friction have proved that the frictions of many kinds of bodies increase in direct proportion to their velocity. But the velocity of a cotton-mill at work may be considered as a mechanical effect, and, if so, must correspond with its producing cause.

XLII. *Account of a new Instrument for the Extraction of Teeth, by the Inventor,* Mr. REECE, *Member of the Royal College of Surgeons, London.*

SIR, Craven-Street, Strand, Aug. 15, 1801.

IN the first Number of the second Volume of your very useful Publication is an account of an instrument for the extraction of teeth, which the inventor (a Mr. Brown) represents as a *very great improvement* of the German key instruments. This *great improvement* consists in a depression on the front of the fulcrum, which (as he observes) "forms a bed to receive the tooth." The experiments of Mr. Brown, I am well informed, were made on an old jaw of a skeleton, the alveolar process of which being imperfect, the application of the concaved fulcrum to the convexity of the tooth was easily admitted; and, no doubt, its extraction effected "without much violence to the jaw, or pain to the patient." But in the *living subject*, the alveolar process and contiguous soft parts being interposed between the *concaved* fulcrum and the tooth, the *great advantages* derived from this *invention* are, an unavoidable laceration and contusion of the gum, and great violence to the jaw-bone and socket, producing troublesome inflammation and often alarming hemorrhagies, from there being no corresponding eminence of the gum, on which it rests, to fill up the hollow (the bed) of the fulcrum: the corners, by the pressure necessary for the expulsion of the tooth (which, when firm, is very considerable) are productive of very serious mischief; and those practitioners who were induced to give these instruments a trial, experiencing their bad effects, have returned them to the maker.

Similar effects (however, in a much less degree) too often arise from the pressure of the heel of the instrument in common use, and the oblique direction in which the tooth is extracted; to obviate which I have invented an instrument which, by the peculiar curvature of the claw, elevates the tooth in nearly a per-a perpendicular direction, and from the structure of the fulcrum, the pressure, not falling on the gum till the tooth is a little raised, is very trifling for its complete expulsion, by which means the injury of the jaw-bone and contusion of contiguous soft parts are avoided, and, consequently, the most painful part of the operation. The surrounding gum being previously separated by the scarificator (which accompanies it) from the tooth, that the claw of the instrument may be applied as low down as the alveolar process will admit of, the upper part of the fulcrum will, on turning the instrument, apply itself exactly opposite to the end of the claw; the operation is afterwards performed with the greatest facility, and my patients have uniformly expressed their surprise at the slight pain they experienced. As the instrument may be seen at Mr. Whitford's, surgical instrument maker, St. Bartholomew's Hospital, who is fully competent to give every information respecting it, I judge any further delineation of it here unnecessary.

Should the instrument I now recommend to the attention of my professional brethren meet with their support by the result of practice, I shall be amply rewarded for my trouble by the honour of their approbation.

I am, Sir,

Your very obedient Servant,

To Mr. Tilloch. RICHARD REECE.

XLIII. *Account of New Publications, &c.*

I. *An Account of Travels into the Interior of Southern Africa, in the Years 1797 and 1798: including cursory Observations on the Geology and Geography of the Southern Part of that Continent; the Natural History of such Objects as occurred in the Animal, Vegetable, and Mineral Kingdoms; and Sketches of the Physical and Moral Characters of the various Tribes of Inhabitants surrounding the Settlement of the Cape of Good Hope. To which is annexed a Description of the present State, Population and Produce of that extensive Colony; with a Map constructed entirely from actual Observations made in the Course of the Travels. By* JOHN BARROW, *late Secretary to the Earl of Macartney, and Auditor-General of the Public Accounts, at the Cape of Good Hope. 4to.* CADELL *and* DAVIES.

THE nature and design of this publication are so fully expressed in the title as to leave us nothing to add on these points.

points. The work is executed in a maſterly manner, and contains much new and uſeful information in the various branches which it embraces. Naturaliſts in particular will be highly gratified, while readers of every deſcription will receive from it much amuſement and inſtruction. The account of the Table and Paarlberg Mountains, given in the preceding pages, is an extract from this work, and may ſerve as a ſpecimen of the author's ſtyle, which is neat and perſpicuous.

II. PIEN-HOE-YE, *The Explanation of the elementary Characters of the Chineſe, with an Analyſis of their ancient Symbols and Hieroglyphics. By* J. HAGER, D. D. *Fol.* Phillips, St. Paul's Church-Yard.

THIS work is the commencement of a great enterpriſe which Dr. Hager propoſes to undertake, viz. a Chineſe Dictionary, and for which he has been collecting materials. As want of room will not permit us to give an analyſis of it, we muſt be contented with obſerving, that after a prelimi ary diſcourſe which diſplays much ingenuity and learning, the author proceeds to explain the elementary characters or keys, which are in number two hundred and forty, and of which a dictionary is given. Each compound character contains one of theſe two hundred and forty elementary characters, which ſerves it as a baſe. The order in which the elementary characters is placed, is determined by the number of pencil-ſtrokes of which they are formed; they are divided into ſeventeen claſſes, the firſt of which is formed of one, and the laſt of ſeventeen, pencil-ſtrokes. Thus, when we wiſh to find an elementary character in the dictionary, we muſt obſerve of how many pencil-ſtrokes it is formed, and this will be ſufficient to aſcertain the principal claſs to which it belongs; the place which it occupies in this claſs is merely arbitrary. The ſame operation will ſerve for finding a compound character; we muſt firſt ſeek for the elementary character, which ſerves it as a key; and whe this is found, we can aſcertain without difficulty to which of the two hundred and fourteen ſecondary claſſes compoſing the dictionary it belongs. This work muſt be of great utility to thoſe who are deſirous of ſtudying the Chineſe language. A reſpectable French Journal (*Magazin Encyclop dique, Meſſidor An.* 9) ſpeaking of it ſays, "We ſincerely wiſh that Dr. Hager may meet with every encouragement to go on with the publication of this important dictionary; and we have no doubt that his name, already juſtly celebrated, will be claſſed among thoſe of of the literati who have greatly contributed to the glory of their age by extending the boundaries of the republic of letters."

XLIV. *Proceedings of Learned Societies.*

ROYAL ACADEMY OF SCIENCES AT COPENHAGEN.

THIS Academy has propoſed the following

Prize Queſtions.

1ſt, It is required to determine whether oxgyen or the gaſes which contain it are abſolutely neceſſary for the expanſion of chickens or other birds in the egg, or whether it be poſſible that this expanſion may take place in irreſpirable gaſes, and in what kind.

2d, What is the influence of poſitive or negative electricity on the elaſticity of the air, and its faculty of receiving water in the ſtate of gas or vapour?

The prize for each of theſe queſtions is a gold medal, of the value of a hundred Daniſh crowns. The papers muſt be tranſmitted to the ſecretary of the ſociety before the end of September 1802.

ROYAL SOCIETY OF GOTTINGEN.

The following queſtion, propoſed as the ſubject of a prize, will be decided in the month of November 1801:—

As the great difference between the oriental hiſtorians and the Greek and Roman writers, in regard to the hiſtory of the antient kingdom of Perſia, has not yet been properly elucidated, the ſociety requires that it may be critically examined, and in ſuch a manner that, neglecting the oldeſt and fabulous kings, the ſubject may be confined to the hiſtorical age after Alexander, that is, the Greek and Parthian kings, or the families of the Arſacidæ and the Saſſanidæ. The kings of theſe dynaſties, together with ſome account of their reigns, muſt be collected from the oriental writers. The ſources from which theſe derived their information muſt be examined, the chronology of theſe kings and periods muſt be compared with the Greek and Roman chronology, and the cauſes of their diſagreement muſt be examined; alſo the means of reconciling them, and which method of computation in regard to hiſtorical truth ought to be preferred.

XLV. *Intel-*

XLV. *Intelligence and Miſcellaneous Articles. Auguſt,* 1801.

ON the 1ſt of January laſt another NEW PLANET is ſaid to have been diſcovered by M. Piazzi, of Palermo, and obſerved by *him alone* for ſix weeks, when he fell ill. It ſeems he concealed the diſcovery, to preſerve all the honour to himſelf, and to enjoy excluſively, for a time, at leaſt all the obſervations. While he obſerved it, it deſcribed an arch of about 10°.

M. Bode thinks it may be not a comet, but a planet between Mars and Jupiter; but ſays however that the arch is too ſmall to allow much confidence to be placed on the calculations of an elliptical orbit, which have been formally made by Dr. Burchardt, aſſiſtant to De Lalande, and publiſhed in Zach's journal.

Burchardt gives its place, computed from his elements for ſome time to come. It was paſt its oppoſition to the ſun, and of the ſize of a ſtar of the 8th magnitude: its mean diſtance from the ſun 2·57 times that of the earth, and the periodical time nearly four years and two months: its eccentricity ſmall; inclination of orbit between 11° and 12°. It was in its aphelion on the beginning of January.

It will ſoon be known whether theſe calculations be well founded or not, when the planet, if it be one, comes again to be viſible by withdrawing from the ſun's rays.

METEORS.

On the night of June 19th, between twelve and one, a moſt beautiful phænomenon was obſerved at Hull, from the S. W. reſembling an immenſe moon, with a black bar acroſs on its firſt appearance; it ſeemed then gradually to form itſelf into ſeven ſmall diſtinct moons, or globes of fire, which diſappeared for the ſpace of a few ſeconds. Its re-appearance was equally brilliant, at firſt ſhowing itſelf like the face of the moon, afterwards in five circular balls, and laſtly like ſeveral ſmall ſtars, which gradually faded away, leaving the whole atmoſphere beautifully illuminated. During the time of its being viſible, a faint blue light fell upon the ſurrounding objects; and when entirely gone, the ſky was ſerene, like that of a fine ſummer's morning.—*Hull Advertiſer, July* 4.

On the evening of the 14th of July, about half after nine, a remarkable meteor was ſeen at Montgaillard. The ſky was clear and the wind calm. An exhalation like a common cloud then gradually aroſe. It ſeemed of the length of 3000 fathoms,

fathoms, in breadth about 1200 or 1500, under an angle of twelve degrees. In a little it appeared to take fire. It burnt with a pale flame like that of spirit of wine. At the edges it exhibited a splendid glory. It continued for fifteen minutes. After an interval it was rekindled for eight or ten minutes more. It was then extinguished, and in a moment appeared a third time, which was of very short duration. It was also seen at a distance of about 2000 fathoms in the same direction, at an elevation of forty-five degrees, but with a much fainter light than at Montgaillard.

MEDICINE.

Dr. Van Deiman, of Amsterdam, has lately announced that he has employed with success the oxygenated muriatic acid for cutaneous disorders, such as the itch and scald head; and he thinks this remedy preferable to all mercurial frictions. He has employed it also for loss of the gums, especially when the latter is occasioned by a high degree of scurvy. Six ounces of rose-water, two ounces of conserve of roses, and from ten to fifteen drops of oxygenated muriatic acid, employed as a wash for the mouth, have in such cases performed wonders.

TO PRESERVE CORN IN SACKS.

Provide a reed cane, or other hollow stick, made so by glewing together two grooved sticks; let it be about three feet nine inches long; and that it may be the easier thrust down to the bottom of the corn in the sack, its end is to be made to taper to a point, by a wooden plug that is fixed in, and stops the orifice. About an hundred and fifty small holes, of one eighth of an inch diameter, are to be bored on all sides of the stick, from its bottom for about two feet ten inches of its length; but no nearer to the surface of the corn, lest too great a proportion of the air should escape there. By winding a packthread in a spiral form round the stick, the boring of the holes may be the better regulated, so as to have them about half an inch distant towards the bottom, but gradually at wider distances, so as to be an inch asunder at the upper part; by which means the lower part of the corn will have its due proportion of fresh air. To the top of the stick let there be fixed a leathern pipe ten inches long; which pipe is to be distended by two yards of spiral wire coiled up within it. At the upper part of the pipe is fixed a taper wooden fasset, into which the nose of a common household bellows is to be put, in order to ventilate the corn.

If corn, when first put into sacks, be thus aired every other

or

or third day, for ten or fifteen minutes, its damp ſweat, which would hurt it, will, in a few weeks, be carried off to ſuch a degree, that it will afterwards keep ſweet with very little airing, as has been found by experience.

By the ſame means many other kinds of ſeeds, as well as corn, may be kept ſweet either in ſacks or ſmall bins.

This method muſt not be underſtood as applicable to barley; all other grain may be ſafely preſerved in this manner; but nothing can prevent a deleterious fermentation of barley, when it is once out of the ſtraw.

AGRICULTURE.

It is with extreme pleaſure we announce to the friends of agriculture, and indeed to the world at large, that the Duke of Bedford is going to eſtabliſh, at his own individual expenſe, an agricultural college at Woburn.

What are to be the particular regulations of this inſtitution, as princely as it is novel, we have not at preſent been informed; all that we yet learn is, that the Profeſſor will have the opportunity of availing himſelf of whatever is going forwards on his Grace's very extenſive farm, and of ſuperintending the various operations and experiments which now are, or will be in future, carried on there. The gentleman, whom the Duke has ſelected to fill this important office is, we underſtand, the Reverend Mr. Edmund Cartwright. His Grace's choice, the reader muſt agree with us, could not have fallen on any one more competent to a ſituation requiring not only much practical knowledge, but great variety of ſcientific attainments.

Sincerely do we congratulate the public on the eſtabliſhment of this moſt uſeful inſtitution, the firſt certainly of its kind in this country, and, we believe, in Europe. Of the REAL patriotiſm and munificence of its truly noble founder, there can be only one ſentiment.

SPANISH WOOL.

One of the prejudices which moſt ſtrongly oppoſe the propagation of ſheep with ſuperfine wool, is the opinion, too generally diffuſed, that this race cannot ſucceed in our climate and with our ordinary paſtures. The uſeful voyage that C. Laſteyrie has recently made in the north of Europe, enables us to announce, that even the exceſſive cold does not contribute to the degeneration of wool, as the Spaniſh race is preſerved pure in the moſt northern parts of Sweden and Denmark. A fact lately obſerved by C. Richard D'Aubigny even enables us to advance, that bad food and paſturage

pasturage in humid places, although they injure the health of the animals themselves, do not impair the beauty of the wool. He had been called to particular functions elsewhere, which obliged him to abandon to the care of inferior agents the flock of the pure race kept on his own property. This flock has been, for ten years past, managed like all those of the department of the Allier, that is to say, shut up at nights in close narrow stables, the dung of which is only taken away once a year, and led out at days by children into the most marshy pastures, and without any precaution against epizootic diseases. C. Richard, on returning to his farm, found his sheep in the worst possible state of health, but the wool had not, by any means, degenerated; and he has presented the Society of Agriculture some patterns of very fine cloth, which he has caused to be manufactured with this wool in many of the best manufactories. Citizen Teissier had recognized the same fact in an experiment which he had tried at Rambouillet. He had abandoned, for many years together, a male and female of pure race, in a meadow very moist and all encompassed with water. Those animals had become completely wild; they took them in order to shear them with snares or gins, and, in spite of such a long and unfavourable residence, their wool and that of their progeny had not degenerated.

IMPROVED PUMP.

We ought to have mentioned in the account of Mr. Buchanan's pump, given in the preceding pages, that a model of it is lodged at the Royal Institution.

MEDICAL AND CHEMICAL LECTURES.

The first week of October next, a Course of Lectures on the Materia Medica, Practice of Physic, and Chemistry, will recommence at the Laboratory, in Whitcomb-street, Leicester-square, at the usual morning hours, viz.—the Materia Medica at a quarter before eight; the Practice of Physic at half after eight, and the Chemistry at a quarter after nine. By George Pearson, M. D. F. R. S. Senior Physician to St. George's Hospital, and of the College of Physicians. A register is kept of the cases of Dr. Pearson's patients, in St. George's Hospital; and an account is given of them at a Clinical Lecture every Saturday morning, at nine o'clock. Proposals may be had at St. George's Hospital, and in Leicester-square.

XLVI. *Description of the Salt Mines of Wielitſka, in Poland.* By J. PESCHIER, *M.D.**

THE village of Wielitſka lies at the diſtance of two leagues to the ſouth-weſt of Cracow; it is ſituated on the gentle declivity of a cultivated mountain, and is very populous. Theſe valuable mines were diſcovered in the year 1251, and ſince that time they have been conſtantly worked; but it is only ſince the late changes effected in the political ſtate of Poland that the working of them has been carried on with the preſent degree of ſpirit.

The deſcent into theſe mines is through ſquare pits, twenty fathoms in depth and from twelve to fourteen in diameter, cut through the pure ſalt, if we except a few fathoms of earth by which they are covered. There are ſix of them, of different dimenſions, diſtant about a hundred feet from each other, and which all communicate with each other internally.

This deſcent, which is attended with ſome novelty, in ſome excites fear rather than curioſity. Thoſe who viſit it are ſeated in a ſort of chair made of ropes, and ſtrongly attached to a thick rope, which paſſes round a large wheel moved by a horſe, and which is thus let down into the pit. From two to ten perſons may be ſeated around this rope, provided they hold very faſt with their hands; but if they are ſubject to giddineſs, they muſt then be ſecured by a girdle which paſſes round the body. It is cuſtomary before they deſcend to offer up a ſhort prayer, which adds conſiderably to the awfulneſs of the preparation for the deſcent; but the efforts which each afterwards makes to conceal his terror on viewing the vaſt and obſcure pit, the extremities of which they dare not conſider, generally overcome every ſenſation of timidity, and the ſix minutes employed in reaching the bottom ſoon glide away amidſt mirth and ſecurity.

When you arrive at the depth of ten fathoms you find yourſelf in freſh and agreeable air, and afterwards experience only very ſlight modifications of the temperature till you reach the bottom, the depth of which is twenty fathoms.

On reaching the bottom of the pit, a great number of the workmen flock round you offering you their ſervices; and you then find yourſelf in the centre of ſix radii, each of which forms an extenſive gallery. It is at this centre that ſalt dug

* From the *Journal Britannique*, publiſhed at Geneva by Profeſſor Pictet.

from the mine is collected, and conveyed to the top of the pit by means of the same rope that brings down those who visit it from curiosity.

The first remarkable object that occurs is a magnificent altar, of moderate dimensions, cut out of the purest salt, and decorated with four columns ten feet in height, one and a half in diameter, and perfectly transparent: it is ornamented all around with sculpture representing the attributes of the vine and agriculture: on the right is Jesus on the cross, of the natural size, and executed with great elegance; on the left is a saint in the attitude of offering up his devotions, the work of the same chisel: three steps conduct to the altar, which is richly ornamented with elegant vessels of salt; and the whole receives a very remarkable degree of splendour from about thirty small flambeaux lighted around it.

In this place the salt is remarkably pure, and is distinguished by the name of *schibika*; the second kind, which is found at the distance of a few fathoms, is mixed with argil, and is called *grün*; the third, called *spiza*, is mixed with calcareous earth, argil, and water: the argil is almost always of a schistous form and of a dark gray colour; in some morsels it serves as a base to the calcareous earth, disposed with great elegance in cottony balls, exceedingly white and of different sizes.

The strata of salt are always parallel to the surface of the mountain; but no regularity has hitherto been observed in the respective situations of the different strata: they are often separated from each other by strata of argil, and in some places intersected by veins of calcareous spar: where the air is dampest the soil falls into a state of efflorescence, and is remarkably white; every where else the colour varies from blackish blue to a dirty white. Where the water is collected and remains the salt dissolves, and then shoots into very regular cubic crystals: crystals of the like kind are found sometimes buried in the mountain itself; the crystallization found there is quite formed in the manner of four steps of equal dimensions, which, placed in a square, and converging towards a centre, form a pyramid of great elegance and regularity.

We proceeded from the altar through a large alley fifteen feet in height and twelve in breadth, entirely cut out in the salt, which conducted us to an immense magazine filled with casks. This cavity, of an enormous size, constructed at the depth of 120 feet below the surface of the earth, was supported only by four pillars of salt, and these even were considered as superfluous. The sides of this hall consist of salt more

more or leſs pure, which reflected the rays of light proceeding from our lamps in a thouſand different points. We then directed our courſe to a large ſtair of a hundred ſteps, each nearly fifteen feet in length and one in breadth, covered with planks to preſerve the angles of them: by this ſtair we deſcend twenty-five fathoms without experiencing any very ſenſible change in the temperature; the dampneſs of the air even is ſo weak, that planks which have been in uſe for upwards of a hundred years, and at the depth of 270 feet below the ſurface of the earth, appear ſtill as freſh as if new. The workmen aſſured me that they experienced almoſt the ſame degree of heat during the whole year: the air here is ſo ſurcharged with ſalt that the ſaline particles are depoſited on the hair, eyebrows, and eyelaſhes of the workmen.

We ſoon arrived at a hall of as great extent as the former, in which the miners were employed in digging out the ſalt with great activity. By the chiſel and gunpowder they ſometimes cut out blocks three feet in breadth, and ſufficiently thick to form three maſſes, each weighing 560 pounds. When the edges are rounded off, they give them the form of an elliptical caſk.

The workmen employed in theſe mines are in number 800; they work in the interior of the mine from five o'clock in the morning to one in ſummer, and from ſeven to three in winter. They are naked to the middle, (which announces a very mild temperature,) and are not ſubject to any particular malady: their paleneſs ariſes from the want of light and bad nouriſhment. They have nothing to dread but the terrible exploſions which often burſt forth from places formerly worked and now cloſed up. At the moment when they enter with their lamp, the air ſeems as if traverſed by flaſhes of lightning in every direction: the combuſtion is ſudden, extends to the neighbouring galleries, extinguiſhes the lamps, and ſeverely ſcorches the workmen if they do not throw themſelves flat on their faces.

We now deſcended a ſecond magnificent ſtaircaſe to the depth of 30 fathoms more, and of 450 feet below the ſurface of the mountain, where we found horſes yoked to a wheel like the former, and which ſerves to move the rope that brings up the ſalt dug out in the lower galleries. Theſe animals paſs the greater part of their lives in theſe ſubterranean regions, and yet enjoy good health. At ſome diſtance is a large ſtable with ſix pair of horſes which relieve each other. Being here ſtruck with a ſtrong ſmell of ſulphur, I found that it aroſe from the diſengagement of ſulphurized and phoſphorated hydrogen gas, produced by the fermentation of the

 horſes'

horses' dung, and, in my opinion, must greatly contribute towards those aërial explosions of which I have spoken.

We next proceeded to a neighbouring gallery, where, after two hours' respectful admiration, we were filled with a sentiment of astonishment and surprise which it is impossible for me to describe. Through the enormous mass of salt, which presents to the eye no interruption in its saline texture, and at the depth of 450 feet, flows a stream of pure fresh and transparent water, which is received in large wooden vessels, where the workmen and horses of these subterranean regions quench their thirst. As it was impossible that this spring could filter through the salt, Nature, which buries her masterpieces in the bowels of the deepest mountains, has placed in this monstrous mass of salt a stratum of clay sufficiently thick to allow this stream of water, destined to refresh the workmen, to pass through it in such a manner as to be protected from the action of the salt, of which a very small quantity would injure its salubrity. To visit a place where Nature seems to have scattered her gifts with profusion, and to have concentrated her most valuable secrets, must be highly interesting.

We now set out to quit the mines, and in our way found several other altars recently cut out from the salt, and in a very neat manner, which displayed considerable taste. Having soon reached the bottom of one of the pits, we placed ourselves, as before, on seats made of rope, and arrived in safety at the village of Wielitska. By an estimation, made nearly fifty years ago, of the size of these mines, it appears that they extend from east to west 6000 German feet, from north to south 2000, and to the depth of more than 800.

The working of these mines, which gives bread to more than 400 families, enriches the village, and supplies the neighbouring countries with salt, produces more than 168,000 quintals per annum, and brings to the emperor a net profit of five millions of florins.

Such are the most interesting circumstances which I observed at the famous mines of Wielitska, of which so many fabulous descriptions have been given, and against which people ought to be on their guard: it is even astonishing that where the mind can scarcely seize the grandeur of what Nature presents, the imagination should still be so lively as to see there "people who never behold the light of the sun, who inhabit subterranean villages, who govern themselves according to their own laws," &c.

During my stay at Cracow, I formed a design of visiting also the salt mines or mountains of salt at Bochnia, five leagues south-

south-east from Cracow, to which I repaired for that purpose; but I was not allowed to descend into them, for want of the necessary written orders. They are constructed like those of Wielitska; but the pits are deeper, and they contain more of that kind of salt called *schibika*. The salt, however, is neither so pure nor so various in its nature, nor are there to be seen in the latter any of those masterpieces of art above described. Large fragments of black wood and alabaster are often found mixed with the salt.

XLVII. *Account of Lord* DUNDONALD'S *Discovery of a Process for extracting from Lichens a Gum applicable to most Purposes in which Gum Senegal has been hitherto employed.*

THIS important discovery was announced by a circular letter from his lordship, which was followed by a meeting of calico printers at Glasgow, and the publication of different papers, a perusal of which will put our readers in possession of all that has yet transpired respecting this business. The following are copies of the letter and papers alluded to:

To Calico Printers and other Consumers of Gum Senegal in Scotland.

GENTLEMEN, April 23, 1801.

IT is now upwards of nineteen years since I discovered that a gummy extract, or gum, (equally well adapted as gum Senegal for most purposes in which that article is employed,) was to be procured, by an easy process, from the plant called in botany *lichen*, or the moss which grows on trees and hedges; to be had in considerable quantities in many parts of this country, and still in much greater abundance in Sweden, Norway, and in the northern parts of America.

At the time I made this discovery other objects, apparently more important, occupied my attention; but having, some months ago, been informed that foreign gums had risen to such a price as to bear hard on several branches of manufacture, I again turned my attention to the preparation of gum from the lichen, and can now, with confidence, inform you that it answers equally well as gum Senegal for your branch of manufacture. I intended at one time to have taken out patents, but have now come to the determination of laying my invention open, for the benefit of the calico printers and other consumers of gum.

With this view, I invite you to meet me at the Black Bull inn, Glasgow, at twelve o'clock, on Tuesday the 28th current, when samples of the raw material and prepared gum extract shall be shown you; directions given how to prepare it, as well as information from whence a sufficient supply of the raw material is to be had.

My life has, in a great measure, been spent in pursuits which appeared to me calculated to advance the manufactures, commerce, and agriculture of my country: to the attainment of these objects, it is well known, I have sacrificed what fortune I possessed. It would therefore be affectation in me to say, that I am independent of such pecuniary recompense as the communication offered to be made may be thought deserving of. This I leave to yourselves, and to the other calico printers and consumers of gum in Great Britain and Ireland. Exclusive of any considerations personal to myself, it gives me satisfaction that I have been able to render you independent of foreign nations for the supply of an article so indispensably necessary for your manufacture, and that at a rate not exceeding 1-12th part of the present price of gum Senegal.

I am, gentlemen,
Your obedient servant,
DUNDONALD.

Lord Dundonald's Gum Substitute.

Glasgow, May 7, 1801.

AT a meeting of calico printers, called by public advertisement, to consider of a plan of recompense to the earl of Dundonald, for laying open, in the handsome manner he has done, his discovery of a substitute for gum Senegal and other gums, James M'Dowall, Esq. in the chair, the meeting came unanimously to the following resolutions:

1st, That the discovery of the use of lichen, &c. as a substitute for gum, is likely to be of great advantage to calico printers, and of national importance.

2dly, That Lord Dundonald should be liberally rewarded for that discovery; and that an annual sum per table, and presses that use gum, is considered by the meeting as the best and most certain method of recompense.

3dly, That the meeting, either by themselves or in conjunction with others, are willing to support Lord Dundonald in an application to Parliament for an act to secure to his lordship the benefit of this discovery on such conditions as may be previously agreed to.

JAMES M'DOWALL, Præses.

Statement

Statement of the Benefits and Advantages to enſue to Individuals and to the United Kingdom of Great Britain and Ireland, from Lord Dundonald's Diſcovery of extracting Gum from the Lichen or Tree Moſs, as a Subſtitute for Gum Senegal and other foreign Gums.

GUM Senegal, or other foreign gums, have hitherto been indiſpenſably requiſite for printing fine goods, and thoſe of light ſhades of colour.

No proper ſubſtitute had been found to anſwer for this part of calico printing until Lord Dundonald diſcovered the preparing gum from the lichen.

Gum Senegal, and foreign gums, are at times ſcarce, and difficult to be procured.

The ſettlement of Senegambia belongs to the French: they have a monopoly of gum Senegal. The price ſince the war has riſen from 150*l.* to 400*l.* per ton.

Gum from the lichen may, all charges included, be prepared at 1-14th part of the preſent price of gum Senegal, and at 1-6th of the peace-time price.

The united kingdoms may now be ſaid to be independent of foreign ſtates for the gum requiſite for their manufactures, ſuch as calico printing, preparation of ink, ſtaining and manufacture of paper, dreſſing and ſtiffening ſilks, &c. &c. And, in conſequence of Lord Dundonald's diſcovery, large ſums of money, formerly ſent abroad for the purchaſe of gum, will, in future, be ſaved.

Starch and wheaten flour have hitherto been uſed as cheap ſubſtitutes for gum in printing coarſe goods, or to fix on other printed goods, the mordants, and ſome of the dyeing materials, for deep ſhades of colour. But there is now reaſon to expect, as gum from the lichen will coſt leſs than thoſe articles, particularly ſtarch, it will be uſed in their ſtead, and ſo prove the means of ſaving or œconomizing a conſiderable portion of wheat and wheaten flour at preſent conſumed in calico printing.

The collecting the lichen from the foreſt and fruit trees and hedges, will give employment to a number of poor people, principally women and children.

A cheap ſupply of gum from the lichen may, perhaps, in ſeveral manufactures, ſuperſede the uſe of the higher priced article of glue or ſize, which often has a very diſagreeable ſmell.

Gum from the lichen may, perhaps, be uſed as a dreſſing in weaving, particularly fine goods, either by itſelf or when made into a kind of soap, according to directions given in a separate publication.

Lastly, It is probable that all the benefits to ensue from the discovery of procuring gum from the lichen may not yet have occurred, it being well known that there is no art or discovery that is not the parent or sister of some other.

Statement of the Expenses of collecting the Lichen or Tree Moss, preparing the Gummy Extract, and Amount of the Saving to accrue to Calico Printers by using it as a Substitute for Gum Senegal, reckoning Gum Senegal at different Prices, from 7l. to 20l. per cwt.

	£.	s.	d.
To gathering 1 cwt. of lichen, at 2*d*. per lb.	0	18	8
To carriage, on an average distance of 30 miles, at 2*s*. per cwt. - - -	0	2	0
To 7 lb. pearl ashes, at 56*s*. per cwt. -	0	3	6
To boiling ditto, say half the price of gathering	0	9	4
	1	13	6
But say the lichen cost in gathering 3*d*. then there falls to be added - -	0	9	4
Charges on the cwt. of lichen -	£. 2	2	10

But with a view to a comparative statement with gum Senegal, this must be reduced 1-3d, as a cwt. of dry lichen has been found to do as much work, in calico printing, as one cwt. and a half of gum Senegal.

In all, the value of the gum extract, on which a comparison is to be made, after deducting one-third, will only cost, say 29*s*.

Thus, when gum Senegal is at 20*l*. per cwt. a substitute is to be had at	1-14th of that price.
When at £. 15, at	1-10th
£. 10, at	1-7th
£. 7, at	1-5th

And, on an average of the peace and war time prices, at 1-9th of the price of gum Senegal.

An individual in the calico printing line informed Lord Dundonald, last November, that at the then prices, viz. 15*l*. per cwt. the supply of gum Senegal for his works cost him upwards of 5000*l*. per annum.

Say - - - - -	£. 5000
An equal quantity of gum from the lichen, at the price stated, would cost, say -	500
In all, a saving annually of	£. 4500

And

And fuppofing 100 tables or preffes ufing gum, there would be an annual faving of 45 *l.* per table; or an annual faving of 22 *l.* 10 *s.* when gum fell to the peace-time price of 7 *l.* 10 *s.* per cwt.

Directions by Lord Dundonald for extracting Gum from the Lichen or Tree Mofs, &c.

IT does not appear, from fuch trials as Lord Dundonald has hitherto made, that there is any very great difference in the produce of gum from the lichen collected from different trees or fhrubs: all of them anfwer equally well for yielding a gum fit for calico printing. The lichen is moft abundant on the trees which grow in a poor, ftiff clay foil, particularly if fituated at fome confiderable height above fea level. It fhould be pulled in dry weather, otherwife it is apt to break in the pulling; befides, in this cafe, requiring to be dried before it can with fafety be laid up in the ftorehoufe, where, if put in dry, it may be kept for years. Should a fufficient quantity of it not be found in this country, it may be had in almoft unlimited abundance in Sweden, Norway, and in the northern parts of America, where it grows to the length of from a foot to eighteen inches, and preffing the branches of the tree by its weight. There is, however, every reafon to believe that a fufficient quantity is to be had in this country. According to information from Dr. Brown, lecturer on botany, it takes three or four years in coming to maturity or its full fize, fo that a crop from the fame tree may be had every fourth year.

The lichen does not confift entirely of a gummy matter. There is the outer fkin or cuticle, below that a green refinous matter: the remainder of the plant confifts of partly gum, partly a matter fomewhat analogous to animal fubftances, and a fmall proportion of fibrous matter, which cannot be diffolved by boiling, or the action of alkaline falts.

The firft procefs in preparing gum from the lichen is to free it of the outer fkin of the plant and the refinous matter. This is done by fcalding the lichen two or three times with boiling water, allowing it to remain fo long in the water as, by abforbing it, to fwell: in doing this the fkin cracks and comes off along with the greateft part of the refinous matter. Or it may be freed from them by gently boiling the lichen for about fifteen or twenty minutes, then wafhing it in cold water, laying it afterwards upon a ftone or brick floor, where it fhould lie for ten or twelve hours, or perhaps more. The reafon for this is, that the expofure for that time to air greatly facilitates the fubfequent extraction of the gum.

The scalded lichen is then to be put into a copper boiler with a due proportion of water, say three Scotch pints, or two wine gallons, to every pound of lichen, and boiled during four or five hours, adding about half an ounce or three quarters of an ounce of soda or pearl-ashes for every pound of lichen; or, instead of these salts, about half an English pint of volatile alkali. The boiling should be continued until the liquor acquires a considerable degree of gummy consistence. It is then to be taken out of the boiler, allowed to drain or drip through a wire or hair cloth, or searse. The residuum to be put into a hair cloth bag or bags, and to be squeezed in a press similar to that which is used by the melters or rinders of tallow.

The first boiling does not extract the whole of the gum. The lichen should be boiled a second and even a third time, repeating the process as above described, diminishing at each process the quantity of water and the quantity of alkali, which a little experience will soon point out. When three boilings are employed, the gummy extract of the last boiling should be kept for the first boiling of a fresh batch of lichen. The extract proceeding from the first and second boilings should be mixed together, and evaporated to the consistence necessary for block or press printing. The evaporating vessels should be of tin or thin lead, placed over a range of stoves, and moderately heated by fire or the steam of water. It has been neglected to state, that before evaporating the gummy extract to the consistence necessary, it should be kept ten or twelve hours, so as to allow the sediment or dregs to subside. The clear liquor may either be drawn off by a syphon, or the dregs may be drawn off by a cock at the bottom of the wooden vessel; the bottom of which should be made sloping, higher at the back than the fore part, in order that the dregs may run more completely off. The proportion of gummy matter remaining in the dregs may be got off by mixing them with a due proportion of boiling water, allowing the liquor to clear, and proceeding as above directed, employing this weak solution for boiling the next batch of lichen.

The residuum of the lichen, after the third boiling, consists of a matter somewhat analogous to that of animal matter, together with a proportion of the fibrous matter of the plant. From the animal matter a kind of soap may be made. The process is as follows:

Let a small proportion of pounded resin be dissolved by boiling in a solution of alkaline salts. When the resin is dissolved, put in a certain quantity of the residuum of the lichen, and continue the boiling until this last article is pretty well

well dissolved. Then add about a pound or a pound and a half of white soap, shaved down or cut into thin slices, to every ten pounds weight of the residuum of the lichen. Continue the boiling until the white soap is fully dissolved. Then pass the soapy solution through a hair sieve or hair bag. Let the soap pan then be cleaned out, and the soapy solution returned to the pan, to be boiled to the consistence necessary. A kind of soap very similar to this may be made from sea weed, as well as from several other articles. Of this and of other matters highly important to calico printers, a more full and detailed account will be given in a future publication. When gum from the lichen is to be employed for making ink, manufacturing and staining paper, and for stiffening silks, crapes, and gauzes, it should be extracted from the lichen without employing any alkaline salts, continuing the boiling or digestion longer, and with a moderate degree of heat, in which case the gummy extract will be nearly colourless. When volatile alkali is used, the boiler should be of iron, as volatile alkali acts on copper.

[We have not yet learnt the issue of the negotiation between Lord Dundonald and the calico printers in Scotland; but we understand his lordship has taken out a patent for his invention for England.]

XLVIII. *An Essay on Bleaching; with the Description of a new Method of Bleaching by Steam according to the Process of* C. CHAPTAL; *and on its Application to the Arts. By* R. O'REILLY, *of the Academy of Bologna, Member of the Lycæum of the Arts, &c.*

[Concluded from p. 264.]

Restoration of Books, and whitening Prints.

THE oxygenated muriatic acid has the property of whitening paper without altering its texture. Chaptal first made known the process for this purpose, which is valuable for restoring old books, and prints stained with smoke. His process has even been executed, with astonishing success, by Vialard and Heudier: when the leaves are not too much decomposed by time, the oxygenated liquor or the acid gas is employed. Immersion in the liquor is to be preferred, as being more expeditious.

[The author here gives C. Chaptal's process, for which see Philosophical Magazine, Vol. II. p. 28. Instead, however, of directing the cylindrical glass vessel, in which torn and pasted prints are put when cleaned, to be inverted on water charged with materials fit for extricating the oxygenated muriatic acid gas, his recipe directs the materials to be put in the bottom of the jar itself, which is certainly better. Great accuracy, however, is necessary in the doses and in the conducting of the process, otherwise the texture of the paper may be destroyed.]

Bleaching by the oxygenated Muriatic Acid and Potash.

The suffocating emanation of the gas has rendered it necessary to employ potash in the liquor; but this mixture, though it enabled the workmen to manage the stuffs without inconvenience, occasioned an outlay of money for the alkali, and weakened the detersive quality of the oxygenated muriatic acid. It is a fact well known, that a solution of oxygenated muriate of potash does not bleach goods, yet it differs from the oxygenated muriatic acid ley only by having the alkali in it: it is, then, incontestable that the acid liquor loses its property of destroying the colouring matter of vegetables in proportion as it is neutralized by potash.

Notwithstanding the truth of this observation, it is proper to say a few words respecting the method of composing this ley: the proportion of the alkali in general is,

8 parts (in weight) of sea salt,
60 parts of concentrated sulphuric acid,
30 parts of manganese,
20 parts of potash.

The subsequent preparations and manipulations are exactly the same as those I above described: it will however follow, from the observation I have made, that the diminution of the detergent force by the alkaline mixture will render a great many more manipulations necessary; and if we add a comparative calculation of the two operations, it will be found, without including the expense of distilling the oxygenated muriatic acid, which is the same in either process, there will be a saving of more than forty-five per cent. besides the extra manipulations, in not employing alkalies. We here subjoin a comparative calculation.

With Alkali.	francs.
8 lb. marine salt, at 15 cents. per lb.	12
60 ditto sulphuric acid, at 65 cents.	39
30 ditto manganese, at 20 cents. -	6
20 ditto potash, at 75 cents. -	15
	72

As

As the ley loses its force by the addition of potash, this loss may be estimated at 15 per cent., or 10 f. 80 cents., which must be added to the preceding 72 francs, making together 82 f. 80 cents.

Without Alkali.

	francs.
80 lbs. of sea salt, at 15 cents. per lb.	12
60 ditto sulphuric acid, at 65 cents.	39
30 ditto manganese, at 20 cents. -	6
	57

The difference between these two processes is considerable.

Of Bleaching with oxygenated Muriates.

This method was first thought of in Ireland. The substance employed is the oxygenated muriatic acid combined, as we have said, with earthy or saline bases. Calcareous earths, such as lime and chalk, are those used in general; magnesia is too dear, and the rarity of barytes and strontian will exclude them for some time from our manufactories. A distilling apparatus of lead, such as we have already alluded to, (p. 259,) is employed. A tube *l*, (see Plate IV. the lowermost figure) three inches in diameter, rises from the top of the alembic *g g*, and proceeds to the bottom of a leaden reservoir *m*, capable of containing about 15 gallons, two-thirds of which are filled with water. Another tube *n*, of the same dimensions, also of lead, the orifice of which is above the level of the water, rises from the reservoir *m*, and enters the tub *o*, *o*, in which the liquid oxy-muriate of lime is prepared. This tub must be large enough to contain twelve barrels, or about 1500 (English) gallons of water: 80 pounds of lime, flaked in the air and well pulverized, is introduced into it: the sides of this tub are furnished with shelves or a grating, *q q q*, which projects in the inside, while the arms of the agitator *l*, to which a rotatory motion is communicated, move between the shelves, and constantly stir the liquor: this disposition is indispensable to prevent the lime from being precipitated before its saturation, and to present, by renewing them, the greatest number of surfaces possible to the action of the acid gas. The use of the intermediate reservoir, *m*, is to arrest the portion of the muriatic acid gas which escapes during the commencement of the operation without being oxygenated, and also any sulphuric acid which may chance to pass, and which would hurt the process if it were suffered to be introduced into the tub *o*, *o*. The property which the muriatic

muriatic acid has of easily combining with water, facilitates its condensation by the intermediate reservoir.

By drawing out a little of the ley from time to time one may know when the liquor in the tub is saturated. When it suffers the lime introduced to be precipitated, the operation is terminated. This oxy-muriate of lime is drawn off from its deposit, and it is then sufficiently concentrated to be employed for bleaching when diluted with three times its volume of water.

This liquor is found to be preferable to the oxygenated muriatic acid and potash. At the great bleach-fields in Ireland, four leys of potash are applied alternately with four weeks exposure on the grass, two immersions in the oxygenated muriate of lime, a ley of potash between the two, and the exposure of a week on the grass between each ley and the immersions. During summer, two leys and fifteen days exposure are sufficient to prepare cloth for the action of the oxygenated muriate; then three alternate leys, with immersions in the liquor, will be sufficient for complete bleaching: nothing then will be necessary but to wind the cloth through the sulphuric acid.

Bleaching by calcareous Sulphuret.

In all the processes for bleaching which I have hitherto described it is seen that potash acts a distinguished part, either as an auxiliary or a principal agent. To find a detersive substance which might be a substitute for it, was an object of the utmost importance. Kirwan suspected that it would be found in the sulphuret of lime, and his opinion was confirmed by Higgins.

Repeated trials, and the most evident success, have proved the advantage of employing this method, and the possibility of bleaching completely by condensing the muriatic acid with the sulphuret instead of potash. The process with the sulphuret of lime is attended with some advantages peculiar to itself. In the first place, quicklime and crude sulphur are matters which can be procured at a cheap rate, especially when the latter enters into the mixture in small quantity: secondly, their combination is effected in the easiest and most expeditious manner, and may be comprehended and executed by any common workman: the application being then made by immersing the cloths cold, there is a complete saving of fuel, and no risk is incurred either from the ignorance or negligence of the workman, as the ley does no injury to the stuffs.

The sulphuret of lime is prepared in the following manner: Take 4 pounds of finely pulverized sulphur, 20 pounds of flaked ſlaked lime ſifted, and 16 gallons of water. When the whole is well mixed, it muſt be kept in a ſtate of ebullition for half an hour, ſtrongly ſtirring it ſeveral times. When the ebullition ſubſides, the ſolution of the ſulphuret becomes clear: the liquor may be drawn off from the inſoluble depoſit by means of a ſyphon *. The liquor will have the colour almoſt of ſmall beer, but is not quite ſo tranſparent.

Sixteen gallons of water muſt ſtill be poured over the depoſit, to take away entirely the remaining ſulphuret. When the liquor becomes clear, (it muſt firſt be well ſhaken,) it is drawn off and mixed with the former: to this mixture of the two liquors 33 gallons of water are to be added, in order to reduce it to the degree of ſtrength neceſſary for the immerſion of cloth.

Making allowance for the water evaporated, and for that retained by the precipitate, there ought to remain 60 gallons of liquor produced by the four pounds of ſulphur.

The cloth freed from the weaver's dreſſing muſt then be immerſed for twelve or thirteen hours in the ſolution of ſulphuret, and be then rinſed in running water. When dry, it is immerſed for twelve or fourteen hours in a ſolution of oxygenated muriate of lime prepared as I have deſcribed, and it muſt then be waſhed and dried as before. The operation muſt be repeated ſix different times; that is to ſay, there muſt be ſix immerſions in each liquor, which will be ſufficient for bleaching it completely. Cloths boiled ſix times in a ley of potaſh, and immerſed as many times in oxygenated muriatic acid, were not whiter than thoſe bleached by the new method.

The cloth, indeed, after the three firſt times it was boiled in the ley of potaſh, ſeemed a little whiter than thoſe immerſed as many times in the ſulphuret: but towards the end of the operation, when the cloth was completely bleached, the advantage was in favour of the ſulphuret, or, at leaſt, the difference was not ſenſible. The cloths whitened by potaſh ſeemed more meagre than thoſe which had been treated by the ſulphuret, and ſupported the proof of being boiled with ſoap better than others; though the latter had acquired in ſome inſtances a ſlight yellowiſh ſhade, which, however, diſappeared after ſix or ſeven days expoſure on the graſs.

An experiment has been tried on the effect of ſulphuret cold and warm, but the difference was ſo little that it did

* Though lime is one of the conſtituent parts of the ſulphuret, as it is intimately united to ſulphur, it has no longer the properties of lime, for the ſame reaſon that the *ſulphuric acid* in the *ſulphate of potaſh* has no longer the properties of that acid.

not

not deserve to be taken into consideration. Cloths immersed in the sulphuret, and then boiled in a ley of potash, and afterwards introduced into the oxygenated liquor, are whiter than after they have been subjected to two immersions in the sulphuret, and been made to pass through the ley: thus the two substances seemed desirous of co-operating. Two successive immersions, however, in the sulphuret, before being immersed in the oxygenated liquor, produced a better effect than one immersion; which is not the case with potash.

It is of importance to observe, that stuffs are always and invariably thicker and more swelled up when they come from the sulphuret of lime than after they have been subjected to the ley of potash; and they continue to retain these qualities even after they have been washed, and dried on the grass. The sulphuret opens the fibres of the cloth better and more speedily than potash, by softening them, and rather by making them swell up, than by dissolving the extracto-mucous or colouring matter. This may serve to explain why potash produces a better effect on cloth when it has been before immersed in a solution of sulphuret of lime.

The proprietors of bleach-fields, who persist in not making use of the oxygenated muriatic acid, but who bleach in the open air, may perhaps derive some advantages from this process, if they use sulphuret of lime and potash either conjointly or separately. The advantage and saving of expense which result from sulphuret of lime are evident: for ten years the price of soda and potash has been excessively dear, and has always increased. In all Europe, at present, the latter article costs about 70 francs (about 2*l.* 18*s.*) per hundred weight; and soda is nearly a third less. Sulphur may be estimated at 25 or 30 francs; on the other hand, lime, as it is every where found, costs very little; the price of this detersive liquor, therefore, will become so low that we have no coin small enough to represent the value of a quart of it. The truth of this fact will appear by a comparison with the price of common ley.

At large bleach-fields the ley is made by dissolving four pounds of potash, or six pounds of soda, in 60 gallons of water: some employ a little more: but four pounds of potash at 70 cents. make two francs 80 cents., and a like quantity of sulphur at 25 cents. makes one franc: but this is not all, as there is a saving in fuel as well as of materials; no more is required than the quantity necessary for boiling eight gallons of water, while the common ley requires that 64 should be brought to the state of ebullition. The time requisite for heating this mass of water presents also a saving which is far

far from being a matter of indifference in a large establishment. To this we may add, that in the application of these detersive liquors the cloth must be boiled at least seven hours in the alkaline ley, while the solution of sulphuret of lime requires only half an hour; and even if we suppose that potash shall continue to be used along with the sulphuret of lime, as is the case at present in Ireland, the saving will be still very considerable.

Bleaching with Steam.

The different processes which we have hitherto described form almost an historical abridgement of the art of bleaching. We have followed the progress of the human mind; and, indeed, a plain account of the various processes and different kinds of apparatus sufficiently shows what service has been rendered to this important art by modern chemistry.

But it still remains to make known a new method, for which we are indebted to Chaptal. This respectable chemist published, about two years ago, a notice respecting the method of bleaching by steam; a process brought to us from the Levant some time after the introduction of that for dyeing Adrianople red, and which is now used in the south of France under the name of *blanchiment à la fumée.* Till the period when Chaptal was so disinterested as to disclose it to the public, it was a secret the knowledge of which was confined to a certain number of manufacturers. It was employed only for bleaching cotton and cotton thread after the manner of the orientals; but C. Chaptal foresaw, with his usual acuteness, the possibility of applying this method to bleaching linen and hemp thread; and he invited manufacturers to adopt this process, in order to improve it and extend its use.

Chaptal's invitation excited several manufacturers both in France and in foreign countries. Almost at the same time, the effects of the new method of bleaching were tried in the neighbourhood of Paris and in Ireland: the apparatus seen at the cotton manufactory of C. Bawens, at Bons-Hommes, near Passy, gives the most astonishing results. It can bleach from two to three thousand yards of cotton cloth per day, at a price so moderate, and with such facility, that no other process can be compared to it. The first experiment which he tried was made on fifteen hundred yards of cloth destined for being printed: it exhibited no blemish or shade, but was all equally white.

His apparatus has a perfect resemblance to that described by Chaptal, and which may be employed exceedingly well alſo for bleaching raw cotton or cotton thread. Though the diſpoſitions which we have recently made preſent great advantages, yet as this new art is, as we may ſay, only in its infancy, we ſhall deſcribe, in the words of Chaptal, an apparatus ſimilar to that which C. Bawens has cauſed to be conſtructed.

"At about the diſtance of ſixteen inches from the grate of a common furnace, heated by pit-coal, is placed a copper boiler of a round form, four feet in diameter and eighteen inches in depth. The edges of this boiler, which are about ſeven inches in breadth, and turned backwards, reſt on the lateral edges of the brick-work of the furnace. The remainder of the furnace is of cut ſtone, and forms an oval boiler, the height of which is ſix feet, and the breadth, meaſured at the centre, five feet. The upper part of the boiler forms a round aperture, the diameter of which is eighteen inches. This aperture may be ſhut by a ſort of moveable ſtone, or a copper lid fitted to it. On the edge of the copper boiler, which forms the bottom of this kind of digeſter, is placed a grating formed of wooden bars, ſo cloſe to each other that the cotton laid upon it cannot fall through between them, and ſtrong enough to ſuſtain the weight of about 1600 pounds."

In the apparatus of C. Bawens, the mode of heating employed in Count Rumford's furnaces has been adopted in order to ſave fuel. The heat of the chimney is applied to heat a veſſel containing diluted ſulphuric acid. (See the three uppermoſt figures of Plate IV.)

The apparatus propoſed in other countries afforded the advantage of being able to wind up the cloth in the inſide: it was, as we may ſay, the boiler of a ſteam-engine, with its tubes, ſafety-valves, and leather collars; but it was neceſſary to introduce the ſtuffs at the top, which is very inconvenient.

With theſe data, and after having maturely reflected on the means of improving this apparatus, I invented ſeveral kinds proper for being applied to different kinds of goods.

The firſt, which I propoſed to be executed at Jouy, repreſented a chamber, arched with cut ſtone, ſix feet eight inches in length, three feet ten inches broad, and three feet and a half in height above the level of the wooden grate. (See Plate V. fig. 1.) At one of its extremities was a door, K, two feet in height and three feet long, covered with a plate of caſt iron, in which was a hole for introducing a conic valve, kept in its place by a very powerful ſcrew and ſpring. The object of this valve was to guard againſt an exploſion, which

which might be occasioned by the extraordinary effort of the steam; an event much to be apprehended. The door, which was moveable, was fastened by ten bars and as many screws, which pressed it against the rabbet (already faced with tow or moistened leather) until it was so close that none of the steam could escape. For the greater convenience it ought to be furnished with two iron handles, in order that it may be taken off with more ease.

The boiler E, E, E, which forms the bottom of this chamber, and in which the alkalino-caustic ley is boiled, is 18 inches in depth: its other dimensions are four inches less than those of the chamber. This diminution is destined for receiving the edges of the boiler, which thus serve to support it, as well as a wooden grate, over which the workmen pass during the manipulation. In the middle of this chamber are placed two reels, A and B, on which are rolled up from 18 to 20 pieces of cloth. The axes of these reels pass through leather collars, which prevent the escape of the steam, and the cloth is rolled up and unrolled by handles fixed on the outside. A regulator, H, which communicates with the inside of the boiler, indicates the height of the ley and the state of its exhaustion. The boiler is heated in the usual manner, or by Count Rumford's plan.

I caused to be constructed at Troyes another apparatus destined for bleaching hosiery. As these articles cannot be unrolled, and as heaping them together might impede the action of the vapour, I employed frames covered with cloth, and placed at the distance of four inches above each other. On these the hosiery was deposited in such a manner, that the vapour, in rising from the boiler, might penetrate it in every part, destroy the colouring matter, and bleach it completely.

Some new observations induced me to propose for the winding of cloth a roller, which might be immersed at pleasure in the boiler in order to moisten the cloth from time to time. All these kinds of apparatus will be explained hereafter.

Having thus spoken of the instruments employed in this new art, I shall examine the principles on which it is founded, and describe the best method of bleaching by this process.

The bleaching of vegetable substances depends on the destruction of their colouring principle by the combined action of the air, moisture, and light, or rather, by the united influence of these principles to alter their natural colour.

Alkalies have on the colouring matter of vegetables an action which produces the effect of a real combustion. Were we intimately acquainted with the nature of potash and soda, we might be able to explain the *cause* of this burning; but it is sufficient for us at present to know the *effect*. The exposure of vegetable matters on the grass subjects them to the action of the solar rays; and moistening them during their exposure facilitates, with the vaporization of the water, the emanation of the carbonic acid formed by the oxygen of the atmosphere, which combines with the carbon resulting from the alkaline combustion. It even agrees pretty well with theory, in terminating the process of bleaching, to immerse the cloth and thread in sour milk, acidulous liquors, or, what is more convenient, very weak sulphuric acid.

In proportion as the alkali, during the first immersion, destroys the colouring matter, the oxygen of the atmosphere, or that furnished by the oxygenated muriatic acid, joins that carbonized matter, and forms carbonic acid, which afterwards resolves itself into gas. This is contained the more in the principles, as the bases of all the acids are insoluble in water; but when the combination takes place between the carbon and the oxygen, it immediately becomes soluble. Thus, on the one hand, to burn the colouring matter, and to dissove it on the other, form the whole secret of the art of bleaching; and the greater or less tendency of vegetable substances to experience that combustion constitutes the gradations of their whiteness, and the facility or difficulty of bleaching.

The slowness of the old processes arose, in a great measure, from bleachers being unacquainted with these principles. A long succession of leys, and exposure on the grass, was necessary to penetrate the fibres of the linen from stratum to stratum. The texture was sufficiently close to resist the action of the heat of a common ley; and a considerable time was required to absorb the oxygen presented by the delicate stratum of atmospheric air.

In the process of bleaching by steam, these difficulties are removed. The high temperature of the steam in the interior part of the apparatus swells up the fibres of the thread or cloth; the pure alkali, which rises with the elastic fluid, seizes with avidity on the colouring matter, and burns it: seldom does the tissue of the flax or hemp resist the penetrating effect of this vapour bath. The whole matter, therefore, by which they are coloured is attacked and decomposed by this single operation; and even if we suppose that a part has been able to resist, nothing is necessary but to repeat the operation, after a previons immersion and exposure on the grass, to insure its complete effect. The alkali even appears to have

a much

a much livelier and more caustic action, when it is combined with caloric, than in ordinary leys, where the temperature never rises above 162° F.: for a ley of one degree of strength, at most, by the areometer, is sufficient for the steam apparatus, and, in general, half a degree will be enough. By making the cloth or thread pass through one ley of oxygenated muriatic acid or oxygenated muriate of lime, an union is effected between the solution and the carbon arising from the burning of the extracto-mucous matter of the flax; carbonic acid is formed; the water, even, in which this new compound is diluted concurs to promote this combination: if the cloth be then exposed on the grass, the carbonic acid is dissipated, and the cloth is bleached.

It was believed that the steam of a pure alkaline ley would not be caustic, and would not produce the same effects as the saline solution; and the reason assigned for this opinion was, the concentration of all the salts by the evaporation of the aqueous fluid: but what takes place in the open air, where the atmosphere every moment absorbs the moisture which is evaporated, cannot be applied to a close apparatus, where the temperature is elevated in an extreme degree: besides, the caloric always carries with it a little alkali even in low temperatures, as is observed when water is poured over potash; the steam which issues from it changes blue vegetable colours green.

It is asserted that in India cloth is bleached by the steam of lime water, and that the Indians brought to France by admiral de Suffrein employed this method. To us, however, it would appear very strange, if it really succeeded, that it should have been so long neglected. In theory, we find nothing that can warrant such an operation, except that the vapour, which issues from quicklime when slaked, changes the colour of vegetables exposed to its action: on this account alone the fact deserves to be put to the test of experiment.

It follows, from these chemical principles, that the action alone of steam does not bleach, and that the concurrence of oxygen is necessary to aid the composition of the carbonic acid: this acid requires for its formation 28 parts of carbon, saturated with 72 of oxygen; but all the oxygen contained in the apparatus would not be sufficient to saturate the considerable quantity of colouring matter burnt by the alkaline combustion and converted into carbon: this deficit must be supplied by immersion in any oxygenated liquor whatever, and the dispersion of the elastic fluid thus formed must be then facilitated by exposure on the grass.

I shall now proceed to the various manipulations to which raw cotton cloth and thread ought to be subjected in order to bleach them by this new method; and I shall begin with that of Chaptal, whose apparatus I have before mentioned.

The cotton, disposed in handfuls, must first be impregnated with a slight solution of soda rendered caustic by lime. This operation is performed in a wooden or stone trough, in which the cotton is trod down by means of the feet covered with wooden shoes. When the alkaline liquor has uniformly penetrated the cotton, it is put into the boiler, and piled up on the wooden grate before mentioned; the redundant liquor runs through the bars into the copper boiler, and forms a stratum of liquid, which permits the mass to be heated without any danger of burning either the cotton or the metal. To form the alkaline ley, Alicant soda equal to a tenth of the weight of the cotton subjected to the operation is employed, and in a boiler such as that the dimensions of which I have given, about 800 pounds of cotton may be put at one time. The ley is generally of two degrees by the areometer. As soon as the cotton is introduced into it, and arranged in the boiler, the upper aperture is shut with its usual covering, scarcely any opening being left, that the steam developed by the fire may assume a much more considerable degree of heat, and react with force on the cotton. When every thing is arranged, the fire in the furnace is kindled, and the ley is maintained in a state of slight ebullition during thirty-six hours. The apparatus is then suffered to cool, and the cotton being taken out is carefully washed; after which it is exposed on the grass for two or three days, extending it on poles in the day-time, and spreading it out on the grass during the night. The cotton will then have acquired a high degree of whiteness; and if any portions of it be still found coloured, they must be put into the boiler for a second operation, or be left on the grass some days longer. These shades in bleached cotton arise, in particular, from all the parts of the cotton in the first operation not having been completely and uniformly impregnated with the ley. They may be owing also to the cotton, when arranged in the boiler, having been too much accumulated on certain points. When it is judged that the ley has been exhausted by ebullition, the boiler is opened, and the dried cotton is moistened with a new quantity of the solution of soda: without this precaution it would be in danger of being burnt. It may be easily conceived, by an estimate of the matters and time employed in this operation, with how much saving of expense it is attended: cotton is bleached by this method in all the manufactories of the south of France, where it is used, at the low rate of two sols per pound.

To

To bleach cloth, it must be immersed in the same manner in a slight alkalino-caustic solution marking two degrees by the areometer. I here suppose that the cloth has been subjected to the necessary preparations to free it from the dressing, according to the instructions I gave when speaking of flax and hemp.

While the cloth is immersed, and impregnating itself with the alkaline liquor, the boiler is filled to the height of a foot with a ley of equal strength. This may be done by means of a bent leaden funnel; but the door is large enough to pour it in, by taking it up from the tub with buckets: the workman then enters the apparatus, and fixes the end of a piece of cloth, with packthread, to one of the arms of the furthest reel A, fig. 1. (Plate V.) while another workman without turns it till the whole piece is rolled up: he then fixes a second piece, tacking it to the former, if this operation has not been done before; then rolls it up, and continues in this manner till eighteen or twenty pieces are rolled up. He then throws the extremity of the last piece which remains over the roller B, near the arch; conveys it under the two lower rollers C, D, in the copper E E E; then makes it pass over the other roller F, placed near the arch of the apparatus; and at last fixes it to one of the arms of the reel G. The workman ascertains the height of the liquor in the inside by means of the regulator H, and immediately shuts the cock; after which he surrounds the door K with old rags or tow, and fixes it strongly in its place by screws, which serve to check and prevent the escape of the steam. The fire being kindled, and the heat increased to that of boiling water, the workman winds up the cloth, beginning with that reel which was empty, until it is entirely charged with it; he then lowers the cranks of the rollers C, D, to immerse the cloth in the boiling liquor, speedily winds it off, rolling it up on the reel which has been emptied, unhooks the lower rollers, and winds back the cloth in another direction without immersing it in the liquor. At the end of two hours, more or less according to the fineness of the stuffs, the alkali carried up by the caloric will have completely penetrated the fibres of the cloth, swelled by the extraordinary heat of the steam. The fire is then slackened; and when the apparatus is sufficiently cold the door is opened, and preparation is made for immersing the cloth in the oxygenated muriate of lime *. Care must be taken, in order to shorten the manipulation, to charge in the last winding the reel near the door:

* The cloth ought not to be immersed till after it has been washed.—*Note of Chaptal.*

the end of the cloth is then unloosed, and it is fixed on the arms of one of the reels of another immersing tub, and it is then unrolled till the whole that was in the apparatus is drawn out: the extremity of the last piece is then placed in such a manner as to pass over the seven rollers of the immersing tub, as is seen in the section of that vessel, (see Plate II. fig. 3. given with Number XXXVIII.) in order to expose as much surface as possible to the liquor; and being fixed to the second reel, the cover is carefully adjusted, and the oxygenated liquor is introduced by means of a leaden funnel which passes through the aperture of the cover, and which proceeds to the bottom of the tub, to prevent the acid gas from being dispersed by agitation. After several windings, a little of the liquor is taken up to examine its degree of exhaustion; it is then drawn off, and the pieces being taken out separately, they are carried to some stream to be well rinsed: they are next exposed on the grass for three or four days, at the end of which they will have acquired a high degree of whiteness. In the last place, to terminate the operation, they are made to pass through very dilute sulphuric acid.

This operation, which is very expeditious, will be sufficient for linen and cotton cloth; but if hemp or linen cloth should retain a yellow tint, still necessary to be destroyed, a second alkalino-caustic vapour bath, and two or three days on the grass, will be sufficient to give them the requisite degree of whiteness.

For bleaching thread as well as hosiery, and the like, an apparatus furnished with frames may be employed, (Plate V. fig. 2. and 3.) following the same processes as for stuffs. The frames (fig. 3.) keep these articles at a sufficient distance from each other to make them be penetrated by the steam in every part; but as they cannot be lowered into the ley to moisten them, as is done with stuffs, by means of cranks and rollers, the operation is stopped at the end of two hours ebullition. The upper frame is then well drenched with ley, which, oozing through, successively moistens the articles placed on the lower frames. The ebullition is again begun, and continued for about four hours. The immersion is performed in an apparatus similar to that of Rupp, in which the thread and hosiery are suspended to the upper end of the reel, which in this case stands vertical, to renew, by a rotary motion, their surfaces of contact, and expose them to the action of the acid. After immersion they are rinsed; they are then exposed on the grass as in the preceding operation, and they are made to pass through dilute sulphuric acid.

In

In manufactories of printed cottons, when it is intended to print various figures by means of mordants, they are made to pass through madder, and a combination is formed between the mordant or *base* and the colouring matter *. The alum used by calico printers is applied to the cloth by means of blocks: after it has been dissolved, by a process foreign to this memoir, in vinegar (acetous acid), it suffers to be deposited on the stuff the earthy *base*, and thus renders it proper for combining with the colouring matter: the strong affinity which exists between that matter and the *base* (mordant) causes the cloth, when it passes through the madder, to assume different shades; however, as some of the colour adheres, though weakly, in the places destitute of the base, it must be removed by repeated boilings with bran or cow's dung, and exposure on the grass.

As one of the properties of the oxygenated muriatic acid is to brighten colours, its agency has been employed in various cases. The process of bleaching by steam makes no change in the old dispositions, but only shortens the labour, especially when its action is combined with oxygenated liquors.

After being made to pass through madder, and lying for a short time on the grass, the cloth is exposed to the vapour bath; then immersed in very dilute oxygenated liquor; and, in the last place, exposed on the grass again. Great care is taken to rinse it well, in running water, after each operation, and to wash it well by means of the usual machinery.

If this method should be adopted in paper manufactories, the following is the manipulation I would recommend: The brown or crude rags ought first to be picked and sorted; they should then be slightly triturated with a cylinder, or with a pestle if the former is not employed; this coarse pulp should then be immersed in a caustic alkaline ley of three degrees, and carried thence to the steam apparatus: it ought to be placed on frames covered with canvas in strata of about an inch in thickness, and the frames for this purpose may be placed at a pro-

* The word *mordant* ought to be entirely banished from the language of the arts, since it is as nonsensical as the expression *oil of vitriol* is absurd when employed as the synonyme of sulphuric acid. The dyers formerly employed saline solutions, in which they immersed their stuffs, thinking that the action of this salt served to bite, as it were, the substance of them, and to enlarge their pores, and, according to this idea, they gave them the name of *mordants* (or biters). At present, when these effects can be better explained, it is much to be wished that the word *base* were substituted for *mordant*, adding some epithet to denote the substance which forms it. We know that these bases in general are the earth of alum (argil or alumine) and white oxide of tin.

a proportional distance from each other. After the steaming it must be immersed in a ley of oxygenated muriatic acid, and should be then put into bags to be rinsed in running water: it is next to be exposed to the light, spread out on large sheets: in the last place, it must be made to pass through sulphuric acid, and the matter will then have acquired the most beautiful degree of whiteness possible to be given to it.

The property which the oxygenated muriatic acid has, when in the state of gas, of expelling the carbonic acid from its saline combinations, a property which it does not possess in the liquid state, gives reason to believe, that if the pulp, after being subjected to the vapour a second time, were exposed in an apparatus or chamber where it might be subjected to the action of the gas, the carbonic acid (formed by the carbon arising from the burning of the colouring matter in the first ley, and by the oxygen which combined itself to it during the immersion in the oxygenated liquor,) would be expelled from the combination which might have been formed during the second ley, and the rags would be immediately bleached without having recourse to exposure on the grass. In all cases it must be observed that this process presents an incalculable advantage, by pointing out the means of employing the coarsest and dirtiest cloth and rags to be converted into pulp of the first quality: besides, this process combines œconomy with speed. It is to be remarked, that in using two leys it is of essential importance to rinse the rags when taken from the first: their fibres are then more relaxed, and their distension permits the water to carry away and dissolve the dirt and colouring matter attacked by the alkaline vapour: in the last place, they must be made to pass through acidulous water in order to expel, by the action of sulphuric acid, the acid of the oxygenated muriate of potash from its combination with the alkali. I must here also call the attention of the intelligent manufacturer to the employment of the refuse arising from the beating and heckling of hemp and flax: these substances, treated by this method, would furnish valuable materials for the fabrication of paper.

The reader will recollect that, about eight years ago, a proposal was made for regenerating old paper by employing it again in the manufacturing of new. This process, which has been repeated with success, was neglected in France, while it was received with interest in foreign countries. At present we must assert our right to this discovery, and prove the possibility of rendering it useful by employing the effect of the alkalino-caustic vapour.

When

When the old paper, soiled, has been exposed, in an apparatus with frames, to the action of the steam of boiling water alone for twelve hours, it is subjected to slight trituration under a cylinder; it is then immersed in a strong alkalino-caustic ley; it is well pounded in the tub, that it may be strongly impregnated; and it is introduced a second time into the apparatus, the boiler of which must also be filled with the ley. The pulp, after being exposed to a vapour bath for ten or twelve hours, is taken out and pressed, that the alkaline liquor which runs off may not be lost: it must then be put into bags to be beaten, and rinsed in running water; after which it is subjected to trituration under the cylinder till it has acquired the proper degree of whiteness. If it be necessary to give the utmost brilliancy to the white, it will be sufficient to employ a second vapour bath, together with a slight immersion in the liquid oxygenated muriate of lime; then to rinse it, and to make it pass through acidulous water. In this operation it is to be wished that mallets and stampers were employed rather than cylinders, which are liable to be attacked by the alkaline liquor. I do not here speak of writing paper, because it is fully proved that this process is too tedious and expensive.

Ley of Acidulous Water.

At all bleach-fields it is customary to terminate the operation by making the cloth or thread pass through acidulous water. In some places sour milk is employed; but almost every where at present, after the example of the Irish bleachers, nothing is used but dilute sulphuric acid. The proportion, in general, is one part in a hundred of acid diluted in water. In Ireland the bleachers sometimes judge of the proportion by the taste; but this practice is liable to much error. The tub in which the articles are made to pass through acidulous water is in general constructed of wood; but the operation being much accelerated when performed warm, I would propose that the heat, which is generally lost, should be turned to advantage. By making the heat to circulate in a flue below the leaden vessel, (already mentioned in speaking of the apparatus of Bawens,) a temperature sufficient to heat it may be obtained. Hosiery and thread ought to be immersed and worked in handfuls for twelve hours: they are then to be rinsed in a large quantity of water, and made to pass a second time through the acid: several immersions brighten the whiteness, and I would recommend them in preference to the bad practice of leaving the matters immersed for several days. Stuffs must be wound up. This is an an excellent method, as it completely renews the surfaces, and calls forth the whiteness in a more uniform manner. When it is requisite to render the cloth fit for certain markets, it is necessary to give it a blueish tint, which is done by diluting a little indigo in water till the wished-for shade is obtained.

CONCLUSION.

A plain comparison of the process of bleaching by steam with the others above described will prove its great superiority in regard to saving of time, materials, fuel, and manipulations, independently of the advantage of not injuring the stuffs: but there is still an application of this principle highly important, which concerns all classes of society—I mean the bleaching of linen. Here no other agent is required than the mere action of steam; an agent much more powerful and more efficacious than the leys and soapy water employed by washerwomen. This process presents also the invaluable advantage of preserving the linen longer, as it is not necessary to rub it with violence, which is done in the usual manipulations merely to save soap and ashes. An apparatus similar to that at Troyes, on the frames of which the linen might be placed, and then exposed to the steam of ley of a *fourth* of a degree only, would be sufficient to dissolve completely the impurities with which it is charged; and by then rinsing it in running water, or in water slightly saponaceous, all the dirt would be removed, and complete whiteness obtained.

It belongs to public functionaries to adopt this process, and to apply it in hospitals and other establishments, where it would be attended with a considerable saving.

I shall observe before I conclude, that experience must decide whether the apparatus I propose for bleaching woollen cloth and stuffs by the vapour of ammonia, might not be employed as well as the other kinds of apparatus for bleaching linen cloth. The condensed steam, by again returning into the boiler, affords the means of totally exhausting the ley, and of using the very last portion of the alkaline substances.

Further Explanation of the Apparatus.

The apparatus employed in Ireland for preparing the oxygenated muriatic acid, and the oxygenated muriate of lime, (see Plate IV. lowest figure) is as follows:

a the ash-hole; *b*, place for the fire; *c*, the door for the fuel; *d*, entrance of ash-hole, where a register is posited to regulate the draught of air; *e*, a cast iron boiler, in which is placed a leaden alembic, *g g*, on an iron trivet *f*; *h*, a glass

or

or leaden bent funnel for introducing the sulphuric acid; *i*, a leaden cover luted to the neck of the alembic, and pierced with three holes to receive the funnel *h*, the handle of the agitator *k*, and the tube *l*, of three inches aperture, which serves to conduct the acid gas into the reservoir *m*, which performs the office of a Wolfe's bottle: the tube *l* descends through the first aperture *m* 1 to the bottom of the reservoir, which to two-thirds of its height is filled with water. In the reservoir *m*, any sulphuric acid which passes combines with the water, while the oxygenated muriatic acid traverses the water, and passes through the tube *n* into the condenser *o o*, made of wood, in which is placed an agitator *t*, the arms of which stirring the lime water assists in combining it with the gas in proportion as the bubbles escape from the lower extremity of the tube *n*. The tub has shelves *q*, *q*, *q*, which serve to oppose the motion occasioned by the agitator, and thus accelerate the combination of the acid gas. The covering of this tub is fitted to the sides of the tub, as expressed at *r*. *s* is a stop-cock.

Chaptal's apparatus for bleaching, nearly similar to that executed by Bawens. See Plate IV. first figure, at the top*.

a the stair for descending into the ash-hole *n*; *b* the door of the fire-place *p*. The flame and smoke circulate round the boiler *i*, and pass through the flue *g*,*g*, down under the leaden vessel *h*, and then back again to the chimney *m*. (See *c c c* the second figure, in which *a* is the stair to the ash-pit, *b* the fire-place, *d d* a winding brick partition to circulate the heat, and *e e e e* the solid mason work.) The *h* (under the arch) is a grate of wood, resting on the edges of the kettle *i*, containing the bleaching liquor: *e e*, brick work; *e* 1, *e* 1, stone work; *q*, a conical stone stopper, which serves as the lid or cover, perforated, and furnished with a safety valve; the stopper is wrapped round with tow or lint to make it steam-tight: *f*, a discharging cock and a regulator to show the height of the internal liquor; *t*, an iron register in the chimney *m*.

The third figure from the top of the plate is a plan of the apparatus taken on a line with the wooden grate. *a*, the stair of the ash-hole; *e e e*, the brick and mason work; *f g*, *f g*, the edges of the kettle built into the mason work; *h*, *i*, the wooden grate over the boiler; *l*, the leaden vessel.

The other kinds of apparatus have been so plainly described where their uses have been alluded to, that any further explanation of them here is unnecessary.

* Part of the impression from the plate was printed off, by mistake, before the *numbers* were put to the figures; they are therefore referred to in the order in which they stand, beginning at the top.

XLIX. *Observations on the Oil extracted from the Female Cornel or Dog-berry Tree, the* Cornus sanguinea *of Linnæus, Class 4th*; Tetrandria Monogynia. *By* C. MARGUERON, *of the Hospital for Military Instruction at Strasburgh* *.

THE *cornus sanguinea* of Linnæus, a shrub much sought after by gardeners for the sake of ornament, both on account of its figure and of the beautiful red colour assumed by its stem, branches, and leaves, towards the end of summer bears a berry which, when in a state of maturity, has a blackish colour, and of which the utility in medicine as well as in the arts has been hitherto unknown.

The fat and unctuous appearance exhibited by these berries when bruised between the fingers inclined me to think that they might contain an oil possessed, no doubt, of some peculiar properties. Fully persuaded of this truth, that nothing which Nature has produced is useless, I engaged C. Chevreuse, a gardener and botanist at Molsheim, in the department of the Lower Rhine, where this shrub grows in great abundance, to collect a quantity of the berries.

Ten kilogrammes (22 pounds English) were collected and spread out in a barn, not to be dried, but to make them assume a softer consistence: in this state they were reduced to a paste, and subjected to the press. Without the assistance of heat I obtained about two *litres* ($2\frac{1}{8}$ wine pints) of a fat unctuous liquid, having a viscosity similar to that of oil, a green though very bright colour, and perfect homogeneity, as well as all the other physical properties of real oil, and without any disagreeable odour or taste; which determined C. Chevreuse and myself to eat of it in salad, which we did several times without experiencing any inconvenience.

But as these different properties were not sufficient to make this liquid be considered as a real oil, I thought it my duty to subject it to various experiments, of which the following is the result:

A drop of this oily liquid, thrown into a vessel filled with water, extended itself into a very thin pellicle, reflecting the prismatic colours.

Being desirous to know whether it would be possible to deprive this oily product of its green colour, I washed it in cold and hot water, charged with sulphate of alumine (alum),

* From the *Annales de Chimie*, No. 113.

powder

powder of ſlate, pulverized charcoal, &c.: but all theſe means were attended with no effect; the above liquids did not become in the leaſt coloured, and the green colour of the oil ſtill remained the ſame.

Alcohol was alſo employed. As this vehicle aſſumed a greeniſh tint, I thought I ſhould be able by its means to carry off the colouring matter; and I added to a portion of the alcohol thus coloured, a certain quantity of water. The mixture immediately became colourleſs, and ſome drops of oil floated on the ſurface of it. Having evaporated in an alembic another portion of this coloured alcohol, the alcohol I obtained was without colour, and there remained a portion of the oil, having the ſame colour as before: the alcohol, then, was indebted for its colour to a ſolution of a portion of the oil, and not to a ſeparation of the colouring matter.

Sulphur combined perfectly with this oil by the aid of caloric. There reſulted from this combination a real balſam of ſulphur of a dark red colour inclining to brown, and of a very fœtid odour.

Potaſh, ſoda, and ammonia, formed with this oil real ſoap more or leſs ſolid.

Concentrated ſulphuric acid combined with this oil produced a real acid ſoap of a yellowiſh colour, having the appearance of reſin.

The nitric and muriatic acids, cold, had nó ſenſible action on this oil, but they aſſumed a ſlight green colour.

The nitric acid heated with this oil made it aſſume a ſolid conſiſtence, and a yellow colour perfectly ſimilar to that of citrine ointment: during the ebullition there was a conſiderable ſwelling, diſengagement of nitrous gas, &c. The theory of this operation being well known, I ſhall forbear ſaying any thing reſpecting it.

Not having been able to procure nitrous acid, it was impoſſible for me to aſcertain the inflammability of this oil with acids.

In boiling this oil for ſome time over litharge, it acquired the drying property which rendered it proper for painting; a property it poſſeſſed before its oxygenation, but in a leſs degree than after it.

By continuing the ebullition the oxide of lead became deoxidated, and was totally diſſolved; the mixture aſſumed conſiſtence, and a brown colour perfectly ſimilar to that of *onguent de la mere*.

The ſame experiment was repeated, taking care to add water, and to ſtir the mixture continually, as is done in regard

gard to *diapalma plaſter*; by which means I obtained an emplaſtic matter of a good conſiſtence, and a colour perfectly ſimilar to that of the plaſter called *vigo cum mercurio*. This colour having induced me to believe that I had failed in my plaſter, which, as I ſuppoſed, ought to be of a whitiſh colour, I ſeveral times repeated the ſame experiment with all the care poſſible, and each time I obtained a plaſter of the ſame colour. The theory of plaſters having been very well deſcribed by C. Deyeux, I ſhall not ſay any thing of it here.

I ſubjected a portion of this oil to the contact of the atmoſpheric air, and found that at the end of ſome time it had aſſumed a little more conſiſtence.

The ſame experiment was repeated, but with the addition of water, taking the precautions preſcribed by Berthollet. At the end of a month the oil had aſſumed a ſolid conſiſtence, and a white colour ſimilar to that of wax.

Being deſirous to aſcertain, in the laſt place, of what uſe this oil might be in domeſtic œconomy, I filled with it a lamp containing a cotton wick, which, when lighted, gave a ſtrong and beautiful light, without ſmoke or any ſenſible ſmell: the ſame lamp, containing a wick of the ſame kind, was ſucceſſively filled with olive oil and rapeſeed oil; the latter laſted two hours, the olive oil two hours and a quarter, and that of the *cornus ſanguinea* two hours and a half.

If we add to theſe different experiments the property which this oily liquid has of not freezing, we ſhall have all the characters of the oil of the *cornus ſanguinea*.

From theſe experiments, the only ones poſſible for me to make, there is reaſon to conclude, that the oily juice obtained by expreſſion from the berries of the *cornus ſanguinea* is a real oil poſſeſſing certain properties which may render it uſeful to the arts, to commerce, and even to medicine. I am of opinion alſo that, according to the principles of Fourcroy, it ought to be placed in the ſecond claſs containing the ſiccative oils, which ſpeedily grow thick, do not become fixed by cold, which inflame by the nitrous acid only, and which, with the ſulphuric acid, form a ſort of reſin.

L. *Re-*

L. *Researches respecting the Laws of Affinity.* By C. Berthollet, *Member of the French National Institute.*

[Continued from p. 208.]

On Metallic Solutions and Precipitates.

1. In the two preceding memoirs * I considered chiefly those substances which are simple, or of which the composition is not variable; in the present one I shall endeavour to ascertain what influence the degree of oxidation of metals may have on their chemical action, and shall compare generally this action with that of other substances, independently of the properties I have already examined (Art. XIII.).

The solutions and precipitates of mercury appear particularly worthy of attention; for chemists have observed them with more care, and it is more easy to determine their conditions.

2. In the Memoirs of the Academy of Sciences 1790, Fourcroy has described a sulphate of mercury analogous to calomel, that is to say, formed by mercury little oxygenated; and has shown that the sulphate of mercury, particularly when such a degree of heat only is employed as not to produce complete desiccation of the sulphuric acid and mercury, is divided by the action of the water into two sulphates, one of which may be called oxygenated sulphate, and the other mild sulphate. A simple method of obtaining this last combination is to dilute, with an equal volume of water, the sulphuric acid which is treated with mercury, and to boil the mixture: a little sulphureous acid is formed, and, instead of oxygenated sulphate of mercury, that sulphate is obtained of which the properties have been so well investigated by Fourcroy. In determining the constituent parts of the mild sulphate of mercury, he fixes at 0,05 the proportion of oxygen which is combined with the mercury; and supposes that, on decomposing this salt by potash, it is pure oxide of mercury which is precipitated. But the metallic precipitates retain a portion of acid which he has neglected; I therefore believe that in his experiment the proportion of oxygen ought to be rather greater than that which he establishes. In many recent determinations made by chemists, this consideration has been overlooked; which renders them, in some measure, uncertain. The mild sulphate of mercury forms a permanent

* The article on this subject, given in our last Number, constituted the author's second memoir.—Edit.

combination, which is not decomposed by water as the oxygenated sulphate of mercury is, upon which I shall proceed to make some observations.

If the process indicated by Fourcroy be employed, a white mass is obtained, composed of sweet sulphate and oxygenated sulphate. By the careful method of washing which he points out, the excess of acid that maintains the solution may be separated from the oxygenated sulphate and a portion of the mild sulphate. When the operation is carried further, or when a sufficient degree of heat is applied to the mild sulphate, a greater quantity of sulphureous acid is disengaged, the mercury becomes too much oxided to form the mild sulphate, and the combination is found entirely in the state of oxygenated sulphate, which varies in the quantity of sulphuric acid which it retains. Let us examine it in the state it possesses when the operation has been carried to dryness, in which, consequently, it may be considered as not possessing an excess of acid.

In this state water causes a separation; the mass which was before white, turns yellow; the liquid becomes very acid, and holds a part of the sulphate in solution; there is formed what has been called, since the time of Rouelle, a salt with excess of acid, and a salt with the least portion of acid: but the proportions of these two combinations vary, 1. According to the quantity of acid the first combination had retained; 2. According to the quantity of water employed: 3. According to the temperature; for the heat concurs with the action of the water.

If for simple water an alkaline solution be employed, which exerts a more powerful action upon the acid than pure water, two combinations are formed, one of which is found to be almost entirely the oxide, and the other in which the acid is for the most part engaged: the precipitate obtained differs principally from that which water alone would have produced, by the smaller proportion of acid which it retains, and which depends on the degree of concentration of the alkaline liquor which acts upon it.

When the oxygenated sulphate of mercury retains a more considerable excess of acid, the action of the latter may be so weakened by the water, that no separation will take place.

3. I have hitherto supposed but two sulphates of mercury to exist, one with the smallest possible proportion of oxygen, and the other with the greatest; but it is manifest that two extremes only are thus fixed, so that they may contain within their limits all the other degrees of oxydation: the properties of

of these intermediate combinations differ so much as to leave no room for the determination of their particular properties, unless both the degree of oxydation and the proportion of the acid be known.

What I now observe as to the intermediate degrees of oxidation must also be applied to the other metallic salts, such as the sulphate of iron, in which there are likewise only two fixed terms, that of the weakest and that of the strongest oxidation.

4. Bergman had before discovered that a solution of mercury by the nitric acid made in the cold, has different properties from that which is prepared by means of heat; and, in his excellent treatise on the analysis of waters, he remarks, that the former does not so readily afford a precipitate with the solutions which contain sulphuric acid, and that the precipitate it forms is white, whereas that of the solution made with heat is yellow; that the first then forms mild sulphate of mercury, which is white, and more soluble in water than the oxygenated sulphate, while the latter forms the oxygenated sulphate.

When nitrate of mercury is prepared by means of heat, some nitrous gas is at first disengaged; but when the disengagement is complete, the mercury is perceived to be dissolved, with the production of scarcely any nitrous gas. I am indebted for this observation to C. Gay, a young chemist of the Polytechnic School, who adds much sagacity to considerable zeal. We see, therefore, that by means of heat an oxygenated nitrate is formed, which, if the operation be not stopped, afterwards combines with mercury, as in another operation the oxygenated muriate of mercury combines with a fresh quantity of this metal *. But in the fluid nitrate of mercury, there are no determinate proportions between the mercury most oxygenated, and that least so: it appears that all the intermediate proportions may exist, as I have observed with respect to the sulphates.

When nitrate of mercury is precipitated by muriate of soda, mercurial muriates are obtained, which differ according to the oxidation of the mercury. With the nitrate a little oxided a white precipitate is obtained, which retains a part of the nitric acid, and cannot be dissolved in the muriatic acid, nor

* Fourcroy has shown that the oxygenated sulphate of mercury, submitted to ebullition with water and mercury, acts also upon the metal; it must therefore pass to the state of mild sulphate. The corrosive mercurial muriate, when dissolved in water, does not act upon mercury; but by trituration with mercury without water, it begins to combine with it, and to impart its oxygen: the combination becomes uniform by sublimation.

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be taken up by the concentrated nitric acid, without giving out much nitrous gas. From the solution prepared by heat, a precipitate is obtained rather of a yellow colour, which is not soluble in muriatic, but readily dissolves in nitric acid, giving out a little nitrous gas. The supernatant fluid affords by evaporation a little corrosive mercurial muriate.

If this experiment be made with a nitrate so prepared that the mercury shall be in the most oxided state, and which has not redissolved any metallic mercury, and if it be diluted with a considerably large quantity of water, no precipitate is formed, but all the mercury is found in the state of corrosive mercurial muriate: it is obtained in this state, however, only but in a small quantity, and sometimes even none is had, according to the proportion of muriate of soda employed, because the corrosive mercurial muriate has the property of forming with the nitrate of soda a quadruple salt. This salt is capable of forming rhomboidal crystals, grooved on their face, of a considerable size: it fuses upon red-hot coals; by exposing it to a sufficient heat in a retort, all the mercury is separated in the form of corrosive mercurial muriate. The residue is a nitrate of soda which retains a little muriatic acid, so that the separation which takes place is decided by the respective volatility of the substances, and by a difference of affinity between the nitric acid and the muriatic acid for the oxide of mercury. After the crystallization of this salt, another is obtained in small needles, which appear to be a complex salt, in which the oxide of mercury is found in a greater proportion.

Nothing certain can be determined as to the results of the mixture of the nitrate of mercury highly oxided, and the muriate of soda, because they vary according to the proportions of the substances which act.

I deduce from the preceding observations, that the nitric solution of mercury may hold this metal in solution from the lowest degree of oxidation to the highest, or to that which is required for the constitution of corrosive mercurial muriate; that it may possess it in all the intermediate degrees, but that its properties will be different according to the degree of oxidation.

5. Fourcroy lays it down as a principle, that any metallic oxide whatever gives to acids a colour similar to that which it has itself; whence he concludes, that when a mercurial precipitate which proceeds from a white salt acquires another colour, a change must have been made in the oxidation. This opinion does not appear to me to be well founded. I took some muriatic acid and dissolved in it some red oxide of mercury;

mercury; the ſolution was eaſily effected, without any diſengagement either of oxygen gas, or oxygenated muriatic acid: it ſpontaneouſly afforded fine cryſtals of corroſive mercurial muriate. I may here remark, that this proceſs appears to me to be the moſt ſimple and the leaſt expenſive for the preparation of the corroſive mercurial muriate. The combination which I had formed contained the red oxide of mercury with all its oxygen; yet it was colourleſs: with ammonia it would have given a white precipitate, and with lime and the alkalis a precipitate more or leſs orange coloured.

The red oxide of mercury readily diſſolves in the nitric acid without any diſengagement of oxygen: this ſolution cryſtallizes and forms a white ſalt; but if there be not a ſufficient exceſs of acid, it gives with water alone a white precipitate; with a greater quantity of water recently diſtilled, a yellow precipitate; with lime and the fixed alkalis, a precipitate of a much deeper yellow colour. A coloured oxide may therefore form white ſalts, and afterwards aſſume other colours, without undergoing any change in its oxidation.

6. It is known that the muriatic acid has a greater diſpoſition to combine with highly oxided metals than the nitric and ſulphuric acids. Fourcroy applied this conſideration with advantage to explain ſeveral phænomena. He thus expreſſes himſelf: (*Mem. de l'Acad.* 1790, p. 381.) "Every acid requires quantities of oxygen in the metals in order to combine with them; the muriatic acid, in general, does not combine with thoſe metals, unleſs they be much loaded with this principle, or highly oxided: the mercury appears to be more oxided in the corroſive muriate than in the nitrate." I ſhall take the liberty to make ſome obſervations on the principles laid down by my learned colleague.

It does not appear correct to ſay, that each acid requires different quantities of oxygen in the metals to combine with them; the nitric, the ſulphuric, and the muriatic acids, form combinations with mercury, from the leaſt to the moſt oxided terms; and it is the ſeries which reſults in the muriates which makes the principal difference in all pharmaceutical preparations, from the corroſive ſublimate to the mercurial panacea: but there is this difference, that the combination of the ſulphuric acid and the nitric acid with highly oxided mercury is much weaker, and more eaſily decompoſed, even by the action of water, than that of the muriatic acid, which preſents a very permanent conſtitution. If we turn our attention to thoſe metals which have the property of aſſuming large proportions of oxygen, ſuch as iron, tin, antimony, &c. we ſhall find the ſame properties with regard to the ſulphuric,

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nitric, and muriatic acids; so that the action of the two first, which diminishes in proportion as the oxidation advances, is sometimes so much weakened, that they abandon entirely, or are incapable of dissolving some very oxided metals: on the contrary, the muriatic acid dissolves them and holds them in solution, so that it cannot be perceived whether its action be weakened, or whether, on the contrary, it be not increased by a greater oxidation. A probable explanation may be given of this. Sulphur and azote, the bases of the two former, are saturated with oxygen, so that their resulting affinity for the substances that are also greatly oxygenated is very weak; but the muriatic acid, which appears to have in its constitution only a very small portion of oxygen, ought to have a much greater disposition to combine with oxygenated substances.

7. In the foregoing observations I have supposed that the different alkalis share the acid of a metallic solution with the oxide which is precipitated. I speak not of precipitates by ammonia, which in some circumstances is decomposed, and by that means changes the constitution of the precipitate, as has been particularly shown by Fourcroy; but this property is subject to modifications which demand particular attention. Bayen's experiments have ascertained that the precipitates of mercurial nitrates and muriates retain a greater or less portion of acid, so that, on exposing the precipitates of the mercurial nitrate to a sufficient heat, some nitrous acid is disengaged; and on making the same experiment on the precipitates of mercurial muriate, a greater or less quantity of insoluble mercurial muriate is sublimed. I shall here add some observations to those I have already made. (Art. XIII. No. 1.)

When oxygenated muriate of mercury is decomposed by the precise quantity of carbonate of soda necessary to effect its precipitation, the precipitate contains muriatic acid, carbonic acid, and oxide of mercury, in excess; so that on exposing the precipitate to the action of heat, carbonic acid gas and oxygen gas are disengaged; nearly half the mercury is reduced to metal, and the rest of the precipitate is sublimed, retaining all the muriatic acid which remained in combination with the oxide, and forming the mercurial muriate observed by Bayen. The liquid over the precipitate affords by evaporation, at first carbonate of soda, and afterwards a triple salt in which soda predominated.

Carbonate of potash presents different phænomena. A small portion only is required to produce a total precipitation in the solution of corrosive mercurial muriate, and the preci-

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pitate obtained does not amount to half the weight of what would be given by the fame quantity of oxygenated muriate of mercury, precipitated by the carbonate of foda. This precipitate, expofed to the action of heat, gives out carbonic acid, and fublimes almoft totally in the ftate of mercurial muriate, with the leaft portion of acid; a very fmall portion only refumes the metallic ftate. The liquid that covers the precipitate makes no effervefcence with the acids; fo that here the whole of the carbonic acid is combined in the precipitate with the oxide, and a portion of muriatic acid nearly double that contained in the precipitate by carbonate of foda. The liquid when evaporated affords a triple falt much more foluble in water than the oxygenated muriate of mercury: this falt cryftallizes in filky needles.

Carbonate of ammonia caufes an effervefcence on decompofing corrofive mercurial muriate, and no acid is found either in the precipitate or in the fupernatant liquid. The weight of the precipitate conftitutes nearly five-fixths of the muriate decompofed; a difengagement of ammonia takes place on the addition of lime. When urged by heat, the ammonia is decompofed, and azote gas only is received. All the mercury is fublimed without reduction. But in this fublimate, the mercury cannot be as much oxided as in the fublimation of precipitates obtained by the fixed alkalis or lime, a part of the oxygen having gone, decompofes the ammonia. The liquid which covered the precipitate contained a combination of oxide of mercury, of muriatic acid, and ammonia.

The precipitation by ammonia prefented the fame phænomena, except the effervefcence.

8. By attending to the other metallic folutions and precipitations, the character of thofe of mercury are eafily difcovered, as well as the modifications which depend on the particular affections of each oxide; I therefore think we are juftified in ftating the following principles:

1. Acids act upon metallic oxides as upon other fubftances, in proportion to their mafs; for when a metal has become but little foluble or infoluble, it may be diffolved by an excefs of acid, or may form, by means of fuch excefs, a more durable combination.

2. When a metallic combination is decompofed, the alkali or alkaline earth made ufe of, produces a divifion of the acid in proportion to the energy of its action. When the metallic combination is weak, water is fufficient to decompofe it; falts with either a maximum or minimum of acid are then formed. In this cafe the metallic oxides follow the fame laws as other fubftances; but it fometimes happens that the

alkaline base which is added does not assume its share of the acid, but the metallic oxide, on the contrary, divides the precipitate with the acid; as when we form fulminating gold, or the orate of ammonia. Sometimes also the precipitant, the acid, and the metallic oxide, form two complex combinations; one of which is insoluble and the other remains liquid, as we have seen in the decomposition of the corrosive mercurial muriate by ammonia, and in the experiments that I have described (first series, Nos. X. and XI.). In general, but particularly with respect to the metallic solutions, we must not separate in our reasonings the substance employed by the name of precipitant from the liquid in which the precipitation is effected. Attention ought to be paid equally to all the substances present which can possibly form new combinations.

3. Coloured oxides may produce colourless combinations; but on giving out a part of the acid with which they have been combined, their colour will again appear in proportion to the quantity of acid they have parted with; so that this colour is an indication of the constitution thus established, provided the state of oxidation has not been changed by any particular circumstance.

4. Metallic oxides cannot be compared together, unless they are taken in a determinate state of oxidation. All the combinations they are capable of forming vary, not only from this cause, but also from the proportion of acid they retain, when this proportion is not determined by a crystallization. With respect to oxidation there are only two extremes; that of the least and that of the greatest oxygenation, which can be considered as constant; and hence it follows, that the nomenclature can only indicate vaguely, and with great latitude, any metallic combinations in which the oxidation and the proportion of the acid are not determined.

5. The acids do not follow the same order in their affinity relative to the degrees of oxidation. There are some in which the affinity diminishes with the oxidation, such are the nitric and sulphuric acids; in others again it appears to increase, such as the muriatic acid. Hence we may perceive, independently of all the considerations I have mentioned, how little reason there was for classing the affinities of metals for the different acids by considering them as constant forces.

6. The results of the complex affinities of metallic solutions, mixed with other salts, may also vary from the proportion of those salts, conformably to what has been observed (*on the influence of proportion in the complex affinities*); so that then the proportion of oxygen in the metallic oxide, that of the

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oxide in the solution, and that of the saline combination brought into action with it, all contribute to the new combinations which are established.

7. In the chemical action of the metallic solutions, the laws which we have established in that of the other combinations might be admitted, if oxidation did not cause a change in the affinity of the metal, either for the acids or for the other substances, and multiply, as it were, in the metals the property of forming combinations; whence the results are often so complicated, that though by accurate observation we may develop the facts and the circumstances which determine them, yet they cannot be foreseen by theory, from the mere consideration of the known properties, as may be done with respect to other substances, the action of which depends on a smaller number of conditions.

8. The state in which oxygen exists combined in the metals, has likewise an influence upon the properties of the metallic oxides, and of the precipitates compared with each other. Bayen observed that several mercurial precipitates, as well as the red oxide, detonate strongly, though in an unequal manner when exposed to heat, after having been mixed with sulphur, and that some do not possess this property; but has not given the reason of the phænomenon and the exceptions. It appears to me indubitable, that this property of the oxide of mercury, and of the precipitates in which it predominates, is a consequence of the oxygen possessing more caloric than it preserves in its combination with the sulphur or in the sulphuric acid. The same thing therefore happens as with the nitrate and oxygenated muriate of potash, except that the effect is less considerable; but in the precipitates of the corrosive mercurial muriate, part only of the mercury can be considered as not combined with the muriatic acid, namely, that part which may be reduced into metal by the action of the heat which produces detonation. Such of the precipitates therefore as retain a sufficient quantity of the muriatic acid to admit only of a small reduction of mercury by the action of heat, cannot produce detonation; and such really are the precipitates by ammonia, by the carbonate of ammonia, and by the carbonate of potash.

9. The property discovered by Bayen is therefore analogous to the fulminating property of the orate and the argentate of ammonia; but it is not perceptible in the other metallic oxides and precipitates. Hence the oxygen in the latter must necessarily contain a less portion of caloric.

10. The properties which depend upon oxidation vary therefore in each metal on account of the proportions of

oxygen; and those which depend on the state of concentration possessed by oxygen, constitute the leading cause of those phænomena which arise from the changes of combination in elastic substances. (Art. XIV. Nos. 12 and 15.)

[To be continued.]

LI. *Experiments on the Ashes of some Kinds of Wood by* C. Pissis, *Physician at Brionde, in the Department of la Haute Loire* *.

Having burnt, during the winter of the year 8, a great deal of poplar as fire-wood, I remarked that the ashes by being re-burnt on the hearth, formed crusts of real frit, such as that of the ashes of sea-weed, with this difference, that they were only thin and of little extent, having neither been stirred, nor received any other heat than that of a moderate fire used in a parlour. I first suspected I had obtained an extraordinary quantity of potash; but as I durst not venture to ascribe it to the quality of the wood, as the white kinds of wood have always been considered as furnishing little saline matter, the trembling poplar (*Populus tremula*, Linn.) a tree of the same kind as our common poplar (*Populus alba*) furnishing only, when burnt with the greatest care, 9 drams, 45 grains, of potash per quintal of wood, I imagined that it depended on an alteration in the ligneous body. We cultivate the poplar for the purpose of obtaining props for our vines, and as it is bad fire-wood, we never cut it till it ceases to throw forth shoots. It is not uncommon to see poplars having the bark and branches exceedingly vivacious, while the trunk is reduced to a few handfuls of vegetable mould.

This idea of the augmentation of potash in rotten wood was not perfectly correct, but it will be seen that it conducted me to results very different from the opinions commonly received. But I shall return to these theoretic points when I have detailed the following experiments, which will serve to illustrate them.

1st, A hundred parts of dry and sound poplar wood produced four parts of ashes.

2d, A hundred parts of dry and rotten poplar wood, but not yet in the state of mould, produced eight parts of ashes.

3d, A hundred parts of each of these kinds of ashes, lixiviated till the water became insipid, and completely dried on an

* From the *Annales de Chimie*, No. 112.

an ignited plate of iron, lost 28 parts in weight: the first waters were very strong.

4th, A hundred parts of the same ashes re-burnt and treated as above lost only 22 parts: the leys were stronger and more caustic than the preceding.

5th, A hundred parts of the ashes of dry and sound oak, re-burnt and treated as above, lost 16 parts.

6th, A hundred parts of moist mould of oak of an ochre colour, placed on an ignited plate of iron, became dried and incinerated very speedily, and left three parts of ashes, which, though re-burnt, had the colour of iron filings. This is nearly the double of what a quintal of dry oak gave when burnt with the greatest care. These ashes were perfectly insipid.

7th, A hundred parts of the frit mentioned in the beginning of this paper, treated in the same manner as the ashes of No. 3, lost 37 parts in weight. This frit appeared at first to be insipid; the potash was concealed in it, but, by length of time and trituration, the water carried off a great part of it; yet it is probable that there remained some of it in the residuum by means of a sort of vitrification. These leys were very caustic.

8th, Some morsels of this frit brought to a red heat in the fire, and quenched in a small quantity of water, furnished a ley so caustic as to convert into soap melted wax and tallow, on which the ley was poured cold.

9th, This ley filtered on baked plaster of Paris (sulphate of lime mixed with lime) reduced to powder, lost its alkaline taste, and furnished by spontaneous evaporation beautiful crystals of sulphate of potash.

It follows from these experiments:

1st, From the four first compared with the fifth, that the wood of the white poplar is richer in saline matter than oak: here then we have an exception to an admitted rule, which considers hard wood as the most abundant in potash. The poplar is a wood so spongy that rats cannot pierce it; the filaments of it resist their teeth in the same manner as hemp would do; it is difficult to be sawn, and is exceedingly subject to rot: in order to be easily sawn it must be cut when in its vigour, which is never thought of, as I have already said. This wood when dry burns with a white flame, gives little heat, is speedily consumed, and makes no cinders. It is evident that it abounds more with incombustible parts than other kinds of wood; which is the case also with the willow, which gives a quantity of ashes twice as great, but only about as much saline matter, as the oak: that is to say, 15 grammes

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(2310 grains English) per myriagramme (22 lbs. 1 ounce) of wood, while the poplar furnishes 72 (11,088 grains.) To what is it indebted for this quantity? An answer to this question will be found by analyzing its sap. The acrid and viscous juice of its buds, used in pharmacy, will also furnish some data.

A myriagramme (22 lbs. 1 ounce, avoirdupoise) of the *populus tremula* (trembling poplar) furnishes only 7 grammes (1078 grains) of saline matter, as appears by a calculation made from a very accurate experiment*. This difference, more than decuple, in saline matter between one tree and another of the same species, will astonish only those who do not know that the rhubarb and sorrel are of the same genus, and that the sour cherry belongs to the same species as the common wild-cherry. Nature is not confined to our narrow ideas of analogy. It has been laid down as a principle, that plants of the same family may mutually supply each others place in medicine, but it is prudent to apply this principle only after a very accurate analysis of the plant employed, and that intended to be substituted for it.

2d, It follows from the first five experiments, that rotten wood gives more ashes than sound wood, often more than double, which may be readily conceived. Wood by rotting becomes spongy and light. I have seen some which weighed a half less, under an equal volume, than sound wood of the same tree. It burns without flame like tinder, and is difficult to be incinerated. It appears that the hydrogen has been almost destroyed, and that the carbon concealed by the earthy parts escapes combustion. This wood is often phosphorescent, a phænomenon the cause of which is yet unknown. Rotten wood must not be confounded with that which is pierced by worms. In the latter case the wood without changing its colour is reduced to an impalpable powder, and in the small part which remains solid is found the orifice the worm has formed, and often the worm itself†. A hundred parts of a vine twig reduced to an impalpable powder,

* *Ann. de Chimie*, vol. xix. p. 178. I did not extract the saline matter from the poplar, as the estimation by exhaustion appeared to me more certain, because it is difficult to bring back the saline matter always to the same point of calcination. But having calculated, that the ashes of the oak loses in lixiviation 0·16, and gives in saline matter 0·13, I deducted 3-16ths, or 0·19, for the loss by lixiviation, and I think I obtained nearly the product in saline matter, this difference arises from the carbonic acid which the saline matter loses in calcination.

† This worm differs according to the wood, the *phalæna cossus*, larva of the goat-moth, a delicate morsel among the ancients, which no modern would venture to taste, is found in old trunks of the oak.

powder by worms, burnt on an ignited plate of iron, were completely incinerated, and left three parts of ashes, which is nearly the quantity obtained from a quintal of dry vine twigs burnt with the greatest care. This wood, which ought properly to be called worm-eaten, has nothing then in common with rotten wood called also worm-eaten, but the name improperly applied to the latter.

It has been said, that rotten wood furnishes little saline matter *: this observation is correct in regard to wood drenched by the rain; the eighth experiment proves it; but it is proved by the third that wood which has rotted without being drenched by rain, does not lose an atom of its potash, and that taking equal weights, as rotten wood furnishes a double quantity of ashes equally rich, it will furnish a double quantity of saline matter. This affords a resource for manufactories, especially when we consider the moderate price of this wood, which in general is much neglected.

The ashes of dead timber, the tops and bark of which being well preserved have left no place of entrance for rain, may be employed either in leys for domestic purposes, in saltpetre manufactories, or salt works. The mould of these trees will also form an excellent manure, since it will have retained all its potash. It is thence seen, that where the mould has been drenched with rain, vegetation has been benefitted. We know by the experiments of Vauquelin, that the potash in the sap of trees is in the state of acetite: it would be highly gratifying to know in what state it is in the wood and in the mould.

3d, The fourth experiment proves that the ashes by being re-burnt lose a fifth of saline matter, and this must be the case since it divests itself more and more of carbonic acid; but by these means it gains as much in quality as is proved in particular by the eighth experiment. However, if very rich ashes, such as that of the poplar, be re-burnt, a frit will be obtained, or a semivitrification, which will retain a part of the potash: besides, this frit, in order to be lixiviated, must be triturated, which will increase the labour. This frit, from which may be extracted 30 per cent. of saline matter, and which will then still contain a great deal of it, would perhaps be as proper for glass-making as certain kinds of soda.

This semi-vitreous state, and the firmness of the soaps obtained in the eighth experiment, induced me at first to be-

* *Annales de Chimie*, vol. xix. p. 160. The same thing has been said of sawdust, and carpenter's chips: this depends on the wood employed, and the manner of cutting or dividing the wood, so as not to change any thing in its nature.

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lieve that the ashes of the poplar contained soda, but the ninth experiment undeceived me. I employed plaster of Paris, which I had at hand, for want of sulphuric acid; it is a convenient thing, said Franklin, to know how to saw with a gimlet: for the same reason I used wax and tallow.

I shall conclude with some ideas suggested by these experiments. Melted wax, tallow, and hog's lard, and heated oils, assume a degree of heat superior to that of water, and even to that of boiling ley. When an alkaline ley is poured into them, the mixture swells up in an extraordinary manner, all the water evaporates in a moment, and with equal proportions of ingredients, the soap remains firmer than that made by the usual processes in manufactories; besides it becomes dry as soon as made. These advantages are worth the trouble of making a trial, and in that case the following questions ought to be examined:

1st, In heating the oil before the water, may not the expansion which takes place at the time of mixture produce some accident?

In my opinion it will not, if the boiler is very deep, and filled only one-fourth.

2d, May the mixture be agitated? Yes, when the whole of the ley has been employed, the mixture then remaining in a state of tranquil fusion.

3d, Do the salts foreign to soap, particularly the alkaline carbonates, pass off with the exhausted ley? I fear not; in my trials on a small scale no liquor remained.

4th, Do not oily bodies too much heated become so much altered as to alter the soaps? I apprehend they do; my soaps were grayish.

LII. *Reflections on the Difference between the Acetous and Acetic Acids.* *By* C. Dabit, *of Nantes* *.

Before the memoir of Berthollet on the acetous and acetic acids (*vulgo* radical vinegar) had appeared, chemists agreed pretty generally in ascribing the difference which exists between them to a greater concentration on the part of the acetic acid. But since the publication of that work, in which the above celebrated chemist proves that this difference is owing to something else than a greater concentration of the acetic acid, this opinion has been almost entirely abandoned. The experiments on which Berthollet supports

* From the *Annales de Chimie*, No. 112.

his opinion seemed so conclusive, that all chemists almost were eager to adopt it. The pneumatic chemists, explaining this opinion in the language of their theory, have said that the acetic acid is the acetous combined with a new quantity of oxygen; consequently, in a state of more perfect combination. Such has been the opinion hitherto generally adopted.

C. Adet, in a memoir read before the National Institute, and inserted in Vol. XXVII. of the *Annales de Chimie*, opposes this opinion, and maintains:

1st, That no such acid as the acetous exists.

2d, That the acid of vinegar continually presents itself at the highest degree of oxygenation to which it can attain; and consequently, that it is always in the state of acetic acid.

3d, That the difference which exists between the acetic acid extracted from the acetate of copper, and that extracted from vinegar, depends on the less quantity of water contained in the latter.

Has C. Adet completely attained the end which he proposed? In my opinion he has not. In the first place, the greater part of the experiments on which the opinion of Berthollet rests, have not even been attacked, and consequently remain in full force. Such are:

1st, The pungent odour and taste which this acid retains though diluted with water so as to make its specific gravity equal to that of distilled vinegar; an odour and taste which the latter does not possess.

2d, The property which the acetic acid has of immediately combining with copper, while the acetous acid does not combine with it until it has been oxidated.

In the next place, the proofs which this chemist brings to support his opinion, are far from being so conclusive as might be wished. C. Adet himself allows that they still leave some desiderata.

I proposed to present some objections to the opinion of C. Adet, and to prove that it cannot be admitted. I even had written a paper on the subject; but C. Chaptal, in his observations printed in Vol. XXVIII. of the *Annales de Chimie*, having discharged this task much better than I could have done, I have thought proper to suppress the greater part of my labour; I should even have suppressed it entirely, if the experiments I made, and the results I obtained, had not led me to adopt an opinion different from that of Chaptal. It is this part of my labour that I have determined to give.

C. Chaptal, after having proved, by several experiments, which appear to me decisive, that the difference between the

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two acids does not arise from a greater concentration on the part of the acetic acid, concludes by saying:

1st, That there is a difference between the acetous and acetic acid.

2d, That this difference arises from a less proportion of carbon in the acetic acid than in the acetous acid.

3d, That the acetous acid does not pass to the state of acetic acid but by carbonization.

4th, That the difference which exists between that acid and some others equally susceptible of modifications by changes made in the proportions of their constituent principles is, that in this acid the oxygen does not appear susceptible of addition nor subtraction, and that the carbon alone experiences variations and determines all the changes, while in other acids it is the oxygen which varies and occasions the changes.

I am of opinion with Chaptal, that there is a difference between the acetous and acetic acids: I even admit that the latter contains less carbon than the acetous acid; but does the acetous acid pass to the state of acetic acid only by decarbonization, as that celebrated chemist asserts? I do not think so. On the contrary, I hope to be able to prove, by several experiments: 1st, That the difference which exists between the two acids is owing to the different proportions of oxygen: 2d, That this substance is in greater quantity in the acetic than the acetous acid: 3d, That by adding oxygen to the acetous acid it may be made to pass to the state of acetic acid.

C. Adet having laid it down as a principle, that the acid of vinegar, in its combination with potash, is in the state of acetic acid, and, as Chaptal has not disputed this assertion, which, if correct, would give great weight to the opinion of C. Adet, I thought it proper first of all to examine whether, as C. Adet asserts, the acetic acid, obtained from the decomposition of the acetite of potash, by means of sulphuric acid, really existed in that salt, because that chemist says "the acetic acid is obtained before the least atom of sulphureous acid manifests itself," or rather, whether it be not owing to a commencement of the decomposition of the latter acid, as seems to be proved by the sulphureous acid obtained towards the end of the operation. To obtain a solution of this problem, which appeared to me to be of the utmost importance, I thought it would be sufficient to employ an indecomposable acid, which, however, should be susceptible of acquiring a concentration nearly equal to that of the sulphuric acid. As the muriatic acid appeared to me to possess

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all the requisite properties, I proceeded in the following manner.

Exper. I. One part of concentrated muriatic acid, and two parts of the acetite of potash, were put together into a retort, and distilled with a proper apparatus, till nothing more passed over; I then unluted the apparatus, and found that the acid obtained was in every thing similar to concentrated distilled vinegar; only that it was mixed with a little muriatic acid.

Exper. II. Equal parts of concentrated muriatic acid and oxide of manganese in powder, and two parts of the acetite of potash mixed together, and subjected to distillation, as in the preceding experiment, gave me acetic acid, similar in all its physical properties to that obtained by sulphuric acid, except that it was mixed with a little oxygenated muriatic acid which was disengaged towards the end of the operation.

Exper. III. Acetite of potash, mixed with the fourth of its weight of sulphuric acid, was distilled in a sand bath, in a moderate heat. Acetic acid passed at the commencement of the operation, and before the least atom of sulphureous acid had manifested itself, as observed by C. Adet; but when about the fourth of the liquor which I obtained had passed, the sulphureous acid began to disengage itself, and continued to do so till the end of the operation.

It evidently results, in my opinion, from these experiments, that in the acetite of potash the acid of vinegar is not in the state of acetic acid, but of acetous acid, and that an addition of oxygen is indispensable, to convert the acetous acid into acetic. These principles being once admitted, no doubt will remain that the sulphuric acid may lose a portion of its oxygen without however passing to the state of sulphureous acid, as I have advanced in my essay on the theory of ether, and consequently that this acid may be in an intermediate state between the sulphuric and sulphureous acid*.

* Fourcroy and Vauquelin, in their observations on my work respecting ether, oppose this opinion. It is not on suppositions, they say, that theories are established, and they add, that I ought to have begun by proving that the sulphuric acid may lose a portion of its oxygen, without passing to the state of sulphureous acid. I am sensible of the full force and justness of this objection. I omitted proving this assertion, because I considered it as an acknowledged principle, which the experiments contained in my essay on ether, and that described in the observations of the above chemists, only confirmed. Though it is only a short time since I received the volume of the *Annales* which contain these objections, I have employed myself on the means of obviating them, and two experiments which I have already made give me hopes of succeeding.

If any doubt ſhould ſtill remain, that an addition of oxygen is indiſpenſably neceſſary to convert acetous into acetic acid, the following experiment muſt, in my opinion, entirely remove it.

Exper. IV. Equal parts of diſtilled vinegar, concentrated by freezing, and of oxide of manganeſe in powder, mixed together and diſtilled to dryneſs, gave me the following products. There firſt paſſed about one half of the vinegar, which had not experienced the leaſt alteration. I then changed the receiver, and the acid which I obtained had acquired the odour which characterizes the acetic acid. When it was thus proved that the addition of oxygen is indiſpenſably neceſſary to convert acetous into acetic acid, it remained for me to examine how the oxygen effects that change,—whether by taking from it a portion of its carbon, as Chaptal ſuppoſes, or rather by combining with it, as the following experiment will prove.

I repeated the ſecond experiment in a mercurial apparatus, that I might collect the carbonic acid gas, which would neceſſarily be diſengaged if the acetous acid paſſed to the ſtate of acetic acid only in conſequence of loſing a portion of its carbon, which in this operation muſt have combined with the oxygen of the manganeſe. When the operation was terminated, lime water did not ſhow the leaſt atom of carbonic acid.

From the above experiments I think myſelf authorized to conclude,

1ſt, That there is a difference between the acetous and the acetic acid.

2d, That this difference is owing to a greater proportion of oxygen in the acetic than in the acetous acid.

3d, That the acetous may be converted into acetic acid, by combining it with a new quantity of oxygen.

4th, That the acid, in what is now called acetate of potaſh, is in the ſtate of acetous acid.

5th, That the acetic acid obtained from the decompoſition of that ſalt, by the means of ſulphuric acid, is owing to a portion of oxygen which it takes from the latter acid.

LIII. *On a cheap Subſtitute for Oil Paint.*

C. Cadet de Vaux has lately publiſhed a memoir, on what he calls painting in diſtemper with milk. His proceſs, which is nearly ſimilar to that of Ludic, given in the firſt volume of this Magazine, is as follows:

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Take ſkimmed milk two quarts, lime newly ſlaked ſix ounces, oil of pinks, linſeed oil, or nut oil, four ounces, Spaniſh white (or well-ground chalk) three pounds. Put the lime into an earthen veſſel, and pour over it a portion of the milk, ſufficient to bring it to the conſiſtence of thick ſoup: add gradually the oil, ſtirring the mixture with a ſmall wooden ſpatula; then pour in the remainder of the milk, and dilute in it the Spaniſh white. Skimmed milk, in ſummer, is often found curdled, but this is a matter of little importance to our preſent object; by coming into contact with the lime it will ſoon be reſtored to fluidity. It muſt, however, not be ſour, as it would then form with the lime a ſort of acetite (or, more correctly, a lactite) of lime, ſuſceptible of attracting humidity.

The lime is ſlacked by immerſing it in water, then taking it out and leaving it to effloreſce in the air. The choice of the oils is a matter of indifference; but, for painting white, oil of pinks ought to be preferred, becauſe it is colourleſs; even the moſt common oils may be employed for painting with ochre. The oil, by falling into the mixture of milk and lime, diſappears: it is completely taken up by the lime, with which it forms a calcareous ſoap.

The Spaniſh white muſt be pounded, and ſtrewed gently on the ſurface of the liquid, by which it is gradually imbibed, and at length falls to the bottom. This paint may be coloured like that for diſtemper, by charcoal pounded in water, yellow ochre, &c. It is employed in the ſame manner as paint for diſtemper. This quantity will be ſufficient for giving a firſt ſtratum to ſix fathoms. The expenſe for the above quantity is about four-pence halfpenny, which makes about three halfpence per fathom.

When it is neceſſary that the painting ſhould be more durable, the following mixture may be employed: ſlacked lime two ounces, oil two ounces, and Burgundy pitch the ſame quantity. The pitch muſt be diſſolved in the oil, in a gentle heat, and the clear liquor of the milk and lime muſt be added. During cold weather, the milk and lime ought to be heated, that the pitch may not be too ſuddenly cooled, and to facilitate its union with the milk and lime. Painting with this ſubſtance has ſome analogy to that known by the name of encauſtic.

Theſe kinds of painting will ſtand againſt the common effects of the weather for years, and anſwer well for garden railings, fencings, and the like. The firſt time that wood is thus painted, it ſhould receive a ſecond coat after the firſt one is dry; but when re-painted, a ſingle coat only will be neceſſary.

LIV. *Extract of a Memoir on the Bronze of the Antients, and an Antique Sword. Read in the Public Sitting of the Institute, July 4. By* C. MONGEZ.

C. TRAULLE, president of the Society of Emulation at Abbeville, presented to the class of literature and the fine arts, a sword of bronze, found near Corbie, in the turf-moss, formed by the deposits of the Somme. A small figure of a warrior found in the same moss, and several Roman medals, some of which are frequently dug up there, give reason to conjecture that this weapon belonged to the Romans; besides its dimensions, the blade, being eighteen inches in length and two-edged, together with its point, its strength, its weight, seem to characterize a sword of the conquerors of the world. Though it was found near the skeleton of a man and that of a horse, it seems doubtful whether it belonged to a horseman, because the swords of the cavalry were longer than those of the foot soldiers. It is also probable that it was an object of luxury, or served as a mark of distinction to some officer, for we know, by the testimony of Polybius, that the ordinary sword of the Romans was of iron. In a word, such a weapon of bronze would cost at present as much money as a cutlass of the same length. It would, therefore, be no saving to adopt the use of bronze swords, but they could be sooner manufactured, as they might be cast; so that in a country destitute of manufactories for making sabres and swords, twenty thousand men might be easily armed in the course of a month.

After having examined the alloy of which the antique sword is composed, I generalized my labour, and made some researches in regard to the bronze of the antients. The following is the result.—We employed copper under the metallic form in three different states:—pure copper; brass or copper alloyed with zinc; and bronze, that is, copper alloyed with tin. I ascertained, by different experiments made in concert with Dizé, that we have no remains of pure copper from the antients. The sheathing even of ships, which was known to, and practised by them, was not performed with copper, but with plates of lead: the nails only were of bronze. Leo-Baptista Alberti observed it on an antient ship, discovered, while some researches were making under his direction, in the neighbourhood of lake Riccia. If to this be added, that all the antient instruments, vases, and medals, have been cast, we may conjecture, that the antients made very little use of pure copper.

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The fame thing cannot be faid of the antient brafs. Collections of medals contain feveral which have been evidently formed of this alloy, which is known to be factitious, but which Pliny believed to have been a long time before extracted from the bofom of the earth quite formed.

By the chemical analyfis of the medals of various nations, of a poniard, of a fword, found at Corbie, of nails, &c. all antiques, and of bronze, we have learned that they contained tin and fome atoms of zinc, but neither arfenic nor iron were found in them. The proportion of tin varies from four thoufandths to thirteen hundredths, one of the nails contained eight hundredths of tin. We know alfo that tin forms a part of the nails ufed for the fheathing of fhips, which are driven into the timbers with as much force as is ufed for iron nails. Why did the antients employ bronze alone? It was not becaufe the earth prefented that alloy quite formed, fince tin mines do not contain a fenfible quantity of copper, but becaufe they caft all their inftruments, and becaufe copper alone, though rendered fluid by an extreme degree of heat, remains in the confiftence of a pafte. The addition of tin renders it very fluid, and difpofes it to affume all the delicacy of the mould. It, therefore, forms a tenth of the metal ufed for cannons, and a fourth of that employed for bells. Befides, bronze is lefs fufceptible of being covered with verdigreafe than pure copper.

This dangerous effect, however, cannot be avoided when greafe, acids, and even vegetables, are long kept in bronze. For this reafon the Romans adopted the ufe of tinning, which Pliny fays had been invented in his time by the Gauls; thefe people they haughtily treated as barbarians, though they had learned from them the art of working iron, and of making ploughs with ears, &c.

Philo of Byzantium has made us acquainted with another object, which the antients had in view when they alloyed copper with three hundredth parts of tin. It was for the purpofe of making elaftic plates, employed in fhooting darts and javelins from their warlike machines. He adds, that they hammered them a long time to give them perfect elafticity. This alloy might be employed in our machines, and particularly in carriages for making bronze fprings, which might be fubftituted for thofe of fteel, the latter being oft fhort and brittle. Bronze alfo might be fubftituted with advantage for iron in machines, which may be fuddenly deranged by the iron work breaking, fuch as axles for carriages, and hinges for rudders. We have already adopted, for fixing the wheels to the axles, boxes of copper, the models of which were furnished by the antiquities found at Herculaneum. It is thus that the ſtudy of antiquity, contributing to the improvement of the arts, will free its followers from the reproach of inutility, which has been ſo often thrown out againſt them by ſuperficial minds.

At the period of the revival of letters, the learned men who examined a great many ſharp inſtruments of bronze, found in the ruins of antient cities, imagined that the antients gave them the hardneſs neceſſary for cutting by means of tempering. Pliny, however, who details all the operations in regard to the working of copper, thoſe in regard to iron, and the method of tempering it, obſerves perfect ſilence reſpecting the tempering of copper: on the contrary, we have ſeen blanks for copper money thrown into cold water, after being ſtrongly heated, to ſoften them. Count Caylus endeavoured to diſcover the pretended ſecret of the tempering of copper. For this purpoſe one of his chemical friends compoſed alloys, that is to ſay, miſtook the method, even if ſuch a ſecret had ever exiſted. By alloying a ſixth of iron with copper he conſtructed a ſword of bronze, which exhibited indeed the form of the antique ſwords, and cut like them, but which conſiſted of a different alloy, exerciſed an action on a magnetic bar, in the ſame manner as different alloys of iron and copper, even to the weak proportion of one part in eighty-one, a term at which the magnetic bar remains motionleſs. But of more than a hundred morſels of antique bronze, medals, ſtatues, knives, poniards, ſwords, &c. which I ſubjected to the ſame proof, not one exhibited the leaſt trace of iron. In a word we aſcertained, by very ſimple experiments, that the antient bronze contained no arſenic, though a modern chemiſt has aſcribed to the addition of that ſubſtance the hardneſs poſſeſſed by the cutting inſtruments of the antients.

C. Darcet, the ſon of our colleague, who analyſed the ſword dug up near Corbie, followed the real method for diſcovering the cauſes which gave to that weapon the faculty of cutting, which it ſtill poſſeſſes. At my requeſt he formed a ſimilar alloy with twelve hundredths of tin: by means of a mould he formed two knife-blades, and one pen-knife blade. One of the knives was ſubmitted to the claſs, who found that it was not inferior to our common knives. The edge was formed by hammering, and ſharpening it on a grind-ſtone. It was thus that the antient ſword had been formed, and traces of the hammer may be ſtill ſeen on its edges.

If bronze were employed for cutting inſtruments uſed at

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fea, the blades, which the acidity of the atmofphere rufts and deftroys when made of iron, would be preferved from that inconvenience.

I fhall terminate this extract with fome reflections on the price of metals in the time of Pliny. Lead at Rome, during the firft century of our æra, was worth twenty-four times the price at which it is fold at prefent at Paris, and tin eight times its prefent price; fo that lead was three times as dear there as tin, while among us it does not coft a third of the price. The comparative dearnefs of thefe metals among the antients muft make us fenfible of the advantage which more extenfive commerce, and metallurgic labours conducted in a more fcientific manner, give us over them. But we ought not to forget that this advantage is the refult of eighteen centuries of experience and improvement; and that, notwithftanding this great number of centuries, the antients are ftill our mafters in that part of literature, and the fine arts, which forms the peculiar domain of the imagination.

LV. *On the Expanfion of Wood by Heat.* *By* DAVID RITTENHOUSE, LL. D. *Prefident of the American Philofophical Society* *.

IN the prefent ftate of experimental philofophy it is well known that bodies in general enlarge their dimenfions, or expand, on being heated, and contract in cooling. From fome experiments heretofore made, wood has been thought to make an exception to the general rule, and this opinion has fo prevailed that many curious perfons have applied wooden pendulum rods to their time-pieces, to prevent the variation in their rate of going, arifing from the expanfion and contracting of a metal rod. From my own obfervations, however, as well as thofe of fome of my friends, the wooden pendulum rod does not appear to anfwer the expectations formed on it. I had in my poffeffion for feveral years an excellent time-piece made for this fociety by an ingenious workman and worthy member of the fociety. The refult of my conftant attention to this clock was, that, though its regular variations with heat and cold were probably much lefs than thofe of metal pendulums, it neverthelefs went always fafter in winter than in fummer, and was liable to very fudden and confiderable variations; arifing, no doubt, from the combined effects of heat and cold,

* From the *Tranfactions of the American Philofophical Society.*

moiſture and dryneſs. This determined me to make ſome careful experiments with a pyrometer capable of receiving a piece of wood of the length of a ſecond pendulum. Several years ago I made ſome experiments of this kind, perfectly correſponding with thoſe I have lately made, and which I now communicate to the ſociety.

I took a ſtraight-grained piece of white hiccory, green, for I could not procure any ſeaſoned, its length 39 inches, and about 3-8ths of an inch ſquare. This I placed in my pyrometer, and kept it fully extended by a weight faſtened to a ſtring, going over a pulley. To the pyrometer I applied the tube and glaſſes of a good compounded microſcope, and a micrometer, the value of the ſmaller diviſions whereof I found to be nearly .00053 parts of an inch each.

The rod of wood being placed in the pyrometer, I poured ſand all around it, heated to about 250 of Fahrenheit, which degree of heat I found the wood would bear without ſcorching. On pouring in the hot ſand, the rod expanded very much, but ſoon began to contract, even before the ſand was ſenſibly cooled, which I ſuppoſe aroſe from the hot ſand extracting the moiſture of the wood. It continued to contract as the whole grew cool, ſo that when the rod had acquired its firſt temperature it was near 30 of the above diviſions ſhorter than at firſt. I repeated the operation a ſecond and third time, and had then reaſon to conclude that the wood was nearly as dry as it would become by lying long in a dry air. I now let it cool to the temperature of the atmoſphere, which was 75°, and heating the ſand to 200 only, I poured it around the rod. In a few minutes it expanded 16 diviſions. In half an hour the ſand had cooled to 125, and the rod had contracted 11 diviſions. In an hour more the ſand was 80, and the rod ſhortened full 4 diviſions more, being nearly equal to its length when the ſand was firſt applied. On the whole I conclude, that very dry wood expands with heat pretty regularly, though certainly in a much leſs degree than any of the metals, or even glaſs.

The rod above mentioned having been kept in a dry place for twelve months, I again tried it with the pyrometer, having fixed near one end of it a ſmall graduated ſcale of ivory, 360 diviſions whereof were equal to one inch. This ſcale was viewed with the microſcope, furniſhed with a croſs hair, and I thought this method preferable to the ſcrew micrometer uſed before.

The rod was placed in the pyrometer when the temperature of the air was about 60°. On pouring ſand around it, heated a little higher than boiling water perhaps, it immediately expanded

panded half a division, but in less than a minute it began to contract, and continued to do so for an hour, when I drew off the sand. It was now full 10 divisions shorter than at first, so that it had imbibed a great deal of moisture from the air, which it again parted with to the heated sand. Three hours afterwards, when the rod was cool, I again poured the sand on it, heated as before. It now continued to expand for about three minutes, when its length was increased $3\frac{1}{4}$ divisions, it then began to contract, and became full 3 divisions shorter than when the sand was poured on it. I caused the sand to run off once more, and let the rod cool. Then heating the sand 250° by a thermometer, I poured it on the rod, and in a few minutes it expanded $3\frac{3}{4}$ divisions, it then began to contract slowly, and in 15 minutes it became 2-3ds of a division shorter than at first. On the whole, I concluded that the expansion of wood, in its length, will be irregular, corresponding partly to the warmth, and partly to the moisture of the atmosphere.

LVI. *Observations on the Means of detecting the Presence of Lead in Wine.* By C. O. Reinecke *.

To gratify sordid avarice at the expense of the health of mankind, by communicating to sour wines a fallacious sweetness by means of the oxide of lead, is a crime which for the dignity of the human race we shall suppose to be committed rather through ignorance than want of principle. Half a bottle of Chably wine was lately sent me to test, with a notice, that a person, whose opinion, on account of his talents, was entitled to great respect, had tried this wine, and believed that he had found in it oxide of lead. To accomplish the object in view I employed the following means:

1st, After being assured that the seal with which the correspondent had marked the half bottle was in good preservation, I began to examine the physical properties of the wine it contained. It was perfectly clear, had scarcely any colour, and had formed no deposit. The taste of this liquor alone convinced me that it had not experienced that adulteration of which it was suspected; it had that pure and pungent taste, which is so much liked in Chably wine, without the slightest trace of that perfidious sweetness communicated by acetite of lead, and which always betrays itself by a styptic relish, however small may have been the quantity of this poison mixed with the liquor.

* From the *Annales de Chimie*, No. 114.

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2d, As it was neceſſary that the detection ſhould be of ſuch a nature as to be evident to thoſe acquainted with the firſt principles of chemiſtry, I endeavoured to find it in the relation which alkaline pruſſiates have with metallic ſolutions. It is well known that they decompoſe them all in conſequence of that double affinity by which the pruſſic acid abandons its firſt baſe to form with the metallic oxide an inſoluble pruſſiate, coloured according to the nature of the metal. Setting out from this principle, I diſſolved cryſtallized pruſſiate of potaſh in diſtilled water, and mixed this ſolution with a part of the ſuſpected wine. Having left this mixture expoſed to the air for twenty-four hours, and then finding no other changes but a few atoms of pruſſiate of iron, very diſtinguiſhable by its blue colour, I conſidered myſelf as authorized to announce that the wine in queſtion did not contain the leaſt particle of lead.

3d, To give to this firſt proof that degree of evidence of which it is ſuſceptible, and to place the principles of it beyond all doubt, I mixed another part of the ſuſpected wine with a ſingle drop of the acetite of lead; to this mixture two drops of the ſame ſolution of pruſſiate of potaſh (2d) were added, and I immediately obtained a precipitate of a dirty white colour, being the pruſſiate of lead, and proving in the fulleſt manner, that in the preceding experiment the ſame wine muſt have given the ſame precipitate if it had contained the ſmalleſt particle of lead.

4th, To theſe proofs and counter-proofs by the pruſſiate (2 and 3), that of the muriatic acid was added: the latter, as is well known, ſeparates lead from its ſolutions under the form of a muriate very little ſoluble; it did not diſturb the tranſparency of the ſuſpected wine, nor produce any change in it: this, then, ſtill tends to prove that the above ſuſpicion was ill founded.

5th, The proof by ſulphuret of potaſh, propoſed long ago as the ſure means of detecting lead in wine, had been employed by the perſon above mentioned. A number of cauſes, well known, render this proof doubtful; and it is well known that it is concluſive only when the preſence of the metal alluded to has been proved by complete deoxygenation, bringing back the oxide to the ſtate of metal. For want of this verification, this proof has very often been the ſource of errors, the more ſerious as the ſuſpicion to which they give riſe is odious. It was more than probable that the ſame cauſe had in the preſent caſe produced the ſame effect; but it was of importance to prove it, which was done as follows;

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The reagent in question was made in the proportions and manner indicated by the person who had employed this test *: equal parts of sulphur and potash (caustic) were dissolved in a sufficient quantity of distilled water; some drops of this solution, which the said person called *sulphuret*, and to which he ought to have given the name of *hydrogenated sulphuret*, were mixed with the suspected wine, and no other change was produced, but that which ought to take place in pure wine of the same kind, viz. a decomposition of the sulphuret, either by the malic acid or by the tartareous acid of the acidulous tartrite of potash. Had this wine held in solution a particle of lead, the latter must necessarily have immediately formed, not a salt, as the author of the note says, but a metallic sulphuret, insoluble, and easy to be distinguished by its colour; being at first of a reddish brown, and passing soon to dark brown. But as the wine did not experience from this reagent any other change than that arising from the said decomposition, giving first a white cloud, then some traces, scarcely sensible, of a deposit of the same colour, which is nothing else than the sulphur precipitated, it is still proved the wine did not contain a particle of lead.

6th, Another part of the same kind of wine, but known to contain lead, was employed to confirm the proof (5) by a counter-test: a drop of the solution of acetite of lead was put into it, and hydrogenated sulphuret being then added, I immediately obtained the insoluble sulphuret of lead of the colour which I have mentioned.

7th, Having at hand all the apparatus necessary for these researches, I applied them to red wine sold in a tavern. One part of this wine being mixed with a few drops of the solution of acetite of lead, and then with hydrogenated sulphuret, the sulphuret of lead was immediately announced by a change of colour. The purple passed to blackish, and soon after the metal was detected by an abundant deposit of the same colour. One part of the same red wine being mixed with hydrogenated sulphuret, without adding acetite of lead, the difference of the phænomena was so striking, that it alone is sufficient to give confidence to persons whose regard for their health may induce them to make trials of this nature: the change of colour is no less speedy in pure wine than in that which contains lead, but this change is altogether opposite to that which I have here noted. Red wine containing lead grows darker by hydrogenated sulphuret: pure red wine, on the other hand, when the reagent is mixed with it, exchanges its

* This indication, under the title of a note on the experiment, was transmitted to me with the wine.—O. R.

purple

purple colour for a bright rose red, and of so beautiful a shade, that on seeing the liquid become turbid, the hope of obtaining a precipitate susceptible of becoming useful to the arts does not enter into the domain of illusions, till the filter and the want of a sensible deposit obliges the artist to acknowledge his error.

LVII. *Memoirs of the Life of* JOHN ROBISON, *LL.D. Professor of Natural Philosophy in the University of Edinburgh, &c.*

THIS eminent mathematician and philosopher is a native of the South of Scotland, the son of worthy parents, in the middle condition of life.

He had, as soon as he was at an age capable of literary instruction, the advantage of attending one of those parish-schools, which are so much celebrated as the sources of the general and extraordinary intelligence of the Scots, acquiring, with great eagerness and facility, that knowledge of English, Latin, Greek, writing, and arithmetic, which usually forms at such schools the complete course. He was considered as a genius that ought to be devoted to one of the learned professions; and his parents resolved to bring him up to be a clergyman.

He went to pursue his studies at the university of Glasgow, in which some of the most eminent philosophers of the age were then teaching with great reputation and success. In every branch of study he made distinguished proficiency, but MATHEMATICS soon became his favourite. Dr. ROBERT SIMPSON was his master in this science; and it is well known how much that great man contributed to the restoration of antient mathematics, and to the general diffusion of a taste for mathematical knowledge, among his contemporaries. The sciences which are employed upon pure truth and reasoning, if, at a first trial, harder and less inviting than most other parts of study, yet, when their first difficulties are, by an ingenuous mind surmounted, rarely fail to delight and captivate, and absorb the whole soul, more than any thing else that can become the subject of investigation or continued thought. With Dr. ROBISON it was perfectly so. His first progress in mathematics was easy and rapid; and, as he advanced, his passion for investigating mathematical truth became continually more ardent, his intuition keener and more vivid, his perseverance in unravelling

ravelling the moſt complex and tedious intricacies of deduction, ſtill more ſteady.

Of ANTIENT MATHEMAMICS, in all its parts, he was ſoon a maſter; but, as it employs words for its ſigns in reaſoning, as it ventures on few daring abbreviations and ellipſes in its chains of demonſtration, as its forms are apt to cumber and cramp the march of a vigorous mind in tracing mathematical truth, as it is in many reſpects ill-adapted to thoſe calculations and inquiries which the due proſecution of the modern diſcoveries in aſtronomy and other parts of phyſics neceſſarily demands,—it was, therefore, natural that he ſhould earneſtly proceed to the ſtudy of a *Syſtem of Signs* for the uſe of mathematical reaſoning, and of methods of abbreviation founded on the peculiar convenience of thoſe ſigns, which were much fitter to give due ſcope to the intuitive force and activity of reaſoning powers like his. ALGEBRA engaged and pleaſed him ſtill more than the previous parts of mathematics. He was eſpecially delighted with that mode of it, for the honour of whoſe invention Newton and Leibnitz, with perhaps nearly equal claims, contended, and which, by ſubjecting the relations of infinite quantities and magnitudes to ſtrict mathematical eſtimate, ſeems abſolutely to exalt and enlarge the powers of man beyond the native deſtination of humanity. As he took a peculiar delight in the ſtudy of FLUXIONS, ſo he, of courſe, advanced in the knowledge of them far beyond any of his fellow-ſtudents. He purſued them eagerly in all their applications to the calculations of aſtronomy, of mechanics, and even of moral probabilities. He contrived to employ them in the ſolution of a variety of problems, in regard to which more prolix methods of demonſtration had been hitherto uſed.

Nor was his proficiency confined to mathematics alone, even at the time of his being the moſt ardently devoted to this ſtudy. He excelled in the knowledge of thoſe authors who belong to the province of polite literature, in taſte to diſcern their beauties, and in ſkill to enrich his mind with the moral wiſdom with which they are pregnant. He entered deep into the ſtudy of moral philoſophy. He became no mean proficient in that philoſophy of public œconomy and legiſlation which at that time was with ſingular fondneſs cultivated at Glaſgow. To the profeſſional ſtudy of theology, indeed, he became firſt indifferent, and then averſe; not, however, out of any ſcepticiſm concerning the truths of chriſtianity, but from that ſtrong paſſion which engaged him to devote his whole life, if it were poſſible, to the advancement of mathematical ſcience.

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The ſtudy of mathematics has generally the effect to form to penſive and compoſed habits of thought, the ſtudent who attaches himſelf to it earneſtly. It had, at an early hour, this influence on Dr. ROBISON. In ſocial converſe he was the delight of his fellow-ſtudents, and was capable of as much vivacity and cheerfulneſs even as thoſe among them who might be the moſt innocent of profound thought. But, he delighted to ſhut himſelf up and muſe alone in his chamber, to ſteal out in ſolitary walks along the banks of the Clyde, to indulge in that ſtudious melancholy which is ſo much akin to true genius. It was not without a ſort of friendly violence that he could be carried from this employment of his hours away into ſociety. But his converſation, when he could be brought among them, was too engaging, not to invite his companions often thus to break in upon, what they thought, the extreme ſeverity and recluſeneſs of his ſtudies.

He was contemporary as a ſtudent in the univerſity of Glaſgow with a number of gentlemen, profeſſors and ſtudents, who, like himſelf, will ever be diſtinguiſhed among the firſt ornaments of the age to which they belong. He obtained the friendſhip of Mr. WINDHAM, lately *Secretary at War*, who was then acquiring, under MILLAR and SMITH, the principles of political, œcumenical, and legiſlative philoſophy. RICHARDSON, ſince eminent as a poet, a critic, a philoſopher, and a profeſſor, about that time finiſhed his ſtudies at Glaſgow, and went to Ruſſia in the family of the late Lord Cathcart, the Britiſh Ambaſſador to that Court. Dr. JOHN GILLIES, the learned interpreter of Ariſtotle, was then entering ſucceſsfully upon the ſtudies in which he has become ſince ſo eminent. Dr. ROBISON lived, for a time, in the houſe of Principal LEECHMAN, one of the moſt pious, learned, and liberal-minded divines, that adorned any religious eſtabliſhment in the eighteenth century.

The civilization of RUSSIA, as far as it has advanced, has been the work chiefly of the *Germans* and the *Scots*. Her Imperial Majeſty, Catherine the Second, was then reviving the great naval deſigns of Peter the Firſt. She was, for that end, deſirous to eſtabliſh marine ſchools, in which young ſea-officers might be inſtructed in thoſe parts of mathematics without which a ſhip's reckoning cannot be kept, obſervations cannot be made at ſea, nor can the duties of a naval engineer be performed. By the intervention, we believe, of Lord Cathcart, an invitation from the Ruſſian Government was ſent, to draw a number of young mathematicians from the univerſities of Scotland, to teach in thoſe marine fchools. Dr. ROBISON, glad to efcape from theology to the profeffional purfuit of mathematics, was one of the foremoft to embrace the invitation. He went from Glafgow to St. Peterfburgh; and entered foon after upon his functions, as the mathematical teacher in a marine fchool, we believe, at Cronftadt.

In teaching mathematics he was employed to his wifhes; but he foon felt it exceedingly irkfome to pafs his days in explaining the firft fimple elements of that fcience, to youths rude, turbulent, carelefs, and illiterate, and in whofe native language he had, for a time, fome difficulty to make himfelf readily underftood. The emoluments of his appointment were comparatively fmall; and the manner of living differed fo much from that to which he had been accuftomed in Scotland, as to be confiderably difagreeable to him. He found that, for his favourite fcience, he had made a great facrifice, and had actually gone into a painful exile.

Yet he was not without experiencing fome flattering confolations: his addrefs and perfonal appearance, uncommonly graceful and ftately, befpeaking rather a military man of high rank, than an obfcure mathematician, recommended him to the polite notice of the beft company wherever he had occafion to appear. He had become in Scotland a freemafon; and his connexion with that fraternity introduced him, with advantage, to many refpectable perfons who were enthufiafts for freemafonry in Ruffia. There were at St. Peterfburgh fome Scottifh merchants, men of pleafing manners and liberal education, who knew how to eftimate merit and talents like Dr. ROBISON's, at their juft value; and were, therefore, ever ready to diftinguifh him by every agreeable civility in their power. Of thefe, he delighted chiefly in the fociety of Mr. PORTER, a gentleman who, after paffing like himfelf with the higheft fuccefs through a complete courfe of academical ftudy, had been led by the circumftances of his life to engage in trade at St. Peterfburgh; and, with manners the moft amiable and the beft of hearts, unites fuch a knowledge of books with fo much of deep infight into the human character in all its diverfities, and fuch a fkill in the modes of bufinefs, as one fhall very rarely find together in one man in any country, or in any condition of life.

But it was, above all, in the purfuit of mathematical and philofophical difcovery that Dr. ROBISON found his beft refource for amufement in Ruffia. An occafion fortunately arofe to enable him to turn that difcovery to advantage. A PLAN was required by the Emprefs, according to which the

Imperial

Imperial palace might be the moſt *conveniently* and *certainly* ſupplied with water. Dr. ROBISON, putting his mathematical ſkill to uſe, as a civil engineer, offered a plan that was preferred to a variety of others which the ſame occaſion produced. A more honourable appointment, preſent emoluments conſiderably augmented, and the grant of a moderate penſion for life, were his rewards for a ſervice ſo acceptable.

All this, however, could not make him prefer Ruſſia to the remembrance of Scotland; and his deſire of return to his native country was at length fulfilled. He was, about 25 years ſince, upon the death or retirement of Mr. RUSSEL, invited, in conſequence of the high reputation to which he had attained, to fill the chair of natural philoſophy in the univerſity of Edinburgh.

High expectations had been raiſed of extraordinary ability to be diſplayed in his lectures in that ſituation. It was amply gratified. The writer of this ſketch heard his lectures in the ſeſſion of 1780-81, and in ſome ſeſſions ſubſequent; and it is but juſtice to own, that, in accuracy of definition, in clearneſs, brevity, and elegance of demonſtration, in neatneſs and preciſion in experiments, in the comprehenſiveneſs of his courſe, extending to every branch of phyſics and of mixed mathematics, and even in fullneſs of detail in each particular diviſion, a more perfect ſyſtem of academical lectures is not to be eaſily imagined. Yet, as men of great original genius in ſcience cannot eaſily endure to dwell for ever in the detail of its ſimpleſt and moſt familiar elements; as they find it often difficult to confine themſelves to the uſe of thoſe media in reaſoning and demonſtration which are alone intelligible to ignorance; as their natural march of thought is not ſeldom too bold and rapid to be cloſely followed by genius and knowledge much leſs than their own; not a few, even of the moſt ingenious of Dr. ROBISON'S hearers, were found, at times, to complain, that they could not always, with clear underſtanding, purſue him through thoſe ſeries of demonſtration of the truths in mixed mathematics, with which his lectures were filled. He heard their complaints with kindneſs, and endeavoured to accommodate his inſtructions ſtill more and more to their apprehenſion. But, till Mr. PLAYFAIR, the preſent Profeſſor of mathematics in that univerſity, had perſuaded the young men intending to ſtudy natural philoſophy, to pay much more previous attention than had been uſual to pure mathematics, the ſubject of the complaint was never entirely removed.

When the ROYAL SOCIETY of EDINBURGH was inſtituted

ſtituted; Dr. ROBISON was perſuaded by the members to undertake the duties of Secretary to its philoſophical claſs. He has diſcharged them in a manner highly honourable to himſelf, and uſeful to the views of the Society. He has enriched ſome of the printed volumes of its TRANSACTIONS with papers which ſignally diſplay his profound knowledge, and the wide, vigorous graſp of his genius as a philoſopher and mathematician.

In his zeal to promote mathematical ſcience, particularly in its application to the uſeful arts, he condeſcended to contribute to the laſt edition of the ENCYCLOPÆDIA BRITANNICA the greater part of its articles in mixed and pure mathematics. They have been unanimouſly diſtinguiſhed, throughout Europe, as infinitely the beſt of the original articles in that compilation. The SUPPLEMENT, alſo, which has been ſince added to it, owes ſome of its beſt materials to his hand.

Having been led to think that the combination of the FREEMASONS might, in this revolutionary age, be abuſed to dangerous purpoſes, he broke off, ſome years ſince, his connexion with that fraternity; and wrote and publiſhed an eloquent book to explain the grounds of his fears, and the reaſons of his ſeceſſion. We preſume not to judge between him and his opponents in this matter: but it will be fortunate if the Freemaſons ſhall, with one accord, conſpire to prove that he has miſrepreſented them, by the loyalty and peaceable patriotic rectitude of their conduct, in every part of the world.

Soon after his return from Ruſſia he entered into the married ſtate, and is now the father of a promiſing family. Some of his children are now grown up, and ſettled in life.

For a conſiderable number of years the ſtate of his health has been uncertain and languid. But nothing could induce him to any continued remiſſion from thoſe ſtudies in which he delights and excels.

LVIII. *On Bleaching. By a Correſpondent.*

To the Editor of the Philoſophical Magazine.

SIR,

IN your laſt number for July, p. 102, in O'Reilly's eſſay on bleaching, it is directed, if a *bright whiteneſs* be required, that,

that, after each process of vapouring, the stuffs be rinsed "always in water a little *soapy*, made with 2 *oz.* of that substance for each *lb.* of wool." It may be necessary to caution those who have never made any experiments in bleaching with sulphureous acid vapour, that soap even of the very best quality will always give the stuffs a *yellow* tint, and that too though it be used in only 1-4th the quantity here prescribed. Indeed, from a number of experiments made about three years ago, (which I now quote from memory) I am convinced, that to attain a bright white, by the use of soap after the sulphureous acid, will be a very difficult, if not impracticable, attempt. Of silk I may venture to speak more positively; that the brightest white possible to be made, *cannot* be produced where *soap* has been used after the sulphuring process. It is in vain, however, to have recourse to the expensive and dubious effort of soap, when weak alkaline leys are equally safe for the stuffs, much cheaper, and much more certain of producing a bright white. In some peculiar kinds of silk, where the sulphureous acid vapour, (applied nearly in the same manner as directed in O'Reilly's valuable essay) the oxymuriatic acid, with soaps and alkaline leys, have all failed to produce a bright white, it has been effected by a mixture of sulphuric and muriatic acids, diluted so as not to impair the texture of the cloth. The proportions of the latter I cannot at present specify.

J. A. B.

Tokenhouse-Yard, Aug. 25, 1801.

LIX. *Facts respecting the Transition of a Species of Fly, from the Chrysalid to the Volatile State. By Mr.* John Snart, *Optician* *.

SIR,

Tooley-Street, London. (No. 209,) Aug. 18.

THE following particulars, the result of several hours observation, which I made upon the development of a species of fly from the chrysalis or piscatory to its volatile state, may prove acceptable to your readers; and the more so as it seldom happens that people chance to be in those circumstances which can make them witness the facts I mean briefly to describe:

June 7th, being Sunday, Fahrenheit's thermometer at 75°, I observed in a water-but, which had not been cleansed for near three weeks, a small annulated and variegated worm

* Communicated by the Author.

rising

riſing to the top of the water, as if the latent fire, by kindling, had diminiſhed the ſpecific gravity of the body, (which in length was about four lines, and in diameter one line); ſoon after I ſaw another, and another yet appeared, until there might be about twenty of them, all formed alike; *i. e.* large toward the head, with a tuft of fine white hair iſſuing from each ſide of the apparent mouth. The ſight being novel I took my ſtation, and a few good magnifiers to watch the event; for, ſeeing ſo vigorous an exertion in each one, and in ſo uncommon and frantic a way, as the delicacy of their muſcles did not ſeem equal to ſupport long, I anticipated a cataſtrophe of ſome kind or other. I had the curioſity to touch ſeveral to try what effect it would produce, and found it a ſtimulus adding new energy to their already amazing agility. They continued theſe violent contortions and dilatations until they appeared quite ſpent; in the laſt effort, however, and after a ſudden contraction, and as ſudden an expanſion, with a kind of wriggle (they have no fins), they would come quite to the ſurface of the water, and, an inteſtine motion taking place, a cleft began to appear upon the back part of the head of this little amphibious creature, out of which, to my great aſtoniſhment, I ſaw emerging, as if propelled by an inward ſcrew, a creature quite of another element, form, and quality; in a word, a gregarious fly, a gnat; from which I judged, (not underſtanding the metempſychoſis) that the ova muſt have been depoſited in the mud, and that in this bed, under the agency of the parent fly, or perhaps nature, the nidification was performed while the incubation was perfected by the water and ſun; the laſt of which had now beſtowed its quickening influence, and revived them from their torpid ſtate. The confines of their priſon, wherein both wings and legs were contracted and bound down to their bodies in a very ſmall compaſs, (as I have ſtated above) beginning to rend aſunder, at firſt appeared their beautiful antennæ (if males), or more beautiful plumage (if females); next the two palpi or feelers, and as many bold and reticulated eyes, whoſe prominence is ſuch as to give the poſſeſſor the privilege of commanding near a whole ſphere at one view; with this ocular advantage, together with wings and ſting, compenſation is pretty well made for the weakneſs of their bodies, and the brevity of life, at leaſt, ſo as to ſet them upon a level with more promiſing creatures; the head being now wholly advanced, the body next appears with wings and legs, which heretofore were bound up in a kind of ſwathing, but now rejoice to unfold themſelves and act according to their different functions, the legs as ſupporters, the wings as ſails, which immediately, nautilus like, are spread to wanton in the breeze. And now, wholly emancipated, they stretch their silken pinions, and launch forth to run a new career, and——

> Exulting spread the wing to fly aquatic care,
> Then spurn the narrow cell, and fan the buxom air;

while the lifeless cuticle, in form a shark, in texture like the pith of a quill, is now deserted, and left to rot on the surface of the water, while its former inhabitant and prisoner commixes with beings of another element, and forgets his base original.

> So men might take example by these flies,
> Leave earthly cares and emulate the skies.

Some few, however, fell victims to that element which had first cherished them; for if by any accident they happened to fall into the water, and their wings got wet, they were incapable of disengaging themselves (yet those that I saw so circumstanced I set at liberty): others, though comparatively few, came to the birth, and were incapable, through want of strength, to bring forth, in which case I undertook, by the assistance of two needles, the part of accoucheur and brought them forth, though much maimed.

I remain, Sir,
Your obedient Servant,

Mr. Tilloch. JOHN SNART.

LX. *Brief Account of the Islands of Banda. By a Gentleman who surveyed them since they came into the Possession of Great Britain*.*

THE islands of Banda, situated 130 miles to the south south-east of Amboyna, are ten in number, viz. Banda Neira, Gonong Api, Banda Lantoir, Pulo Ay, Pulo Rondo, Rosyngen, Pulo Pisang, Craka, Capella, and Sonangy; of these, Banda Neira is the seat of the supreme government of the whole. In Gonong Api there is a volcano which constantly emits smoke, sometimes accompanied with a crackling noise: the surface of the island is covered with a quantity of sulphur and chalk. There is no vegetation whatever on upwards of one-third of the eminence on which the volcano is situated: there is a steep descent on the outside of it toward the sea, but, towards the harbour, the declivity slopes gradually to the water, on the side of which are some plantations and a few

* From the *Asiatic Annual Register for* 1800.

straggling

ftraggling houfes. In the fpace between Banda Lantoir and thefe two iflands there is a very good harbour, formed with entrances both from the eaft and weft, which enable veffels to enter it in either of the monfoons: thefe channels are well defended with feveral batteries, particularly the weftern one, which is, moreover, very narrow. Between Gonong Api and Banda Neira there is a third channel into this harbour from the north, but it is navigable only to fmall veffels. Pulo Ay is about nine miles weft of Gonong Api, and Pulo Rondo about four miles further, in fomewhat a more northerly direction. On the latter ifland the Englifh had once a factory; but at the time they were expelled from Amboyna they were alfo driven from thence, and the Dutch, not choofing to inhabit the ifland, it foon grew into a wildernefs. Pulo Pifang is fituated north-eaft of Banda Neira about two miles, and yields fome fine fruits, as well as mace and cocoa nuts, but not any nutmegs. Rofyngen is about feven miles to the fouth-eaft of Banda Lantoir; it produces mace and yams, and feeds fome cattle. The convicts of Amboyna ufed to be kept on this ifland, and were compelled to cultivate the land for the ufe of the fupreme government. The other three iflands are nothing more than fmall barren rocks.

The nutmeg-tree is cultivated only in the four firft mentioned of thefe iflands; but the Dutch thought it advifable to prohibit the cultivation of it in the other iflands, on account of their diftance from the feat of government, and of their thereby affording greater opportunities of fmuggling. The ifland of Banda Lantoir appears very high from the fea; its hills are fteep, and from the top of them there is a fort of table land, which extends nearly from one end of the ifland to the other. The Banda iflands are all high; but Gonong Api, which rifes 1940 feet from the fea, is the higheft of them.

The foil of all thefe iflands, except that of Gonong Api, which is for the moft part lava, is an exceedingly rich black mould, every where covered with trees, chiefly nutmegs. The almond-tree grows in great plenty, and is very ufeful, as well for the fhelter it affords the nutmeg-trees, as for the fruit it yields. There are alfo fandal-wood trees, and a variety of others which grow wild. Near the fea fide, round the different iflands, trees of all kinds are permitted to grow, as they are confidered ufeful in keeping off the fpray of the fea in ftormy weather from the nutmeg-trees, which is very prejudicial to them.

The principal fortification in the Banda iflands is Fort Naffau, which is fituated on the fouth fide of Banda Neira; it is a fmall fquare fort, with a wet ditch, defended by a horn-work towards the sea. In this fort the troops are quartered, and the public granaries are kept; but the storehouses for the nutmeg and mace are on the outside of the fortress, and situated near the government house. Above Fort Nassau, on an eminence, stands the castle of Belgica *; an old pentagon with round towers at the angles, and a surrounding wall with small bastions; but it has no ditch; it is said to have been built by the Portuguese. The next fortress of any consequence is situated on the island of Banda Lantoir, and is called Fort Holandia. It commands the western entrance into the harbour of Lantoir; but the works are very flimsy, and quite defenceless towards the land.

At a first view, the situation of this fortress appears infinitely preferable to that of any in these islands for the residence of the supreme government, not only on account of its being the strongest, and the most commanding situation, but from this island being the largest, as well as the richest, in respect to the produce of spices. Its unhealthfulness, however, proves a sufficient objection; and numbers of houses, now mouldering into decay, show that the experiment has been tried, and found not to answer: moreover the water is said to be bad, and the vapour, which sometimes descends from the volcanic mountain of Gonong Api, is represented as being particularly noxious. These circumstances seem to be confirmed by the experience of the Wirtemberg company, who formerly garrisoned this fort; and out of a hundred men eight died, and forty fell sick, in the course of two months.

Besides the above-mentioned forts, there are a number of redoubts and military posts all round these islands, for the purpose of preventing smuggling, and of protecting the plantations and the villages situated on the shores against the predatory invasions of the Papoo pirates, who infest these seas in large prows, and frequently land and carry off the inhabitants, and whatever else they can take by surprize, though they are seldom hardy enough to attack where resistance may be expected. The two redoubts of Kyk and the Kap, both situated on the south side of Gonong Api, were originally intended to defend the west channel of Lantoir harbour; but, owing to the irruption of the volcano in 1778, at the same time that a dreadful hurricane laid waste the whole of the islands, the lava flowed down in such quantities as to form a considerable promontory between these batteries and the channel they were intended to defend, so that they are now, in a great degree, useless. Some material improvements,

* The *g* in this word is pronounced hard as in give, and the syllable long.

however,

however, which have been recently made to the batteries of Batavia and Sebergorberg, have put the weſtern channel into a ſtate of ſecurity; and a new battery, which has been erected on the north-eaſt part of Banda Neira, renders it a difficult matter to force an entrance into the harbour by the eaſtern channel.

The frame of this government is different from that of Amboyna; the whole ſociety conſiſts of the company's ſervants, ſome burghers, and ſlaves. The ſole object of their attention being the care and cultivation of the nutmeg-trees, the affairs of government cannot be ſuppoſed to be very complicated: nevertheleſs it is at preſent a diſtinct eſtabliſhment, conſiſting of a governor, a council of three, and a ſecretary, together with a regular court of juſtice as at Amboyna; but the governor of Banda not being ſubject to the check, much leſs the control, of any ſuperior authority, his will may be juſtly conſidered the only law of the ſettlement.

The Dutch company were the abſolute proprietors of the ſoil, as well as of the ſlaves who cultivate it. The rearing of the nutmeg-tree being the only object in view, thoſe iſlands that produce it are divided into a number of plantations, or parks, as they are termed, which are ſuperintended by native burghers, deſcendants of the Dutch, who originally ſettled in theſe iſlands. A certain number of ſlaves belonging to the company is allotted to each park, whom the park-keepers employ in the cultivation of the nutmeg-trees. They are ordered to ſend daily two-thirds of their ſlaves to the parks to clear the trees and to gather the ripe fruit, as well as to pick up all that may have fallen from the trees in the night: for this purpoſe each ſlave is furniſhed with a ſmall baſket and a hoe.

When the nutmegs are brought in, the mace is ſtripped off, and kept in baſkets to dry in the ſun; and the nutmegs with ſhells on, are put into a drying-houſe allotted for the purpoſe, where they remain, on hurdles expoſed to the influence of a ſlow fire, and to ſmoke, for about three months; when they are dry, their ſhells are broken, and the fruit put immediately into chunam or lime, which is neceſſary to preſerve them from worms and other inſects. It requires much experience, as well as a conſiderable degree of judgment, to aſcertain the preciſe time that they ſhould be ſuffered to remain in the lime; for if they be taken out too ſoon they are worm-eaten, and if left too long in it, they are burnt up, and rendered uſeleſs. After the nutmegs are taken out of the lime, they are cleaned and packed up in rattan bales of 200lb. ready for being ſhipped. The mace is delivered into ſtorehouſes every month, and the nutmegs every three

 months:

months: they are both paid for on delivery, the mace at 7½ stivers per pound, and the nutmeg at 2½. From this price, however, a deduction is made of 17 per cent. from the weight of the spices; 10 per cent. in favour of the company as an acknowledgment of their right to the soil, and 7 per cent. in favour of the servants of the company. The 7 per cent. is an old custom; but the additional 10 per cent. has only been levied a few years previous to the arrival of the English.

The quantity of nutmegs and mace produced for several years past, has been inconsiderable, owing to an unaccountable inattention in the collection of them. But since the arrival of Mr. Boeckholtz, the late Dutch governor, the produce was so much increased, that the half-yearly collection which was found in store when taken possession of by the English in 1796, amounted to 81,618 lb. of nutmegs, and 23,385 lb. of mace. This was the first half year's crop since Mr. Boeckholtz's government had commenced; the crop of the half year following equalled it in quantity; and in future years, under proper management, the quantity produced may with confidence be supposed to average 600,000 pounds of cloves, and 200,000 pounds of nutmegs—an estimate founded upon the most moderate computations of the most experienced and best informed persons in the Spice islands.

The nutmeg-tree grows to the size of a pear-tree; its leaves resemble those of the laurel; it begins to bear fruit at ten years growth, and the fruit improves in quality and increases in quantity until the tree has attained the age of a hundred years. It requires to be securely sheltered from the hurricanes to which these islands are sometimes exposed; for many of the nutmeg-trees are situated on the steepest sides of the hills, where they cannot take deep root, and by consequence are likely to be torn up by sudden gusts of wind. It is asserted that the chief loss which the nutmeg plantations sustained by the hurricane in 1778, was in consequence of a great many of the almond-trees, which had afforded them shelter, having been cut down.

The nutmeg, when ripe on the tree, has both a very curious and beautiful appearance: it is about the size of an apricot, and nearly of a similar colour, with the same kind of hollow mark all round it; in shape it is somewhat like a pear: when perfectly ripe, the rind over the mark opens, and discovers the mace, of a deep red, growing over and covering in part the thin shell of the nutmeg, which is black.

There are persons called foresters who superintend the parks and the drying of the nutmegs and mace. They are directed to make regular reports to the governor respecting the state of the

the different parks, and of the quantity of ſpices which they yield. Beſides theſe perſons there are directors of the parks, who viſit them every month to ſee that the trees are properly attended to, and planted at regular diſtances from each other; and alſo to obſerve whether the foreſters are active and careful in the execution of their duty.

Almoſt the whole of theſe iſlands being appropriated to the cultivation of nutmegs, they neither feed cattle nor produce grain enough for the maintenance of the inhabitants. Like Amboyna, they have therefore been ſupplied annually from Batavia with rice and other articles of proviſion.

All the aforeſaid regulations concerning the cultivation of the nutmeg-trees, and the price paid for the produce of them, were eſtabliſhed by the late Dutch governor, who arrived about fifteen months before the Engliſh took poſſeſſion of the Banda iſlands. Previous to his arrival, moſt of the planters were in great diſtreſs, having been charged with very heavy debts incurred on account of loans in rice and money, made at different periods, to the former governors: and this circumſtance, together with the great loſs which they ſuſtained by the dreadful hurricane in 1788, entirely ruined their private fortunes as well as their plantations. In this diſtreſsful ſituation, the Dutch government, with a wicked avarice, aggravated their miſery by compelling them to deliver their nutmegs at the reduced price of three farthings per pound, and the mace at a ſtill lower rate. Under the preſſure of this accumulated diſtreſs, the ſpirit which had animated their fathers in the rude days of their ſavage independence ſeemed once again to revive, and they remonſtrated in bold and determined language: they claimed the lands as their own preſcriptive inheritance, and actually proceeded to portion them out to each other. And the Dutch, though unſuſceptible of any feelings of remorſe for their own oppreſſive folly, which had reduced the country to this deplorable condition, had yet prudence enough to avert, by conciliatory meaſures, the imminent danger which threatened them; and when they found that the fury of the people was not to be appeaſed but by ample conceſſions, they gladly conſented to grant them. But the general idleneſs, and conſequent neglect of the nutmeg plantations, to which this inſurrection had given birth, reduced the annual quantity of ſpices from 600,000 lbs. to 50,0 0 lbs. weight. It was thought adviſeable, therefore, by the ſupreme government of Batavia, to adopt the ſcheme of reform propoſed by Mr. Boeckholtz, and to appoint him governor of the Banda iſlands. One of the firſt acts of his government was entirely to cancel the old arrear of debt, which was confidered as due from feveral of the planters to the company, and which moft of them were little able to pay: he alfo made fome judicious regulations with refpect to the government of the flaves. The price of the fpices was likewife raifed at this time, from the old low rate to that at which it is now fixed.

The alterations were fuppofed to hold out great encouragement to the planters to give more attention to the culture of the nutmeg-trees, and thereby to increafe the quantity of the annual produce. But, however fpecious this fuppofition may feem, it is utterly unfounded in truth; for it will appear evident, from a clofe examination of the fubject, that although the fyftem of regulations eftablifhed by Boeckholtz be coloured with juftice, it in fact depends on, and is intimately blended with, the moft defpotic principles, as the following circumftances will fufficiently explain. The debt which the Dutch government take the merit of having cancelled as an act of indulgence, deferves not to be confidered in that light; for the principal part of it was incurred on account of rice and other articles of provifion given to the planters for their own ufe and for that of their flaves, and without which they would have perifhed and the fettlement have been annihilated. And for this debt the planters certainly never expected to be made accountable, having, at the time they received it, confidered it as a donation upon which their exiftence depended. As to their other debts on account of loans of money, &c. though there were fome individuals who, from idlenefs and inattention, were in low circumftances, and unable to difcharge them without mortgaging their little property, yet the greater part of the planters would have much rather continued in poffeffion of their parks, and paid the juft demands upon them, than, under colour of remiffion of thefe debts, be deprived of that which, from long undifputed poffeffion, they confidered as their actual right. Befides, it appears that fome of the planters had purchafed their land from the company; and for the company, therefore, to repoffefs themfelves of thofe lands by compulfion, was an act compounded of wanton infult, treachery, and tyranny, which, as it juftified the moft exemplary vengeance, fo it demands the fevereft reprobation.

In the four iflands which produce nutmegs, there are fifty-feven plantations, and 1708 flaves; but there is no regularity either in the divifion of the plantations or in the diftribution of the flaves: and it would be one of the moft effential fteps towards the improvement of thefe iflands to make an accurate furvey of them, to have the plantations better proportioned, and their boundaries more clearly defined. From the beft information,

information, it alſo appears requiſite to procure about 800 additional ſlaves, in order to bring the plantations into the higheſt ſtate of cultivation.

The want of inhabitants in theſe iſlands ſeems to impoſe the unfortunate neceſſity of keeping up the above-mentioned number of public ſlaves; though, when the expenſe attending their maintenance is compared with the little work they perform, they muſt be conſidered as the moſt expenſive people that could be employed. When works of any magnitude are carrying on, government are obliged to hire, at a very dear rate, the few free artizans who are willing to work, as well as the private ſlaves of individuals, whoſe labour their maſters turn to great advantage.

Excluſive of the proviſions ſent annually from Batavia to the Banda iſlands, there is alſo ſent a large ſupply of piece goods, cutlery, iron, and other articles of merchandize, which are ſold by auction either quarterly or at ſuch periods as the governor knows the inhabitants are beſt able to pay for them: upon all theſe articles there is a profit of fifty per cent. The burghers, and Chineſe merchants ſettled here, not only buy up all the goods which are ſold on the company's account, but alſo thoſe which are imported by individuals. For, beſides their own conſumption, the Chineſe merchants export the aforeſaid articles to the iſlands of Aron, New Guinea, Ceram, and the ſouth-weſt iſlands, between all of which and the Banda iſlands there is a conſtant traffic carried on. In return, they get from Ceram, ſagoe in bread and flour, and ſometimes ſalted deer; and from Aron they get pearls, birds neſts, and tortoiſe ſhells. From theſe iſlands they are alſo ſupplied with ſlaves.

The iſlands which lie ſouth-eaſt of Banda are very low, and ſurrounded with dangerous rocks and ſhoals. The natives of them as well as thoſe of New Guinea are extremely treacherous in their diſpoſitions and ſavage in their manners, notwithſtanding which the Dutch have a continual intercourſe with them.

The ſouth-weſt iſlands, as they are called, are ſeven in number, the chief of which is Kiſſier, in which the reſident or governor of the whole reſides. His garriſon conſiſts of fifty men, a few of whom are attached to the adjoining iſlands. The only advantage drawn from theſe iſlands is ſome ſandal wood and ſalted deer, which they produce, and a few ſlaves which they furniſh. The inhabitants of them are repreſented by the Dutch as being exceſſively ferocious. They appear to be a mixed breed, between the Cofferees of Africa and the Popoos, or natives of New Guinea: their hair is neither ſo

ſhort

ſhort or woolly as the one, nor ſo long and buſhy as the other; but in their features they bear a reſemblance to both.

In the laſt account of the Banda and ſouth-weſt iſlands, all of which are under the ſame government, the numbers of all deſcriptions of people were as follow*: The iſlands of Banda contain 5763 inhabitants, of which 119 are Europeans; and the ſouth-weſt iſlands contain 38,266, of whom 2322 were natives, who have been converted to the Chriſtian faith. From this ſtatement it appears that the population of the ſouth-weſt iſlands is very conſiderable, though the Dutch derived little benefit from them. Although ſo great a number of the inhabitants of theſe iſlands have embraced Chriſtianity, yet it ſeems to have had very little effect in promoting civilization among them; and, unleſs the Dutch kept poſſeſſion of thoſe iſlands, in order to prevent other European powers from eſtabliſhing themſelves in any ſituation that might open an avenue of communication between them and the Spice iſlands, the diſperſing their troops and extending their poſſeſſions to ſuch inconvenient, unprofitable, and hazardous diſtances, cannot well be accounted for.

However, as it is no leſs oppoſite to the policy than unſuitable to the diſpoſition of the Engliſh to extend their conqueſts from ſuch a motive, or form eſtabliſhments on ſuch principles, it is unneceſſary to take theſe iſlands under our conſideration in the following ſuggeſtions, which we throw out for the better management of the ſpice trade in Banda.

The circumſtance of Banda having been hitherto a diſtinct government, has at different times produced very inconvenient effects; and the great diſtance of Banda from the ſupreme government of Batavia has rendered it difficult to detect thoſe delinquencies which are ſaid to have exiſted for ſeveral years paſt in the adminiſtration of that iſland. Hence the governors being left without check or control, and their council poſſeſſing merely a nominal power, they attended to nothing but their own private advantage, and made no other uſe of the authority with which they were inveſted, but to defraud the company from whom they derived it: they not only ſent ſpices to the neighbouring iſlands on their own account, but even ſupplied the natives of them with fire-arms and military ſtores at the very time when theſe people were at war with the government of Amboyna. If, therefore, we conſider the value of the Banda iſlands, together with the evils which have ariſen from the manner in which they have been

* The Aron iſlands, though alſo dependent on the government of Banda, are not included in this account of the population.

been governed, it appears essential to put them under the authority of the governor of Amboyna. He will thereby be enabled, from the contiguity of his place of residence, to make himself acquainted with all the occurrences in the subordinate settlement, regulate its intercourse with the adjacent countries, furnish it with every necessary supply, receive regular returns of the state and produce of its plantations, and finally, punish every infringement of the established regulations. By these means the affairs of the Spice islands might be conducted with an union and consistency which would at once extend their commerce and consolidate their strength.

With regard to the dispute between the Dutch company and the native burghers, relative to the right claimed by the latter of a property in the soil, though it behoves the justice of our government to investigate that claim, it were little instructive to our readers to enter into a consideration of it; for it cannot be of much consequence to have it ascertained who is the nominal proprietor of the soil, when the whole of its produce is monopolized by government. As the want of population, therefore, seems to be the greatest hindrance to the progress of improvement, the planters should be encouraged to increase the number of their slaves; and, in order to give them an interest in the produce of the soil, they should have the privilege of transferring their property.

The company are, at present, obliged to furnish the Banda islands with rice and other provisions at a rate so low as to subject them to a considerable loss; they are also liable to a vague and undefined charge on account of new buildings and repairs for storehouses, &c. all of which, in the general scale of expenditure, should be considered as deductions from the value of the spices. It would therefore be not only a material saving to the company, but far more suitable to the interests of the planters themselves, to increase the price of the spices, and make them chargeable with all the expenses attending those buildings and repairs; and also to furnish themselves with rice, which, however, the government must at any rate supply, but in this way would not lose by that obligation which necessity has imposed on them.

Upon investigating this subject with the most impartial and best informed persons at Banda, it appeared evident that this mode of arrangement would be the most agreeable to the people, and the most likely to produce beneficial effects to the state; and, with regard to the increase necessary to be made to the present price of the spices, an addition of $7\frac{1}{2}$*d.* for the nutmegs, and 15*d.* for the mace, per pound, would sufficiently satisfy the planters.

As

As ſmuggling is become very common in the Banda iſlands, and the company are thereby defrauded of great quantities of ſpices, a ſevere law ſhould be enacted againſt thoſe who purchaſe them, and the ſelling of them be made puniſhable by the forfeiture of all the property of the delinquents.

LXI. *Proceedings of Learned and other Societies.*

ACADEMY OF SCIENCES AT TURIN.

THIS Society has propoſed the following queſtions as the ſubject of two prizes, to be adjudged on the 23d of September.

1. To point out what are the different vices contracted by wine caſks; the modifications which wines experience by vitiated caſks; and the means of remedying both.

2d, To determine the phyſical and political cauſes of the decay of the woods and foreſts of every kind in the ſix ſub-alpine departments; the means of preventing it; and thoſe of increaſing the cultivation of timber, eſpecially on the mountainous countries.

BOARD OF AGRICULTURE.

On the 9th of June the Board reſolved that a præmium of the gold medal be offered to each of the five perſons who ſhall, in the moſt ſatisfactory manner, prove, by experiment, the practicability of cottagers being enabled to keep one or two milch cows on the produce of land cultivated with the ſpade and hoe only, and who ſhall ſend to the Board, on or before the firſt of January 1803, the beſt accounts of ſuch experiments; detailing,

1. The expenſe of erecting the cottage, ſhed, and any other building thought neceſſary.
2. The expenſe of providing the ſtock and tools neceſſary.
3. The extent of land, and nature of the ſoil, occupied.
4. The expenſe of digging and fencing the land.
5. The rent, taxes, &c. paid for the ſame by the cottager.
6. The courſe of cropping that has been adopted.
7. The quantity and value of each of the different crops.
8. How the cottager and his family are maintained, and how they manage to cultivate the ground, and to harveſt the different crops.
9. How the cow is maintained during the year, and what profit is derived from it.

10. What profit is derived from pigs, poultry, and other articles.

11. How many days they were enabled to labour for other people. And

12. How, on the whole, the plan has been found to anſwer.

N. B. The Board reſerves to itſelf the power of withholding any præmium when the communication or communications are not deemed ſufficiently important to merit the reward.

The manuſcript, &c. ſent in claim of præmiums to remain the property of the Board.

All memoirs, &c. ſent in claim of præmiums to be without names, but with a mark or number, and accompanied by a ſealed letter (on which is to be written the ſame mark or number) containing the name and addreſs of the claimant, which ſealed letter will not be opened unleſs the præmium is adjudged to that mark or number.

XLII. *Intelligence and Miſcellaneous Articles. September* 1801.

THE NEW PLANET.

SIX aſtronomers of Lilienthal, near Bremen, have formed an aſſociation of twenty-four practical aſtronomers, charged with correſponding from different parts of Europe, and whoſe object is to ſearch for the planet ſuppoſed to exiſt between Mars and Jupiter, on account of the great diſtance of theſe two celeſtial bodies. M. Bode, the well known aſtronomer of Berlin, maintains that this planet to be diſcovered is nothing elſe than the comet ſeen by Piazzi. But the aſſociation are not ſatisfied with this idea. They have choſen as their preſident M. Schrœter of Lilienthal; they have divided the whole zodiac among the twenty-four aſſociate correſpondents, in order that each in his department may more eaſily follow the traces of the bodies, the poſition of which they are deſirous of aſcertaining. Almoſt all the aſtronomers ſelected for this employment have accepted the honourable taſk impoſed on them. Their ſerene highneſſes the duke and ducheſs of Gotha, ſeconding the zeal of M. Von Zach, author of the project, have preſented M. Wurmb, profeſſor, of Blaubeuren, with all the inſtruments neceſſary for making his obſervations. M. Sniaderly, profeſſor at Cracow, could not accept the part of the zodiac offered to him, becauſe the univerſity univerfity of Cracow is going to be fuppreffed, fo that he muft renounce the obfervatory of that city.

ASTRONOMY.

Paris, Sept. 13.

On the 2d of Vendemiare, year 4, I announced that I had determined the longitude of Rome by an eclipfe which I obferved there in 1765. Since that time the duke of Lermonetta eftablifhed there an obfervatory, and fent me an obfervation, which he made with profeffor Scarpellini, of the eclipfe of the ear of corn of the Virgin, which took place on the 24th of May; it gave me 40 minutes 36 feconds for the difference of the meridians. I found the fame thing by an eclipfe of the ftar Sigma of the Lion, which the abbé Conti obferved at Rome on the 24th of April. It was only four feconds more than by my former determination. Thus we at length know very exactly the fituation of the cupola of St. Peter's, which I always call the moft remarkable point of the world. LALANDE.

EARTHQUAKES.

An earthquake was felt at Edinburgh on Monday the 7th of September, at fix in the morning. It extended through Fife, along the north bank of the Forth, from Kirkaldy by Aberdown, Dunfermline, Kincardine and Alloa; likewife northwards by Kinrofs, to fome diftance in a north-weft direction to Callander, and various parts of Perthfhire. At Stirling and Glafgow the fhock was alfo very diftinctly felt, at nearly the fame time as in the other places mentioned. The appearances were nearly alike in all. At Edinburgh it continued two or three feconds; was preceded by a rumbling, rufhing, hollow noife from the ground; and had a tremendous, undulating motion, fomething refembling the motion of the waves of the fea. Beds, tables, chairs, &c. in fome houfes were obferved to fhake, refembling the rocking of a cradle. Some perfons who felt it had a very difagreeable fenfation, attended with a headach. The morning was gloomy, warm, and calm; the barometer high, and the thermometer about 50. The preceding day, Sunday, there was a good deal of rain. A parrot in a gentleman's houfe in the fouth fide of the town, fcreeched feveral times during the fhock, in the fame manner as thefe birds do in the Weft Indies, during an earthquake: and in one houfe the bells were fet a ringing.

It would feem that this fhock has been pretty general. At Dunfermline, its duration, it is fuppofed, was only two feconds. People who were in high ftories, and confequently had

had the beſt opportunities of obſervation, thought they felt two ſmall ſhocks, and in their ſituations, things that were hanging on the walls were evidently moved from their places, occaſioning ſome noiſe. Many people were awakened from their ſleep by the motion which they felt in their beds, which they generally deſcribe by the rocking of a cradle, or as if a perſon had lifted up one ſide of the bed from the floor, to which a tremulous motion ſucceeded for a ſhort ſpace. At Grangemouth, and over all that neighbourhood, two pretty ſevere ſhocks were felt, one at four, the other at ſix in the morning.

At Crieff it reſembled the ſudden fall of a houſe, attended with a rumbling noiſe, which continued about the ſpace of ſix ſeconds. It appeared to go from Weſt to Eaſt. One perſon ſtates that the roof over his head cracked, and appeared as if it would burſt. The rattling of the diſhes on the ſhelves, and the looſe partitions, helped to increaſe the fears of the people, who ran to the doors.

A letter from Stirlingſhire deſcribes it in the ſame manner. The writer ſays, "at ten minutes before ſix, I was ſurpriſed with a ſudden ſhaking of my bed, which continued for about half a minute. The motion ſeemed to come from beneath, but I can ſay nothing elſe concerning its direction. A ſervant who ſleeps in a room adjoining to my barn, was alarmed by the creaking which it occaſioned in the joiſts. There was not a breath of wind, and the ſky, though ſomewhat cloudy, was altogether calm. Soon after the morning became very bright and warm; nor was there any miſt on Benlomond, Benledy, or any of the neighbouring mountains."

On the morning when it was felt, the gable of a barn, a few miles to the weſtward of Edinburgh, where ſome ſhearers were ſleeping, fell in, whether from the inſtability of the building, or the concuſſion of the earthquake, is uncertain; but the unfortunate tenants were completely buried in the rubbiſh. When the accident was diſcovered, and theſe poor people dug out, two women were found dead, and another very much bruiſed, who was immediately brought to the Royal Infirmary. The others, eight or ten in number, were not much hurt.

It was obſerved at Leith, that the tides, for three days, had not ebbed ſo much as uſual at the then age of the moon; ſo much ſo, that the workmen at the New Dock had not been able to accompliſh the work they ordinarily do while the tide is out.

In the year 1755, when the earthquake deſtroyed a great part of Liſbon, there were ſmart ſhocks felt in different places of Scotland; with violent agitations of Loch Nefs, Loch Tay, &c.

The foreign journals alſo notice an earthquake having taken place at Colmar on the morning of the 11th of September, which had ſpread a conſiderable degree of alarm. That morning, at a quarter paſt one, a great number of people were awakened by a hollow noiſe and certain agitation, which was felt in the houſes, and ſhook the furniture. Several ſhocks followed the firſt: at a quarter paſt two, there was one pretty ſtrong.

WATER-PROOF CLOTH.

To diſcover a proceſs for rendering cloth water-proof, without at the ſame time filling its pores in ſuch a manner as to prevent perſpiration, has long been a deſideratum. It gives us pleaſure to announce a diſcovery which promiſes ſo many advantages, in point of health and comfort, to all ranks in the community. By favour of the patentees, Meſſrs. Ackermann, Suardy, and Co. we are enabled to preſent our readers with a ſpecimen of the art, namely, a piece of blotting paper; one-half of which has been ſubjected to the water-proof proceſs. By ſprinkling a little water over it, the prepared part will eaſily be diſtinguiſhed.

GALVANISM.

At a late meeting of the committee for apparatus of the Aſkeſian Society, ſome experiments were made with a Galvanic trough, of the conſtruction invented by Cruickſhank. The one belonging to the ſociety conſiſts of ſixty pieces of ſilver, and the ſame number of pieces of zinc, each $2\frac{1}{4}$ inches ſquare. They are ſoldered together at the four edges, and are very exactly in contact. The trough is of mahogany, with grooves half an inch apart from each other. The pieces are ſecured in theſe groves by a cement, compoſed of hard varniſh and bee's wax. The cells between each pair were filled with a weak ſolution of muriat of ammonia a quarter of an ounce to two quarts of water, which is nearly the quantity the apparatus takes. The ſhock taken from this trough by two metallic conductors is felt plainly in the ſhoulders. The ſpaſm or contraction at the time is ſo ſevere as to deprive the perſon of the power of holding the conductors in contact with the end plates. When kept in contact by an aſſiſtant, a ſenſation reſembling a highly heated fluid is felt ruſhing through the wriſts and fore-arm.

A piece of ſmall ſteel wire being made a conductor to unite the end pieces, on making the contact, a bright ſpark was

obſerved,

observed, with ſmall ſcintillations, and had it been in oxygen gas, the wire would no doubt have deflagrated.

The wire being armed at the end with a ſmall piece of phoſphorus, the latter inflamed inſtantly upon contact.

A connection was made from the trough to a galvanometer on the conſtruction propoſed by Pepys *. Upon moving the regulating ſcrews, the gold leaves, at the diſtance of half an inch, began to divide: one of them ſuddenly ſtruck the zinc and inſtantly inflamed, burning with a bright flame of a white colour;—a ſound was heard as though a ſmall quantity of nitre had been projected upon ignited charcoal, and about a quarter of an inch of the gold was deſtroyed, leaving a ſmoke-coloured ſtain upon the plate of zinc. This experiment was ſeveral times repeated with the ſame ſucceſs.

A ſmaller trough, conſiſting of fixty pieces of ſilver and zinc, of an inch and a half ſquare, being connected in the order of arrangement with the beforementioned, evidently decreaſed its power, which ſeems to prove that there will be no advantage obtained by uniting troughs of inferior powers to ſtronger ones, as is the caſe with electrical batteries; but experiments are ſtill wanting completely to determine the point.

Profeſſor Pictet, Mr. A. Aikin, and ſeveral other ſcientific gentlemen, were preſent at theſe experiments.

GERMINATION.

E. A. Lefebure, aſſiſtant chemiſt in the School of Health at Straſburgh, has lately made ſome curious experiments on germination. As he employed in his experiments only rape-ſeed, they cannot be conſidered as ſufficiently varied to admit of general concluſions; but as they may furniſh hints to others who may be diſpoſed to give them greater latitude, we ſhall briefly ſtate the moſt ſtriking reſults.

Lefebure firſt obſerves that taking away the cotyledons or ſeed-leaves, retards and weakens vegetation, but by no means impedes the germination, if the upper part of the fibre, to which the cotyledons are attached, be not removed. M. Lefebure contradicts Böhmer, who ſays that imbibing the moiſture of the earth is performed merely by the umbilical fibre; whereas Lefebure found, by experiments, that this function is diſcharged by the whole ſurface of the ſeed. The earth is merely the excipient of the matter requiſite for the germination of ſeeds. The conditions of tenderneſs, moiſture, warmth, and darkneſs of colour in the excipient, are conſidered as neceſſary to the germination of the ſeeds depoſited in it. M. Lefebure, after the example of Bonnet, made choice of other ſubſtances for excipients, and found that

* See page 38 of the preſent Volume.

the feeds germinated in feveral of them; but not in the oxide of mercury, alcohol, ammonia, camphor, and faltpetre: nay, oxide of mercury, cantharides, and falts, deftroyed vitality and the property of germinating. Many of thefe matters, and particularly falts, feem to impede germination, chiefly by their requiring too much water for their folution, and by thefe means depriving the feeds of it: for this reafon, cream of tartar impeded germination the leaft, becaufe it deprived the feeds the leaft of water. Afhes alfo impeded germination as long as they contained foluble falts, but as foon as they were oxidated they promoted that procefs. M. Lefebure examined alfo the different depths of the earth at which feeds germinate, the neceffity of drawing the carbon from the earth, and of the accefs of atmofpheric air. Though many cafes are known in which feeds have germinated without the accefs of air, fhut up in animal bodies or in potatoes, the matter of light, however, was not excluded.

Of the different kinds of gas of which the atmofphere confifts, germination requires oxygen alone. Carbonic acid, hydrogen, and azote, on the other hand, impeded germination without deftroying vitality. Seeds grew in atmofpheric air, however, mixed with different fubftances, provided it contained oxygen. The air in which feeds had germinated, M. Lefebure found to be furcharged with carbonic acid.

He examined alfo, in a more accurate manner, the influence of water on germination, and found that the more foreign matter water is impregnated with, the more unfit it is for the purpofe of germination.

THE ARTS.

In order to diffufe a knowledge and infpire a tafte for the fine arts, the French government has refolved to eftablifh galleries in 15 of the principal towns of the republic. The principal motives for this arrangement are explained in the following report, prefented to the Confuls of the French republic, by the minifter of the interior, 31ft of Auguft.

"The mufæum of arts prefents at this moment the richeft collection of paintings and antique ftatues in Europe; there are to be found all the riches which were difperfed before the revolution. We may reckon at prefent 1390 pictures of the foreign fchools, 270 of the antient French fchool, and more than 1000 of the modern fchool. It poffeffes 20,000 defigns of different fchools, 4000 copper-plate engravings, and 30,000 prints, befides 150 antique ftatues, and the moft valuable articles in Etrufcan vafes, tables of porphyry, &c.

"The immenfe gallery opened for public infpection cannot contain a moiety of the *chefs d'œuvre* of which the nation is possessed. More than 1000 pictures are deposited at Versailles, and 6 or 700 remain in the cabinets of Louvre, in expectation of a place proper to receive them.

"The collection of these *chefs d'œuvre* was doubtless an advantage at those critical moments when the breath of Vandalism would have destroyed, without remorse, the works of genius.

"It was an acquisition we were in want of, when our victorious arms procured us the numerous riches of Italy. But these times are no more! and we ought now to endeavour to conciliate the great advantages derivable from the arts, with the duties we have to fulfil towards the departments; some of which have enriched us with their spoils, and all of which have concurred in appropriating to us the rich monuments of vanquished nations.

"Without doubt Paris ought to reserve the *chefs d'œuvre* of every kind. Paris ought to possess in its collection the works which most essentially belong to the history of the arts, which mark its progress, characterize its qualities, and enable the artist to read on its pictures all the revolutions and periods of painting. Paris merits on every account this honourable distinction: but the inhabitants of the departments have also a sacred right to a share in the fruit of our conquests, and in the inheritance of the works of French artists.

"This consideration alone will doubtless not permit the French government to hesitate with regard to the manner in which it ought to act; but this determination, which springs from a sentiment of justice, should nevertheless be fortified by the idea, that it is conformable to the real interest of the arts.

"In fact, the contemplation of what is beautiful develops talent, and inspires the artist better than lessons. The valuable picture, which by being placed by the side of one still more so is disregarded, will recover its right to admiration when it shall be isolated, or, to use the expression, restored to itself. Some paintings, by being sent to the place that gave them birth, will acquire a new interest by tradition, and the recital of the circumstances which attach to productions of merit. The inhabitants of Anvers, Montpelier, and Andelys, will be fond to show foreigners the *chefs d'œuvre* of their countrymen Rubens, Bourdon, and Poussin; and the traveller will be unable to direct his steps to any part of the republic, which will not offer a rich collection of pictures, or the work of some men of genius who have shed lustre on their country.

"However, the monuments of painting must not be disseminated at hazard among the different points of France.

In order that the collections may be profitable to the arts, they ought only to be formed where a degree of knowledge already acquired may give them a value, and where a numerous population and the natural disposition of the people afford a presage of success in the education of the pupils. It is for that reason I propose to form 15 grand depôts of pictures at Lyons, Bourdeaux, Strasburgh, Brussels, Marseilles, Rouen, Nantes, Dijon, Toulouse, Geneva, Caen, Lisle, Mentz, Rennes, and Nancy.

"But it is little to have determined the places for these depôts—it is necessary to make choice of such collections as present an interesting series of paintings of all masters, of all kinds, and of all schools; and I think it is necessary to appoint a committee charged with the labour of preparing for each of the cities pointed out the collection adapted for them."

A decree passed agreeably to this report.

DISCOVERIES IN AFRICA.

According to accounts from Trieste, dated March 1801, published in the German Mercury. Horneman the traveller had written to a friend in Egypt, by the last caravan from Darfur, which had been absent for two years, because the last had been plundered during the unsettled state of affairs in Egypt. At the time Horneman wrote he was at the court of the king of Darfur, where he had met with a very favourable reception, and was treated with great kindness.

SILVER MINE.

We lately announced the discovery of a lode of silver in the Herland mine. The working of it, we are sorry to hear, has been discontinued, as the produce was not equal to the expense. Several other mines in Cornwall have been abandoned for the same reason.

HORSE WITHOUT HAIR.

The following notice has been published by Professor Pfaff, of Kiel, respecting the horse without hair: in one of the Berlin journals, *Neue Berlinische Monatschrift* for February, 1801, G. F. Sebald, groom and farrier at Ulm in Suabia, has given a short account of the real nature of the horse without hair, which has lately been described by Lasteyrie in the *Journal de Physique**. This horse had excited the attention also of the German naturalists: he was considered in general as a variety produced by the influence of climate, and Professor Nauman inserted an engraving of him in his Manual on the Science of the Horse, and assigned to him a very warm climate as his native country.

* See Philosophical Magazine, p. 36 of this Volume.

M.

M. Sebald in this account gives a very correct and minute hiſtory of this animal, from which it reſults, that he was originally nothing more than a common German hack, formerly covered with hair, and in the poſſeſſion of a coachman of Hohenlohe-Ochtinguen, in Franconia, who ſold him to a peaſant near Ober-Maſholderbach, where that change took place, which rendered him an object of curioſity.

According to the declaration of all the inhabitants of the village, the proprietor of this horſe, who has been dead ſome time, finding the animal attacked with the ſtrangles, gave him to eat, for a whole year, leaves of the ſavine tree, which grew in his garden, by way of a cure, and afterwards as a preſervative. Soon after uſing this nouriſhment, the horſe began to have new hair, which the peaſant conſidered as a good ſymptom, and he hoped to make the horſe a new animal. He continued therefore to ſupply him with this new food. The hair, though beautiful, ſmooth, and ſleek, dropped off, and was ſucceeded by another coat no leſs beautiful: but after ſome months the hair diſappeared entirely, in ſuch a manner that the horſe became quite naked. Nature, however, made a laſt effort; the hair grew up for the third time; but it at laſt dropped off entirely, the peaſant always continuing his treatment with the green leaves of the ſavine tree.

The horſe therefore became naked and free from hair for the fourth time, and irreparably, except a few hairs on the upper part of the neck, on the four feet and the tail, of which the perſon to whom the peaſant ſold the horſe, and who had become the jeſt of the whole village, at laſt deprived him. In this ſtate M. Sebald found the horſe of which he had before heard ſome account, at the houſe of a coachman of Ochtinguen, to whom the peaſant had ſold him for three Louis d'ors, in the month of January, 1793, he was then covered with a cloth, and employed in drawing a cart.

M. Sebald then informs us how the horſe was carried about from place to place by his new poſſeſſor, in order to exhibit him for money, pretending that he was a horſe from the iſland of Cyprus. The coachman of Ochtinguen being ſtruck with ſome qualms of conſcience, and fearing that the impoſture might be detected, reſolved to ſell him to an Italian, who afterwards ſold him to M. Alpy, in whoſe hands this horſe became ſo famous.

As M. Sebald mentions all the places, and being himſelf a perſon whoſe teſtimony is above ſuſpicion, natural hiſtory muſt in future renounce this pretended addition of a new race, but this particular effect of the leaves of the ſavine tree is an object worthy the attention and reſearches of veterinary profeſſors.

INDEX TO VOL. X.

Nitric

Steam

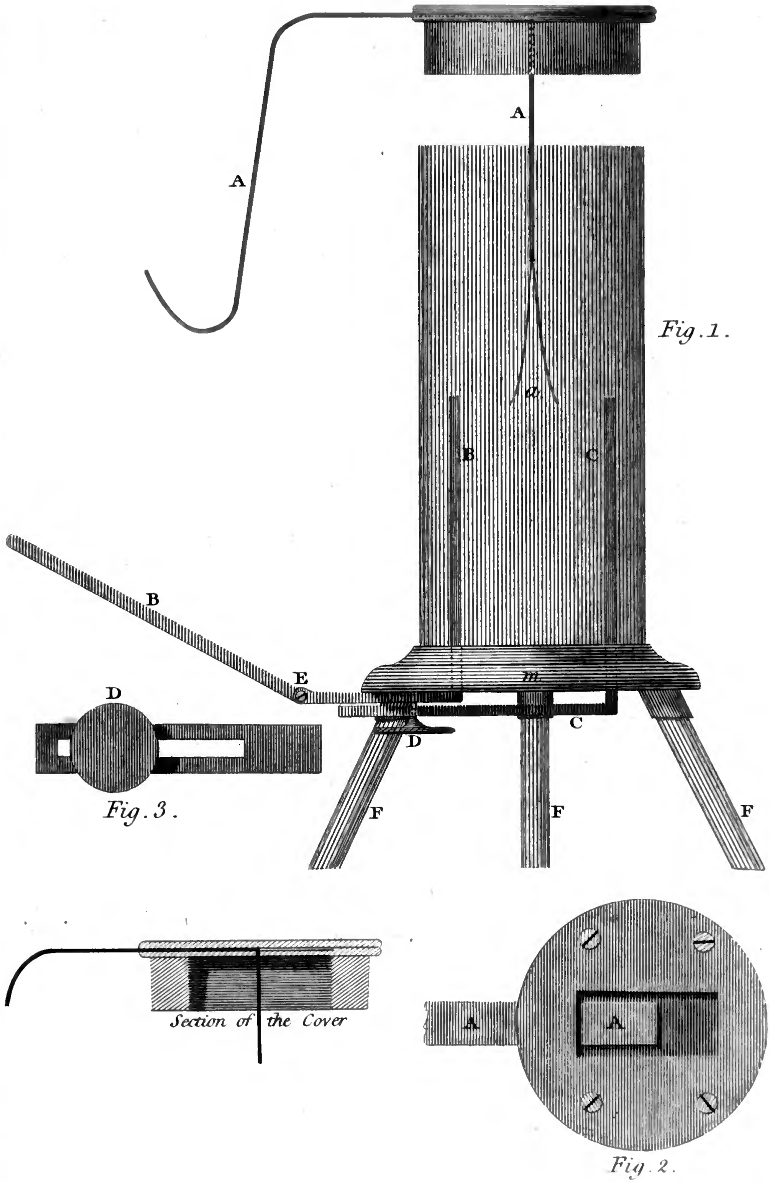
END OF THE TENTH VOLUME.

ERRATA.—Page 102, line 5, *after* "30 degrees," *read*, "of Reaumur, or 100 of Fahrenheit." Page 265, line 3, *for* oheim *read* uncle.

TO THE BINDER.

Please to bind up Ackermann and Suardy's Bill along with the Plates, as it is a specimen of Blotting Paper rendered water proof.

Printed by TAYLOR and WILKS, Chancery-Lane.



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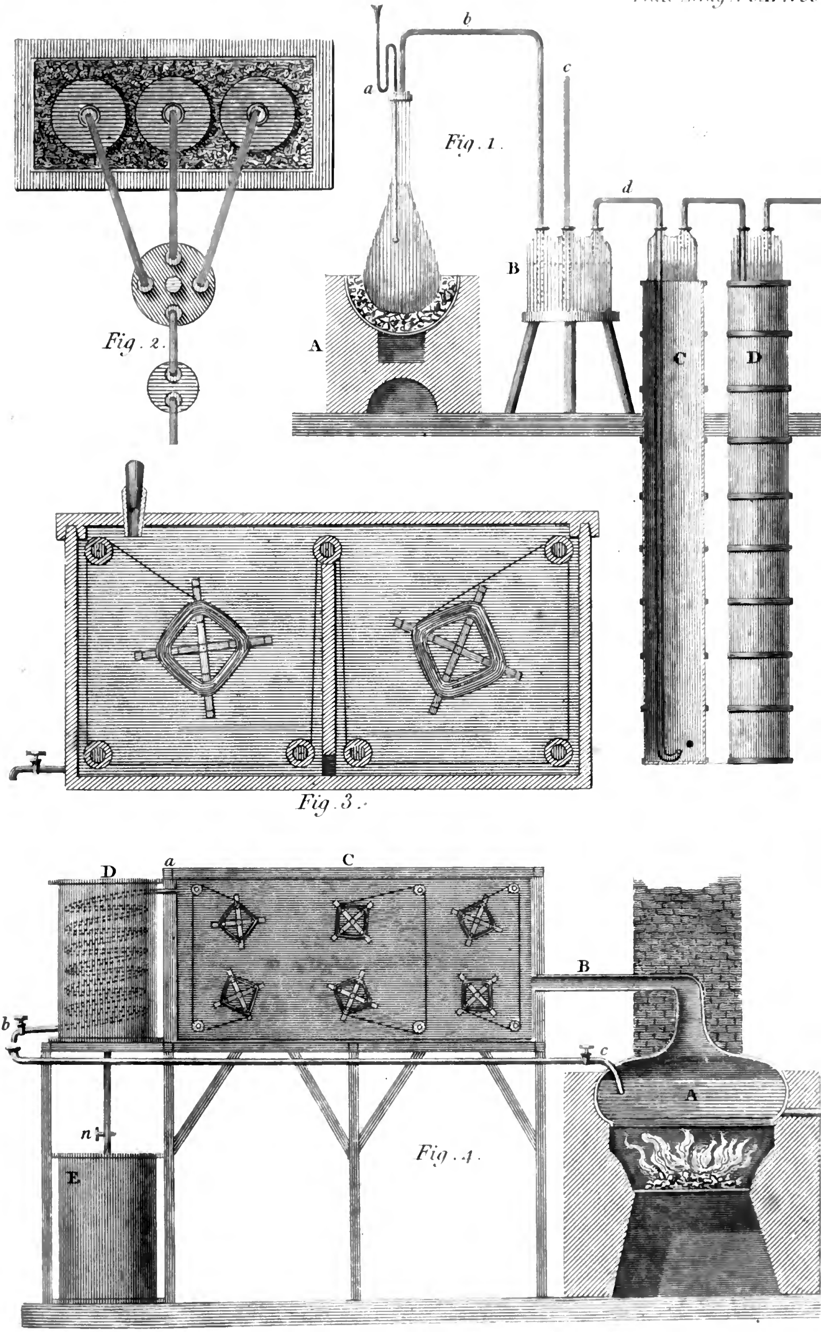
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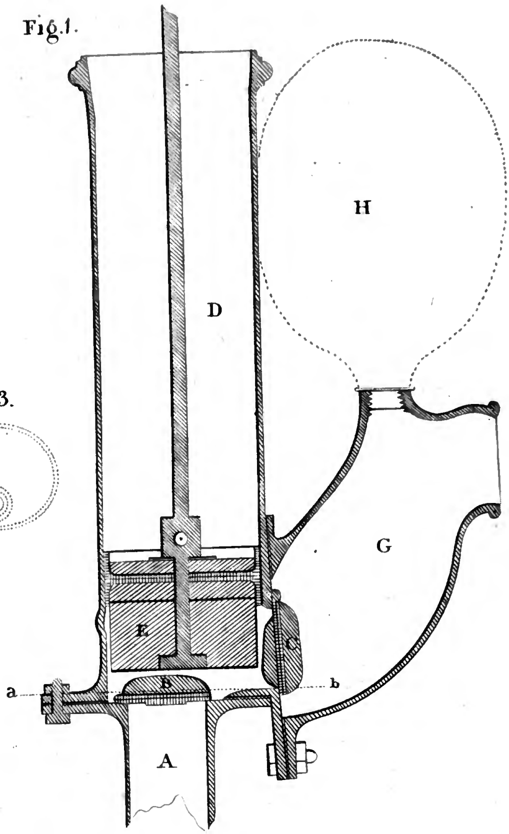

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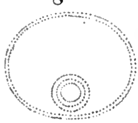

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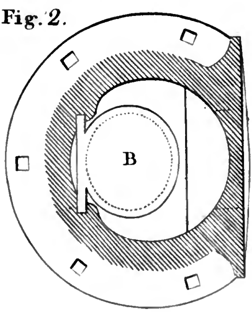

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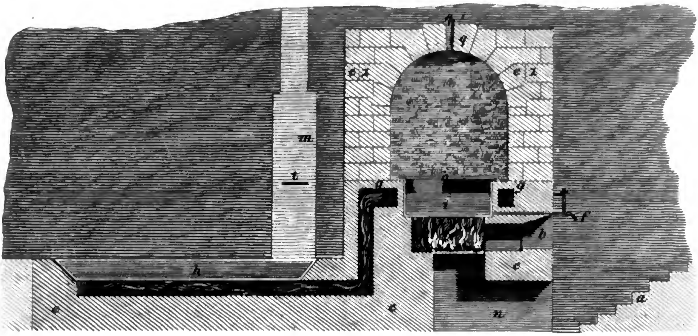

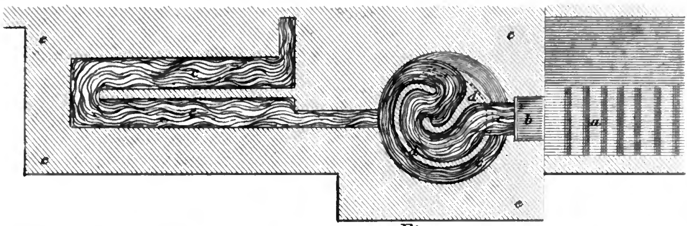

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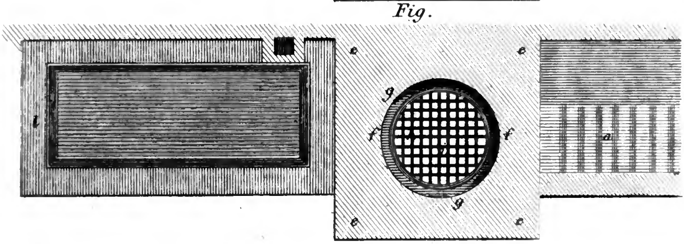

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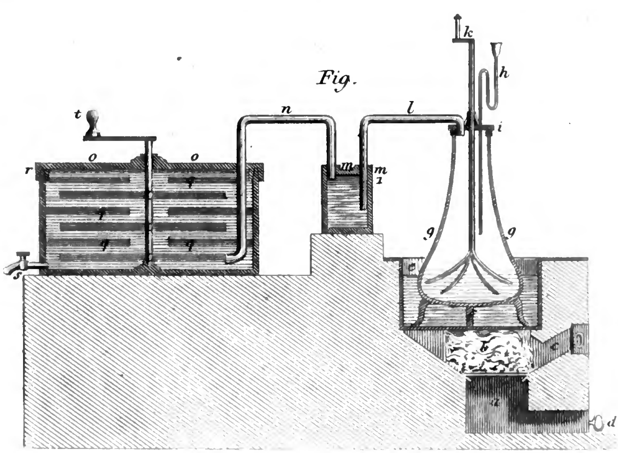

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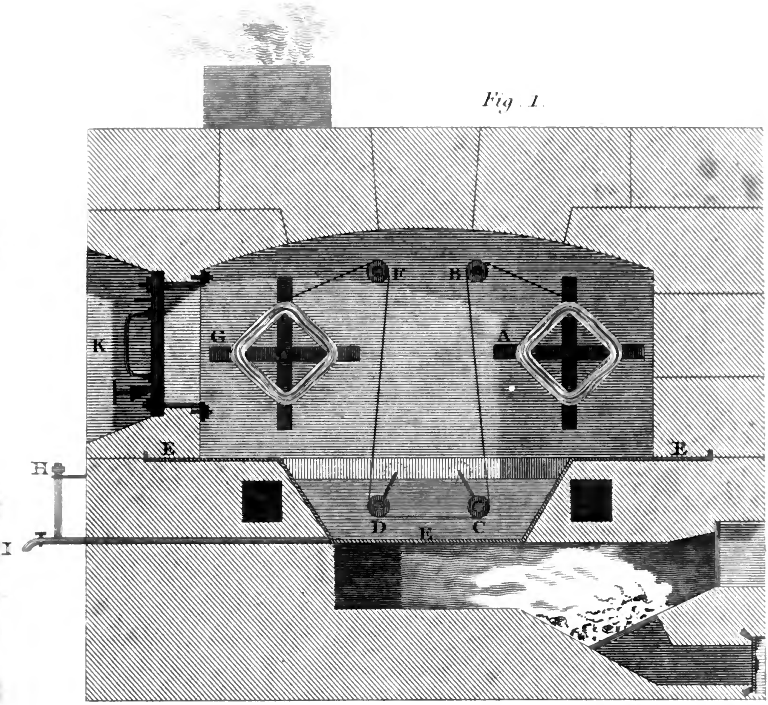

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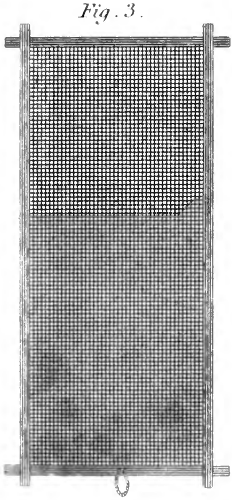

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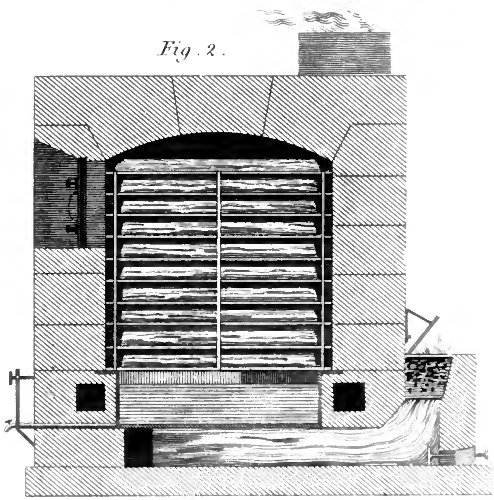

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