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VOL. 21. FEBRUARY 1805. No. 81.

Published the Last Day of every Month,
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THE PHILOSOPHICAL MAGAZINE:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,
THE LIBERAL AND FINE ARTS,
AGRICULTURE, MANUFACTURES,
AND
COMMERCE.

NUMBER LXXXI.
For FEBRUARY 1805.

EMBELLISHED AND ILLUSTRATED WITH THE FOLLOWING ENGRAVINGS:

1. A Portrait of Dr. HUTTON; engraved by KNIGHT, from a Likeness painted by Miss BYRNE.
2. The *Perameles nasuta*; engraved by LOWRY.
3. The *Perameles obesula*; also engraved by LOWRY.

BY ALEXANDER TILLOCH,
HONORARY MEMBER OF THE ROYAL IRISH ACADEMY, &c. &c. &c.

LONDON:
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FOR A. TILLOCH:
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ENGRAVINGS.

Volume XX. is illustrated with a Quarto Plate to illustrate the Anatomy of the Rhinoceros—A Quarto Plate of an improved Malt Kiln—An Astronomical Chart, exhibiting the Path of the new Planet—A Quarto Plate of Fossil Teeth of the Rhinoceros: engraved by LEE—A Plate relating to the Principles of Pump-work: engraved by LOWRY—Mr. KNIGHT's improved WOULF's Apparatus—A Quarto Plate to illustrate Mr. MARTIN's Paper on the Principles of Pump-Work—Mr. STEEVENS's Instrument for equalizing the Efflux and Pressure of non-elastic Fluids—A View of a Water-Spout, taken from Nature.

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COMMERCE.

NUMBER LXXXII.
For MARCH 1805.

ILLUSTRATED WITH THE FOLLOWING ENGRAVINGS,
BY LOWRY:

1. Mr. Rawlinson's improved Mill for grinding Oil Colours; and an improved Mill for grinding Indigo, or other dry Colours.
2. Mr. Hardy's improved Method of Banking the Balance of a Time-keeper.

BY ALEXANDER TILLOCH,
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ENGRAVINGS.

Vol. XVIII. is illustrated with a Head of the late JOHN DOLLOND, F.R.S. Inventor of the Achromatic Telescope: engraved by Mackenzie from an original Portrait in the Possession of the Family—A new Fish called the *Bichir*, found in the Nile: engraved by Lowry—A quarto Plate containing Plans and Representations of the Buildings and Apparatus employed by Mr. J. C. CURWEN in Steaming Potatoes for the Use of Cattle—The Rev. MICHAEL WARD's Method of adjusting HADLEY's Sextant, so as to take *Back* as correctly as *Fore* Observations; and to measure Angles of 150, 160, or 170 Degrees, as accurately as Angles of 30, 40, or 50 Degrees—A Quarto Plate containing an accurate Representation of Mr. ROBERT HALL's Expanding Crane—Mr. GEORGE RUSSEL's improved Water Bucket for drawing Water from deep Wells—A Plate containing Improvements made in Clock-work, by Mr. MASSEY—Another Plate on the same Subject.

Vol. XIX. is illustrated with a Likeness of the Princess DASHKOFF, lately Directress of the Imperial Academy of Sciences at St. Petersburgh—Mr. BOWLER's improved Churn—The Orbits of the two new Planets, by LALANDE—M. TINGRY's Furnace for dissolving Copal for the Purpose of making Varnish——Mr. WRIGHT's Apparatus to prevent Conduit Pipes from being burst by Water Freezing in them—Mr. HEALY's Method of cutting Screws in the common Turning Lathe—A Portrait of M. DELAMETHERIE, Editor of the *Journal de Physique*—Figures to illustrate a Paper on the Mensuration of Timber, by Mr. FAREY—Representations of some curious Ornitholites found at Vestena Nova.—Skeleton of the one-horned Rhinoceros.—Diagrams to illustrate a Paper on the Velocity of calorific Rays emitted by the Sun.

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NUMBER LXXXIII.
For APRIL 1805.

ILLUSTRATED WITH THE FOLLOWING ENGRAVINGS,
BY LOWRY:

1. A Plan of Mr. Bullock's improved Draw-back Lock.
2. Mr. Bowler's Screw-Press.
3. A Survey to illustrate some Geographical and Topographical Improvements proposed by J. Churchman, Esq. Member of the Imperial Academy of Sciences at Petersburgh.

BY ALEXANDER TILLOCH,
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NUMBER LXXXIV.
For MAY 1805.

ILLUSTRATED WITH THE FOLLOWING ENGRAVINGS,
BY LOWRY:

1. The Chevalier EDELCRANTZ's Safety-Valve for Steam Engine Boilers (Described in our last Number).
2. A 4to plate, containing magnified Representations of the Parasitic Plant which causes the Blight in Corn, engraved by Permission of the Rt. Hon. Sir JOSEPH BANKS, P.R.S. from the original drawings.—(Another 4to Plate on this subject, executed in the same superior Style with the one now given, was intended for the present Number, but in consequence of the indisposition of Mr. LOWRY, it must be deferred for a future Number.)

*** A CONSTANT READER will find the Electrometer he wants described in our 11th Vol. Page 251.

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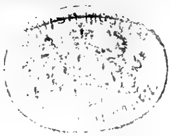

Mary Byrne pinx C Knight sculp

CHARLES HUTTON, L.L.D.

F. R. S. S. of London & Edinburgh, and of the Philosophical Societies of Haarlem & America, and Professor of Mathematics in the Royal Military Academy, Woolwich.

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"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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1805.

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OF THE
TWENTY-FIRST VOLUME.

CONTENTS.

THE

THE PHILOSOPHICAL MAGAZINE.

I. *On the present State of Husbandry in Bengal. By a Gentleman now residing in that Country**.

The regular succession of periodical rains, followed by a mild winter, which exempt from frost, is almost as free from rain; and this succeeded by great heat, refreshened occasionally by showers of rain and hail, affords its proper season for every production of tropical and temperate climates. Few are altogether unknown in Bengal. Those which actually engage the industry of the husbandmen are numerous and varied. Of these, rice is the most important. Corn in every country is the first object of agriculture, as the principal food of the inhabitants; in this, where animal food is seldom used, it is especially important.

The natural seasons of rice are ascertained from the progress of wild rice. It sows itself in the first month of the winter; vegetates with the early moisture at the approach of the rains; ripens during that period; and drops its seed with the commencement of the winter.

A culture calculated to conform to this progress is practised in some districts. The rice is sown in low situations when nearly desiccated; the soil hardening above the seed gives no passage to early showers; the grain vegetates at the approach of the rains, and ripens in that season, earlier or later, according as the field is overflown to a less or greater depth.

This method is bad, as it exposes the seed to injury during a long period in which it should remain inert: the practice is not frequent. Common husbandry sows the rice at the season when it should naturally vegetate, to gather a crop in the rains; it also withholds seed till the second month of that season, and reaps the harvest in the

* From the *Asiatic Annual Register* for 1802.

beginning of winter: and the rice of this harvest is esteemed the best, not being liable to early decay.

In low situations, where the progress of desiccation is slow, and on the shelving banks of lakes which retain moisture till the return of the rains, a singular cultivation sows rice at the end of the rains, and, by frequent transplanting and irrigation, forces it to maturity in the hot season: and in situations nearly similar, sows in the cold season for an early harvest, obtained by a similar method at the commencement of the rains.

In almost every plant the culture, in proportion as it is more generally diffused, induces numerous varieties. But the several seasons of cultivation, added to the influence of soil and climate, have multiplied the different species of rice to an endless variety, branching from the first obvious distinction of awned and awnless rice. The several species and diversities, variously adapted to every circumstance of soil, climate and season, might exercise the judgment of sagacious cultivators: the selection of the most suitable kinds is not neglected by the husbandmen. There is room, however, for great improvement, from the future light to be thrown on this subject by the observations of enlightened farmers.

Other corn is more limited in its varieties and its culture. Of wheat and barley, few sorts are distinguished. All sown at the commencement of the winter, and reaped at the beginning of the hot season.

A great variety of different sorts of pulse finds its place in the occupations of husbandry. No season is without its appropriate species: but most sorts are sown or ripen in the winter. They constitute a valuable article in husbandry, as thriving on the poorest soils, and requiring little culture.

Millet and other small grains, though bearing a very low price, as the food of the poorest classes, are not unimportant: several of these grains, restricted to no season, and vegetating rapidly, are useful, as they occupy an interval after a tardy harvest, which would not permit the usual course of husbandry. Maize, which may be placed in this second class of corn, is less cultivated in Bengal than in most countries where it is acclimated. For common food, inferior to white corn, it has not a preference above millet to compensate the greater labour of its culture.

The universal and vast consumption of vegetable oils is supplied by the extensive cultivation of mustard, linseed, sesame, palmachristi, &c. The first occupy the winter season; the sesame ripens in the rains.

 Among

Among the most important of the productions of Bengal, rich in proportion to the land they occupy, valuable in commerce and manufactures, are tobacco, sugar, indigo, cotton, mulberry, and poppy. Most of these require land solely appropriated to the respective culture of each; they would here deserve full notice, with some other articles, if we were not in this place limited to a general review of the usual course of husbandry, and the implements and methods it employs.

The arts and habits of one country elucidate those of another. The native of the North may deem every thing novel in India; but if he have visited the southern kingdoms of Europe, he will find much similarity to notice.

The plough, the spade of Bengal, and the coarse substitute for the harrow, will remind him of similar implements in Spain. Cattle treading out the corn from the ear, will recall the same practice in the south of Europe: where, also, he has already remarked the want of barns and of inclosures; the disuse of horses for the plough; the business of domestic economy conducted in the open air; and the dairy supplied with the milk of buffaloes.

The plough is drawn by a single yoke of oxen, guided by the ploughman himself. Two or three pair of oxen assigned to each plough, relieve each other until the daily task be completed. Several ploughs in succession deepen the same furrows, or rather scratch the surface; for the plough wants a contrivance for turning the earth, and the share has neither width nor depth to stir a new soil. A second ploughing crosses the first, and a third is sometimes given diagonally to the preceding. These frequently repeated, and followed by the substitute for the harrow, pulverize the surface, and prepare it for the reception of seed. The field must be watched for several days, to defend the seed from the depredations of numerous flocks of birds. This is commonly the occupation of children, stationed to scare the birds from the fresh sown field.

After the plant has risen, the rapid growth of weeds demands frequent weedings, particularly in the rainy season. For, few indigenous herbs vegetating in the dry season, weeding is little, if at all required for plants which are cultivated in the absence of rain. Viewing the labours of the weeders, the eye is not easily reconciled to see them sitting to their work. The short-handled spud, which they use for a hoe, permits no other posture: but however familiar that posture may be to the Indian, his labour is not employed to advantage in this mode of weeding.

The hook (for the scythe is unknown) reaps every harvest. In this also much unnecessary labour is employed; not merely from the want of a more expeditious implement, but from the practice of selecting the ripest plants, which, taught by the harvest of different plants ripening successively, the Indian extends to the harvest of a simple crop. Yet such is the contradictions of custom, that while the peasant returns frequently to one field to gather the plants as they ripen, he suffers another to stand long after the greatest part of the crop has passed the point of maturity. He justifies his practice upon circumstances which render it impracticable to enter these fields to select the ripe plants without damaging the rest; and upon the inferiority of crops which mix with ripe corn a considerable proportion not fully ripened. Though his excuse be not groundless, his loss is considerable, by the grain which drops before the harvest in so great a quantity, that if the field remain unsown it will afford a crop by no means contemptible*.

The practice of stacking corn intended to be reserved for seed, or for a late sale, is very unusual. The husk which covers rice preserves it so perfectly, that, for this grain, the practice would be superfluous: and the management of rice serving for the type of their whole husbandry, it is neglected by the peasants for other corn. A careless stack which waits the peasant's leisure to thrash it out serves for a convenient disposition, rather than as a defence from the inclemencies of weather. With the first opportunity his cattle tread out the corn, or his staff thrashes the smaller seeds. The grain is winnowed in the wind, and stored in jars of unbaked earth, in baskets, or in twisted grass formed into the shape of baskets.

The want of roads, which, indeed, could not possibly be provided to give access to every field, in every season, does not leave it in the option of the farmer to bring home all his harvests by cattle; but the general disuse of cattle in circumstances which would permit this mode of transport, is among the facts which show a great disproportion between the population and the husbandry.

* Of this, instances are frequent: the remarkable result of one instance deserves to be mentioned. An early inundation covered a very extensive tract before the rice had been sown: the landlord remitted the rents, but claimed the spontaneous crop; and he profited by the accommodation, realising from this harvest a greater amount than the rents he remitted; although, in addition to the common expenses, he was at considerable cost to watch the crop, and was probably defrauded of a large proportion of the harvest.

Irrigation is less neglected than facility of transport. In the management of forced rice, dams retain the water on extensive plains, or reserve it in lakes, to water lower lands as occasion requires. For either purpose much skill is exerted in regulating the supplies of water. For the same culture, ridges surrounding the field retain water raised by the simple contrivance of a curved canoe swinging from a pole. In other situations ridges are also raised round the field, both to separate lands and to regulate the water on considerable tracts. In some provinces water raised by cattle, or by hand, from wells, supply the deficiencies of rain. Each of these, being within their compass, is the undertaking of the peasants themselves. More considerable works, not less necessary, are much neglected. Reservoirs, water-courses, and dykes, are more generally in a progress of decay than of improvement.

The succession of crops, which engages so much the attention of enlightened cultivators in Europe, and on which principally rests the success of a well-conducted husbandry, is not understood in India. A course extending beyond the year has never been dreamt of by a Bengal farmer: in the succession of crops within the year, he is guided to no choice of an article adapted to restore the land impoverished by a former crop. His attention being fixed on white corn, other cultivation only employs the intervals of leisure which the seasons of white corn allow to the land and to labour; with an exception however to sugar, silk, and other valuable productions, to which corn is secondary; but which, grown on appropriate lands, belong not to the consideration of the course of crops. In this, which is not regulated by any better consideration than convenience of time, it would be superfluous to specify the different courses which occur in practice: as little would it tend to any useful purpose to develope the various combinations of different articles grown together on the same field, or in the stubble of a former harvest, or sown for a future crop before the preceding harvest be gathered.

A competent notion may be formed of this practice by conceiving a farmer eager to obtain the utmost possible produce from his land, without any consideration for the impoverishment of the soil; able to command, at any season, some article suited to the time, and not content to use his field so soon as the harvest makes room for succession, but anticipating the vacancy, or obtaining a crop of quick vegetation during the first progress of a slower plant.

It may be judged that his avidity disappoints itself, both as the several articles deprive each other of the nourishment which would have afforded a more abundant crop of either separately, and as the land impoverished makes bad returns for the labour and seed. In most situations the land racked in this husbandry soon requires time to recruit; the Indian allows it a lay, but never a fallow. This would be well judged, if the management of stock gave to the lay all the benefit which belongs to this method, and if the inefficacy of the plough, which must be preceded by the spade, did not greatly increase the expense of opening old lays.

The abuse of dung, employed for fuel instead of being applied to manure, must have concealed from the husbandman the benefit of well managed stock: else, in his practice of pasturing his cattle in the stubble of his harvest, and in fields of which the crop has failed, he could not omit to notice the advantage of a farm well stocked. For want of perceiving this benefit, the cattle for labour and subsistence are mostly pastured on small commons, or other pasturage, intermixed with arable lands, or fed at home on straw or cut grass; and the cattle for breeding, and for the dairy, are grazed in numerous herds on the forests and downs. Wherever fed, the dung is carefully collected for fuel.

Cultivation suffering very considerably by the trespasses of cattle, through the wilful neglect of the herdsmen, it is a matter of surprise that inclosures are so much neglected. For a reason already mentioned cattle cannot be left at night unattended: but, in the present practice, buffaloes only are grazed at night; cows and oxen are pastured in the day. For these, inclosures would be valuable, and even for buffaloes would not be useless; and the farmer would be well rewarded by suffering the cattle to fertilize all his arable lands, instead of restricting the use of manure to sugar-cane, mulberry, tobacco, poppy, &c.

Few lands unassisted are sufficiently fertile to raise these productions; the husbandman has yielded to the necessity of manuring for them. On the management of it little occurs for particular notice in this place, except to mention, that khully, or oil-cake, is occasionally used as manure for the sugar-cane. A course of experiments would be requisite to ascertain whether the methods actually employed be better suited to the soil and climate, than others which might be or have been suggested from the practice of other countries, or from the varying practice of different parts of Bengal.

For a similar reason the consideration of other produce

(of

(of which the culture is now general, or which might be generally diffused, as cotton, indigo, arnotto, madder,) may also be deferred. Enough has been said to show that husbandry in Bengal admits of much improvement; or, rather, that the art is in its infancy.

An ignorant husbandry, which exhausts the land, neglecting the obvious means of maintaining its fertility, and of reaping immediate profit from the operations which might restore it; rude implements, inadequate to the purpose for which they are formed, and requiring much superfluous labour; this again ill divided, and of consequence employed disadvantageously, call for amendment.

The simple tools which the Indian employs in every art are so coarse, and apparently so inadequate, that it creates surprise he should ever effect his undertaking; but the long continuance of feeble efforts accomplishes (and mostly well) what, compared to the means, appears impracticable: habituated to observe his success, we cannot cease to wonder at the simplicity of his process, contrasting it to the mechanism employed in Europe. But it is not necessary that the complicated models of Europe should be copied in India. A passion for the contrivances of ingenuity has adopted intricate machinery for simple operations. The economy of labour in many cases justifies the practice, whether an effect be produced at a smaller expense, or more be performed at proportionate expense, but with less labour. In Bengal the value of money, and the cheapness of labour, would render it absurd to propose costly machinery; but is no objection to simple improvements, which, adding little to the cost of the implements, would fit them to perform, more effectually, and with less labour, the object undertaken. The plough is among the implements which stand most in need of such improvements.

The readiness with which he can turn, from the occupation in which he has been accustomed, to another branch of the same art, or to a new occupation, is characteristic of the Indian. The success of his earliest efforts, in a novel employment, is daily remarked with surprise. It is not so much a proof of ingenuity and ready conception, as the effect of slow and patient imitation, assisting a versatile habit necessarily acquired where the division of labour is imperfect; and though its performance may surpass expectation, it must ever fall short of the expeditious and finished performances of the expert mechanic, whose skill is formed by constant practice in a more circumscribed occupation.

The

The want of capital, employed in manufactures and agriculture, prevents, in Bengal, the division of labour. Every manufacturer, every artist, working for his own account, conducts the whole process of his art from the formation of his tools to the sale of his production. Unable to wait the market, or anticipate its demand, he can only follow his regular occupation as immediately called to it by the wants of his neighbours. In the intervals he must apply to some other employment in immediate request; and the labours of agriculture, ever wanted, are the general resource. The mechanic, finding himself as fully competent as the constant cultivator to the management of common husbandry, is not discouraged from undertaking it at his own risk. Every labourer, every artizan, who has frequent occasion to recur to the labours of the field, becomes a tenant. Such farmers are ill qualified to plan or conduct a well judged course of husbandry, and are idly employed, to the great waste of useful time, in carrying to market the paltry produce of their petty farms.

If Bengal had a capital in the hand of enterprising proprietors, who employed it in husbandry, manufactures, and internal commerce, these arts would be improved; and, with greater and better productions from the same labour, the situation of the labourers would be less precarious and more affluent, although the greatest part of the profit might rest with the owners of the capital.

Capital is certainly not less deficient to the internal commerce of Bengal than to manufactures and agriculture. The small capitals now employed require large returns. Blessed as Bengal is, beyond any country, with an extensive internal navigation, the want of roads (though a great evil) would not sufficiently account for the very limited intercourse of commerce at present existing. But the large profits which small capitals require, explain the want of intercourse. This conspires with the deficiency of capital in manufactures and husbandry to depress Bengal; for in agriculture particularly, which is the basis of prosperity to a country, the want of capital is a bar to all improvement. Under a system of government which neither drained its wealth nor curbed rational enterprise, Bengal could not fail to revive; the employment of capital in husbandry would introduce large farms, and from these would flow every improvement wanted; and which must naturally extend from husbandry into every branch of arts and commerce.

Without capital and enterprise, improvement can never be obtained. Precept will never inculcate a better husbandry on the humble unenlightened peasant. It could not, without example, generally engage a wealthier and better informed class. Positive institutions would be of as little avail. The legislator cannot direct the judgment of his subjects; his business is only to be careful lest his regulations * disturb them in the pursuit of their true interests.

In Bengal, where the revenue of the state has had the form of land-rent, the management of finances has a more immediate influence on agriculture than any other part of the administration. The system which has been adopted, of withdrawing from direct interference with the occupants, and leaving them to tenant from landlords, will contribute, more than any of the remediary † regulations which have been promulgated, to abuses and evils which had rendered the situation of the cultivator precarious. But not yet having produced its effect, it requires us to review the system of finances, under which abuses had grown, and placed the occupant in a precarious situation, as discouraging to agriculture as any circumstance yet noticed; for without an ascertained interest for a sufficient period, no person could have an inducement to venture a capital in husbandry.

* A strong instance of such ill-advised institutions occurs in a local regulation, which prohibited farms exceeding fifty begahs.

† Regulations on this and other subjects have copied too closely the notions and forms of European nations. Though they have been framed by persons well informed of the customs and prejudices of the natives, a predilection for the maxims of European societies has introduced rules, which, if not incompatible with the disposition of the Indian, have at least been pressed with too eager haste, not allowing time to the natives to accommodate themselves to new forms and to innovating maxims. The provisions of new laws, not easily apprehended by the natives, are to them the more obscure, being framed in a foreign language, from which translations cannot assimilate to the idiom of their own tongue. Hence the best intentions have not yet produced good effects. The people have received no material relief, no considerable benefit; the only consequence is, that their understandings are confounded, and their minds alarmed.

II. Analytical

II. *Analytical Experiments and Observations on Lac.* *By* Charles Hatchett, *Esq. F.R.S.*

[Continued from our last volume, p. 358.]

§ II.

Analytical Experiments on Stick, Seed, and Shell Lac.

Lac, when placed on a red-hot iron, at first contracts, and then melts, emitting a thick smoke, of a peculiar but rather pleasant odour; after which, a light spongy coal remains.

Distillation of Stick Lac.

100 grains of the best stick lac, separated as much as possible from the twigs, were put into a glass retort, to which a double tubulated receiver and hydro-pneumatic apparatus were adapted. Distillation was then gradually performed, with an open fire, until the bottom of the retort became red hot.

The products thus obtained were,	Grains.
1. Water slightly acid - - - -	10.
2. Thick brown butyraceous oil - -	59.
3. Spongy coal - - - -	13.50
4. A small portion of carbonate of ammonia, with a mixture of carbonic acid, carbonated hydrogen, and hydrogen gas, which may be estimated at - - - -	17.50
	100.

Seed Lac.

100 grains of very pure seed lac were distilled in a similar manner, and afforded,

1. Acidulated water - - -	6.
2. Butyraceous oil - - -	61.
3. Spongy coal - - - -	7.
4. Mixed gas nearly as before, but without ammonia, amounting by estimation to -	26.
	100.

Shell Lac.

100 grains of shell lac, treated as above, yielded,

1. Acidulated water - - -	6.
2. Butyraceous oil - - -	65.
3. Spongy coal - - - -	7.50
4. Mixed gas, amounting by estimation to -	21.50
	100.

The

The coal of the shell lac, by incineration, afforded about one grain of ashes, which contained a muriate, probably of soda, and a little iron, with some particles of sand, which may be regarded as extraneous.

Analysis of Stick Lac.

A. 200 grains of stick lac, picked and reduced to powder, were digested in a pint and a half of boiling distilled water during 12 hours. The liquor was transparent, and of a beautiful deep red; this was decanted into another vessel, and the operation was repeated, with fresh portions of water, until it ceased to be tinged: the lac then appeared of a pale yellowish-brown colour.

The whole of the aqueous solution being evaporated, left a deep red substance, which possessed the general properties of vegetable extract, and weighed 18 grains.

B. The dried lac was digested for 48 hours, without heat, in eighteen ounces of alcohol; and the clear tincture being cautiously decanted, different portions of alcohol were added, and the digestion was repeated, until the alcohol ceased to produce any effect.

The whole of the solutions in alcohol were then poured into distilled water, which was heated, and an attempt was made to separate the precipitated substance by filtration; but, as this did not succeed, on account of the filter speedily becoming clogged, the whole was subjected to gentle distillation; by which a brownish-yellow resin was obtained, amounting in weight to 136 grains.

C. The remainder of the lac was again digested in boiling distilled water; by which 2 grains of the colouring extract were obtained.

D. The residuum was then digested with one ounce of muriatic acid diluted with two ounces of water, which, by boiling, became of a bright pale red, but changed to purple, when saturated with a solution of carbonate of potash.

A flocculent precipitate was thus obtained, which possessed the characters of precipitated vegetable gluten combined with some of the colouring extract; this, when completely dried, weighed 11 grains.

E. There now remained 25 grains, which evidently consisted of a sort of wax, mixed with small parts of twigs and other extraneous substances.

A part of the wax was separated by heat and pressure in a piece of linen; and another portion was separated by digestion in olive oil, which assumed the consistency of an unguent.

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The residuum was then boiled with lixivium of potash, and became tinged with purple, in consequence of some of the colouring extract which had not been dissolved by the preceding operations.

The undissolved part, now consisting only of the extraneous vegetable and other substances, weighed 13 grains; so that the wax, with a small portion of the colouring extract, may be estimated at 12 grains.

By the above process, 200 grains of stick lac afforded,

			Grains.
A. C.	Colouring extract - -	18 2	20
B.	Resin - - - -		136
D.	Vegetable gluten - - -		11
E.	Wax, with a little colouring extract, about		12
	Extraneous substances - -		13
			192.

Analysis of Seed Lac.

200 grains of very pure seed lac were subjected to operations very similar to those which have been described, and afforded,

	Grains.
Colouring extract - - - -	5
Resin - - - - -	177
Vegetable gluten - - - -	4
Wax - - - - -	9
	195.

Analysis of Shell Lac.

A. 500 grains of this substance were first treated with boiling distilled water, as above-mentioned, and yielded of extract only 2.50 grains.

B. The 497.50 grains which remained, were then digested with different portions of cold alcohol, until this ceased to produce any effect; the resin which was thus separated amounted to 403.50 grains.

C. As the shell lac had not been reduced into powder, but only into small fragments, these were become white and elastic, and, when dry, were brittle, and of a pale brown colour; the whole then weighed 94 grains.

D. These 94 grains were digested in diluted muriatic acid; and the acid, being afterwards saturated with solution of carbonate of potash, afforded a flocculent precipitate (resembling that obtained from solutions of vegetable gluten), which, when dry, weighed 5 grains:

E. Alcohol

E. Alcohol acted but feebly on the residuum; it was therefore put into a matrass, with three ounces of acetic acid, and was suffered to digest without heat during six days, the vessel being at times gently shaken; the acid thus assumed a pale brown colour, and was very turbid. The whole was then added to half a pint of alcohol, and was digested in a sand-bath; by which a brownish tincture was formed, and at the same time a quantity of a whitish flocculent substance was deposited, which, being collected, well washed with alcohol on a filter, and dried, weighed 20 grains.

This substance was white, light, and flaky, and, when rubbed by the nail, it became glossy, like wax; it also easily melted, was absorbed by heated paper, and, when placed on a coal or hot iron, emitted a smoke, the odour of which very much resembled that of wax, or rather spermaceti.

F. The solution formed by acetic acid and alcohol being filtrated, was poured into distilled water, which immediately became milky; and, being heated, the greater part of the resin which had been dissolved assumed a curdy form, and was partly separated by a filter, and partly by distilling off the liquor; this portion of resin amounted to 51 grains.

G. The filtrated liquor, from which this resin had been separated, was saturated with a solution of carbonate of potash; and, being heated, a second precipitate of gluten was obtained, which, when well dried, weighed 9 grains.

The 500 grains of shell lac thus yielded,

		Grains.
A.	Extract - - -	2.50
B. F.	Resin - - -	454.50
D. G.	Vegetable gluten - -	14.
E.	Wax - - -	20.
		491.

The mode of analysis adopted for the shell lac, must undoubtedly appear less simple than that which was employed for seed and stick lac; but, upon the whole, it was attended with advantages; for the shell lac being in small fragments, and not in the state of a powder, considerably facilitated the decantation of the solution in alcohol from the residuum; and although, in this last, a portion of the resin was protected from the action of the alcohol, by being enveloped in the gluten and wax, yet, by the assistance of acetic acid, the remainder of the resin, as well as the whole

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of the gluten, were dissolved; the wax was obtained in a pure state, and a separation of the resin from the gluten was afterwards easily effected by the method which has been described. As therefore acetic acid is capable of dissolving resin, gluten, and many other of the vegetable principles, it certainly may be regarded as a very useful solvent in the analysis of bodies appertaining to the vegetable kingdom.

From the results of the preceding analyses it appears, that the different kinds of lac consist of four substances, namely, extract, resin, gluten, and wax, the separate properties of which shall now be more fully considered.

Properties of the colouring Extract of Lac.

1. When dry it is of a deep red colour, approaching to purplish crimson.

2. Being put on a red-hot iron it emits much smoke, with a smell somewhat resembling burned animal matter, and leaves a very bulky and porous coal.

3. Water, when digested with it in a boiling heat, partially dissolves it; but the residuum was found to be absolutely insoluble in water.

4. Alcohol acts but slowly on it, and, in a digesting heat, dissolves less than water. The colour of the solution is also not so beautiful; and a considerable part of the residuum left by alcohol was, when digested with water, found to be soluble, although this was not the case when the residuum left by water was treated with alcohol.

5. It is insoluble in sulphuric ether, excepting a very small portion of resin, which appeared to be accidentally mixed with it.

6. Sulphuric acid readily dissolves it, and forms a deep brownish-red solution, which, being diluted with water, and saturated with potash, soda, or ammonia, becomes changed to a deep reddish-purple.

7. Muriatic acid dissolves only a part: the solution is of the colour of port wine, and, by the alkalis, is changed to a deep reddish-purple.

8. Nitric acid speedily dissolves it: the solution is yellow, and rather turbid; but the red colour is not restored by the alkalis, for these only deepen the yellow colour. This nitric solution did not afford any trace of oxalic acid.

9. Acetic acid dissolves it with great ease, and forms a deep brownish-red solution.

10. Acetous acid does not dissolve it quite so readily, but the solution is of a brighter red. Both of the above,

when

when saturated with alkalis, are changed to a deep reddish-purple.

11. The lixivia of potash, soda, and ammonia, act powerfully on this substance, and almost immediately form perfect solutions, of a beautiful deep purple colour.

12. Pure alumina, put into the aqueous solution, does not immediately produce any effect; but, upon the addition of a few drops of muriatic acid, the colouring matter speedily combines with the alumina, and a beautiful lake is formed.

13. Muriate of tin produces a fine crimson precipitate when added to the aqueous solution.

14. A similar coloured precipitate is also formed by the addition of solution of isinglass.

These properties of the colouring substance of lac, especially its partial solubility in water and in alcohol, and its insolubility in ether, together with the precipitates formed by alumina and muriate of tin, indicate that this substance is vegetable extract, perhaps slightly animalized by the coccus.

The effects which it produced on gelatin, also demonstrate the presence of tannin; but this very probably was afforded by the small portions of vegetable bodies, from which the stick lac can seldom be completely separated.

Properties of the Resin of Lac.

This substance is of a brownish-yellow colour; and, when put on a red-hot iron, it emits much smoke, with a peculiar sweet odour, and leaves a spongy coal.

It is completely soluble in alcohol, ether, acetic acid, nitric acid, and the lixivia of potash and soda.

Water precipitates it from alcohol, ether, acetic acid, and partially from nitric acid; and it possesses the other general characters of a true resin.

Properties of the Gluten of Lac.

It has been already observed, that when small pieces of shell lac have been repeatedly digested in cold alcohol, they become white, bulky, and elastic. By drying, these pieces become brownish and brittle; the elasticity is also destroyed by boiling water, exactly as when the gluten of wheat is thus treated.

If the pieces of shell lac, after the digestion in alcohol, be digested with diluted muriatic acid, or with acetic acid, the greater part of the gluten is dissolved, and may be precipitated in a white flaky state, by alkalis; but, if these last be added to excess, and heat be applied, then the glutinous substance is redissolved, and may be precipitated by acids.

If the pieces of shell lac, after digestion in alcohol, be treated with alkaline lixivia, then the whole is dissolved, and forms a turbid solution. But when acids are employed, the chief part of the gluten is alone acted upon, and a considerable residuum is left, consisting of the wax, some of the resin, and a portion of gluten, which has been protected from the action of the acid by the two former substances.

The above properties indicate a great resemblance between this substance and the gluten of wheat; I therefore have called it gluten, but at a future time I intend to subject it to a more accurate examination.

Properties of the Wax of Lac.

If shell lac be long and repeatedly digested in boiling nitric acid, the whole is dissolved, excepting the wax, which floats on the surface of the liquor, like oil, and, when cold, may be collected; or it may be more easily obtained in a pure state, by digesting the residuum left by alcohol in boiling nitric acid.

The wax thus obtained, when pure, is pale yellowish white, and (unlike bees-wax) is devoid of tenacity, and is extremely brittle.

It melts at a much lower temperature than that of boiling water, burns with a bright flame, and emits an odour somewhat resembling that of spermaceti.

Water does not act upon it, neither does cold alcohol; but this last, when boiled, partially dissolves it, and, upon cooling, deposits the greater part; a small portion, however, remains in solution, and may be precipitated by water.

Sulphuric ether, when heated, also dissolves it; but, upon cooling, nearly the whole is deposited.

Lixivium of potash, when boiled with the wax, forms a milky solution; but the chief part of the wax floats on the surface, in the state of white flocculi, and appears to be converted into a soap of difficult solubility; it is no longer inflammable, and, with water, forms a turbid solution, from which, as well as from the solution in potash, the wax may be precipitated by acids.

Ammonia, when heated, also dissolves a small portion of the wax, and forms a solution very similar to the former.

Nitric and muriatic acids do not seem to act upon the wax: the effects of sulphuric acid have not been examined.

When the properties of this substance are compared with those of bees-wax, a difference will be perceived; and, on the contrary, the most striking analogy is evident between the wax of lac and the myrtle wax which is obtained from the Myrica cerifera.

An

An account of the latter substance has been published by Dr. Bostock, of Liverpool, in Nicholson's Journal, with comparative Experiments and Observations on Bees-Wax, Spermaceti, Adipocire, and the crystalline Matter of biliary Calculi *.

The properties of the myrtle wax, as described in Dr. Bostock's valuable paper, so perfectly coincide with those which I have observed in the wax of lac, that I cannot but consider them as almost the same substance; indeed I think they may be regarded as absolutely identical, if some allowance be made for the slight modifications which have been produced by the different mode of their formation.

From the preceding experiments and analyses we find, that the varieties of lac consist of the four substances which have been described; namely, extractive colouring matter, resin, gluten, and a peculiar kind of wax. Resin is the predominant substance; but this, as well as the other ingredients, is liable, in a certain degree, to variation in respect to quantity.

According to the analyses which have been described, one hundred parts of each variety of lac yielded as follows.

Stick Lac.	Grains.
Resin - - -	68.
Colouring extract - -	10.
Wax - - -	6.
Gluten - - -	5.50
Extraneous substances -	6.50
	96.0

Seed Lac.	
Resin - - -	88.50
Colouring extract - -	2.50
Wax - - -	4.50
Gluten - - -	2.
	97.50

Shell Lac.	
Resin - - -	90.90
Colouring extract - -	0.50
Wax - - -	4.
Gluten - - -	2.80
	98.20

* Nicholson's Journal for March 1803, p. 129.

The proportions of the substances which compose the varieties of lac, must however be subject to very considerable variations; and we ought therefore only to consider these analyses in a general point of view. Hence we should state, that lac consists principally of resin, mixed with certain proportions of a peculiar kind of wax, of gluten, and of colouring extract.

The relative quantity of the two latter ingredients very considerably affects the characters of the lacs; for instance, we may observe that the glutinous substance, when present in shell lac in a more than usual proportion, probably produces the defect observed in some kinds of sealing-wax, which, when heated and burned, become blackened by particles of coal; for the gluten affords much of this substance, and does not melt like the resin and wax. From what has been stated, therefore, lac may be denominated a *cero-resin*, mixed with gluten and colouring extract.

§ III.

General Remarks.

From the whole of the experiments which have been related, it appears, that although lac is indisputably the production of insects, yet it possesses few of the characters of animal substances; and that the greater part of its aggregate properties, as well as of its component ingredients, are such as more immediately appertain to vegetable bodies.

Lac, or gum lac, as it is popularly, but improperly, called, is certainly a very useful substance; and the natives of India furnish full proofs of this, by the many purposes to which they apply it.

According to Mr. Kerr it is made by them into rings, beads, and other female ornaments.

When formed into sealing-wax, it is employed as a japan, and is likewise manufactured into different coloured varnishes.

The colouring part is formed into lakes for painters: a sort of Spanish wool for the ladies is also prepared with it; and as a dyeing material it is in very general use.

The resinous part is even employed to form grindstones, by melting it, and mixing with it about three parts of sand. For making polishing grindstones, the sand is sifted through fine muslin; but those which are employed by the lapidaries are formed with powder of corundum, called by them Corunc*.

* Philosophical Transactions 1781, p. 380.

But

But in addition to all the above uses to which it is applied in India, as well as to those which cause it to be in request in Europe, Mr. Wilkins's Hindû ink occupies a conspicuous place, not merely on account of its use as an ink, but because it teaches us to prepare an aqueous solution of lac, which probably will be found of very extensive utility.

This solution of lac in water may be advantageously employed as a sort of varnish, which is equal in durability and other qualities to those prepared with alcohol; whilst, by the saving of this liquid, it is infinitely cheaper.

I do not mean, however, to assert that it will answer equally well in all cases, but only that it may be employed in many. It will be found likewise of great use as a vehicle for colours; for, when dry, it is not easily affected by damp, or even by water.

With a solution of this kind I have mixed various colours, such as vermilion, fine lake, indigo, Prussian blue, sap green, and gamboge; and it is remarkable, that although the two last are of a gummy nature, and the others had been previously mixed with gum (being cakes of the patent water-colours), yet, when dried upon paper, they could not be removed with a moistened sponge, until the surface of the paper itself was rubbed off.

In many arts and manufactures, therefore, the solutions of lac may be found of much utility; for, like mucilage, they may be diluted with water, and yet, when dry, are little if at all affected by it*.

We find, from the experiments on lac, that this substance is soluble in the alkalis, and in some of the acids. But this fact (considering that resin is the principal ingredient of lac) is in opposition to the generally received opinion of chemists; namely, that acids and alkalis do not act upon resinous bodies. Some experiments, however, which I

* The alkaline solutions of lac are evidently of a saponaceous nature, and, like other soaps, may be decomposed by acids. The entire substance of lac is not however completely dissolved, as appears from the turbidness of the liquors. Three of the four ingredients; namely, the resin, the gluten, and the colouring extract, appear to be in perfect solution; whilst the wax is only partially combined with the alkali, and forms that imperfectly soluble saponaceous compound which has been formerly mentioned, and which remains suspended, and disturbs the transparency of the solution.

From various circumstances, it does not seem improbable that the long sought for, but hitherto undiscovered vehicle employed by the celebrated painters of the Venetian School, may have been some kind of resinous solution, prepared by means of borax, or by the alkalis.

 have

have made on various resins, gum-resins, and balsams, fully establish that these substances are powerfully acted upon by the alkalis, and by some of the acids, so as to be completely dissolved, and rendered soluble in water.

It will be a very wide and curious field of inquiry, to discover what changes are thus produced in these bodies, especially by nitric acid. Each substance must form the subject of a separate investigation; and there cannot be a doubt but that much will be learned respecting their nature and properties, which hitherto have been so little examined by chemists.

The alkaline solutions of resin may be found useful in some of the arts; for many colours, especially those which are metallic, when dissolved in acids, may be precipitated, combined with resin, by adding the former to the alkaline solutions of the latter. I have made some experiments of this kind with success; and perhaps these processes might prove useful to dyers and manufacturers of colours. It is probable also, that medicine may derive advantages from some of this extensive series of alkaline and acid solutions of the resinous substances.

III. *Some Account of the Trade of Siam**.

The English know so little of this place and its trade, that it will require a particular description, as the traffic may be much improved, particularly for the import and consumption of British manufactures, such as broad cloths, cutlery, ironmongery, jewelry, and toys.

The Portuguese have principally enjoyed the trade and profits of this place. There have been some speculations made by British merchants from Calcutta, and which always turned out to advantage.

The Menam (the chief river), by which ships enter Siam, discharges itself into the gulph of Siam, and is rendered difficult of access on account of a bar, to cross which it is necessary to have a pilot.

The winter here is dry, and the summer wet, occasioned by the different monsoons, which act here as in the bay of Bengal, viz. the north-easterly monsoon bringing in dry, and the south-westerly monsoon bringing in heavy clouds, thick weather, and rain.

* From the *Mariner's Directory and Guide to the Trade and Navigation of the Indian and China Seas.*

The

The southerly monsoon is therefore the season for ships to go to Siam, as it is a fair wind to cross the bar; and the northerly monsoon to leave the bar, and proceed to India through the straits of Malacca.

Bankasoy, situated on the river near the bar, is the principal place of trade; and the king is the chief merchant, for his revenues are paid in elephants' teeth, sapan, and aquilla wood. This is the best part of the Malay coast for procuring that exquisite sauce called ballichong, which the eastern epicures so much seek, value, and regale upon: it is made of a composition of dried shrimps, pepper, salt, seaweed, &c. &c. beaten together to the consistence of a tough paste; and then packed in jars for sale, use, or exportation.

Siam, near the shores, (the only places where Europeans have access to,) is very unhealthy. The land seems to be formed by the mud descending from the mountains; to which mud, and the overflowings of the river, the soil owes its fertility; for in the higher places, and parts remote from the inundation, all is dried and burnt up by the sun soon after the periodical rains are over.

The arts have been in more repute, and better attended to formerly, than at the present time. Few travellers will omit noticing the many casts at this place, both of statues and cannon, of an immense calibre and length, as well as many other curiosities, many of them in gold.

The mountains produce diamonds of an excellent water, (little if at all inferior to those of Golconda, though not so large,) sapphires, rubies, and agates.

They have tin of a very fine quality, of which they make tutanag; steel, iron, lead, and gold: they have copper also of a fine quality, but not in great plenty.

The low grounds produce rice in great quantities; and on the higher grounds, that are not inundated, they raise wheat. They have many medicinal plants and gums, oil of jessamine, sack, benzoin, crystal, emery, antimony, cotton, wood, oil, varnish, cinnamon, cassia buds, and iron-wood, which is much used by the natives, Malays, and Chinese, as anchors for their vessels. They have also great quantity of white betel nut, which is exported to China, by the junks and Portuguese ships, which have enjoyed almost uninterruptedly the whole trade of this place, and the coast of Cochin-China, from the Ridang islands to Macao.

They have also the fruits known in India, as well as the durian, mangostein, and tamarind, which are remarkable for thriving here.

The animals are horses, oxen, buffaloes, sheep and goats, tigers, elephants, rhinoceroses, deer, and some hares.

There is poultry in great abundance, with peacocks, pigeons, partridges, snipes, parrots, and many other birds.

They have insects and vermin, as peculiar to other parts of India.

The sea yields them excellent fish of all kinds, particularly flounders, which are dried and exported to all the eastern ports; and they have extraordinary fine lobsters, small turtles, and oysters. Here too are very fine river fish, particularly the beatie (or cockup), silver eels of a very large size, and mangoe fish, so much esteemed in Calcutta.

From the humidity of the soil, it is almost unnecessary to observe, that the chief disorders to which Europeans are subject, are fluxes, dysenteries, fevers, and agues.

No private merchant here dare trade in tin, tutanag, elephants' teeth, lead, or sapan wood, without leave from the king; which permission is seldom granted, as he monopolizes these articles to himself, and pays in them for any goods he purchases, at the highest prices they will bring at most markets in India.

The following are the general prices for elephants' teeth from the king in payment:

2 teeth	to the	pecul,	equal to	120 ticalls.
3 do.	-	do.	-	112
4 do.	-	do.	-	104
5 do.	-	do.	-	96
6 do.	-	do.	-	88
7 do.	-	do.	-	80
8 do.	-	do.	-	72
9 do.	-	do.	-	64
10 do.	-	do.	-	56
11 do.	-	do.	-	48
12 do.	-	do.	-	40
13 do. to 20 or 30 do.			-	32

thus falling eight ticalls in each pecul, as the number of teeth increases. But if you purchase with ready money, instead of receiving them in barter (or payment) for goods, you will buy each quality eight ticalls per pecul cheaper than the above prices; and still lower if you have permission to trade with the Christians, or private merchants.

In purchasing sapan wood, it is customary to allow five catties per pecul for loss of weight; and as each draft is

 weighed

weighed by the large or five pecul dotchin, you are allowed 525 catties; which, if it is the first sort, should not be more than 16 to 18 pieces: second sort runs 22 to 24 pieces; and as the number of pieces increase the price falls in proportion.

After you have settled with the ministers what part of your cargo the king is to have, (which is commonly called a present, unless he asks particularly to buy any thing,) some of the principal merchants of the place are called to value them; and as they are valued you are paid by the king, as a present, in the fore-mentioned goods at the highest prices they will bear.

It may not be deemed superfluous here to observe, that a complaisant behaviour and a cheerfulness of disposition are absolutely necessary, particularly if you have, as all traders must have, a point to carry. Presents, as they are called, but in grosser language bribes, properly applied, give the officers of government and the people in power the true tone and relish to serve you, as you will have frequent occasion to call upon them in their official capacities.

Every application for a permit to purchase any description of goods costs 10½ ticalls: this permit only serves for one house, and one time of weighing; so that if you are about receiving any quantity of goods of the same quality from different merchants, agree with them to send it all to one house, and make one day for weighing off the whole in the merchant's name at whose house it is weighed. This mode will save the expense of a multiplicity of permits, and quicken dispatch. Upon each of these weighing days you must have three of the king's writers; the first and second shabunder, and the linguist: to each of these, daily, you pay one-quarter ticall; but it will be your interest to give them some trifling presents.

Elephants' teeth, tin, sapan wood, and lead, purchased from the king, are free of all customs; but if bought from private merchants, they pay as follows:

Elephants' teeth (any sort)	4 ticalls	per pecul.
Tin - -	2 ditto	per bhar.
Sapan wood -	4 ditto	per 100 pecul.
Lead - -	2 mace	per bhar.

If from any part of India, (as Bengal, the Coromandel, Malabar, or Guzerat coasts, Bombay, Surat, &c.) you pay the following customs before you sail:

Measurage, if above 3 fathoms, or 18 feet beam, to the king - - -	10 ticalls.
To the barcola, or first shabunder -	10

To

To the second shabunder - -	10	ticalls.
For your arrival at the bar - -	10½	
To pilots and entrance - -	10½	
To pass the two tobangoes, or chop-houses, each - - -	10½	
To each permit - - -	10½	
To a permit to measure - -	10½	
To a permit to open your bales -	12	
To a permit for leave to sell -	10½	
And on going away, to each of the two tobangoes - - -	20	

At the place where they insist on your landing your guns, 20 ticalls; with some other charges which are trifling.

The duties upon your imports are eight per cent.; except dates, kissmisses, almonds, and some other trifles which are excused.

Vessels from Malacca, Palambang, Banca, Batavia, Tringano, Campodia, Cochin China, and their coasts, pay neither duties nor customs on their goods; they only pay

For registering inwards - -	1½	ticalls.
Two permits to pass the tobangoes, each	10½	

If the vessel has no goods, she will pay 1 ticall per covid (of 14¼ inches) for her breadth of beam; but if she has trade, she pays 2 ticalls per covid.

I would advise all vessels from India, going to Siam, to take a fresh port clearance from Malacca; as the great indulgences she will enjoy, and the saving in the measurement and charges, must appear obvious.

IV. *Account of the Self-immolation of the two Widows of Ameer Jung, the late Regent of Tanjore*.*

The regent died on the 19th of April 1802, about ten o'clock *a. m.* The moment he expired, two of his wives adorned themselves with their jewels and richest clothes, entered the apartment in which the body was laid, and, after three prostrations, sat down by it; and announced to the whole court, which had assembled around it, their determination to devote themselves to the flames.

The youngest of the women was the regular wife, and about twenty years of age, and without children; the other was a wife of inferior rank, aged twenty-six, having one

* From the *Asiatic Annual Register* for 1802.

child,

child, a daughter four years old. The fathers and brothers of both were present in the assembly; they made use of the most pressing and affecting entreaties to avert them from their purpose, but without success.

The British resident at Tanjore, having been apprised of the intention of these ladies, and not being able to be personally present at the residence of the late regent, had sent his hircarrah to the spot, with orders to use every possible effort, short of absolute force, to prevent the horrid sacrifice. When the relations of the ladies found their entreaties of no avail to induce them to relinquish their purpose, the hircarrah was sent for; but his threats of the displeasure of government had only a temporary and feeble effect. The Mahratta chiefs observed, that the Company had never interfered in their religious institutions and ceremonies; that the sacrifice in question was by no means uncommon in Tanjore; that it was highly proper to use every art of persuasion and entreaty to induce the women to relinquish their resolution; but, if they persisted in it, force ought not to be used to restrain them. The women laughed at the menaces of the hircarrah, when he told them that their fathers and brothers would be exposed to the displeasure of government. The younger widow observed, that it was not the custom of the English government to punish one person for the act of another; and pointing to her father, who had actually thrown himself at her feet in an agony of grief, asked the hircarrah if he thought any other inducement could alter her resolution when the affliction of her father failed to move it. The young brother of the other widow went into the women's apartments and returned with his sister's child in his arms, which he laid at her feet; but such was the resolution of these astonishing women, that not a single expression of regret, not a sigh or tear could be drawn from them. Any one of these weaknesses would have disqualified them from burning with the body; and the efforts of the relations were strenuously and constantly directed to excite them, but in vain. In answer to an observation of the hircarrah, that if the late regent had been aware of their intention he would have forbidden it, they said they had formed their resolution a year before, and communicated it to him; who, after several ineffectual attempts to dissuade them, had consented to it.

The hircarrah, however, determined to protract the performance of the obsequies, if possible, until the arrival of the resident. The women waited with patience until seven in the evening, taking no other refreshment than a little betel occasionally. They then sent for the hircarrah, and told him that they suspected the cause of the delay, and were resolved, if the procession did not immediately set out, to kill themselves before him. Their relatives now gave up the point in despair. The other chiefs, who had taken no part hitherto, now interfered, and said they had a right to be indulged, and should not be restrained. The hircarrah retired, and the procession set out. The younger and regular wife mounted the pile on which the body of the deceased regent had been placed, and they were consumed together. The fate of the other, who was not entitled to this distinction, was, in appearance, more dreadful. A pit eight feet deep, and six in diameter, had been dug a few yards distant from the pile; it was filled with combustible matter, and fire set to it. When the flames were at the fiercest, fire was applied to the pile in which the young widow and the body of the regent had been enclosed. The other, unsupported, walked thrice round the pit, and, after making obeisance to the pile, threw herself into the midst of the flames, and was no more heard or seen!

V. *Memoir on a new Genus of Mammalia with Pouches, named Perameles. By* E. GEOFFROY*.

THE animals with pouches which first engaged the attention of naturalists are, as is well known, natives of America. They are carnivorous animals, which easily catch their prey by means of their long canine teeth, and divide it by employing their molar teeth, which, are laterally compressed and terminated by three points. Like the apes of the same country, they can make use of their hind feet as a hand, the thumb being at the same distance from the other toes, and suspend themselves by means of their long tail, which is naked and covered with scales. They are more particularly characterized also by being the only mammalia which have ten incisor teeth in the upper jaw and eight in the lower.

Linnæus mentions these animals under the name of the *didelpha*. This denomination, by expressing that they are provided with two matrices, has the advantage of bringing to remembrance one of the most remarkable facts of their organization, the existence of a pouch under the belly of the females, where the gestation begun in the real matrix is in some measure completed.

* From *Annales du Muséum National d'Histoire Naturelle*, no. 19.

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The genus of the *didelpha* was scarcely established when new animals with pouches were discovered in the Indian Archipelago; but at first they were described only in a vague manner. It was however known that the females had their dugs inclosed in a bag, and in consequence of this circumstance naturalists did not hesitate to comprehend these new quadrupeds among the didelpha. It was not till a long time after, that it was known that the marsupials of India differed from those of the new world by important organs, such as those of mastication, digestion, motion, and prehension; but they were then so accustomed to denote them by the same generic name, that they hesitated to make any change; and, as through respect for a usage introduced contrary to rules, they had retained in the genus of the *didelpha* species which were anomalous; they found themselves encouraged after the important discovery of the kanguroos to rank among the latter the didelpha, though they were very remote from it. In a word, as if after so much confusion it had been allowed to venture on any thing, Gmelin admitted into the same genus a quadrumanus fully known as such, which my illustrious master Daubenton published under the name of the *Tarsier*.

In the year 4, I conceived the idea of enabling naturalists to estimate with some precision the distance there is between these different animals, and, in a dissertation which appeared in the 9th volume of the *Magazin Encyclopédique*, I submitted to a sort of revision the last labour of Gmelin in regard to the genus of the *didelpha*.

My first care was to bring this genus to its primitive state. I left none in it but the animals with bags, of America, to which all the characters without exception assigned by Linnæus are applicable. This groupe, deducting three animals, which are placed there under a double point of view, will be carried to nine species by my future publications.

I then proposed to form, under the name of *phalanger*, a genus of the marsupials of the Archipelago of India, which have the upper jaw armed with incisor and canine teeth like the carnivorous animals, and in the lower jaw of which, however, there is found only that system of dentition which characterizes the *rodentia*. Fourteen species, of which almost the half are yet unpublished, unite the characteristic traits of these two great orders, with this difference, that seven of them are endowed with the faculty of leaping from tree to tree, and of flying by means of membranes extended on their flanks; while the other seven, unprovided with these

these membranes, have nothing to facilitate their existence on trees but their tail, with which they can lay hold of any thing, like the didelpha, and which is naked either entirely or in part.

The kanguroos, so remarkable by the disproportion of their extremities, the want of canine teeth and the thumb of the hind feet, formed my third genus; and the fourth was composed of the *daysures*, on which I wrote a paper printed in the third volume of that work.

I flattered myself with the idea that the order of the *marsupials*, which I proposed to establish, would be confined to these four genera. They form a direct and very natural series. By means of the *daysures* and the *didelpha* this series was connected with the carnivorous animals, and by the *phalangers* and the kanguroos it was blended in some measure with the numerous species of the *rodentia*. There was no interruption, no gap, whether we consider in general the organs of mastication and digestion in particular, or attend only to the organs of motion and prehension. But this result, which was so striking that I thought it at the time worthy of remark, was susceptible of being changed by the discovery of a new family; nature, properly speaking, being unacquainted either with continued series or chains in one single direction. Two new genera indeed have destroyed the whole simplicity of this combination. The first is that of the *phascolomes*, the characters of which I have already traced out*, and the second is the new genus, which I now announce under the name of the *perameles* (*blaireau à poche*).

I. *Description of the Genus.*

The perameles are animals which on the first view have a pretty near resemblance to the *didelpha*, but their head is longer and the muzzle much slenderer. They are far also from participating in the habits of these mammalia, and from being able to live on the summits of the largest trees. Their whole economy indicates that they live on the earth: as in the badger, their nose is elongated, their hair stiff, and their feet terminate in large claws almost straight; there is no doubt therefore that they dig for themselves holes, and they do it perhaps with more dexterity than any other animal, as they have no reason to apprehend either that their claws will break or be detached, an advantage for which they are indebted to the form of the last phalangium

* *Annales du Museum d'Histoire Naturelle*, vol. ii. p. 364.

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of the toes, which, like that of the sloth, pangolin, and myrmecophagi, is cleft at the free extremity.

It needs excite no surprise that I should here employ the last character among the number of those which may serve for the determination of the genera, if we recollect the result to which my colleague, Dumeril, was conducted by his learned researches in regard to the different configurations of the unguical bone. It is indeed natural that this small bone which terminates the fingers, and serves as a mould to the corneous matter with which they are covered, should contribute more than all the other parts of the hand to those determinations of animals which are founded on touching.

The feet of the perameles, remarkable by the conformation of the last phalangium, are distinguished also by the combination and numerical arrangement of the fingers in the fore feet: the three middle fingers only can rest on the ground while the animal is walking; those on the sides are so short that they exist only in rudiments, and they are perceived behind the feet only, under the form of a spur.

The hind feet have a great analogy to those of the kanguroo: the fourth finger is the longest and the largest; the second and third are united and enveloped under common integuments. They are distinguished, however, by their claws, which are free; these two fingers are besides shorter and slenderer than the last or the fifth. The character by which the feet of the perameles differ however from those of the kanguroos, is the presence of a thumb, which really exists though it is very short. It is needless, no doubt, to add that this thumb has no nail, since it is one of the distinguishing attributes of all the marsupials.

The organs of mastication appear also in the new family of the perameles, in an order which has never yet presented itself to observation. The canine and molar teeth have indeed a resemblance, in regard to their number, form, and arrangement, to those of the daysures and the didelpha; that is to say, the perameles have four long canine teeth and twenty-eight molar. But the case is not the same in regard to the incisors; for if there be ten in the upper jaw, as in the didelpha, the order is different. The last incisor on each side is very much separated both from those of the same kind before and from the canine tooth behind; and this incisor has besides the form, and discharges the office, of a second canine tooth: it is implanted however in the intermaxillary or incisive bone: moreover in the lower jaw there are only six teeth; a curious anomaly, since this

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is the first time that the combination of ten and six incisors has been met with among the mammalia: the last incisor below is a little broader than the rest, and is half divided by a small groove.

All the marsupials are able, more or less, to assist themselves readily with their tail: on the other hand it does not appear that the *perameles* can employ theirs for any thing; it is too short, is covered with short hair, and is destitute of the faculty of prehension.

Their muzzle, which is much too long, gives them an air exceedingly stupid; but this dismal and disagreeable physiognomy is compensated by the lightness of their motions, and the gracefulness of their gait, since they have the posterior extremities twice as long as those before. I have already remarked that the form of their hind feet has some analogy to that of the kanguroos. This disproportion between the paws gives them a greater similarity: it is indeed so great that I have no doubt that they possess the means as well as the latter of raising themselves on their hind legs, and of using them to take leaps almost as extensive.

In the last place, it is probable that the organs of generation of the perameles, while they exhibit that analogy of form which characterizes all the marsupials, might have afforded some generical differences, but I had no opportunity of examining them.

These considerations, however, on which I have here enlarged, seem to me to require the establishment of a new family of the *perameles*, in the natural order between the didelpha and the kanguroos.

Description of the Species.

This genus hitherto has been composed of two species: that published by Dr. Shaw, under the name of *didelphis obesula*, and another which is new, and to which I have given the name of *nasuta*.

I. *Perameles nasuta.* (Plate I.) The length of the muzzle and nose of this peramele forms its principal character; measured from the extremity of the lips to the root of the tail, its length is 0·45 metre; its head 0·11 metre, and its tail 0·16 metre: its anterior extremities are 0·18 metre, and its posterior 0·16 metre.

Its last incisor, the canine tooth, and the first molar, instead of being contiguous, are very much separated from each other, and hence the great length of the muzzle. The cutting molars are lobed and have three points; those in in the bottom of the mouth, with a broader base and a flat crown, do not seem to have been used: they are furrowed transversally, so that their crown is rough, with several small points, which are the summits of these molar teeth. This observation might give reason to suspect that the *Perameles nasuta* does not supply, like the daysures and the didelpha, the want of flesh by a vegetable regimen, but that this marsupial contents itself with insects; and indeed there is reason to suppose that it forms of them its principal nourishment, its muzzle being too long to fit it with any advantage for combat: its fore feet, which render it so easy for it to dig up the earth when searching for its food, appeared to me to be a proof of it.

The ears of the *Perameles nasuta*, however, are short and oblong, and its eyes are very small. Its hair is moderately thick, more abundant and stiffer on the shoulder, mixed a little with some very thick, and abundance of silky hair, ash-coloured at the root, and fawn-colour or black at the points; the general tint above is of a bright brown colour: the whole lower part of the body is white, and the claws are yellowish; the tail may be sufficiently strong to contribute in the same manner as that of the kanguroos to progressive motion; it is besides of a more decided tint, brown inclining to maroon above, and below of a chesnut colour.

2. *Perameles obesula.* (Plate II.) Though I do not observe that this animal is in any manner fatter than others of the same genus, I have retained the trivial name given to it by Dr. Shaw. In my opinion we cannot be too cautious in changing a denomination consecrated by usage.

I was acquainted long ago, by means of the *Naturalist's Miscellany*, with the figure of the *didelphis obesula*, but I in vain endeavoured to determine its relations. I set out on this research neither by the way of analogy, since this species belonged to none of my genera of the order of the marsupials, nor by the description of Dr. Shaw, since he qualifies the teeth only by the epithet of numerous. I however presumed that this might be the type of a new family; and, under this persuasion, knowing that the *obesula* formed part of the collection of Dr. Hunter, I wrote to England, to Mr. Parkinson, for the information I wished to obtain. I received in return the drawing from which the annexed figure was engraved.

It was therefore only when I saw the first peramele of which I have spoken, that I was able to supply, by conjecture, the ideas which were still wanting, and to ascribe to the *obesula* the teeth of the *nasuta*. I do not think that I have been more deceived by analogy on this occasion than before. The organs of motion are too perfectly similar in the two perameles for the organs of mastication not to be the same. The relation which always exists between them is well known.

The *obesula*, in the proportions of its body, resembles the preceding. The only difference is, that its head is shorter, and, if I can trust the drawing now before me, a little more arched; the ears are broader, and entirely rounded; the hair is also mixed with some of a silky texture, which is blackish at the extremity; the colour in general is yellow, inclining to russet, and the belly is white.

I refer to this species, but with some doubt, an individual in the collection of the Museum of Natural History, which was brought also from New Holland. It came to me in a bad state of preservation, without the tail and some of the toes: it is more than double the size of the *obesula*. It resembles it in its rounded ears, its short muzzle, and the colour of the hair, which inclines, however, a little more to brown; its head also is not so much arched.

I caused the cranium to be engraved, that it might be compared with that of the *nasuta*. The difference in their proportions is striking: the last of the incisors above is much nearer that which precedes it, and the first molars are perfectly triangular and contiguous. Those in the bottom of the mouth have their crown very much worn, which might give reason to believe that this peramele is more carnivorous than the other. The last incisor below is scarcely lobed; the interval which separates it from the canine tooth has only the thickness of one tooth, &c. all characters by which the cranium differs from that of the *Perameles nasuta*.

Explanation of the Plates.

A, the cranium of the *Perameles nasuta*. B, a hind foot. C, a fore foot. D, extremity of the lower jaw. E, extremity of the upper.

VI. *Memoir*

VI. *Memoir on the Tinctorial Properties of the Danaïs of Commerson, a Shrub of the Family of the Rubiaciæ. Extracted from the Flora of Madagascar.* By AUBERT DU PETIT-THOUARS. *Read in the French National Institute**.

BOTANY †, like all the other physical sciences, may be considered under two points of view. In the first, we examine in plants those things which are perceptible to the senses; and, by comparing the differences observed, deduce the means of distinguishing them with certainty from each other. In the second, we endeavour to discover the qualities by which they may be useful to man:—the one is pure botany, the other is the application of botany. Most people who have devoted themselves exclusively to one branch of knowledge, or who have not had an opportunity of acquiring any, being accustomed to judge superficially, value only the second, and consider the first as almost entirely useless. It ought, however, to be considered as the foundation of the second; for as it alone establishes, as we may say, the state of a vegetable, it is by it that we can be assured what plants are capable of giving us that assistance for which we may have occasion. The moment, therefore, that the theoretic botanist seems to attend least to the wants of society, is very often that when he is about to announce an important discovery. Being enabled by an exact synonymy to consult all the books which have been written on the object he examines, he takes advantage of the knowledge of all nations and all periods. In the second place, if the vegetable he examines have escaped the researches of his predecessors, observation enables him to find out the purpose for which it may be employed. The science which he cultivates affords him still another mean

* From the *Journal de Physique*. Brumaire, an 13.

† This is the third memoir of M. du Petit-Thouars read in the Institute since his return. In the first, after a short view of a voyage of ten years to the isles of France, Bourbon, and Madagascar, entirely devoted to the natural sciences, and particularly botany, he gives a brief description of the deserts of Tristan d'Acugna, which are little frequented by navigators. The second is an essay on germination, and the natural relations of the *Cycas*. This interesting memoir forms part of a first number, which the author has published, and which is to be followed by twelve more, destined to make known the new, or little known, genera which he had an opportunity of observing; and which are to be accompanied with dissertations, in the manner of the present one, on interesting points of vegetable physiology. This first number contains also the description and figures of nine plants, which M. du Petit-Thouars considers as forming new genera.

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of interrogating nature; it is the examination of affinities, or the study of natural families; for observation has taught, that, in general, plants which have an external resemblance in their organization, retain it in the immediate principles of which they are composed. The natural classification, therefore, may give reason for conjecturing the virtues of a new plant, but, unfortunately, the labour which could give us any certainty in this respect has not been carried to a sufficient length:—to bring it to perfection would require the complete union of a thorough knowledge of botany and chemistry. Hitherto, therefore, the senses of taste and smell have been almost the only guides for discovering in several families, exceedingly natural, one common principle. In the umbelliferous plants, for example, it is traced from plants the most wholesome and the most commonly used for food, such as the carrot, to those which are aromatic, as fennel, and even to poisonous plants, such as hemlock; one observes in all these plants a particular taste, more or less striking, and which is found in its highest degree in those species accounted poisonous. It even appears that the observation of it is sometimes more certain than the common classifications. It is thus that the *lagacia* could not by these means be separated from the umbelliferous plants, when by its fruit it was referred to them only with doubtfulness: we must therefore hope that botanists will be able to discover a substance common to all these plants, an umbelliferous principle. In a word, there exists one equally striking in the leguminous plants, from which it passes also, but more rarely, from those that are fit to be eaten to those which are poisonous, when it exists in its state of greatest concentration.

But there are several other families which seem to be equally natural, and in which it is difficult to discover a common principle: of this kind are the rubiaceous plants of Jussieu. The signal services derived from a small number of the plants which they comprehend are of a nature so different that it is difficult to deduce a general induction for the rest. Of this kind is madder, the root of which possesses a dyeing quality in so eminent a degree; coffee, the berries of which are so useful; and, in the last place, cinchona, rendered so valuable by the febrifuge qualities of its bark. Though all the plants comprehended in this family have a greater affinity to each other than they have to any other of the vegetable kingdom, it appears itself to be composed of particular groupes or species of sub-families, and each of the plants I have mentioned may be considered as the type

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of one of them. It may be readily seen that the other plants which accompany each of them, either as belonging to the same genus or as its neighbour, participate more or less in the quality on account of which it is employed. Thus it has been found that almost all the *stellatæ* of Ray are tinctorial; almost all the seeds of the neighbouring genera of the coffee shrub, sufficiently large to be torrified with advantage, appear to be of the same nature. The case is the same with cinchona. I have seen the bark of a beautiful *mussenda* of the Isle of France employed as a febrifuge by a physician, one of my friends.

These qualities also are seen to pass from one groupe to another. It is thus that the Indians extract the beautiful red colour of the *chailliver*, which, according to Adanson, was a *hedyotis*, and which Roxburgh has described as an *oldenlandia*. They extract also a red colour from the *royoc* or *morinda*. The cinchonas themselves have given colours. Some of their particular properties have been found also in shrubs which had a very distant relation to them. The *psychotria emetica* approaches near to some of those which have been found to be emetic. The *antirhea* of Commerson, or wood of the *losteau*, participates in the anti-dysenteric quality of the last-mentioned plant. In a word, according to Gærtner and several others, a kind of coffee has been extracted from the seeds of the *aparine*.

Other properties less extensive in one groupe have others analogous to them in another. Thus the pretty species of the mussenda, which Commerson named, after his countryman, *Lalandia stelliflora*, has a relation to the *asperula odorata*. Its dried leaves, like those of that plant, acquire an agreeable odour, on which account they are put among linen: on the other hand, the fetid and cadaverous odour of the *pæderia* is found in the *serissa* of Jussieu, or the *dysoda* of Loureiro, and in the fruit of some kinds of *pyrostria*.

However vague these indications may be, they may serve as guides in experiments; and though one cannot previously assert that a rubiaceous plant possesses any of its properties, one will not be surprised to find them in it. When I was in Madagascar, in 1795, I saw without astonishment the natives of the country extract, from the root of a rubiaceous plant, the red dye they employed for the cloth which they wore of thread, made from the tafia palm. I readily knew it to be a creeping shrub, common in the elevated places of the Isle of France.

On my return to the Isle of France, I proposed to make some experiments in regard to the utility it might be in giving an intense and fixed colour; but having no apparatus, and being unprovided with books which might point out the process I ought to follow, I could only make a few trials, which convinced me of its utility, but they were not sufficient to indicate the method of using it. They exhibited one phænomenon which was very remarkable; it is not however peculiar to this plant, for it is found in another vegetable, but which has so little relation to the one in question, and exhibits it in a part so different, that the conformity itself is still another singularity. But before I describe it I must speak of the plant.

It has been described by Commerson, and is found in his herbals. This naturalist, whose premature death was sensibly felt by all those who cultivate the sciences, besides his knowledge, had a particular instinct in the application of names. Observing that this plant was diœcous by abortion, so that the stamina seemed to be choked by the pistil, he compared it to the Danaides, which put to death their husbands, and thence gave it the name of *Danais;* he was not able to procure any of its fruit. The fruit being the important character of this family, it was impossible for him to determine its place with precision, and Jussieu and Lamarck united it to the *pæderia.* The latter, in his Dictionary, calls it the *odoriferous danais,* because its flowers, according to the remark of de Court, are exceedingly odoriferous, and of a beautiful orange colour. These two naturalists having afterwards procured some of its fruit, found that they had two cells, each containing several seeds, and consequently that it differed from the *pæderia,* which had only two. Having an opportunity of seeing them in all their states, I observed the same thing; and finding also that the seeds were bordered by a membranous circle, I considered it as a species of cinchona: but it appears that there are several peculiar characters in the internal construction of the capsule, and its manner of opening, which renders it necessary to restore the genus of Commerson, and this is confirmed by the difference of appearance; but it ought to be placed between the mussenda and the cinchona, and very near to the latter. I discovered four species which belong to this genus; the present is the only one which I found to possess the tinctorial quality; a description of them here would be misplaced, they will form part of my Flora. I shall at present confine myself to an account of the

the few experiments which I made, to point out the route to some one more successful who may be able to determine the means of employing it.

Having pulled up the roots of this plant, I was much surprised to see them of an orange colour, inclining rather to yellow than to red: the rind was pulpy and succulent. Having cleaned them, I put some pieces of it into spirit or rack extracted from the sugar of the country, which in a little time became charged with a tincture of a very pure yellow. When it appeared to me that it had extracted all it could, I poured it into a saucer; the pieces of the root were then of a beautiful red colour: having poured more rack over them, some more particles of yellow were extracted, but it became still redder, and this colour continued unalterable, though I suffered the liquor to remain over them several days. What I poured into the saucer having evaporated, the residuum was of a very beautiful yellow colour. For want of other means, I contented myself with rubbing it over paper. Being desirous to try whether a pigment proper for water colours could be extracted from it, I mixed it with gum arabic: it spread very well on the paper; I tasted also the extract, it had the bitterness of cinchona in such a degree as gave me reason to hope that it may be rendered of utility in this point of view.

Having tried this root with spirit of wine, I put some of it fresh into pure water. By ebullition the water became charged in like manner with the yellow colouring principle, which it extracted entirely: the root also assumed a red colour, which could no longer be attacked by water. One of my friends had given me a small quantity of a solution of tin in the nitric acid; I poured a few drops of it into the liquor I had obtained, and they precipitated all the colouring parts suspended in it. Having decanted the water, the residuum was of a beautiful yellow colour: I hoped I should obtain from it a kind of Dutch pink; I therefore poured more water over it to wash it, but the water, though cold, took up all the colour: nothing then remained at the bottom of the vessel but oxide of tin exceedingly white.

I learned at Madagascar that the process employed by the natives, and probably from time immemorial, to obtain a red colour, is to boil the root with ashes: I thence presumed that alkalis were its solvent, but at that time I was unable to procure any; I contented myself, therefore, with boiling it in alum; the two colours were then perceptible; the yellow appeared first, and then the red: at first very

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little mixed, but afterwards combined, which formed the colour of a fawn's belly, exceedingly beautiful. These were all the experiments I was able to make. They are sufficient to show the relation between this plant and the carthamus: its flowers give in like manner a yellow colour; and the beautiful red which they produce becomes purer in proportion as it is separated. I wish I could present results more satisfactory; but, being buffeted by circumstances, I was seldom able to carry my plans into execution; and in regard to many other objects I have nothing left but regret: but I easily console myself when I reflect, that I shall be exceedingly happy if I can publish what I have left of ten years' observations made in a field almost new.

Since this memoir was written, having had an opportunity of observing the *asperula tinctoria*, I remarked that its roots exhibit the same colour as those of the *danais*. Having put them into spirit of wine they gave also a yellow colour, but not so pure as that of the *danais*. I obtained the same thing from the *rubia tinctorum*; and I have since learned that it had been observed that these plants give two colours, according as they are treated, which still tends to confirm the analogy I have announced.

VII. *Observations on the Change of some of the proximate Principles of Vegetables into Bitumen; with analytical Experiments on a peculiar Substance which is found with the Bovey Coal. By* Charles Hatchett, *Esq. F. R. S.**

§ I.

One of the most instructive and important parts of geology, is the study of the spontaneous alterations by which bodies formerly appertaining to the organized kingdoms of nature have, after the loss of the vital principle, become gradually converted into fossil substances.

In some cases this conversion has been so complete as to destroy all traces of previous organic arrangement; but in others the original texture and form have been more or less preserved, although the substances retaining this texture, and exhibiting these forms, are often decidedly of a mineral nature. Some, however, of these extraneous fossils (as they are called) retain part of their original substance or principles, whilst others can only be regarded as casts or impressions.

* From the *Transactions of the Royal Society of London for* 1804.

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From the animal kingdom we may select, as examples, the fossil ivory, which retains its cartilage *; the bones in the Gibraltar rock, consisting of little more than the earthy part or phosphate of lime; the shells forming the lumachella of Bleyberg, which still possess the lustre and iridescence of their original nacre; and the shells found at Hordwell in Hampshire, and in Picardy, which are chiefly porcellaneous, but more or less calcined; also the fossil echini and others so commonly found in the limestone, chalk, and calcareous grit of this island, which, although they retain their original figure, are entirely, or at least externally, formed of calcareous spar, incrusting a nucleus of flint or chalcedony. And if, in addition to these, we may be allowed to regard the more recent limestone and chalk strata as having been principally or partly formed from the detritus of animal exuviæ, we shall possess a complete series of gradations, commencing with animal substances anagous in properties to those which are recent, and terminating in bodies decidedly mineral, in which all vestiges of organization have been completely destroyed.

The vegetable kingdom has likewise produced many instances not less remarkable; and it is worthy of notice, that animal petrifactions are commonly of a calcareous nature, while, on the contrary, the vegetable petrifactions are generally siliceous †.

It is not, however, my intention here to enter into a minute discussion concerning the formation of these extraneous fossils; I shall therefore proceed to consider other equally or perhaps more important changes, which organized bodies, especially vegetables, appear to have suffered (after the extinction of the principle of life), by being long buried in earthy strata, and by being thus exposed to the effects of mineral agents.

§ II.

The principal object I have in view is to adduce some additional proofs that the bituminous substances are derived from the organized kingdoms of nature, and especially from vegetable bodies; for although many circumstances seem to lead to the opinion that the animal kingdom has in some measure contributed to the partial formation of bitumen, yet the proofs are by no means so numerous, nor so

* I have also found the cartilage perfect in the teeth of the mammoth.

† Pyrites, ochraceous iron ore, and fahlertz, are also occasionally found in the forms of vegetable bodies.

positive,

positive, as those which indicate the vegetable kingdom to have been the grand source from which the bitumens have been derived. But this opinion (founded upon very strong presumptive evidence), although generally adopted, is however questioned by some persons; and I shall therefore bring forward a few additional facts, which will, I flatter myself, contribute to demonstrate, that bitumen has been, and is actually and immediately formed from the resin, and perhaps from some of the other juices of vegetables.

The chemical characters of the pure or unmixed bitumens, such as naptha, petroleum, mineral tar, and asphaltum, are, in certain respects, so different from those of the resins and other inspissated juices of recent vegetables, that, had the former never occurred but in a separate and unmixed state, no positive inference could have been drawn from their properties in proof of their vegetable origin. Fortunately, however, they have been more frequently found under circumstances which have strongly indicated the source from whence they have been derived; and much information has been acquired from observations made on the varieties of turf, bituminous wood, and pit coal, on the nature of their surrounding strata, on the vestiges of animal and vegetable bodies which accompany them, and on various other local facts, all of which tend considerably to elucidate the history of their formation, and to throw light upon this interesting part of geology.

Some instances have already been mentioned which show that fossil animal substances form a series, commencing with such as are scarcely different from those which are recent, and terminating in productions which have totally lost all traces of organization.

Similar instances are afforded by the vegetable kingdom; but, without entering into a minute detail of every gradation, I shall only cite three examples in this island, namely,

1. The submarine forest at Sutton, on the coast of Lincolnshire, the timber of which has not suffered any very apparent change in its vegetable characters*.

2. The strata of bituminous wood (called Bovey coal) found at Bovey, in Devon; which exhibits a series of gradations, from the most perfect ligneous texture, to a substance nearly approaching the characters of pit coal, and, on that account, distinguished by the name of stone coal.

3. And lastly, the varieties of pit coal, so abundant in

* Account of a submarine Forest on the East Coast of England, by Dr. Correa de Serra. Phil. Trans. for 1799, p. 145.

many

many parts of this country, in which almost every appearance of vegetable origin has been destroyed.

The three examples abovementioned appear to form the extremities and centre of the series; but as, from some local circumstances, the process of carbonization and formation of bitumen has not taken place in the first instance, and as these effects have proceeded to the ultimate degree in the last, it seems most proper that we should seek for information, and for positive evidence, in the second example, which appears to be the mean point, exhibiting effects of natural operations, by which bitumen and coal have been imperfectly and partially formed, without the absolute obliteration of the original vegetable characters; and, although I have selected the Bovey coal as an example, because it is found in this country, we must recollect that similar substances, or strata of bituminous wood, are found in many parts of our globe; so that the example which has been more immediately chosen is neither rare nor partial*.

The nature, however, of the various kinds of bituminous wood may in some respects be different: but this I have not as yet had the means of ascertaining; I shall therefore only state the facts resulting from experiments made on Bovey coal, and more especially on a peculiar bituminous substance with which it is accompanied. But, before I enter into these particulars, it will be proper to mention a very remarkable schistus with which I was, some months since, favoured by the right honourable Sir Joseph Banks.

§ III.

This schistus was found by Sir Joseph, in the course of his tour through Iceland, near Reykum, one of the great spouting hot springs, distant about twenty-four English miles from Hafnifiord; but circumstances did not permit him to ascertain the extent of the stratum.

The singularity of this substance is, that a great part of it consists of leaves, which are evidently those of the alder, interposed between the different lamellæ. I do not mean mere impressions of leaves, such as are frequently found in many of the slates, but the real substance, in an apparently half-charred state, retaining distinctly the form of the leaves and the arrangement of the fibres.

The schistus is light, brittle, of easy exfoliation; in the transverse fracture earthy, and of a pale brown colour; but,

* Strata of bituminous wood are found in various parts of France, in the vicinity of Cologne, in Hesse, Bohemia, Saxony, Italy, and especially in Iceland, where it is known under the name of surturbrand.

when

when longitudinally divided, the whole surface constantly presents a series of the leaves which have been mentioned, uniformly spread, and commonly of a light gray on the upper surface, and of a dark brown on the other; the fibres on the light gray surface being generally of a blackish-brown, which is also the colour assumed by the schistus when reduced to powder.

The leaves appeared to be in the state of charcoal, by being extremely brittle, by the blackish brown colour, by deflagrating with nitre, by the manner of burning, and by forming carbonic acid. I was, however, soon convinced that the substance of these leaves was not complete charcoal, but might more properly be regarded as vegetable matter in an incipient state of carbonization, which, although possessed of many of the apparent properties of charcoal, still retained a small portion of some of the other principles of the original vegetable.

My suspicion was excited, partly by the odour produced during combustion, which rather more resembled that of wood than that of charcoal, and partly by the brown solution formed by digesting the powder of the unburned schistus in boiling distilled water; for by various tests I ascertained that the substance thus dissolved was not of a mineral nature. In order, however, fully to satisfy myself in this respect, I digested 250 grains of the pulverized schistus with six ounces of water.

The liquor was, as before, of a dark brown colour.

It had but little flavour.

Prussiate of potash, muriate of barytes, and solution of isinglass, did not produce any effect; nitrate of silver formed a very faint cloud; sulphate of iron was slowly precipitated, of a dark brownish colour; and muriate of tin produced a white precipitate.

A portion of the solution, by long exposure to the air, was partially decomposed; and a quantity of a brown substance was deposited, which could not again be dissolved in water.

Another portion was also evaporated to dryness, and afforded a similar brown substance, which was only partially soluble in water; and the residuum, in both of the above cases, was found to be insoluble in alcohol and in ether.

When burned it emitted smoke with the odour of vegetable matter.

250 grains of the schistus afforded about three grains of the above substance; and, when the properties of the aqueous

aqueous solution are considered, such as its partial decomposition, and the deposit which it yielded by exposure to air, and by evaporation; the insolubility of this deposit when again digested with water, alcohol, or ether; the smoke and odour which it yielded when burned; and the precipitates formed by the addition of sulphate of iron and muriate of tin to its solution; when these properties, I say, are considered, there seems much reason to conclude, that the substance dissolved by water was vegetable extract, which had apparently suffered some degree of modification, but not sufficient to annul the more prominent characteristic properties of that substance.

The powder of the schistus which had been employed in the preceding experiment, was afterwards digested in alcohol during two days; and a pale yellow tincture was thus formed, which, by evaporation, left about one grain of a yellow transparent substance, possessing the properties of resin.

It appears, therefore, that a substance very analogous to vegetable extract, and a small portion of resin, remain inherent in the leaves of this remarkable schistus.

As solution of isinglass did not produce any effect, there was reason to conclude that the aqueous solution abovementioned did not contain any tannin; but, as the tannin might be combined with the alumina of the schistus, I digested a portion of it in muriatic acid, which, after filtration, was evaporated almost to dryness, leaving, however, the acid in a slight excess. This was diluted with water, and afforded a blue precipitate with prussiate of potash, a yellowish precipitate with ammonia, and a white precipitate with muriate of tin, but not any with solution of isinglass. The tannin which might have been contained in the recent vegetable appears therefore to have been dissipated or decomposed, with the greater part of the other vegetable principles, excepting the woody fibre reduced to the state of an imperfect coal, and the small portions of extract and resin which have been mentioned.

Previous to having made the analysis, I had an idea that this schistus might be a lamellated incrustation, formed by the tufa of the hot springs; but, according to Mr. Klaproth's analysis*, the tufa of Geyser is composed of,

Silica - -	98
Alumina - -	1.50
Iron - - -	50
	100.

* *Beiträge; Zweiter band,* p. 109.

It

It is therefore very different from the schistus, the component ingredients of which were ascertained by the following analysis.

Analysis of the Schistus from Iceland.*

A. 250 grains, by distillation, yielded water, which, in the latter part of the process, became slightly acid and turbid, = 42.50 grains.

B. The heat was gradually increased, until the bulb of the retort was completely red hot. During the increase of the heat, a thick brown oily bitumen came over, which weighed 7.50 grains; it was attended with a copious production of hydrogen, carbonated hydrogen, and carbonic acid, the whole of which may be estimated at 23.75 grains.

C. The residuum was black, like charcoal, and weighed 176.25 grains; but, being exposed to a strong red heat in a crucible of platina, it burned with a faint lambent flame, and was at length reduced to a pale brown earthy powder, which weighed 122 grains; so that 54.25 grains were consumed.

D. The 122 grains were mixed with 240 of pure potash; and, as some particles of charcoal remained, 50 grains of nitre were added, and the whole was strongly heated, during half an hour, in a silver crucible. The mass was then dissolved in distilled water; and muriatic acid being added to excess, the liquor was evaporated to dryness, and was again digested with muriatic acid much diluted; a quantity of pure silica then remained, which, after having been exposed to a red heat, weighed 98 grains.

E. The liquor from which the silica had been separated was evaporated nearly to dryness, and added to boiling lixivium of potash; after the boiling had been continued for about one hour, the liquor was filtrated, and a quantity of oxide of iron was collected, which amounted to 6 grains.

F. Solution of muriate of ammonia was added to the preceding filtrated liquor; and the whole being then heated, a copious precipitate of alumina was obtained, which, after having been made red hot, weighed 15 grains.

Carbonate of soda caused the preceding liquor (after the separation of alumina) to become slightly turbid, but not any precipitate could be collected.

* The remaining specimens are now in the British Museum, and in the collection of the Right Honourable Charles Greville.

By

By this analysis, 250 grains of the schistus afforded,

		Grains.
Water - - -	A.	42.50
Thick brown oily bitumen	B.	7.50
Mixed gas (by computation)	B.	23.75
Charcoal (by computation)	C.	54.25
Silica - - -	D.	98
Oxide of iron - -	E.	6
Alumina - - -	F.	15
		247.

But the water and vegetable matter must be regarded as extraneous; and if they are deducted, the real composition of the schistus is nearly as follows.

Silica - -	82.30
Alumina - -	12.61
Oxide of iron -	5
	99.91

It evidently, therefore, belongs to the family of argillaceous schistus, although the proportion of silica is more considerable than has been found in those hitherto subjected to chemical analysis.

This schistus has not been noticed by von Troil, nor by any of those who have written concerning Iceland; for the slate which was sent to Professor Bergmann by the former, and which is mentioned by the latter in one of his letters, is there expressly stated to be the common aluminous slate containing impressions*.

§ IV.

From the experiments which have been related, we find that the leaves contained in the Iceland schistus, although they are apparently reduced almost to the state of charcoal, nevertheless retain some part of their original proximate principles; namely, extract and resin. This, of itself, is

* Letters on Iceland, by Uno von Troil, p. 355.

Mr. Faujas St. Fond has, however, described a schistus nearly similar, which is found near Roche-Seauve, in the Vivarais. The stratum extends about two leagues; and the only difference is, that, according to Mr. St. Fond, the schistus at Roche-Seauve is of the nature of marle, or, as he terms it, argillo-calcareous, whereas this of Iceland is undoubtedly argillaceous. From Mr. St. Fond's account, it does not appear that the vegetable leaves contained in the schistus of Roche-Seauve have been chemically examined. *Essai de Géologie*, par B. Faujas St. Fond, tome i. pp. 128 and 134.

undoubtedly a remarkable fact; but if it were unsupported by any other, the only inference would be, that the schistus was most probably of very recent formation, and had been produced under peculiar circumstances.

I was desirous, therefore, to discover some similar cases which might serve as additional corroborative proofs of the gradual alterations by which vegetable bodies become changed, so as at length to be regarded as forming part of the mineral kingdom; and from the reasons which have been stated in the commencement of this paper, as well as from a certain similarity in the external characters of the substance composing the leaves abovementioned with those of the Bovey coal, I was induced to make this last also a subject of chemical inquiry.

In the Philosophical Transactions for the year 1760 *, some remarks on the Bovey coal, and an account of the strata, are stated, in a letter from the Rev. Dr. Milles to the Earl of Macclesfield. The object, indeed, of the author was to establish that this and similar substances are not of vegetable but of mineral origin; and, to prove this, he adduces a great number of cases, most of which, however, in the present state of natural history and of chemistry, must be regarded as proving the contrary; whilst others, mentioned by him, such as the Kimmeridge or Kimendge coal, are nothing more than bituminous slates, and of course are of a very different nature.

Dr. Milles's account of the varieties of the Bovey coal, and of the state of the pits at that time, appears to be very accurate; and for the present state, or at least such as it was in 1796, I shall beg leave to refer to a paper of mine, published in the fourth volume of the Transactions of the Linnean Society †; for, as this is more immediately a chemical investigation, I wish to avoid, as much as possible, entering into any minute detail of geological circumstances.

It may however be proper to observe, that the Bovey coal is found in strata, corresponding in almost every particular with those of the surturbrand in Iceland described by von Troil ‡ and by Professor Bergmann §. The different strata of both these substances are likewise similar, being composed of wood or trunks of trees, which have completely lost their cylindrical form, and are perfectly flattened,

* Vol. li. p. 534.

† Observations on bituminous Substances, p. 138.—See also Parkinson's Organic Remains of a former World, vol. i. p. 126.

‡ Von Troil's Letters, p. 42.

§ *Opuscula* Bergmanni, tom. iii. *De Productis Volcaniis*, p. 239.

as if they had been subjected to an immense degree of pressure *.

The Bovey coal is commonly of a chocolate-brown, and sometimes almost black. The quality and texture of it are various in different strata: from some of these it is obtained in the form of straight flat pieces, three or four feet in length, resembling boards, and is therefore called Board coal. Others have an oblique, wavy, and undulating texture, and, as Dr. Milles observes, have a strong resemblance to the roots of trees, from which, most probably, this sort has in a great measure been formed.

Some kinds also appear to be more or less intermixed with earth; but that which produces the most powerful and lasting fire is called stone coal: it is black, with a glossy fracture; has little or none of the vegetable texture; is more solid and compact than the others, being almost as heavy as some of the pit coals, the nature of which it seems very nearly to approach.

For chemical examination I selected some of the coal

* Bergmann, in the dissertation above quoted, accurately describes this appearance of the surturbrand, and then says, "Quæ autem immanis requiritur vis, ut truncus cylindricus ita complanetur? *Nonne antea particularum nexus putredinis quodam gradu fuerit relaxatus?* Certe, nisi compages quodammodo mutatur, quodlibet pondus incumbens huic effectui erit impar. Ceterùm idem observatur phænomenon *in omni schisto argillaceo.*" This is certainly a very curious fact; and the learned Professor, with his usual acuteness, rejects the idea that mere weight can have been the cause. As a further proof also, he afterwards observes, "Orthoceratitæ, quæ *in strato calcareo conicam figuram perfectè servant,* in schisto *planum fere triangulare compressione efficiunt.* Idem valet de piscibus, conchis, insectisque petrefactis." And again, "Observatu quoque dignum est, quod *idem reperiatur effectus, quamvis stratum calcareum sub schisto collocatum sit, et majori ideo pondere comprimente onustum.*" *De Productis Volcaniis*, p. 240. It is evident, therefore, that weight alone has not produced this effect; and Bergmann's idea, that the solidity of the vegetable bodies may have undergone some previous change, in the manner of incipient putrefaction, by moisture, and by becoming heated in the mass, must be allowed to be very probable. But bodies such as shells could not be thus affected; and therefore they must have been exposed to some mechanical effect peculiar to argillaceous strata; which effect, however, from the circumstances which have been adduced, evidently could not have resulted from the mere pressure of the superincumbent strata. To me, therefore, it seems not very improbable that, together with a certain change in the solidity of vegetable bodies, produced in the manner imagined by Bergmann, and, together with some degree of superincumbent pressure, a real and powerful mechanical action has been exerted, by the contraction of the argillaceous strata, in consequence of desiccation; this, I believe, has not hitherto been much considered; but I am inclined, from many circumstances, to attribute to it a very great degree of power.

 which

which had a wavy texture, and rather a glossy fracture; the quality of this sort being apparently intermediate between the others, as it retains completely the marks of its vegetable origin, while, at the same time, it possesses every perfect character of this species of coal.

A. 200 grains of the Bovey coal, by distillation, yielded,

		Grains.
1. Water, which soon came over acid, and afterwards turbid, by the mixture of some bitumen		60
2. Thick brown oily bitumen - - - - -		21
3. Charcoal - - - - - - - -		90
4. Mixed gas, consisting of hydrogen, carbonated hydrogen, and carbonic acid,	estimated at	29
		200.

The charcoal, in appearance, perfectly resembled that which is made from recent vegetables. By incineration, about 4 grains of yellowish ashes were left, which consisted of alumina, iron, and silica, derived most probably from some small portion of the clay strata which accompany the Bovey coal. But it is very remarkable, that neither the ashes obtained from the charcoal of the Bovey coal, nor those obtained from the leaves of the Iceland schistus, afforded the smallest trace of alkali*.

B. 200 grains of the Bovey coal, reduced to powder, were digested in boiling distilled water, which was afterwards filtrated and examined; but I could not discover any signs of extract, or of any other substance.

C. 200 grains were next digested with six ounces of alcohol, in a very low degree of heat, during five days. A yellowish-brown tincture was thus formed, which, by evaporation, afforded a deep brown substance, possessing all the properties of resin, being insoluble in water, but soluble in alcohol and in ether; it also speedily melted when placed on a red hot iron, burned with much flame, and emitted a fragrant odour, totally unlike the very unpleasant smell produced by burning the coal itself, or by burning any of the common bituminous substances. The quantity, however, which could be extracted from 200 grains of the coal,

* This, as far as relates to the Bovey coal, has been also noticed by Dr. Milles. Phil. Trans. vol. li. p. 553. But wood, however long submerged, is not deprived of alkali, unless it has more or less been converted into coal; for I have, since the reading of this Paper, made some experiments on the wood of the submerged forest at Sutton, on the coast of Lincolnshire, and have found it to contain potash.

by

by alcohol, was but small, as it did not exceed 3 grains. But this small quantity was sufficient to prove, that although the Bovey coal does not contain any vegetable extract, like the schistus formerly mentioned, yet the whole of the proximate principles of the original vegetable have not been entirely changed; as a small portion of true resin, not converted into bitumen, still remains inherent in the coal, although the bituminous part is by much the most prevalent, and causes the fetid odour which attends the combustion of this substance.

Upon a comparison of the general external characters of the Bovey coal with those of the substance which forms the leaves contained in the Iceland schistus, a very great resemblance will be observed; and this is further confirmed by the similarity of the products obtained from each of them in the preceding experiments, with the single exception that the leaves contain some vegetable extract, which I could not discover in the Bovey coal. They agree however in every other respect; as they both consist of woody fibre in a state of semicarbonization, impregnated with bitumen, and a small portion of resin, perfectly similar to that which is contained in many recent vegetable bodies; and thus it seems, that as the woody fibre, in these cases, still retains some part of its vegetable characters, and is but partially and imperfectly converted into coal, so, in like manner, some of the other vegetable principles have only suffered a partial change. Undoubtedly there is every reason to believe that, next to the woody fibre, resin is the substance which, in vegetables passing to the fossil state, most powerfully resists any alteration; and that, when this is at length effected, it is more immediately the substance from which bitumen is produced. The instances which have been mentioned corroborate this opinion; for the vegetable extract in one of them, and more especially the resin which was discovered in both, must be regarded as part of those principles of the original vegetables which have remained, after some other portions of the same have been modified into bitumen.

The smallness of the quantity of resin obtained in both the preceding cases by no means invalidates the proof of the above opinion; but, as an additional confirmation of it, I shall now give an account of a very singular substance, which is found with the Bovey coal.

[To be continued.]

VIII. *On the Use of Green Vitriol, or Sulphate of Iron, as a Manure; and on the Efficacy of paring and burning depending partly on Oxide of Iron.* By GEORGE PEARSON, *M. D. Honorary Member of the Board of Agriculture, F. R. S. &c. &c. &c.**

I TAKE leave to lay before this honourable Board an account of a substance as a manure which I find, on examination, is one of the things hitherto universally believed to be a poison to vegetables. Having ascertained that this substance is what is commonly known by the name of vitriol of iron (the sulphate of iron of the chemists), inveterate opinion prevented me for some time from accepting the testimony of it as a manure; but feeling the weight of the respectable evidence by whom it was attested, after consideration I perceived that the fact in question was not at variance with established principles of vegetable philosophy, as I shall, I think, make appear in this communication.

My friend John Williams Willaume, esq. of Tingrith, in Bedfordshire, having desired his brother, Charles Dymoke Willaume, esq. to ask my opinion of a saline substance collected from peat, which has been used with profitable consequences as a manure in his neighbourhood, I proposed a set of queries to Mr. John W. Willaume, the answers to which, in the two following copied letters, comprehend the evidence I have to offer.

LETTER No. I.—*To Dr. Pearson, from C. D. Willaume, Esq.*

MY DEAR SIR,

I received the inclosed last Saturday, and hope the answers to your queries will be satisfactory, and tend to elucidate this curious subject. Though the answers under the article *dust* only relate to your queries, yet my brother has thought proper to advert to the *ashes*, which you conceive to be a *caput mortuum*; but which have been used as, and have been supposed to be, a beneficial manure from time immemorial. I have reserved a piece of the peat from which the ashes are produced, and if you would wish to analyse it, I will send it you. Favour me with the result of your future inquiries on this subject; and I am,

My dear sir, yours very sincerely,

C. D. WILLAUME.

Walham Green,
Aug. 24, 1801.

* A communication to the Board of Agriculture.

LETTER

LETTER No. II.—*From John W. Willaume, Esq. to C. D. Willaume, Esq.*

Queries proposed by Dr. Pearson.

1. How long has the salt of peat been used?
2. How much per acre is laid on?
3. On what kind of lands?
4. The effects of it on vegetation?
5. Whether it is mixed with dung manure, or lime?
6. In what parts of the country has it been employed?
7. Any other facts which can be collected relative to the use of this substance?

In answering the above queries, I shall divide the subject into three articles: 1st, The peat considered as an object of fuel: 2d, The ashes: 3d, The salt of peat, or dust: the two last as objects of manure.

1. *Peat.*

The peat, which is found after the removal of the turf or exterior surface to about a spade's depth, has long been known as an article of fuel. It is, however, used only by cottagers, who burn it on a brick hearth: it has been rejected from the parlour, the kitchen, the brewhouse, &c. as being injurious to grates, and to all sorts of vessels put on it; it cannot be employed in the roasting of meat, as it will impart a disagreeable taste; and it is destructive of all sorts of furniture by the effluvia which it emits, or by the dust or ashes which may chance to be blown from it. If these disagreeable consequences could be obviated, it might be made an article of general consumption as a substitute for coal, much to the advantage of the seller and consumer: it is dug out in the form of a brick to a certain depth, well known to the common labourer. This depth must be carefully attended to, lest you should cut out the staple, in which case it would never be retrieved; but, this circumstance attended to, it will grow again to its former state in the space of fifteen years. Thus the whole moor is divided into proper portions, and periodically cut once in fifteen years.

2. *Ashes.*

The turf or surface, and such parts of the peat as do not appear to be of the best quality, are laid up in considerable heaps and reduced to ashes by the action of fire. The ashes are red.

Answer to Queries.

1. The ashes have been long known as a manure, and the demand is on the increase.

2. The quantity usually laid on an acre, by spreading or sowing it, is fifty bushels, either on grass or arable land.

3. It is laid on hot land. By hot land we understand sandy, gravelly, chalky soils of a dry nature, such as are burnt up on the long continuance of hot weather. It is most commonly used for grasses; but is in considerable esteem as a manure for oats or barley, on land of the nature abovementioned.

4. The vegetable effect is surprising, inasmuch as it will double or treble a crop of any new sown grass, such as trefoil, &c. I have seen the benefits arising from it on old pasture land much overgrown with moss, which it effectually destroys, and produces in its stead white or Dutch clover. You may trace to an inch the cessation and recommencement of this manure. It is observable, that near the fire-heaps, as far as the wind can carry the lighter parts of the ashes, the production of clover is sure to be abundant: it is equally favourable to the growth of barley or oats.

5. It is not mixed with lime, or any other manure.

6. These ashes are bought by a set of higglers, who carry them in bags loaded on asses to a considerable distance, where they are known to be in great repute; they must come excessively dear to the consumer by this mode of conveyance. The farmers in the vicinity send for them in waggons, particularly Mr. Brumiger, near Sundon, in Bedfordshire, a considerable and intelligent farmer, who increases his consumption every year, both for his grass and arable land.

3. *The Salt of Peat, or Dust.*

Answer to Queries.—1. The dust or gray saline substance is produced by beating the earth containing this salt to a powder; it is found in particular spots, not universally, the earth not being equally impregnated with it in all places: it has not been known as a manure above six years; but on trial greatly increases in reputation and demand.

2. Fifty bushels are the proper quantity per acre. This should not be exceeded, for if it be laid on in too great abundance it may prove extremely deleterious.

3. It is used for cold lands. By cold lands we understand clayey, or any wet grounds.

4. It will much improve the vegetation of sowed grasses and

and old pasture, and is equally favourable to the production of corn; the ground, whether grass or arable, being of a cold nature.

5. It is not mixed with lime, or any other substance.

6. The dust is likewise bought by the higglers, and carried to great distances. The nearer farmers likewise send for the dust in waggons, particularly Mr. Anstie, of Dunstable Houghton, and Mr. Smith, of Sundon, who hold this manure in great esteem.

Yours, &c.

Tingrith,
Aug. 19, 1801.

J. W. WILLAUME.

Dr. PEARSON's *Experiments, Observations, and Remarks, on the Substance called Salt of Peat, or Dust.*

1. It is a blackish gray, coarse, and rather heavy powder. Has no smell; tastes strongly styptic; readily dissolves in the mouth; did not deliquesce on exposure to the air.

2. Dissolves in four times its weight of water of the temperature of sixty degrees of Fahrenheit, and in twice its weight of boiling hot water, giving a pale green coloured solution, with a trifling sediment, which is insoluble in muriatic acid.

3. To the solution (2) I added a little liquid prussiate of vegetable alkali in a perfectly neutral state, which occasioned immediately a most abundant precipitation of prussiate of iron; and this test was added gradually, till no further precipitation took place.

4. Into the decanted and filtrated fluid (3) was poured liquid caustic volatile alkali, but without inducing any change.

5. Into the same fluid (3) was poured liquid carbonate of vegetable alkali, which produced a scarcely perceivable cloudy appearance.

6. Into the solution (3) was dropped the aqueous solution of muriate of baryt, which occasioned immediately a milky appearance.

7. To the solution (3) I added the oxalic acid, and turbidness ensued.

8. A little of the powdery substance, called the salt of peat, with concentrated sulphuric acid, produced no emission of fumes, nor smell.

9. The solution (2) with muriate of baryt, immediately grew thick and white as cream.

10. The solution (2) with carbonate of potash, deposited a very

a very copious greenish sediment; and the same effect ensued with caustic volatile alkali.

11. The solution (2) with oxalic acid, gave instantly a very turbid blueish green precipitation.

The preceding experiments manifested that the peat salt consists of sulphate of iron, vulgarly called green vitriol of iron, mixed with a very minute proportion of siliceous earth, and of lime united either to sulphuric acid or to carbonic acid. But the presence of the earths magnesia and argil; the uncombined alkalis; the uncombined acids; are by these experiments excluded. In short, the salt of peat is almost pure sulphate of iron.

REMARKS.

1. The salt of peat is, I apprehend, deposited by evaporations which run over the moors where it is found; and hence I should expect many of such waters to be strongly impregnated with it, and in many parts the soil to be tinged red and yellow by ochre. Very likely* on inquiry much iron pyrites will be found on or near the moors.

2. The quantity spread on land is said to be fifty bushels per acre, which I estimate at 2,250 pounds avoirdupoise; this will give near seven ounces and a half per square yard, If a larger quantity be applied, it is observed it will prove extremely deleterious. This is true also of every other manure, such as lime, alkaline salts, marine salt; nay, of the dung of animals; for if they be used in certain quantities they poison plants instead of promoting their growth. This is equally true in the animal kingdom; for there is not an article taken as food, or as seasoning, which is not a poison if taken in certain quantities. A human creature may be poisoned or alimented by beef or pudding, according to the quantity of them taken into the stomach. He may be poisoned or have digestion greatly assisted by salt or pepper, according to their quantity. In brief, the vulgar notion of the term *poison* is erroneous: for by it is conceived that substances so called are in their nature positively destructive of life; but the truth is, that the most virulent poisons are, in all reason and fact, only deleterious according to the quantity applied. White arsenic, swallowed in the quantity of ten grains or less, will destroy life; but in the quantity

* "This is," says Mr. Willaume, "exactly the fact. This sulphate of iron, the salt of peat, during the heat of the summer is frequently found in a crystallized state, very white, and crackling under the feet; but is deliquescent in that form, and turns to its former dark colour when the air becomes moist."—*Note by Mr. J. W. Willaume.*

of

of one-sixteenth of a grain, it is as harmless as a glass of wine; and further, in that dose is a remedy for inveterate agues.

From these considerations I conclude, that there is no admissible contradictory evidence to the testimonies for the fertilizing effect of sulphate of iron, unless by such contravening evidence the quantity stated to be used exceed fifty bushels per acre; it being an established fact, that in certain proportions this metallic salt is a poison to plants.

This discovery of Mr. Willaume will, I think, give new light, so as to explain fully the *rationale* of the improvement of land by the burnt earth and ashes from paring and burning. It is usual to account for the effects of this process, by referring to supposed alkaline or other salts; but of these there is no evidence; nay, on trial I have not detected them, or at least not in any efficient quantity; but this I know, that such earth and ashes contain oxide of iron, and as I suspect of manganese; which from the analysis, and the effect of salt of peat, must now be admitted into the class of manures. This very communication of Mr. Willaume affords evidence of the truth of this conjecture; for the ashes of the peat which affords the salt "have been long known as a manure, and the demand is on the increase:" of course, these ashes contain an unusual quantity of oxide of iron. A consequence of this reasoning is, that the burnt earth of soils will, *cæteris paribus*, fertilize in proportion to the oxide of iron it contains. Accordingly, the ashes of the peat, says Mr. Willaume, have a surprising effect; they "will double or treble a crop of any new sown grass, such as trefoil, &c.": they are so beneficial, that, in spite of the expence, they are carried in bags by higglers to great distances. It would be extending this paper beyond the proposed limits, to reason at greater length, and to make a further induction of facts; therefore I will close with asserting, that the more I contemplate the facts in Mr. Willaume's letter, the more evidence I perceive for the truth, that metallic salts and metallic oxides in general, and salts and oxides of iron in particular, are manures, if applied in proper doses.

I do not think it is within the design of this paper to make observations on the answers to the 2d, 3d, 4th, 5th, and 6th queries, except once for all, desiring that it may be understood that I consider the salt of peat, and the ashes of peat, as operating in promoting vegetation analogous to seasoning, or condiments, taken with the food of animals; that is, analagous to mustard, cinnamon, ginger, &c. which are

are not of themselves at all or necessarily nutritious, but contribute to render other things nutritious by exciting the action of the stomach and other organs of digestion and assimilation. I have no doubt of the truth of the proposition, that no living thing, neither plant nor animal, can grow and live in a state of visible action without constant supplies of matter which has been alive; in other words, living animals and vegetables can only live on dead animals and dead vegetables. No plant nor animal has ever been known by experience, nor in the nature of things does it seem reasonable, that they can be nourished by mere water and pure air, as some persons have asserted.

I shall make a very few remarks on the other two substances which are the subject of Mr. Willaume's letter.

2. *The Peat.*

The peat is a dense mass of vegetable matter for a certain depth, partly in a dead and partly in a living state, with which is mixed more or less earth, and in burning it affords so much empyreumatic oil as to give a disagreeable taste to roasted provisions; hence, as we are told, it has been rejected from the kitchen. This fuel affords a vast quantity of what the chemists call *lignic acid*; hence it is rejected also from the parlour, as very destructive to the grates. I beg to suggest that this lignic acid might be saved in burning the peat as fuel, and be used for various purposes in manufactures; and the charred peat may be used in place of charcoal of wood. Probably, too, other useful products will be found, on examining the matters more accurately which are afforded by distillation.

3. *Ashes.*

If the peat were mere vegetable matter, the ashes afforded by it would be as trifling as those of wood; but some parts of the moor contain so much earth and oxide of iron as to leave behind, on burning, a considerable quantity of incombustible matter; and such kind of peat, we are told, is not used as fuel; but, after burning, the residuary matter is an efficacious manure, much more so than is commonly afforded by paring and burning. The ashes are more red and more fertilizing than ashes of common turf, because they contain more iron.

The spontaneous springing up of white clover, in land manured with these ashes, is similar to the spontaneous growth of this plant on heath land which has been covered with lime to destroy all its present vegetation; and this fact shows that probably these are seeds buried in the earth for many ages, which yet remain alive, but do not grow until exposed to the stimuli of air, water, calorific, and lifeless animal or vegetable matter.

APPENDIX.

The following facts, lately discovered by most respectable chemists, appear to be worth adding to the preceding memoir, as they serve to show that other salts, besides sulphate of iron, and certain earths, may be employed advantageously as manures, although, like iron, they have been esteemed deleterious to plants.

1. *Ashes of Pit Coal are a good Manure for Grass.*

My much valued friend, the Rev. Wm. Gregor, of Grampound, on examination of the ashes of coal from Liverpool, found them to contain both sulphate of magnesia and sulphate of lime, especially the former, salt. I apprehend that these ashes also contain oxide of iron, or perhaps sulphate of iron. These ashes, says Mr. Gregor, *skeaded** over grass apparently produced good effects notwithstanding the sulphate of magnesia, which I was well assured they contained. (See Nicholson's Journal, vol. v. p. 225.)

From this observation of Mr. Gregor, it seems he is aware of the prevailing popular opinion, that sulphate of magnesia is not favourable to vegetation; and to reconcile his fact with the unfriendly nature of magnesia to plants, as discovered by Mr. Tennant, he observes that the effects of sulphate of magnesia may be very different from those of magnesia and carbonate of magnesia. I apprehend it is the magnesia (calcined magnesia) only which this learned chemist found hurtful to vegetables, as the discovery was made on the examination of Nottingly lime, which the farmers near Doncaster employ as a manure, while they reject the lime of their own neighbourhood. In the latter Mr. Tennant met with magnesia, and in the former none. (See the account of this important discovery in the Philosophical Transactions.)

2. *The Earth from Ashes called Cinis, is a durable and efficacious Manure: by Professor* MITCHILL, *of New York, one of the Representatives in Congress. Addressed to Dr.* PEARSON.

Dr. Mitchill, in a letter addressed to me on cinis, or earth found in the ashes of wood, has made some observa-

* From σκεδάω.

tions

tions relative to the preceding memoir, which seem worthy of notice.

"Ashes of wood contain very commonly sulphate of potash, also phosphoric acid, besides other well known salts; but after these salts are separated by lixiviation, there remains a peculiar earth and a small proportion of iron. This earth differs from lime, baryt, magnesia, strontian, or any other known species of earth. I would call it *cinis*, for plentiful, common, and important as it is, science has not dignified it with a name. To judge of the excellence of this earth as a manure, after all the salts are extracted from soap-boilers' ashes, the earth sells for ten cents the bushel; and, notwithstanding this high price, it is not unusual for the farmer to pay for the article twelve months beforehand. When ploughed into steril ground, at twelve loads per acre, it produces great crops of wheat, clover, and other sorts of grass and grain, and its fertilizing operation will last twenty years. Although some of the other ingredients of the ashes left after lixiviation may prove beneficial, yet the effects are chiefly from the cinis, or new named earth.

"This earth, which is so prized in America as a manure, was esteemed of old in Asia as an ingredient in a cement: among the antient Syrians it was one of the materials forming the plaster of their walls; and, as it holds an intermediate place between lime and potash, it can easily be conceived how it may act both as a cement and a manure. It is to be hoped chemists will turn their attention to this important subject." (See Tilloch's Philosophical Magazine, vol. vii. p. 273, for the whole of this interesting letter.)

3. *Several metallic Salts promote Vegetation, shown by the Experiments of Professor Barton, of Philadelphia.*

Letter from BENJAMIN SMITH BARTON, *M. D. Professor of Medicine in the College of Philadelphia, to Dr.* PEARSON, *containing Experiments with metallic Solutions to determine their Effects on Plants.*

SIR, Philadelphia, Oct. 28, 1802.

In the *Annals of Medicine* for the year 1801, you inform us that you have lately read a paper at the Board of Agriculture "containing an account of the effects of a saline body collected from peat as a most powerful manure, which turns out to be sulphate of iron; a substance, you remark, hitherto considered to be a poison to plants." This piece of intelligence gave me much satisfaction. I have, for some years, been engaged in an extensive series of experiments relative

relative to the effects of various stimulating articles, such as camphor, &c. upon vegetables; and on the absorption of certain powerful mineral substances into the organic system of vegetables. In numerous instances I have subjected the stems and leaves of plants, young and old, large and small, to the influence of the sulphates of iron and copper. I have found that both of these metallic salts are very greedily absorbed by vegetables, insomuch that I have detected the presence of iron in the vessels of a branch of mulberry, at the height of five or six feet above the place of immersion, in a solution of the sulphate of this metal. A full account of my experiments I design to communicate to the public in two memoirs. Permit me to observe in the meanwhile, that the sulphate of iron applied to vegetables in the manner I have mentioned "is only (to use your own words) a poison, like almost every thing else, from the over-dose." In several of my experiments the branches of vegetables that were placed in vessels containing solutions of the sulphate of iron and copper, lived longer and exhibited more signs of vigour than similar branches that were placed in equal quantities of simple water. It is true, that in many other experiments these metallic salts proved fatal to my plants; but this was when I employed too large a dose. In like manner I had found, several years ago*, that camphor, by greatly stimulating, often kills vegetables; and yet, when properly dosed, this is a very wholesome stimulant to plants. I had also found that large doses of nitre (which is unquestionably a powerful stimulant, both with respect to animals and vegetables) produce an appearance like genuine gangrene in the leaves of vegetables; and yet it is certain that nitre, when it is judiciously dosed, may be made to greatly assist the healthy vegetation of plants.

Excuse the liberty I have taken in troubling you with these few loose hints, and permit me to subscribe myself,

Sir, your very humble and obedient servant, &c.

To Dr. Pearson. BENJAMIN SMITH BARTON.

4. *Sulphate of Iron in the Peat of Russia, found by Professor Robinson.*

Something else besides vegetable matter is necessary to form peat or black moss of the moors. The smell of burning peat is different from that of vegetable matter. Peat ashes, says the professor, always contain a very great pro-

* See Transactions of the American Philosophical Society, vol. iv. no. 27.

portion

portion of iron: he has seen three places in Russia where there is superficial peat moss, and in all of them the vitriol is so abundant as to effloresce. In particular, on a moor near St. Petersburgh, the clods show the vitriol (sulphate of iron) every morning when the dew has evaporated. According to this learned professor's observation, the sulphate of iron in pit coal may be accounted for in the following manner:—"Peat mosses form very regular strata, lying, indeed, on the surface; but if any operation of nature should cover this with a deep load of other matter, it would be compressed and rendered very solid; and, remaining for ages in that situation, might ripen into a substance very like pit coal. (See the Medical and Chirurgical Review for November 1803.)

5. *Mr. Anstey's Testimony of the Use of Peat Dust and Peat Ashes.*

SIR, Houghton Regis, Dec. 3, 1801.

I received yours, dated the 18th of November last, in which you requested me to inform you what experiment I had made from the turf dust taken from Tingrith Moor. I have made use of the ashes and dust near thirty years, and I frequently lay on from eighty to a hundred bushels per acre. Our land is dry, and very thin stapled, owing to the chalk rock laying so very near the surface: it encourages vegetation in moist warm weather; but when hot and dry, the reverse. We never mix any other manure with it. It costs about fourpence per bushel, including all expenses.

We chiefly spread it on our seed grass, clover, &c.

I am, sir, your humble servant,

JOS. ANSTEY.

IX. *Biographical Anecdotes of* CHARLES HUTTON, *L.L.D. F.R.S.*

THIS gentleman, so much distinguished by his abilities, is a native of Newcastle-upon-Tyne, where he was born about the year 1737. At an early age he was placed at a school in that town, where he soon made a rapid progress; and about the eighteenth year of his age, having lost his parents, who, though in the humbler ranks of life, were always respectable, he endeavoured to provide for himself by commencing country school-master. His first establishment in this line was at the village of Jesmond, about

about two miles from Newcastle, where he remained some years; during which he improved himself by close study, reading all the mathematical and other books he was able to purchase.

About the year 1760, Mr. Hutton removed to Newcastle, where he had a better opportunity of displaying his talents to advantage, and where he gave extraordinary proofs of the progress he had made, by the solution of several curious and difficult questions in various periodical publications; and particularly in the Ladies' Diary, in his own name, and in Martin's Magazine of Sciences, under the signature of *Tonthu*, being the letters of his name transposed. The first of Mr. Hutton's separate publications was a little work on arithmetic, for the use of schools, first printed at Newcastle in 1764. It has already gone through ten large editions; and in printing the first, to supply the want of proper mathematical types, which at that time could not be procured in Newcastle, Mr. Hutton was obliged to cut with a pen-knife, on the reversed end of old types, many of the algebraical characters used in the vulgar fractions and other parts of the work.

Mr. Hutton employed his evenings in composing a large work on mensuration, which came out in quarto numbers, the last of them in the year 1770. It was printed at Newcastle. This work met with a very favourable reception, and a second edition, with improvements, was published at London in 1788, large octavo. Mr. Hutton soon gave another proof of his genius and industry, by a republication of all the useful parts of the Ladies' Diaries, from the commencement in 1704 to that of 1773. This work was given to the public, in parts or numbers, quarterly, beginning in July 1771, and ending in July 1775, forming altogether five volumes, viz. two volumes of the poetical parts, and three of the mathematical. These extracts were accompanied with numerous notes and illustrations, which supplied the defects in the original solution of the questions. Each number contained also a few sheets of new mathematical correspondence, of original essays, questions, &c. making one volume, in which the contributions of the editor himself made a considerable portion, but under various fictitious names. About the years 1771 and 1772, Mr. Hutton was employed by the magistrates of Newcastle to make an accurate survey of the town and county of Newcastle-upon-Tyne, which he did with great correctness. This plan was soon after engraved and published in a map consisting of two very large sheets, with an abridged

account

account of the history, trade, and population of that place.

The old bridge of Newcastle being borne down by a very high flood on the 17th of November 1771, which raised the waters in the river about nine feet higher than the usual spring tides,—this accident gave rise to so many absurd notions among the people in regard to the arches of bridges, that Mr. Hutton conceived that a demonstration of the relation between the more essential parts of bridges might be of great utility to such architects and builders as might have mathematical knowledge sufficient to enable them to comprehend the theory of arches. In a few months, therefore, he composed, and published at Newcastle, a very learned and useful little book, entitled " The Principles of Bridges, &c.," 1772, 8vo. As this tract had been out of print for many years, the author was induced, in consequence of being consulted on the project of a new bridge for the improvement of the port of London, to give a new edition of it. This edition, as the author thought, was very illiberally and unfairly attacked in the Monthly Review for March 1802; and he consequently wrote a very able and masterly reply to the reviewer, which was published in the Monthly Magazine for August the same year.

About this period the health of Mr. John Lodge Cowley, professor of mathematics at Woolwich, having so much declined that he could no longer attend the duties of his office, the master-general and principal officers of the Board of Ordnance, came to the resolution of permitting him to retire. His successor was to be appointed by competition; and the gentlemen made choice of to examine the candidates were the ablest mathematicians that could be found, viz. the Rev. Dr. Horsley, now bishop of St. Asaph, the Rev. Dr. Maskelyne, astronomer Royal, Colonel Watson, chief engineer in the service of the East India Company, and Mr. Landen, well known by his publications on mathematical subjects. The candidates were in number seven or eight; but Mr. Hutton, who had repaired to London for the purpose of competing on this occasion, was the person whom the examiners thought it their duty more particularly to recommend, on account of the very able manner in which he had answered all the proposed questions.

In consequence of the advantage which Mr. Hutton acquired by his new situation at Woolwich, he entered upon a new and severe course of study, with a view of qualifying himself better for the important task he had undertaken,

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and for the execution of some new works which he had projected.

The first publication which he engaged in after this period was the Ladies' Diary, to which for many years he had been an useful contributor. On his arrival in London, he was informed of the death of the last compiler, and a few days after the future management of this favourite work was confided to his judgment and industry, by the Stationers' Company, with increased emoluments.

For several years after his settling at Woolwich, Mr. Hutton employed part of his time in writing accounts of mathematical and philosophical books for the reviews published monthly in London. The same year that he removed to Woolwich he was elected a fellow of the Royal Society, to the Transactions of which he was afterwards a valuable contributor. The first of his papers published in that work was "A new and general method of finding simple, and quickly converging series, by which the proportion of the diameter of the circle to its circumference may be easily computed to a great number of figures," printed in the Transactions for 1776. The second was "A demonstration of two remarkable theorems mentioned in a former article of the Transactions," published also in the same year, 1776. The next was a paper, in the year 1778, "On the force of fired gun-powder, and the initial velocities of cannon-balls, determined by experiments; from which is also deduced the relation of the initial velocity to the weight of the shot, and the quantity of the charge of the powder." This paper contains the account and calculation of a great number of curious experiments with cannon-balls, made at Woolwich, in the year 1775, by the author and other ingenious gentlemen; and so sensible were the Society of the value of this communication, that Mr. Hutton was honoured with the prize medal of that year. Soon after, he was elected one of the council, and appointed Latin secretary for conducting the foreign correspondence, vacated by the election of Mr. Maty to the reading secretaryship.

In the Transactions of the same year appeared "An account of the calculations made from the survey and measures taken at Schehallien, in order to ascertain the mean density of the earth." The determination of the mean density of the earth was an important problem proposed by the Society, and the survey and measurements for this purpose were taken at the hill of Schehallien, in Perthshire, in the years 1774, 1775, and 1776, by the direction, and partly under the inspection, of Dr. Maskelyne,

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the astronomer royal; after which the Society entrusted to Mr. Hutton the important charge of making the calculations, and drawing the proper conclusions from them. The result was, that the mean density of the earth was found to be in proportion to that of the hill of Schehallien, as 9 to 5, so that when the actual density of the hill shall be ascertained, the real density of the earth will in some measure be determined.

The year following, Dr. Hutton gave another paper, as a supplement to the preceding, which contained "Calculations to determine at what point in the side of the hill its attraction will be greatest." The next communication, which was in the year 1780, was a long tract on cubic equations, and this was followed, in 1783, by "A project for a new division of the quadrant." This was the last of his communications to the Transactions, as, it seems, a stop was put to his usefulness in this way by a misunderstanding between him and the Society, in consequence of which he resigned his office in the year 1784.

Soon after, that is in 1786, Dr. Hutton published a volume of mathematical and philosophical tracts, in quarto, containing a number of curious papers, which would probably have appeared in the Philosophical Transactions had not the before-mentioned misunderstanding taken place. One of these tracts consists of "New experiments in artillery for determining the force of fired gun-powder; the initial velocity of cannon-balls; the ranges of pieces of cannon at different elevations; the resistance of the air to projectiles; the effect of different lengths of cannon, and of different quantities of powder," &c. These experiments were made in the years 1783, 1784, and 1785.

Besides these, Dr. Hutton has given to the public several other useful and ingenious works on mathematical subjects; as, in 1781, a folio volume, containing "Tables of the products and powers of numbers," published by order of the Commissioners of Longitude:—In 1785, "Mathematical tables of the common hyperbolic and logistic logarithms; also sines, tangents, and secants, versed sines, both natural and logarithmic, with several other tables useful in mathematical calculations; to which is prefixed an original history of the discoveries and writings relating to these subjects;" a second edition of this work was printed in 1794:—In 1786, "The compendious measurer; being a brief yet comprehensive treatise on mensuration and practical geometry; with an introduction to decimal and duodecimal arithmetic, adapted to practice and the use of schools."

This

This is chiefly an abridgment of his large work on mensuration, and has since gone through several editions:—In 1787, in one volume 8vo, "Elements of conic sections, with select exercises in various branches of military mathematics and philosophy, for the use of the Royal Military Academy, Woolwich." This volume, which consists chiefly of practical exercises for the use of the cadets at the Academy, was ordered to be printed by the Duke of Richmond, then master-general of the ordnance; and on this occasion Dr. Hutton had the honour of being presented to the king, and of kissing his majesty's hand.

In 1796, Dr. Hutton published, in two large volumes, in quarto, his "Mathematical and philosophical dictionary," an useful and laborious work, replete with curious and original matter. It has been said that one article alone in it, namely, that on algebra, occupied no less than two years of the author's time, in reading all the treatises on the same subject to collect the materials and arrange them.

In 1798 appeared, "A new course of mathematics," in two volumes, composed, and more especially designed, for the use of the gentlemen cadets in the Royal Military Academy, Woolwich. In this work the author has condensed into two octavo volumes, of a middling size, a great variety of useful matter, and the subjects, though mostly elementary, are treated in a novel manner, with great neatness, precision, and even elegance.

In 1799 our author had the honour of being presented with a diploma of Doctor of Laws by the University of Edinburgh, and he has since been elected honorary member of several learned academics and societies both in Europe and America.

X. *On Pithing Cattle**.

The method of killing cattle by dividing the spinal marrow, with a view to lessen or prevent entirely the suffering of the animal, was introduced at Mr. Mellish's slaughtering-houses by the laudable perseverance of Lord Somerville and other members of the Board of Agriculture, and Mr. Mellish found the flesh of the beasts so killed equally good, if not better, than the flesh of those slaughtered in the usual way. And as the operation is performed quietly, and without alarm to the animal, all bruises are avoided, and such

* From Plymley's *General view of the Agriculture of Shropshire.*

 are

are not very uncommon in forcing them into a proper position to receive the stroke when they are to be knocked down. A butcher at Wisbech practised this mode several years ago, from the representations made to him by captain Clarkson, of the navy, who had seen them so slaughtered for the use of our fleet when at Jamaica. After this person's death, Mr. Smith, a butcher of the same place, adopted the same method, and in the year 1796 I procured, by favour of Mr. Clarkson (whose name accords so well with any question of humanity), the following account, which he had from Mr. Smith.—"Mr. Smith informed me, that he kills all his bullocks by striking them in the spinal marrow. If a line were drawn from ear-root to ear-root (at about an inch and half distance from the horns), and the centre of this line were found, this centre would be the place where the knife should enter. The knife is not in the form of a dagger, nor is it thrust in with any force. It is rather larger than a common penknife, but the blade is permanently fixed to the handle. The handle is taken into the hand, and the forefinger goes down it towards the point, merely to direct it. The person using the knife takes hold of one ear of the beast with his left hand, and with the right he strikes it with the knife. In the same instant the bullock drops, and is out of sensation of any pain. He informs me, that it is not once in a thousand times that any person misses the right place; perhaps an apprentice may at the beginning, but the rule is so certain that it may be said hardly ever to fail, and if it should fail, the knife is at any rate so near the proper place, that by the least alteration of the position (without even taking it out) it finds its way. In this case there would hardly be the pain of two seconds. I was obliged to leave Wisbech before the killing-day, or I would have seen this method practised. I talked to Smith's apprentice, who assured me that he had no difficulty in finding the proper spot, and that the beast drops instantly. Though Smith kills in this manner, no other butcher of Wisbech follows the example. He says, however, that the practice obtains pretty universally on the Lincolnshire bank of the Humber, as at Barton and several other places. Calves, sheep, pigs, &c. are killed by Smith in the same manner. I saw three sheep that had been skinned, and were hanging up in his shop, which had been killed by his apprentice in this way. He showed me the small hole on the back of the head, or neck, which the knife had made."

Plausible, however, as these experiments are, I believe now that they proceeded upon a mistaken principle; or rather,

rather, that the operation did not accord with the principle, so far as tenderness towards the animal is concerned: for though a beast is managed completely by this mode, it is not so certain that his sense of feeling is destroyed. The contrary indeed seems proved by the meritorious pains taken by Mr. Du Gard, of the Shrewsbury Infirmary, who has shown in the following communication, that though the spinal marrow was divided, the nerves that supplied the organs of respiration and most of the senses were uninjured. Mr. Du Gard's experiments were communicated to Mr. Everard Home, of London, and by him, through sir Joseph Banks, to the Board. Mr. Home afterwards sent lord Carrington the valuable paper that follows Mr. Du Gard's, in which he has suggested a mode of performing the operation which would answer completely, could we be sure of having operators sufficiently skilful. We may the less regret the difficulty in getting new modes established, when we thus see the superiority of an old custom under very improbable circumstances; and if well-meant reformers wanted any additional motives to care and circumspection, a very forcible one is furnished in the instance of the time and trouble taken to introduce this operation, and which, as it has been hitherto practised, is the very reverse of what was intended.

Observations and Experiments on Pithing Cattle. By THOMAS DU GARD.

"The subject of slaughtering cattle by puncturing the medulla spinalis, with a view of superseding the method generally practised in England, has lately engaged the attention of the Agricultural Board, and been strongly recommended by them.

"It is, I believe, universal in Portugal and other parts of the continent, as well as in some of our West India islands, but is only of late introduction into this country.

"Pain and action are so generally joined, that we measure the degree of pain by the loudness of the cries and violence of the consequent exertion; and therefore conclude, on seeing two animals killed, that the one which makes scarcely a struggle, though it may continue to breathe, suffers less than that which is more violently convulsed and struggles till life is exhausted.

"It appears, however, that there may be acute pain without exertion, perhaps as certainly as there is action without pain; even distortions that at the first glance would seem to proceed from pain, are not always really accompanied with sensation.

"To constitute pain, there must be a communication between the injured organ and the brain.

"The heart of a viper pulsates after being taken out of the body; and that pulsation is increased if it be goaded with a pin. Limbs suddenly separated from the human body sometimes start and twitch for a few moments. The viper cannot be said to *feel* pain on its heart being pricked with a pin: nor would any man who saw his own finger contract from electricity or heat, after it was cut off, fancy *it* suffered pain. The pain in both instances is in the part only from whence the separation took place.

"Perception, and the power of exertion, are derived from the brain in the skull and back-bone. That part which lies in the skull seems principally to supply our senses and appetites with nervous energy; and that part which lies in the spine, and is called marrow, is more particularly appropriated to the action of the large locomotive muscles.

"An injury to the skull not sufficient immediately to take away life, often leaves the patient with the power of moving his limbs, though without any feeling or perception, lying in a profound apoplectic sleep.

"On the contrary, an injury to the spine leaves the power of perception perfect, though the limbs are immoveable; but as life depends more on the functions of the brain and of the lungs, than on the spinal marrow and its dependent locomotive muscles, the animal feels and lives longer on its sustaining a given injury in the spinal marrow than on a fracture or concussion of the head*.

"J. B.

* That perception may remain in the head, and respiration be continued after the division of the medulla spinalis, will be evident to any one who consults the anatomy of those parts.

In the human subject, the par vagum, or eighth pair of nerves, arises from the corpora olivaria of the medulla oblongata, and passes out of the cranium through the foramena lacera into the neck, thorax, and abdomen, sending off branches to the tongue, larynx, pharynx, lungs, and abdominal viscera.

Cuvier, in his *Leçons d'Anatomie comparée*, after stating the course of this nerve in the human subject, observes also,

"Dans les mammifères.

"Cette distribution du nerf vague étoit à-peu-près la même dans quatre ou cinq espèces de mammifères sur lesquèls nous avons fait des recherches à cet égard. Le *veau* seul nous a offert une particularité que nous avons indiquée à l'article du nerf facial; mais les anastomoses avec le grand sympathique, les nerfs récurrens, les plexus cardiaques et pulmonaires ne

nous

"J. B. fell in the summer of 1801 from a load of hay; he was bled, and brought to the infirmary at Shrewsbury, which, being my residence, gave me hourly opportunities of examining him: *he complained of great pain in the upper and back part of his neck,* but of none lower down: he had not the power of using the least motion with any of his limbs. His arms, body, and legs, were all quite insensible to any pain or feeling from pricking or pinching, and therefore all sensation below the injured part of the spine was destroyed. In this state he languished a week, being apparently in full possession of the feelings and faculties of his mind, and of his senses of hearing, sight, smell, and taste. He took food for two or three days, though the power of retaining or protruding his evacuations was lost. On examining the neck after death, the second cervical vertebra was found fractured.

"On reflecting on this case it occurred to me, that a *dumb* animal, if reduced to the state of this poor man, would not have the power of expressing the pain it endured, for J. B. had great pain *above* the injured part, though all power of moving, as well as feeling, was destroyed below; and in the brute creation, we judge of pain by the muscular efforts of the animal. I therefore, by means of a dagger, punctured the spinal marrow of a cow according to the new method of slaughtering, and having divided it as much as possible after she fell, reduced her to the same state as the poor man whose case I have related. The animal breathed with freedom, and perception in the head continued, as was evinced by the eyelids closing on the approach of my hand, till the butcher struck a blow near the horns, when her breathing ceased, and the eye became fixed with immediate death.

"In all the experiments I have hitherto tried, the animal has suddenly dropped, and has been slightly convulsed, but has not died immediately. In sheep, after puncturing the medulla spinalis in the new way, I have seen their eyes close and open on the approach and withdrawing of my hand, for twenty times successively, and the pupil as much contracted as in health, till I was anxious to terminate their misery by having the blood-vessels of the throat divided.

nous ont présenté de différence que dans le nombre des filets, ce qui peut dépendre de l'addresse du prosesteur des espèces que nous avons desséquées sont le *chien*, le *raton*, le *corbon*, le porc-épic."

I have examined the head and neck of a sheep killed by the puncture, and found the par vagum uninjured.

From the loss of blood their eyes have then soon become dilated and insensible.

"In the old method of slaughtering, a concussion of the brain takes place, and therefore the *power of feeling* is destroyed. The animal drops, and although convulsions take place generally longer and more violent than when the spinal marrow is divided, yet there is, I think, reason to believe that the animal suffers less pain.

"The *immediate* consequence of the blow is the dilatation of the pupil of the eye, without any expression of consciousness or fear on the approach of the hand.

"In this state of insensibility, which in man would be called apoplexy, or extreme stupor, the blood is always drawn off by the butcher cutting the throat, and the animal dies without the least sign of feeling or uneasy faintness.

"In severe epilepsy the brain suffers a temporary suspension of power, in many respects very similar to the concussion of the brain from a blow, only that the convulsions and expressions of pain seem greater: yet the patients uniformly agree, that they do not recollect any pain; the reason is obvious, the disease is a suspension of the power of feeling.

"From all these circumstances I conclude that the new method of slaughtering cattle is more painful than the old. The puncture of the medulla spinalis does not destroy feeling, though it renders the body quiescent; and in this state the animal both endures pain at the punctured part, and suffers, as it were, a second death, from the pain and faintness from loss of blood in cutting the throat, which is practised in both methods."

Copy of a Letter from EVERARD HOME, *Esq. to Lord* CARRINGTON.

"MY LORD,

"I had the honour of presenting to your lordship, through sir Joseph Banks, some experiments and observations made by a surgeon at Shrewsbury, to show that the mode adopted in this country, of killing animals by wounding the spinal marrow, is less humane than the more common one of knocking them down.

"I have, at your lordship's request, repeated these experiments, and find the results agree with those of the author of the paper in every respect; but the want of success appears to arise entirely from the operation having been performed in a very imperfect manner.

"On

"On Thursday the 15th of July 1802, the following experiment was made at Mr. Giblet's, in Bond-street: A very fine ox was pithed, as it is termed, by Benjamin Bartholomew, who has performed this operation more than twenty different times, and is considered to be very expert in the mode of doing it. I begged that he would take some pains, so as to do it in the most effectual manner.

"The instrument he used was in the shape of a bricklayer's trowel, made sharp at the point, and having a guard at the shoulder, to prevent the blade from being buried in the neck.

"He plunged it, with great dexterity, into the canal containing the spinal marrow, and the animal instantly dropped, but the breathing continued, the motions of the eye and eye-lids were perfect, and the whole face lost no part of its animation.

"This being ascertained by observation for ten minutes, and the animal not being sufficiently quiet to admit of the throat being cut, it was knocked on the head, and every appearance of animation in the countenance immediately ceased, and the breathing stopped.

"The spinal marrow was afterwards examined: it was found completely divided, but too low in the neck, the wound having been made one inch and a half below the origin of the nerves that supply the diaphragm.

"That a division of this part of the spinal marrow does not deprive an animal of life, has been known to anatomists for many years; and the causes of its failure cannot be better explained than by extracting an account of some experiments made by Mr. Cruickshank, in the year 1776, at which I was present, and gave my assistance. They are published in the 85th volume of the Philosophical Transactions.

"*Experiment* VI. *April* 19, 1776.—I divided the spinal marrow of a dog, between the last vertebra of the neck and first of the back. The muscles of the trunk of the body, but particularly those of the hind legs, appeared instantly relaxed; the legs continued supple, like those of an animal killed by electricity. The heart, on performing the operation, ceased for a stroke or two, then went on slow and full, and in about a quarter of an hour after the pulse was 160 in a minute. Respiration was performed by means of the diaphragm only, which acted very strongly for some hours. The operation was performed about a quarter of an hour before twelve at noon; about four in the afternoon the pulse was ninety only in a minute, and the heat of the body

body exceedingly abated, the diaphragm acting strongly, but irregularly. About seven in the evening the pulse was not above twenty in a minute, the diaphragm acting strongly, but in repeated jerks. Between twelve at night and one in the morning the dog was still alive: respiration was very slow, but the diaphragm still acted with considerable force. Early in the morning he was found dead. This operation I performed from the suggestion of Mr. Hunter. He had observed in the human subject, that when the neck was broke at the lower part (in which cases the spinal marrow is torn through), the patient lived for some days, breathing by the diaphragm. This experiment showed that dividing the spinal marrow at this place, on the neck, if below the origin of the phrenic nerves, would not for many hours after destroy the animal; it was preparatory to the following experiment.

"*Experiment* VII. *April* 26.—I divided the par vagum and intercostal nerves, on both sides, in a dog. Soon after, I performed on the same animal the operation of the last experiment, and the same symptoms took place. His respirations were five in a minute, and more regular than in Experiment III.; the pulse beat 80 in a minute. Five minutes after, I found the pulse 120 in a minute, respiration unaltered; at the end of ten minutes, the pulse had again sunk to 80 in a minute, respiration as before; at the end of fifteen minutes, the pulse was again 120, respiration not altered. The operation was performed about two in the afternoon, at Mr. Hunter's in Jermyn-street. At three-quarters of an hour after five, the respirations were increased to fifteen in a minute; the pulse beating 80 in the same time, and very regularly: the breathing seemed so free, that he had the appearance of a dog asleep. At a quarter before eight, the pulse beat 80, respirations being ten in a minute. At three-quarters of an hour after ten, respiration was eight in a minute, the pulse beating 60. The animal heat was exceedingly abated: I applied heat to the chest, he breathed stronger, and raised his head a little, as if awaking from sleep. At half after twelve Mr. Hunter saw him; the breathing was strong, and twelve in a minute, the heart beating forty-eight in the same time, slow, but not feeble. He shut his eyelids when they were touched; shut his mouth on its being opened; he raised his head a little, but as he had not the use of the muscles which fix the chest, he did it with a jerk. Mr. Hunter saw him again between four and five o'clock in the morning; his respirations were then five in a minute, the heart beating

beating exceedingly slow and weak. We suppose he died about six in the morning, having survived the operation sixteen hours. This experiment I made from the suggestion of Mr. Hunter, with a view to obviate the objections raised against the reasoning drawn from the three first experiments. It was urged, that though by these experiments I had deprived the thoracic and abdominal viscera of their ordinary connexion with the brain, yet, as the intercostals communicated with all the spinal nerves, some influence might be derived from the brain in this way. This experiment removed also the spinal nerves, and consequently this objection.

"As I found by the two last experiments that dividing the spinal marrow in the lower part of the neck did not immediately kill, although instant death was universally known to be the consequence of dividing it in the upper part of the neck, I expressed my surprise to Mr. Hunter, that the spinal marrow should, according to modern theory, be so irritable in the one place, and so much less so in the other.

"He told me, that from the time he first observed that men who had the spinal marrow destroyed in the lower part of the neck lived some days after it, he had established an opinion, that animals who had the spinal marrow wounded in the upper part of the neck did not die from the mere wound, but that in dividing it so high we destroyed all the nerves of the muscles of respiration, and reduced the animal to the state of one hanged; whereas, in dividing it lower, we still left the phrenic nerves, and allowed the animal to breathe by his diaphragm. If this opinion be well-founded, though dividing the spinal marrow in the lower part of the neck does not kill instantly, whilst the phrenic nerves are untouched, yet, if I divide the phrenic nerves first, and then divide the spinal marrow in the lower part of the neck, the consequence, I said, will be the same as if I had divided it in the upper part.

"*Experiment* VIII.—By detaching the scapulæ of a dog from the spine and partly from the ribs, I got at the axillary plexus of nerves on both sides from behind. I separated the arteries and veins from the nerves, and passed a ligature under the nerves close to the spine. I thought I could discern the phrenic nerves, and instantly divided two considerable nerves going off from each plexus. The action of the diaphragm seemed to cease, and the abdominal muscles became fixed, as if they had been arrested in expiration, the belly appearing contracted. His respirations were now about

about twenty-five in a minute, the pulse beating a hundred and twenty. As I was not willing to trust the experiment to the possibility of having divided only one of the phrenics (which I afterwards found was really the case), and some different nerve instead of the other, after carefully attending to the present symptoms I divided all the nerves of the axillary of each side. The ribs were now more elevated in respiration than before; respirations were increased to forty in a minute, the pulse still beating a hundred and twenty in the same time. Finding that respiration went on very easily without the diaphragm, in about a quarter of an hour after dividing the axillary plexus of each side I divided the spinal marrow as in Experiment VI. The whole animal took the alarm; all the flexor muscles of the body seemed to contract, and instantly to relax again: he died as suddenly as if the spinal marrow had been divided in the upper part of the neck.

"Having explained the causes of failure in the present mode of pithing animals, it becomes necessary to state, that when the operation is properly performed, its success is complete. Of this I will mention the following instances:

"A small horse was killed in this manner, that a cast might be made of its muscles in their natural state of action. The animal was allowed to stand upon a pedestal, and the operation was performed by Mr. Hunter, with a large awl: the breathing ceased instantaneously, and the animal was so completely dead as to be supported by the assistants, without making the slightest struggle, and was fixed in the position in which he stood, without ever coming to the ground*.

"A dog was killed so instantaneously in the same way, by Mr. Hunter, that Mr. Clift, the conservator of the Hunterian Museum, who held the legs, and did not see the awl introduced, was waiting till the animal should struggle, and had no knowledge of any thing having been done, till he was told to let go, and was surprised to find that the animal was completely dead.

"In these operations the instrument was small, and directed by the skill of an anatomist upwards into the cavity of the skull, so as to divide the medullary substance above the origin of the nerves which supply the diaphragm.

"By adopting this method of performing the operation of pithing cattle, it will be attended with the same success."

* The cast of this horse has a place in the Hunterian Museum

XI. *Memoir on the Natural History of the Coco-nut Tree and the Areca-nut Tree; the Cultivation of them according to the Methods of the Hindoos; their Productions, and their Utility in the Arts and for the Purposes of domestic Economy. By M.* Le Goux de Flaix, *an Officer of Engineers, and Member of the Asiatic Society at Calcutta.*

[Continued from our last volume, p. 332.]

The usual product of one coco-nut tree in India, a country where provisions of every kind are extremely low, is about six shillings per annum. This produce is no doubt considerable. There is no tree in any part of the world which in this respect is equal to it, if we reflect on the small space which the coco-nut tree occupies: if it be considered also that various kinds of leguminous and gramineous plants, and even fruit-trees, can be cultivated under its shelter; that it scarcely requires any care or expense; and that all its parts are useful, as will be shown in this memoir.

It is well known that the fibrous covering of the coco-nut is converted into good ropes, which are useful in navigation, and for various purposes on shore. Cables for anchors made of this substance are much better than those made of hemp. They are exceedingly elastic, stretch without straining the vessel, and scarcely ever break; inappreciable advantages, which are not possessed by those of hemp. They are also lighter, and never rot, in consequence of their being soaked with sea water. They never, like those of hemp, exhale damp miasmata, exceedingly hurtful to the crews of ships who sleep on the same deck where these ropes are kept when ships are under sail. To all these advantages must be added, that ropes made of the *kuer* * float like wood, that they are much easier managed, and run better in the pulleys during nautical manœuvres.

The utility of the second covering of the coco-nut is so well known in Europe that it is needless for me to speak of it here.

The palms of this tree, when entire, are employed to make mats for sleeping upon. When split through the middle, according to the length of the foot-stalk, they are wove into mats for covering sheds and houses. The use of these mats, even for the largest edifices, is general on the coast of Malabar. Such roofs are more agreeable than those made

* The name given by the Hindoos to the fibrous covering of the coconut.

of

of straw. They do not attract rats and reptiles like the latter; and they are lighter, equally strong and durable, and much less exposed to danger in the case of fire. If fire happen to fall on a roof of this kind, which consists of two leaves placed one over the other, it can burn only a small surface, and is prevented from spreading for want of aliment. It may therefore be said that the coco-nut tree, which in the fields defends the wearied Indian by its shade from the scorching rays of the sun, protects the peaceful farmer in the night from the long and heavy rains of the monsoons.

The liquor of the coco-nut, when it is yet tender, is an agreeable and cooling beverage; its kernel, when newly formed, is sweet, and exceedingly pleasant to the taste. Both of them are salutary to persons afflicted with the scurvy. It would be dangerous, after long sea voyages, to make immediate use of them: instead of being beneficial, they would produce pernicious consequences.

When the coco-nut has attained to maturity, it detaches itself from its stalk and falls spontaneously; but its fall might be dangerous, and to prevent accidents the bunch is cut by the chana some days sooner than the period at which it attains to complete maturity. When the nut is rasped with a circular-teethed piece of iron, there is extracted from it a kind of milk or emulsion, by mixing with it a small quantity of boiling water and then straining it through a piece of thin cloth in the same manner as those do who extract milk of almonds.

This emulsion is employed for different purposes: it is used for preparing saloop and sago. When put into coffee, instead of cream, it gives it an exquisite taste: that of our almonds produces nearly the same effect. This emulsion is employed also in the art of painting chintzes; to remove stains of the colours, and scour the cloth after the colours have been applied. The milk of the coco-nut, though oily, effervesces with an acid extract of that plant called by the Hindoos *colechi*, and the acid then precipitates it into a grayish lime, which becomes of a rich violet colour by the addition of fixed alkali; it is with this colour that cotton cloth and chintzes are dyed. When this emulsion is mixed with quicklime the alkali becomes rose-coloured. It is by these means that the Hindoos prepare the rose-coloured lime which they use with betel.

The dyers employ this milk with great advantage for silk, cotton, and woollen stuffs, which they dye black. It prevents that colour, which is generally caustic, from burning the stuffs, and the dye becomes darker and more beautiful.

tiful. I suppose that emulsion of almonds would produce the same effect as that of the coco-nut; our black stuffs then would not be burnt, as is generally the case: this observation may be of use to dyers.

If the milk of the coco-nut be concentrated by ebullition over a moderate fire, a sweet oil, agreeable and fit for the table when fresh, is obtained from it. The physicians of the country compose with this emulsion a gentle purgative, which is not nauseous: it produces no cholic or violent pain. It is administered in cases of plethora, gonorrhea, and other diseases; it is also an excellent vermifuge. It is composed of half a pint of emulsion in which three or four heads of garlic have been dissolved, by boiling over a slow fire, to the consistence of marmelade: it is given to the patient fasting, while warm, with the addition of a little sugar.

The oil of this nut is extracted by pressure; it is fit only for being burnt in lamps; it is of a drying quality, a little acrid, white, and so light that it becomes fixed even in the torrid zone; when burnt it gives a clear bright flame without exhaling any odour or smoke. It is employed by rich people and in the houses of the Europeans in preference to any other kind. The substance from which this oil has been squeezed is given to beasts of burden mixed with their forage; this food when given to cows and goats increases the quantity of their milk.

Such are the properties and different uses made of this palm. If the wood could be employed for building or for domestic purposes, it might justly be said that the coco-nut tree alone would be sufficient for the use of man. It is, however, a useful vegetable production, a valuable gift of Providence to the peaceful inhabitants of that fine country where it has been placed.

It was the coco-nut tree which gave the Hindoos the first idea of inventing the allegory and ingenious fable of the phœnix, as may be seen in the fifth chapter of the Poronia, one of the commentaries of the vaides, a sacred book of these people, which contains the principles of their religion, the history of the country, their sciences, and in general all their knowledge, as well as the practical knowledge of all the arts which are cultivated in it.

The coco-nut tree does not renew the buds of its flowers after an interval of two months, but in April, a period at which the year of the Hindoos commences, it is produced only from its fruit, which are their children. This is exactly

actly the idea which the antients had of the phœnix; that is to say, that it nourished and reproduced itself. It is seen in the Indian mythology that these people deified the coconut tree in the same manner as many other trees and small vegetables; useful animals, such as the ox; the sea, and all rivers. The Egyptians and all the neighbouring nations adopted the mythology and fables, as well as the arts and sciences, of these people, as is fully proved by researches made for more than half a century: the Egyptians, the Tyrians, and the Greeks deified therefore, like the Hindoos, animals, useful vegetables, and rivers. Hence the ox became the god apis, and the date-tree the phœnix.

[To be continued.]

XII. *Experiments to ascertain whether there exists any Affinity betwixt Carbon and Clay, Lime and Silex, separately or as Compounds united with the Oxide of Iron forming Iron Ores and Iron Stones. By* DAVID MUSHET, *Esq. of the Calder Iron-Works.*

[Continued from our last volume, p. 235.]

3d, *Siliceous Ironstone.*

THE varieties of this ironstone are in general much poorer in iron than the common qualities of ironstone: from 15 to 25 per cent. seem to be the medium contents in metal. Some specimens have been obtained as high as 35 per cent. and 38 per cent. At first sight this class of ironstones resemble sandstone; but, upon minute examination, there appear other characteristic features, of which density is always one, to distinguish them from each other.

The varieties of this class are, like the argillaceous and calcareous, found both in balls and in regular strata, and subject to the same general rule, *i. e.* the thicker the band or stratum, the less metal will be found in a given quantity of the ore. Siliceous ball ironstone is generally rich in iron, and is commonly found with a fracture more or less granulated resembling a coarse variety of freestone. What distinguishes it from sandstone is the calcareous earth that is found in the state of chalk, and which appears in some measure to be the seat or bond of union of each individual granule of ore.

The poorer varieties of siliceous ore are sometimes found

 from

from 2 to 4 feet in thickness; they are either called *hard-eeking freestone*, or *water-whin*, or *dyke metal*; and have seldom been suspected of containing iron. Almost every variety I have examined has contained a portion of calcareous earth, either in the state of chalk, spar, or crystal. This circumstance, added to density, leads always to a strong suspicion of iron being contained in quantity.

The ironstone subjected to the following experiments is found in an irregular stratum from 4 to 8 inches thick. A bed of coal is immediately below it, and a carbonaceous ironstone 14 inches thick is incumbent to it.

Its appearance is like gray freestone or sandstone, but much more compact and heavy. Its surface is entirely covered with large plates of mica, and interspersed with calcareous earth. Its specific gravity is — 3·41.

Exp. I. 400 grains of raw siliceous ironstone,
8 —— of carbon, or 1-50th.

The fusion of this mixture yielded a very glass crystallized in feathered radii upon the surface. The fracture was finely prismatic, and the lustre of some of the shades uncommonly luminous and deep. Towards the bottom two cavities of a pearly white colour were found; and immediately below, in one similar, a metallic spherule which weighed 5½ grains. Equal to 1·375 per cent. from raw ironstone.

Exp. II. 400 grains of raw ironstone,
10 —— of charcoal, or 1-40th.

A complete fusion was also obtained in this experiment. The surface of the glass, however, in place of being shining and crystallized, as in No. I., was dull, black, and covered with an enamel of oxide usual in these experiments, but of an unusual thickness. The fracture was prismatic and wavy. A metallic spherule was obtained which weighed 10½ grains. Equal to 2·625 per cent.

Exp. III. 400 grains of raw ironstone,
20 —— of carbon, or 1-20th.

This experiment was also completely reduced, though under appearances somewhat different from No. I. and II. When the cover was taken off, after redness had ceased, the surface of the glass was found semi-spherical. In half a minute part of the convex was removed: at the time a slight explosion was heard, accompanied with a flash of sparkling light blue flame. Beneath, the glass was found of a variety of brown and blue colours. Their fragment displayed a dark amber considerably transparent. A neat smooth skinned

skinned button of metal was obtained which was found to weigh 17 grains, and equal to 4¼ per cent.

Exp. IV. 400 grains of raw ironstone,
40 —— of carbon.

The result of the fusion of this compound was a shining pearly coloured glass. A minute hollow sphere of glass in cooling reared itself upon the surface: this was quite transparent, and became immediately filled with a smoky blue vapour. It then burst with a fine flash of light, as happened in the former experiment.

The metallic product consisted of one button of white cast iron and five carburated globules, weighing in all 32 grains; and equal to 8 per cent. A large portion of charcoal remained untaken up, and symptoms of general infusibility were evident from the nature of the glass. To correct this, and by the effects of the addition of calcareous to siliceous ironstone, the following experiment was made:

Exp. V. 400 grains of raw ironstone,
40 —— of charcoal,
140 —— of chalk.

The reduction of this mixture was complete. The whole of the charcoal had disappeared and a dark green glass obtained, which in thin fragments possessed a little transparency. A metallic button and a few small globules were obtained, which weighed 70 grains, equal to 17½ per cent.

Increase of metal in consequence of the addition of chalk 38 grains, or 9½ per cent.

Exp. VI. 400 grains of raw ironstone,
50 —— of charcoal, or 1-8th.
140 —— of chalk.

The result of this experiment was a very perfect fusion, A wavy green glass whitish upon the surface was obtained, and possessed of more transparency than the former. The whole of the charcoal had disappeared, and there was found revived a button of crude iron weighing 96 grains: equal to 24 per cent.

Exp. VII. 400 grains of raw ironstone,
60 —— of charcoal, nearly 1-7th.

This mixture was exposed to a heat of 160° Wedgewood. The result was a rough blackish gray honeycombed mass, covered with globules of bright cast iron. A large proportion of charcoal remained untaken up. The whole mass had sunk, but had not entered into fusion.

The same experiment was repeated with 250 grains of chalk. Only 18 per cent. of iron was revived. A consi-

derable

derable portion of the mixed formed a kind of infusible carburate, which always betokens an excess of calcareous earth.

Recapitulation of the Experiments with raw siliceous Ironstone.

				per cent.
Exp. I.	1-50th	carbon yielded of metal	5½ grs.	or 1·375
II.	1-40th	ditto	10½	or 2·625
III.	1-20th	ditto	17	or 4·250
IV.	1-10th	ditto	32	or 8
V.	1-10th	& 140 grs. chalk	70	or 17½
VI.	1-8th	yielded ditto	96	or 24
VII.	1-7th	fusion became imperfect both with		

and without the addition of calcareous earth.

The same ironstone was found to lose 28½ per cent. in roasting. Its colour was now changed to brownish red; the mica had assumed several prismatic shades, and resembled small metallic plates tarnished by a slight degree of oxygenation. The following are the results of experiments made with the ironstone in this state upon 400 grains of matter.

					per cent.
Exp. I.	1-50th	carbon yielded no metal.			
II.	1-40th	ditto	ditto		
III.	1-30th	ditto	7 grains of metal,		or 1·75
IV.	1-20th	ditto	19	ditto	4·75
V.	1-10th	ditto	43	ditto	10·75
VI.	1-8th	ditto	72	ditto	18·
VII.	1-5th	ditto	infusible.		
VIII.	1-8th chalk 150	ditto	119 grs. of metal,		or 29·75
IX.	1-5th ——	ditto	infusible.		

From a review and comparison of these experiments, made with the natural productions of our mines and similar compounds artificially compared, we may perceive a very strict analogy. The following abstract or table may be compared with one in the last volume of this work, p. 137.

Table

Table of the Results of Experiments made with Argillaceous, Calcareous, and Siliceous Ironstones.

Proportions of Carbon.	Argillaceous Ironstone.	Argillaceous Ironstone roasted.	1st, Calcareous Ironstone.	1st, Calcareous Ironstone roasted.	2d, Calcareous Ironstone.	Siliceous Ironstone.	Siliceous Ironstone roasted.
1-80th	$2\frac{1}{8}$ per cent.						
1-57th	$3\frac{37}{100}$						
1-40th	$8\frac{3}{4}$	$1\frac{8}{10}$ per ct.				2·625 per ct.	
1-30th	no exper.	no exper.	$2\frac{1}{4}$ per ct.	$4\frac{3}{4}$ per ct.	1 per cent.	no exper.	1·75 per ct.
1-20th	$14\frac{3}{4}$ per ct.	no exper.	$7\frac{1}{4}$	$7\frac{1}{2}$	$6\frac{1}{4}$	$4\frac{1}{4}$ per ct.	4·75
1-15th	no exper.	no exper.	$9\frac{1}{2}$	15	no exper.	no exper.	no exper.
1-10th	$21\frac{1}{10}$ per ct.	$24\frac{1}{2}$ per ct.	17	28	17 per cent.	8 per cent.	10·75 per ct.
1-7th	not fusible	not fusible	not fusible	$36\frac{1}{2}$	28	24	18
1-5th	not fusible	$28\frac{1}{2}$ per ct.	not fusible	$32\frac{1}{2}$	$41\frac{1}{4}$	not fusible	not fusible

Uniformly

Uniformly we find that argillaceous ore lets fall its first portion of metal with the smallest quantity of carbon; or, what amounts to the same thing, with equal portions of carbon it yields a greater produce in metal than the siliceous ironstone. On the contrary, we find that the calcareous ores require a greater dose of carbon to separate the first portions of iron; or, what is similar, with equal portions of carbon less metal is revived from the ores of this class than from any of the other two; with this limitation, however, that calcareous ironstones in general never become infusible, even with a very high proportion of carbon, until nearly the whole metallic contents become revived. This, by a strict examination of the tables, will not be found applicable to the argillaceous and siliceous, one-half of the metallic contents of which are either not separated or not revived.

The general results of these experiments are sufficient to establish an operation of affinity directly betwixt carbon, clay, and silex, in temperatures of fusion, or approaching thereto. They are also sufficient to establish the operation of a principle still more powerful, when these enter into the composition of ores of iron and become subjected to the heat of the assay furnace. Under these circumstances we find calcareous earth, the affinity of which for carbon, by fusing them together, could not be detected by any alteration of colour or combination, operating as a stimulus to the well known affinity that exists between iron and carbon, and by its simple agency alone doubling the produce from an argillaceous or siliceous ore. In some of these experiments we find the result accompanied by a small portion of iron, and a large proportion of the carbonaceous matter originally introduced. If the same experiment is repeated with the addition of 1-3d or 1-4th of calcareous earth, the charcoal will be no longer found, the metallic contents will be considerably increased, and the glass, from being black and spongy, will exhibit a mass of uniform colour, density, and comparative transparency.

As numerous experiments have formerly been given to point out the effect which the addition of calcareous earth has in reviving the metallic produce from an ore, the following experiments will prove its secreting powers in the early stages of separation.

Exp. I. I took a quantity of the same oxide of iron used in former experiments upon this subject; I weighed 200 grains,
and added 1-10th part of charcoal dust, or - 20

 The

The result of this was a well shaped button of iron which weighed 58 grains; equal to 29 per cent.

Exp. II. The same oxide - - 200 grains.
Charcoal 1-10th, or - 20
Chalk one-half - - 100

This mixture was carefully and completely fused. A polished looking button of metal was found weighing 35 grains; equal to $17\frac{1}{2}$ per cent: being 23 grains, or $11\frac{1}{2}$ per cent. less than Exp. I, and inexplicable upon any other grounds than in consequence of the introduction of calcareous earth.

Exp. III. Oxide same as formerly - 200 grains.
Charcoal 1-10th - - 20
Chalk 1-4th, or - - 50

The result by fusion yielded a perfect button of metal weighing 43 grains: equal to $21\frac{1}{2}$ per cent. In this experiment the chalk being less than in former by one-half, the metallic product increased 8 grains, or 4 per cent.

Exp. IV. Oxide as formerly - - 200 grains.
Charcoal 1-10th - - 20
Chalk 1-8th - - - 25

A metallic button was obtained from the fusion of this mixture, and found to weigh 49 grains: equal to $24\frac{1}{2}$ per cent. In this experiment the quantity of calcareous earth was reduced to 1-8th, and the revived metal approached to within nine grains of Exp. I.

Recapitulation.

Exp. I. Oxide and 1-10th of charcoal yielded 58 grains of metal, or 29 per cent.

Exp. II. Oxide and 1-10th of charcoal, and 100 grains of chalk, 35 grains of metal, or $17\frac{1}{2}$ per cent.

Exp. III. Oxide and 1-10th of charcoal, and 50 grains of chalk, 43 grains of metal, or $21\frac{1}{2}$ per cent.

Exp. IV. Oxide and 1-10th of charcoal, and 25 grains of chalk, 49 grains of metal, or $24\frac{1}{2}$ per cent.

The comparative effects of clay and sand used in a similar manner were proved by the following

Exp. V. Oxide the same as formerly - 200 grains.
Carbon 1-10th - - - 20
Dried Cornwall clay - - 100

The result was a metallic button possessed of a smooth polished surface weighing 42 grains, or 21 per cent.

This experiment was twice repeated, and the results were 43 grains, or $21\frac{1}{2}$ per cent.; and 42 grains, or 21 per cent.

Exp.

Exp. VI. Oxide of iron - - 200 grains.
Carbon 1-10th - - 20
Cornwall clay vitrified in 166°
of Wedgewood - 100

A very black glass was obtained by the fusion of this mixture, and a metallic button which weighed 54 grains: equal to 27 per cent. Again fused, and yielded 52 grains, or 26 per cent,

Exp. VII. Oxide of iron - - 200 grains.
Charcoal 1-10th - 20
Pure sand - - 100

The result from this mixture was a prismatic coloured glass partially crystallized in radii upon the surface. The metallic button weighed 47 grains: equal to $23\frac{1}{2}$ per cent. This experiment was twice repeated, and the results were the same as the former, and $43\frac{1}{2}$ grains or $21\frac{3}{4}$ per cent. From these experiments it appears most evident that the effects of the carbonaceous matter at a certain stage of separation are more extensive with clay and sand than with lime; and still more so when fused with oxide alone than in addition with any of these earths; though vitrified Cornwall clay nearly approaches the same standard.

XIII. *Proceedings of Learned and Economical Societies.*

SPRING WHEAT.

THE Board of Agriculture having received information, from various districts, of the benefit arising from the cultivation of spring wheat; and it appearing to the Board that, at the present period, it may be particularly useful to promote that object, have resolved to offer the following premiums:

To the person who shall, in the spring of 1805, cultivate the greatest number of acres of spring wheat, not less than twenty, fifty guineas; or a piece of plate of that value.

Accounts, verified by certificates, to be produced on or before the first Tuesday in February 1806. It is required that the soil, quality of seed, sorts of wheat, time of sowing, produce, and value of the crop, and the effects of any distemper which may attack the plants, be reported.

For the next greatest quantity, thirty guineas; or a piece of plate of that value.

For the next greatest quantity, twenty guineas; or a piece of plate of that value.

 The

The Board has been informed, that the true spring wheat may be sown successfully so late as the end of April. Several correspondents on the subject of the last harvest observed, that the spring wheat had escaped the mildew in parts of the country where the autumnal had not, and yielded better.

To the person who shall report to the Board the result of the most satisfactory experiments on spring wheat, which shall ascertain the soil, the sort of wheat, the time of sowing, the produce, and value, the comparative advantages of this and common wheat, and any other circumstances useful to be known, a piece of plate of the value of twenty pounds.

To be produced on or before the first Tuesday in April 1807.

XIV. *Intelligence and Miscellaneous Articles.*

VOYAGES AND TRAVELS.

St. Petersburgh, Dec. 31st.

EXTRACT of a letter from Capt. Lieut. von Kreusenstern, commander of the ships Nadeshda and Neva, to the academician Schubert, dated the Harbour of St. Peter and St. Paul, in Kamtschatka, Aug. 8, 1804.

" On the 4th of February we left the island of St. Catherine and the coast of Brazil; on the 25th we discovered Staten Land; and on the 25th of March doubled Cape Horn. After entering the Great South Sea, or Pacific Ocean, we had stormy and cloudy weather, in consequence of which the two ships were separated, and did not meet till six weeks after, when they arrived at the Marquesas: on the 6th of May we saw Hood's island and some other islands to the north-west of the Marquesas; on the day following we anchored at the island Nukatera in the harbour of Anna Maria, a bay called by the natives Tayo Hoae. Three days after, that is on the 10th of May, the other ship the Neva entered also, after having cruised three days around Easter Island in search of us. In this island we discovered an excellent harbour, never before known, which has deep water close to the shore, and is so sheltered by the land that vessels can lie in calm water during the most boisterous winds. The inhabitants behaved exceedingly well, showed us every mark of attention, and the good understanding between us was never interrupted. The island, however, supplied only wood, fresh water, coconuts,

nuts, bananas, and some bread-fruit. In regard to provisions, we could with difficulty procure six swine, because the inhabitants had only a few themselves.

"On the 18th of May we left this island; and on the 25th crossed the equator in the 129th degree of west longitude.

"On the 7th of June we discovered the island Owhyhee, celebrated by the death of Capt. Cook, which is the southernmost and largest of the Sandwich islands. We sailed three days along the coast in order to procure fresh water from the inhabitants; but there is so great want of it in this island, and the inhabitants were so well supplied with iron articles, that they brought us only a sow, which they would not barter but for a cloke of the finest cloth. I therefore found myself under the necessity, on the 10th of June, of bearing away for Kamtschatka, especially as the slightest symptom of the scurvy or of any other disease had not manifested itself among the people, though they had lived so long on salt meat. The Neva remained some time longer at the Sandwich Isles.

"On the 11th of July we saw the coast of Kamtschatka, and on the afternoon of the 14th anchored in the harbour of St. Peter and St. Paul, thirty-four days after our departure from Owhyhee, and somewhat more than five months after we had left the coast of Brazil. The whole crew were in perfect health, and the rich lading destined for Kamtschatka was found in the best condition. Soon after our arrival the whole country experienced the beneficent consequences of this voyage. At our arrival, wretched brandy cost 20 roubles the can; at present the best is sold for 8; sugar cost 3½ roubles the pound; at present it costs 1¼ rouble; and other articles in the same proportion. On a proposal made by the worthy governor, General Koschelef, a subscription was opened for establishing a lazaretto and hospital, which in half an hour amounted to above 4000 roubles. I hope to be ready in ten days to put to sea, in order to convey our ambassador to Japan and then to bring him back hither. I shall then proceed to China, and thence perhaps return through the eastern passage to Europe."

Intelligence has since been received that the Nadeshda sailed from Kamstchatka to Japan on the 28th of August.

PALLADIUM.

We hear that Dr. Wollaston was the person who originally supplied Mrs. Foster with the palladium for sale. He gave a paper in the last volume of the Philosophical Transactions,

Transactions *, describing the other new metal, which he named *rhodium*, and showing that palladium might be got from crude platina. He had some years ago purchased a considerable quantity of platina with a view to make it malleable. In the course of his experiments he found out the palladium; but observing that there were yet many phænomena which could not be explained, he wished to secure his claim to the discovery without directing the attention of chemists to a subject he desired to investigate more fully. He afterwards detected the other new metal, rhodium, the presence of which unknown body was one cause of the difficulties which presented themselves. Having now finally completed the analysis of crude platina, we understand he intends to give a detailed account of its composition, and of such properties of the new metals as he has since been led to observe.

ORIGINAL VACCINE POCK INSTITUTION.

At the quarterly court held on the 29th January, a critical examination of Mr. Goldson's second pamphlet was read by Dr. Pearson. We are sorry our limits do not admit of our laying before our readers more than the concluding remark of Dr. Pearson, which was as follows:

" Dr. Pearson repeats his proposal to Mr. Goldson, of coming himself, or deputing two friends to the Vaccine Pock Institution, to decide the questioned facts by experiments, and lay the issue before the public. In the mean time Dr. Pearson, in the name of the institution in general, and his own in particular, returns his acknowledgment to Mr. Goldson for provoking the investigation of a subject which is so much wanted to obtain precision in practice, which has been checked hitherto by so many pretenders to knowledge of the subject, and who would wish it to be believed that the history of vaccine inoculation was exhausted by the publication of half a dozen instances of inoculated cases on the promulgation of the new practice. Dr. Pearson willingly concedes to Mr. Goldson, that a test of security is wanted for many of those who have been or shall be inoculated, because a criterion has been wanting to guide practitioners, and determine whether constitutional affection was produced or not; and that, admitting that even all the adverse cases published are cases of small-pox after cow-pock, which does not appear to be the truth, they will only serve to regulate practice in future; for the

* See Philosophical Magazine, vol. xix.

immense mass of evidence in favour of unsusceptibility of small-pox after the cow-pock demonstrates that the failures are more reasonably to be imputed to deceptions and deficiency of knowledge, than to exceptions to the law of the animal economy, that the vaccina produces unsusceptibility of the small-pox."

ENCOURAGEMENT OF LITERATURE AND SCIENCE.

The emperor of Russia, while he attends to the prosperity of the people whom he governs, seems anxious to promote, by his patronage, the cause of science every where, as being beneficial to the general interests of mankind.

Among recent instances of his munificence in this respect we have to record the following:

A prize question on gun-shot wounds having been proposed by the Royal College of Surgeons, Mr. Chevallier, surgeon, gained the medal, as the author of the best dissertation. The Emperor Alexander, in consequence, bestowed on him a diamond ring of considerable value*.

Dr. Thornton, author of the *Temple of Flora* and *Philosophy of Botany*, a work now publishing, has also been presented with a diamond ring from the Emperor of Russia, accompanied with the following letter:

"His Imperial Majesty the Emperor of Russia having, with much satisfaction, examined into the contents of your *splendid*, *elaborate*, and *useful* botanical work, has directed me to transmit to you the ring herewith sent, as a mark of his benevolence, and a proof of his regard for every thing which is of public utility.

"NOVOSSILZOFF,

"*Pres. of the Imper. Acad.*"

We have likewise learnt that the author of the Costumes of Russia has received a testimony of the munificence of the same potentate.

NATURAL HISTORY.

Count von Hoffmansegg, known by his travels through Portugal for improving natural history, obtained leave some years ago from the Prince regent of Portugal to send to Brazil a person named Sieber, well experienced in the science of natural history and in collecting the productions of nature, for the purpose of obtaining a series of observations in regard to that extensive country. Sieber proceeded,

* Mr. Chevallier was also appointed surgeon extraordinary to his Royal Highness the Prince of Wales.

under

under the protection of the governor Count dos Arcos, to Para, where he has remained above a year. In a letter lately received from him, he gives the following testimonies respecting the *ayapana* (*eupatorium, ayapana,* Ventenat and Willdenew), which confirm the healing powers ascribed to that plant*, and render it more worthy the attention of physicians, as we have already obtained from the neighbourhood of the same district, ipecacuanha, quassia, and cantharides; the last of which are become indispensable in medicine.

Para in Brazil, June 12th, 1804.

In regard to the celebrated plant ayapana, which is said to be an antidote to all poisons, I have made two experiments on myself. A soldier brought me a brown catterpillar covered with hair, an inch in length and intermixed with small prickles. I took it from the leaf into my hand, upon which the soldier cried out, "For God's sake take care, the caterpillar is poisonous." His exclamation however was too late: I received three pricks in the middle finger of the right hand, the finger appeared red, swelled, and became exceedingly painful. In a quarter of an hour the redness and swelling extended over the whole arm, and as far as the elbow, so that in half an hour I could scarcely move it; I recollected the ayapana, sent for it, expressed the juice, and applied it to my arm with some of the bruised plant: in two or three minutes the pain decreased; in half an hour I was able to bend my arm, and the next day I recovered the perfect use of it. The pricks in my finger, however, retained a dull pain for two days, but at the end of that time it went off.

The second trial was more disagreeable. A small scolopendra stung or bit me, while asleep in the night-time, in the forehead above the right eye; I immediately waked and searched for the animal, which I found next day and killed. As I could not in the night-time procure the plant, the poison before next morning had made a considerable progress: after applying the ayapana, the pain and inflammation went off; suppuration, however, I was not able to prevent; a corneous excrescence of above an inch in length arose on my forehead, and as I could not put on my hat I was obliged to remain four days in the house: the scar will still be apparent when I return.

My assistant was bitten in the woods in the right foot; at first he knew nothing of it, and felt no bad consequences

* See Philosophical Magazine, vol. xiii.

till the evening of the following day, at which time he could not put on his shoe: after using the ayapana the inflammation and swelling subsided; it was not, however, possible to prevent suppuration. I was obliged to open the place, but in six days his foot was well.

This beneficent plant must, where possible, be employed immediately after being bitten or pricked: its speedy action may then be traced; if applied later it removes the heat and swelling, and counteracts the effects of the poison, but connot prevent suppuration.

ASTRONOMY.

If astronomers are very anxious to determine the orbits of the planets lately discovered, their principal object is to ascertain their route, in order that they may be able to find them again when bad weather, or any other cause, has produced a long interruption of observations. This has been the case in regard to the new planet discovered by M. Harding: for a month we have not been able to see it; and it would have been impossible to find it again, in consequence of the great faintness of its light, had not its position been previously known. This observation succeeded on the 20th and 21st of December: it is the more important, as the planet is in that situation most favourable for determining its position from the sun. It has now passed over the twelfth part of its orbit; at the time of my preceding researches it had made only half that progress. These new elements, then, deserve more confidence. They, however, differ little from the former; for I have found nothing to be changed in the mean distançe and in the revolution, which is four years four months, almost equal to that of the other two planets, Ceres and Pallas. But I have increased the eccentricity by a 70th part, so that it is determined that this new planet has the greatest eccentricity of all the planets known: the perihelion has been advanced to 24 minutes; the node and inclination have changed only a very few minutes.

The effect of this great eccentricity is so sensible, that the time employed by the planet to pass over the first part of its orbit, the middle of which is occupied by its aphelion, is the double of that necessary for completing the second half. In like manner, its greatest distance from the sun is almost double the least distance: in absolute measures the difference between these two distances is 45 millions of leagues, or equal to one and a third of the distance of the earth from the sun.

The

The planet is approaching the sun, and will not pass its perihelion till the 15th of February. This circumstance affords some hope that we shall still be able to observe it. I have therefore thought it might be useful and agreeable to astronomers to give the following ephemerides with the new elements:

Elements.

Ascending node	- -	171°	6′	0″
Inclination	- -	13	5	0
Perihelion in 1805	-	59	49	33
Epoch (31 Dec. 1804, at noon)		42	17	23
Eccentricity	- -	0·25096		
Larger semi-axis	- -	2·657		
Revolution	- -	1582 days.		

Ephemerides.

			Longitude.			Latitude.	
1804. Dec. 21	-	0°	43′	-	9°	40′	S.
31	-	4	32	-	9	45	
1805. Jan. 8	-	7	47	-	9	52	
16	-	11	18	-	9	57	
23	-	14	33	-	10	0	
31	-	18	27	-	10	0	
Feb. 8	-	22	28	-	9	59	
15	-	26	8	-	9	58	

BURCKHARDT,

Dec. 25, 1804. Member of the Institute.

VOLCANOES.

Naples, Nov. 24, 1804.

Last night Vesuvius, which had been pretty tranquil for some weeks, suddenly began to excite attention. A smart shock of an earthquake was first felt: a column of flame of an astonishing height then issued from the crater; and this was followed by an abundant discharge of lava, which in three hours flowed beyond the boundaries to which that thrown up by the volcano three months ago had proceeded. The inhabitants of the mountain were thrown into the utmost consternation, and most of them fled with whatever they could carry with them. The greatest danger seemed to threaten the town of Torre del Greco, for the current of lava ran directly towards it; but it has not yet reached it: and this day the discharge of the lava has perceptibly decreased. The court is now at Portici, an elegant seat belonging to the king at the foot of Mount Vesuvius, and is resolved to remain there unless the danger becomes greater.

LIST OF PATENTS FOR NEW INVENTIONS,
Which have passed the Signet Office from Dec. 24, 1804, to Jan. 24, 1805.

To Thomas Hamilton Keddie, of Duke-street, Grosvenor-square, in the county of Middlesex, sadler, for a cartouch-box or receptacle for cartridges of gunpowder or gunpowder and ball for charging musquetry or artillery, or any other description of fire-arms.

To John Heppenstall, of Doncaster, in the county of York, machine-maker and engineer, for certain improvements in slivering, and preparing hemp, flax, and substitutes for hemp and flax, previous to the operation of spinning.

To John Robert Lucas, of Charlton-House, in the county of Somerset, Esq. for an improvement in the art or method of making, spreading, or flattening sheet-glass, commonly called German sheet-glass, or any other spread glass requiring a polished surface.

To Samuel Chifney, of Newmarket, in the county of Suffolk, rider, for certain improvements upon bitts of bridles.

To John Jones, of the city of Chester, chymist, for a liquor for printing or dyeing of cotton, linen, or woollen.

To William Lester, of Piccadilly, in the county of Middlesex, engineer, for certain improvements on an engine or machine for separating corn seeds and pulse from the straw.

To William Hackwood the younger, of Shelton, in the county of Stafford, potter, for a method of making windows and lights upon new principles.

To Edward Shorter, of New Crane, Wapping, in the county of Middlesex, mechanic, for certain mechanical apparatus, by which the raising of ballast is rendered more easy, cheap, and expeditious, and which may also be applied to other useful purposes.

To Simeon Thompson, of Red Cross Wharf, Upper Thames-street, in the city of London, coal-merchant, for a bushel or bushels and other measures upon a new construction for measuring coals, grain, seed, and other dry measurable commodities.

To John Ball, of the city of Norwich, engineer, for certain improvements in a machine for thrashing corn and pulse.

To Edward Thunder, of Brighthelmstone, in the county of Sussex, for an improved mode or method of keeping in tune certain musical instruments called piano fortes, grand piano fortes, harpsichords, spinets, and other stringed instruments.

METEOR-

METEOROLOGICAL TABLE
BY MR. CAREY, OF THE STRAND,
For February 1805.

Days of the Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock, Night.	Height of the Barom. Inches.	Degrees of Dryness by Leslie's Hygrometer.	Weather.
Jan. 27	28°	29°	29°	29·70	10°	Fair
28	28	29	30	·50	7	Cloudy
29	29	34	32	·00	6	Fair
30	32	36	33	28·90	0	Rain
31	33	34	29	29·40	0	Snow and rain
Feb. 1	28	30	27	·78	6	Cloudy
2	21	34	31	·82	7	Fair
3	29	37	34	30·00	10	Fair
4	35	41	46	29·79	0	Rain
5	46	46	34	28·95	0	Stormy
6	29	35	32	29·82	6	Fair
7	32	41	40	·90	5	Showery
8	42	49	47	·65	8	Fair
9	49	53	49	·82	10	Fair
10	49	55	46	·72	7	Fair
11	44	44	35	·70	0	Rain
12	35	39	30	·91	16	Cloudy
13	30	39	28	30·20	18	Fair
14	28	38	34	29·99	15	Fair
15	33	38	34	30·04	18	Cloudy
16	32	42	30	·07	20	Fair
17	27	38	32	29·85	18	Fair
18	32	39	30	·80	19	Fair
19	28	40	30	·92	22	Fair
20	27	41	39	30·00	10	Fair
21	39	49	48	29·69	4	Rain
22	41	48	40	·78	11	Fair
23	41	49	44	30·04	21	Fair
24	46	48	40	29·78	0	Rain
25	38	47	44	·76	18	Fair

N. B. The barometer's height is taken at noon.

XV. *On the Means most proper to be resorted to for extinguishing accidental Fires in Ships.* By ALEXANDER TILLOCH. *Read before the Askesian Society in December* 1801.

It is impossible for human imagination to conceive any calamity more horrid and distressing than that of a *ship on fire*,—a species of accident to which vessels are much exposed, owing to the combustible nature of the materials of which they are constructed, and which, unhappily, too often baffles every effort to subdue it.

To discover some means by which those on board, in such circumstances, may extinguish the flames efficaciously and speedily, has long been a desideratum; for experience has but too fully proved, that buckets and fire-engines, with water, the methods heretofore resorted to, are not effectual. To point out such means as are calculated to arrest the progress of the devouring flames will not be thought an useless labour; nor will they be the less valued for being *simple*, and, in almost every case likely to occur, perfectly within the reach of the people. That the efficacy of the means to be proposed may be established on incontrovertible principles, it may be of some use to examine, previously, what takes place in deflagrations of the kind to which we allude. This inquiry will also probably lead us to a knowledge of the cause why the methods usually employed prove inadequate to the end proposed.

The laws and operations of nature are extremely simple, and, if we attend to what she points out, we cannot be misled.

For maintaining the common process of combustion, certain conditions are indispensable.

1. A substance or substances capable of undergoing a chemical decomposition, and of entering, wholly or partially, into new combinations when circumstances favour the process.

Such are wood, tar, hemp, &c.

2. The presence of some other substance which, by its decomposition, may furnish a principle or principles capable of entering into union with those of the combustible substances, thereby liberating *caloric* or the matter of heat, which, with the light also liberated, constitutes the most striking phænomena in combustion.

Atmospheric air is such a substance.

It is a fact well known, that the atmosphere consists of two distinct substances dissolved in *caloric* or heat, which forms a third ingredient. The two first are *oxygen* and *azote*.

The azote is in such strong chemical union with the caloric, in which it is dissolved, that in no common process of combustion is the union destroyed: or, in other words, that portion of the heat of the atmosphere which is united to the azote is never liberated to exercise its action in forming new combinations *.

It is otherwise, however, with the portion of heat united to the oxygenous part of the atmosphere. These two have so weak an affinity for each other, that a little increase of temperature is all that is necessary to determine their separation, if substances to which the oxygen can unite itself be present. In proportion as the oxygen joins itself to these substances, the heat thus liberated raises the temperature of other portions of them to that point which determines their union with oxygen; thus more air becomes speedily decomposed, and all the phænomena of combustion are rendered more and more conspicuous, till complete deflagration precludes all possibility of checking the progress.

What office does water perform when employed for the purpose of checking the progress of a fire? It extinguishes the flame *by cutting off the communication between the burning body and the air which maintains the combustion*. But this it can do only in certain cases.

Water is known to consist of two substances, *oxygen* and *hydrogen*. The former, as has already been noticed, is an ingredient also in atmospheric air, and is that substance which unites itself to the burning body in every case of combustion: the latter is the base of *hydrogen gas* or *inflammable air*.

Water, like atmospheric air, may be decomposed by presenting to it, under certain circumstances, substances for which either of its constituent principles has a stronger affinity than the two have for each other.

When a fire has got to such a height that water cannot be thrown on it in sufficient quantity to interpose itself as *a wall of separation between the burning materials and the atmosphere*, but is itself instantly converted into vapour and decomposed,—in that case, *instead of extinguishing, it adds*

* It must be here observed, however, that this remark should be taken with some limitation: modern chemistry is in some measure forced to suppose that the azote goes to the formation of alkalis when they result from the combustion; in which case the caloric may be supposed to exercise some action; but that affects not our general argument.

to

to the deflagration. Its oxygen joins the combustible materials, while its hydrogen, disengaged in the form of inflammable air, mixes with the atmospheric air present, and inflames almost as quickly as it is liberated.

A ship in such a case becomes filled with flames, even in those places where, before, there was no fire; and it may truly be said, *these parts are set on fire* BY WATER!

But water has been the only means hitherto employed to extinguish fires; and if this is not to be used, what other method can we resort to?

The question is answered in part by what we have stated respecting water when it succeeds in any case in extinguishing fire. *Cut off all communication between the burning body or bodies and the atmosphere.*

The presence of air, we have already observed, is indispensably requisite to maintain combustion.

This fact has been long known, and it appears wonderful that advantage was never taken of it to extinguish fire in ships; especially when it is considered that their structure is such that, had this been one of the principal objects in view in the building of them, they could not possibly have been better constructed to enable us to take advantage of this law of nature.

If a glass jar be inverted over a burning taper in such a manner as to bring the mouth of the jar into *contact* with the table on which the taper stands, the flame soon grows languid, and in a little time we see it expire altogether. The oxygenous part of the atmosphere has been decomposed, and having, by that decomposition, given up all its oxygen to the combustible body, the process ceases of itself, not for want of fuel, but for want of a fresh portion of oxygenous air to be decomposed. If this experiment be performed over water, its ascent in the jar, as every one knows, will prove that a portion of the air has disappeared; its oxygen having become concrete in the burning body, or assumed a less volume in the new products formed, viz. *carbonic acid gas* and *water*; and that portion of its caloric not necessary to the formation of the acid gas having been liberated.

The larger the flame of the taper compared with the quantity of air; or, in other words, the smaller the quantity of air compared with the size of the burning body, the sooner does the process of combustion cease. It is on this principle that a common extinguisher puts out a candle.

These simple facts furnish us with sufficient data on which to found a rational and infallible method for extinguishing

 fire

fire on board a ship. If the fire cannot be got at, and instantly extinguished with a bucket or two of water, no time should be wasted in fruitless attempts to reach the spot; for during all this time the prime auxiliary, the most formidable ingredient in the conflagration, viz. the atmospheric air, is allowed to pour itself upon the burning materials and to furnish the very essence of the flame,—for *the fire* IS FURNISHED BY THE AIR, *and not by the wood, tar, &c.*; a fact too well established to be insisted on here. Instead of suffering this to take place, all hands should be called up; the ports, hatches, &c. should be shut, and every one set to work to stop up with oakum, tallow, pitch, (any thing,) every chink and crevice all over the vessel. She would thus literally become a *large extinguisher*; and it would be just as rational to insist that a man could live deprived of fresh air, as to assert that fire can continue to burn in the interior of a ship when every possibility of a fresh supply of air is thus cut off.

Such is the general principle that ought to direct the proceedings of the officers and crew on every emergency of this kind. They ought all to be drilled to the business, that every one may know the particular station and specific duty allotted to him in case of such an accident taking place. This would be an antidote against that confusion and insubordination which almost always take place in cases of fire. The means are so infallibly certain in their effect, that not only the officers, but a great number of the men would have full confidence in the issue of their exertions; this would insure firmness, and the unruly would be as effectually kept in order as on any common occasion.

The general principle we have stated to be, *the cutting off every possibility of a fresh supply of atmospheric air getting into the interior of the ship.* But a still further advantage may be taken of the natural laws before examined, so as *to hasten the destruction of the whole air contained in the ship*, and to render it *unfit for maintaining combustion.* We have already brought to recollection, that the larger the mass of burning materials compared with the quantity of air present, the sooner will the fire extinguish itself: this is a truth that cannot be too forcibly impressed on the minds both of the officers and crews; for, however fiercely the fire may be raging below, *the sooner will it be extinguished* if they can only *succeed in making every thing air-tight* above decks and round the ship (as the ports, scuttles, scuppers, windows, &c.): the full conviction of this truth will prevent them from relaxing in their exertions, and wonder-

fully

fully conduce to their ultimate safety. This is no small advantage that results from the law of nature now under considertion; but a further use ought still to be made of it. *If a number of fires be made between decks,* by setting fire to pitch and other inflammable substances in pots, stew-pans, &c., before closing down the hatches and making every thing air-tight, *the sooner will the air left in the vessel be deprived of its oxygen, and the combustion of course be terminated.*

Thus we see that FIRES MAY BE EMPLOYED TO EXTINGUISH FIRE; and the more there are of them, the sooner will all of them, as well as the *prime fire,* be extinguished. This is the more necessary because, if all the air in the interior of the vessel must expend itself in the *prime fire,* a hole may possibly be the consequence, and there fresh air would rush in to maintain the flame; but a number of fires in different parts of the vessel would quickly destroy all the air, and render that accident impossible. In short, if the people be once made thoroughly masters of their duty in such cases, they need not fear even to kindle fires *on the bare boards* for the purpose of extinguishing one where they cannot reach it; for the exclusion of fresh air will soon arrest the progress of the flames.

If fears (groundless fears) should be entertained that such fires would increase the danger, candles may be employed with considerable effect. A good sized candle consumes about a gallon of air in one minute of time: several hundreds of them lighted between decks, before closing all up, would contribute not a little to exhaust the oxygen of the atmosphere. In short, proper receptacles for fires, to be employed for this express purpose, should constitute a part of the outfit of every ship, especially those of the royal navy and East India company. If such arrangements were made a part of the system (they surely ought to be so), *any fire below decks might be extinguished in less than half an hour.*

It need hardly be remarked here, that in this case, as in every case of danger, the foe should be opposed with firmness from post to post. If the fire breaks out in the hold, the first stand should be made on the lower deck. It ought instantly, and with deliberation, to be cleared, fore and aft, that not a chink or crevice may escape observation. Every opening, the pumps among others, ought to be closed, and the officers and men to be at their stations. This search ought to be a close one; for the escape of smoke ought not to be held as the only criterion of a seam being open. Where air is rushing in, smoke cannot come out; for two streams cannot, at one and the same time, blow in opposite directions through the same aperture: therefore every seam should be examined; nor will it be difficult to do so, when it is considered in what a close and substantial manner ships are built.

While this is going on in the deck immediately above the fire, the officers and men on the next deck above should be preparing every thing for a second barrier to the ingress of air; and so of the third deck: and each, before quitting their own deck, should light the *extinguishing fires* before recommended. Similar fires should, if possible, be introduced under the lower deck, the sooner to exhaust the air in the hold.

If these means be cooly and deliberately pursued, when a ship is on fire below or between decks the flames may be as effectually extinguished as a burning candle when an extinguisher is put over it; the ship, as we have already said, is in fact converted into an extinguisher; nor is she less so on account of the combustible nature of the materials of which she is constructed: for *a cone* MADE OF PAPER *extinguishes a candle as effectually as one made of metal.* A fact of which any one may easily satisfy himself by making the experiment.

To discover when the conflagration is subdued, the test of a candle should be employed. For this purpose there ought to be a few places in each deck that can be opened when necessary. Into one of these introduce a lantern and candle, taking care instantly to close the hole again. If the candle, after remaining a few minutes below, is found, on being drawn up, to have been extinguished, it may be concluded that all is safe, and that the air left is unfit for maintaining combustion. The people will then feel cheerful; nor will they be impatient to open the decks when informed that, though the fire is out, some articles may have attained such a high temperature, that the access of fresh air might occasion a new deflagration. Even when, by the test of a candle, it is found that all the air is destroyed, the precautions should be continued for a number of hours.

(It will occur from what has been stated, that if there be any particular part of a ship where fires are supposed to originate oftener than in any other, that part ought to be insulated, as it were, in the building of the vessel; that is, every part of it, all round, ought to be caulked up so as to make that room or apartment air-tight, that, when an accident occurs, no more might be necessary than to close the door or entrance, and caulk it up.)

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In the preceding remarks we have pointed out the principles that ought to be kept constantly in view in every attempt to extinguish fire on board a ship. That we might not interrupt the connection we purposely avoided mentioning another mean which it might be advisable to provide against such accidents, and which depends on the same principles. The methods already laid down, if followed up with firmness, cannot fail to answer the purpose intended; but what we are going to mention would prove a most powerful auxiliary.

We have already noticed that the presence of oxygen in combination with caloric is an indispensable requisite in the process of combustion, and that atmospheric air contains these two ingredients in such a state of combination, and therefore serves to maintain combustion by giving up its oxygen to the combustible body, in consequence of which its caloric is liberated. It follows from this, that the substitution of any gas for atmospheric air, or *the introduction of any gas into the interior of the ship, to displace the whole or a part of the atmospheric air contained in it, would hasten the extinction of the flames,* provided the gas so substituted for air be one that cannot be decomposed by the action of the fire.

It ought to be a gas that can be easily procured, and also one specifically heavier than atmospheric air, that it may descend, get below the common air, take its place in the vessel, and thus be certain (when a sufficient quantity is introduced) to reach the place on fire, and interpose itself as a wall of separation between the burning materials and the atmosphere.

Carbonic acid gas, or fixed air, is well calculated for this purpose. It can be procured even on board a ship with little trouble (if the proper requisites have been provided), and at a small expense. It is considerably heavier than common air, and *extinguishes flame in a moment.*

All that is necessary to insure a supply of any quantity in a very few minutes is, that each ship should be furnished with a certain stock of common oil of vitriol, (vinegar or any other acid would answer, but would be more expensive,) and a quantity of common chalk or unburnt lime.

The sulphuric acid or oil of vitriol is an article of a much less dangerous nature, with respect to accidents, than is vulgarly believed. Compared with gunpowder, which means are found to keep safe, even in a ship, it may be considered as perfectly harmless. Indeed, it ought to be put on board in a *diluted state*; and, in that case, would produce no

 more

more mischief, should a vessel of it by accident be broken or spilt, than as much strong vinegar. No good objection can therefore be offered against its use on the score of its being dangerous.

The chalk should be in powder, either in a dry state or diffused in water, and the vessels containing it should be so disposed and arranged in regard to those containing the diluted oil of vitriol, that, without needing to hunt for and arrange them in the hour of danger, (when the hurry and alarm might make it impossible to get at them, or to make a proper use of them when found,) no more might be necessary than to turn a cock, somewhere near the cabin, under the immediate eye of the commander or some intelligent officer to allow the acid to convey itself through leaden pipes into the vessels containing the chalk or limestone.

The moment the sulphuric acid comes in contact with the chalk, the latter will be decomposed and part with the carbonic acid, one of its constituent principles, which will escape in the gaseous form, while the lime, its other principle, will remain united to the sulphuric acid.

All the articles connected with this process should be made of lead, or lined with it, as the sulphuric acid exercises little or no action on that metal, which renders it preferable to every other material for the purpose.

The ways in which the parts of such an apparatus might be arranged to advantage are so various, that to insist on any one in particular is unnecessary. The principle of the arrangement is all that need be noticed here. The vessel or vessels containing the acid must be in a higher situation than those containing the chalk or unburnt lime. The latter may be in the hold, or in any situation lower than the former; and pipes of communication, that can be opened or shut at pleasure by turning a cock, as already mentioned, must pass from the vessels containing the acid to those in which the chalk is.

The latter, if in the hold, should have perforated covers, that the fixed air, when liberated from the limestone or chalk by the action of the sulphuric acid, may have a free escape. If above any of the decks, a hose or tube should pass from their tops down to the hold and lower decks for the liberated gas to descend through. These tubes should be secured from injury by covering them with planks, or casing them at the time of their fitting up.

Such an apparatus as is here recommended would be found much more simple than it can possibly appear to be from a description,

description, nor can any fire-engine that has ever yet been constructed be compared with it in point of simplicity. Still less will fire-engines bear comparison in point of efficacy; for the gas that may be liberated by this simple apparatus will infallibly extinguish flames, but the water thrown by a fire-engine seldom succeeds in doing so, and often, as we have before proved on physical principles, increases their fury*.

With a view to the application of the means for extinguishing fires which we have pointed out, care ought to be taken in future in the construction of ships, to fill up, at the decks, all the seams and joinings between the side timbers, that an air-tight line of division may reach from the decks even to the outside planks, to prevent all passage of air behind the linings. But I shall not insist longer on this. The principles I have laid down are sufficiently obvious, and the only wonder is, that they have not been resorted to before this time as a safeguard against fires below and between decks.

As the minor details are perfectly obvious, and cannot fail to present themselves to the minds of those in whose department it may lie to give efficacy to the plan we have proposed, it would be carrying the present paper to an unnecessary length to enter into them. There is one point, however, that must not be overlooked, being connected with the safety of the people:—

After the fire has been extinguished by the means that have been recommended, the air which remains in the interior of the vessel will be found as unfit for maintaining animal life as for maintaining combustion. It would instantly suffocate those who should descend into it; and consists of two non-respirable gases, azotic gas and fixed air. It would be unsafe, therefore, to venture down till after the vessel has been ventilated by opening the ports from the outside of the ship, and by means of bellows and leathern hose thrown down into the hold. In short, any or all the ways now employed for ventilating ships may be employed to remove the foul air, and make it safe for the people to go down.

* It is possible that in some cases a vessel may not be able to afford room for a sufficiency of these materials to furnish a quantity of fixed air equal in volume to her hold, and there may be other objections to taking so large a supply which have not occurred to me; but as in a case of fire it may be necessary to stave the rum and brandy on board, as much oil of vitriol and chalk should always be provided as would furnish a stratum of fixed air able to rise a few inches at least over any spirits that may thus be staved into the hold.

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To determine when the air is sufficiently renewed to admit of this, a lantern with a burning candle should previously be let down at the end of a string. If, after being allowed to remain below for some time, it come up unextinguished, the people may venture down,—and so from deck to deck till they have got every part completely ventilated.

In the preceding observations I have confined myself to fires which may happen below or between decks; but as accidents (though this is perhaps less to be apprehended) may also take place above decks, or below the quarter-deck, &c., where the same means cannot be employed for extinguishing them as in the former case, it may not be thought superfluous to offer a few hints for subduing them when they occur.

It is obvious that the means adapted to accidents below are inapplicable to such as may happen above decks; but it is equally obvious, that, whatever method may be resorted to, it must agree in principle with the former. *A wall of separation must be interposed between the burning materials and the atmosphere, or the flames cannot be extinguished.*

Water, we have already seen, can but seldom be applied with effect for this purpose; and the experience of ages has only served to furnish evidence that it ought not to be trusted to. By its great volatility and its extreme liquidity (even if it could not be decomposed, and so add to the conflagration, as it has already been proved to do,) it is but little fitted to remain on the places where its presence might be serviceable.

Some other matters, therefore, ought to be provided, that may, when employed, be able to serve *as an effectual covering to the burning materials, or to the subjacent parts of the vessel, to prevent the fire from penetrating downwards.* They ought to be such as can be met with in every port, and at the cheapest rate: *such are sand, or mould, or clay.*

The first is perhaps the best, because it can be moistened with water in a moment; though the last, if means could be insured for speedily converting it into a kind of soft pap or puddle, would answer better for throwing upon such burning parts as may be vertical or over head.

Every ship carries some ballast, or might carry as much as would be necessary for the end in view. A part of the ballast ought to be sand or clay, in bags or in small casks, and these ought to be so disposed in the hold, that, in the case of a fire above decks, they may be easily got at, and taken up. A number of buckets should also be provided that the people may not be without the means of hoisting up the sand, &c. even when the rigging takes fire and prevents them from employing a tackle for that purpose.

The sand, as brought up, should be thrown upon the burning materials, especially on those on the deck. Wherever it rests *it will instantly extinguish the flames by preventing the access of atmospheric air.* In fact, the whole deck, especially near the spot on fire, should be covered with sand to the depth of three inches, which will be much more easily accomplished than at first may appear possible; for the people have only to begin at the side of the fire next to them, covering the deck before them with sand, and spreading it with shovels,—thus *making a road for themselves to advance upon,* still covering more of the deck as they advance; an advantage that cannot be commanded by the use of mere water. By these means, even where the deck has been absolutely on fire, the flames will be so effectually extinguished that the people may *instantly walk over the place with perfect safety.*

This will enable them to gain upon the fire, and with mops (especially if a clay puddle instead of water be employed) to dash out the flames on such parts of the sides (under the quarter-deck for instance) or over head as may have caught fire. Let it be particularly observed, that if means can be found to enable the people (sand, &c., would enable them) to advance on the flames, in that case mops with water, or rather water mixed with clay or sand, applied directly to the burning wood, &c., beginning at the part on fire immediately next to them, and proceeding step by step, *will extinguish flame better than water thrown from a fire-engine.* The reason is obvious: water so thrown on runs off by the most direct course it can find, and will not stop to spread itself over prominences or to penetrate into interstices; but when dashed on by means of mops, it has no choice, but must apply itself where it is intended it should.

I do not mean by this that a fire-engine ought in no case to be employed; but when resorted to, its jet should be directed forward further than the people can yet advance, and never in such a manner as to wash away the bed of sand from the decks, or the coating of sand or clay that has been applied by mops to the uprights and parts over head. And the moment the people can advance to apply mops, the engine should be stopt.

In mopping, the process should go on *from the lower parts*

parts upwards; there will then be the least waste of labour, and consequently the greater chance of success: for when a contrary mode is followed (which is always more or less the case with water thrown on by an engine) the parts extinguished are again rekindled by the flames ascending from the lower parts, and which therefore ought first to be subdued.

Clay or sand is recommended to be applied with the water employed in mopping, *that a kind of incrustation may be formed wherever the mops are applied*; but in attending to this, the uniform continuity of the bed of sand, distributed and still distributing on the deck, must be carefully maintained; for this is the chief ultimate security that the men have for saving the hull of the vessel, and consequently their own lives.

The red-hot balls employed by the garrison of Gibraltar to destroy the Spanish floating batteries, were carried from the furnaces to the bastions *in wooden barrows with only a layer of sand interposed; and this was found sufficient to prevent the balls, though in a high state of incandescence, from setting fire to the wood.* A fact so notorious renders it perfectly unnecessary to insist further on the efficacy of sand on the upper deck to prevent the descent of the fire from above.

As to the rigging, there appears but little hope of any means being ever devised to secure it effectually from the effects of a fire above decks, and perhaps the least evil will result from clearing it away in such a case, and getting it overboard as fast as possible. I shall, however, venture to hint at one improvement. The hull is sheathed with copper as a guard against the worm.—Would there be any thing absurd in sheathing the masts with copper to preserve them from fire? I think not: and the expense would be no object *. In that case an iron or copper chain (composed of very long links to make it require the less weight of metal) should accompany each main-stay, to secure the masts in any case when the other rigging might be destroyed by fire. The chains, of course, would require to be less tight than the stays, that they might only act in case of the other being destroyed.

All the upper works ought to be covered with sheet copper to secure the side timbers from being set on fire by any

* This could be done without increasing the weight of the masts; for the copper would add so considerably to their strength, that they might be made much smaller than at present.

accident

accident that may happen above the upper deck. This would effectually answer the end intended; for as to those parts where cross timbers of any kind join the side, and where consequently the fire might communicate, they could *individually* be extinguished in succession, by the means we have pointed out, with much less trouble than if all the upper works were exposed to the accident.

But, though we recommend sheet copper as a covering for the upper works, which surely ought to be as well secured against fire as the lower are against the worm and against water, even if this improvement be not adopted, the means we have pointed out (wet sand, wet mould, and wet clay,) should be provided to enable the people to extinguish the parts in detail till they master the fire; which in many cases they will be able to accomplish when the application of water would not be of the smallest avail. I need hardly add, that when any part of the cargo consists of articles that will of themselves, by the aid of an increased temperature, furnish a sufficient supply of oxygen to maintain combustion without the aid of atmospheric air, (as for instance saltpetre,) such part of the cargo should be disposed low in the hold, and should, if possible, be cut off from all communication with the other parts of the lading, that, should a fire happen, there may be the less chance of its being communicated to that part of the cargo. For this purpose a part of the hold should be set aside, and ought to be boarded up, caulked, and covered with sheet copper. If that cannot be done, a false flooring should be laid in above that part of the cargo, which should be covered over with coarse matting of any kind: over the matting there ought to be a layer of sand or earth of two or three inches in thickness, and over the sand another cover of matting, to prevent it from being displaced by the stowing of the rest of the cargo.

But whether such arrangements are practicable respecting the *oxygenous* parts of the cargo or not, the other general precautions ought to be strictly enjoined, and the people should be appointed and trained to their respective duties in case of fire: books of instructions should also be profusely distributed among the officers and crews, and these instructions ought to be drawn up in a manner so plain and simple that no one may be at a loss *to know what is necessary to be done, whether he understand the scientific principles on which they are founded or not.* But the better the crew in general, and the officers in particular, under-

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stand *the science of extinguishing fires*, the more effectual will their endeavours be in every case.

Though in this essay I have taken no notice of cases of spontaneous ignition, the principles recommended are equally applicable to these as to other cases of fire. Even when the exciting cause of the combustion may be in the cargo itself, it cannot be maintained without the access of atmospheric air.

XVI. *Memoir on the Natural History of the Coco-nut Tree and the Areca-nut Tree; the Cultivation of them according to the Methods of the Hindoos; their Productions, and their Utility in the Arts and for the Purposes of domestic Economy. By M.* LE GOUX DE FLAIX, *an Officer of Engineers, and Member of the Asiatic Society at Calcutta.*

[Concluded from p. 80.]

THE areca-tree is that beautiful palm which Linnæus has so judiciously characterized by giving it the name of *catechu*, because its ligneous nut furnishes *cachou* by means of an easy preparation. This fact, though contradicted by a great number of authors, is no less certain; and I propose to prove it in the course of this paper.

This tree is called *pakmarou* in almost all the languages of the peninsula; in the Hindostanee, the modern idiom of that antient country, it is denominated *soupari*, which signifies the areca-tree.

Though this palm is not so extensively useful in all its parts as the coco-nut tree, it is no less necessary to the Hindoos and the inhabitants of that vast part of the world called the East Indies, who all employ themselves in the cultivation of it.

The areca-tree, without having the beauty and port of the coco-nut tree, is of an elegant and agreeable form. It always rises vertically, and nothing is able to derange its direction. It is attacked by no insects: they are all kept at a distance by the sourness of its juice and of its gum. Its stem is somewhat thicker in the middle, but slender, smooth, and perfectly well proportioned in all its parts.

Its foliage presents an agreeable spectacle by the regular arrangement of its palms, which are known in botany by the name of *spadix*, to characterize their form, and in general that of the branches of this family. The palms in the

the centre of the crown of the areca-nut tree, to the number of seven or eight, stand erect, while the rest, being five in number, incline, rounding themselves by a slight curvature, and by their union form a kind of elegant crown. The leaves of the areca-nut tree, as long as they vegetate, are of a rich and brilliant green colour; the eye can behold them without being fatigued: as they grow old they assume successively an orange colour, which, though it contrasts with the brilliant green of the other leaves, does not offend the sight.

This palm exhibits, as a distinguishing character, very small flowers of a pale apple green colour, with a sweet and agreeable odour, monœcous, disposed in a panicle inclosed in a very thin spath or sheath like that of the coconut tree, which differs from it only by its thickness, and by the other being fibrous. Each of these flowers consists of a calyx half a line in length, with three acute and coriaceous points; a corolla of three petals perfectly similar to the calyx. The male flowers have six and sometimes nine stamina not projecting, and the female an upper ovarium furnished with three styles. The male are placed along small twigs proceeding from a common pedicle which form the panicle. They are parted from each other in groups of five or six; in these intervals is the group of female flowers consisting of from nine to ten. The fruit are all set before the spath opens.

It is seen by this exact description that most naturalists are deceived, or at least have implicitly believed and mutually copied each other, instead of making observations before they wrote. I shall make known the rest of their errors as circumstances furnish me with an opportunity. These facts, though apparently of little importance in regard to a vegetable which we do not possess, are, however, interesting to botany; and this consideration alone has induced me to indulge in this kind of critique, for which I hope I shall be forgiven, as it tends to promote truth.

The areca-nut tree, as well as all the other palms, are reproduced only by the fruit: to thrive, it requires good soil, and this is a character which distinguishes the coco-nut tree from vegetables of this family; it needs less watering, but it requires much more air, and the full enjoyment of the rays of the sun, without which its vegetation would only languish.

Some plants which I cultivated in a large garden, and beneath which I caused animals to be interred, produced much more than usual; yet this increase of fecundity did not

not seem to hurt or exhaust them. I shall here observe, that I obtained the same results in the cultivation of orange and lemon trees, vegetables which we have naturalized in our climates.

The areca-nuts are planted in beds, with their husk or fibrous covering, one by one, in holes five or six inches in depth, and at the distance of twelve or fourteen inches in every direction. The plantation is slightly watered.

On the twenty-ninth or thirtieth day the germ issues from the earth: in form it is similar to that of the coco-nut, but it differs from it by its hardness, and by an acrid or sour taste.

They are generally transplanted in a year or fifteen months: they may be removed without danger even in the seventh year, because they are exceedingly lively, and expand very slowly. Their total duration, however, is only fifty or sixty years; they never go beyond the seventieth. Of all the palms it is the shortest lived. This forms a contrast with the slowness of its vegetation, and particularly with the hardness of its wood, which is surpassed only by that of the *sindi*, called by Linnæus *lontarus*. This palm has given its name to the river which separates Hindostan from Persia, and which, copying the Greeks, we have disfigured by the denomination of the Indus.

As the palms of the areca-tree are not above eight or nine feet long, they can give only a shade of a moderate extent, and which it would appear could not hurt the plants cultivated in the same ground; but experience proves that this shade, though it cover only a small surface, is hurtful, and would certainly occasion the destruction of the most of those vegetables over which it extends: neither men nor animals ever remain under its immediate shelter, especially during the strong heats. Its foliage is so thick that the sun's rays can never penetrate it; the rain water, therefore, which falls on its palms is thrown off; they form a real parapluie.

Though this tree be one of the most beautiful ornaments of gardens, there are few worse neighbours: it attracts all the adjacent juices; and herbs, as already said, cannot vegetate under its shade. The different kinds of banana, however, called commonly the Indian fig, known in botany under the name of *musa*, thrive when planted in the same soil, provided they are not brought too near to the areca-nut tree. I shall add, that I saw at Nigambo, a maritime town in the island of Ceylon, an immense orchard of areca-trees, among which were cultivated coffee shrubs which appeared to me to thrive, as they were exceedingly beautiful.

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An orchard of areca-trees, between which the Hindoos almost always plant bananas, exhibits a charming and delightful prospect. To form a just idea of such a spectacle, it must be seen.

The areca-nut, of which we make no use, might, in my opinion, become an advantageous object of exchange in some of the African markets. This fruit might be rendered useful also in Europe in regard to the arts, as I shall hereafter show.

The leaves of this palm are fit only for being burnt. The ashes which arise from them produce good manure when mixed with the dung of sheep or of cows. They give also by lixiviation a kind of soda, employed for bleaching raw silk. This manure is used with great advantage in the cultivation of the *anil*, or plant which produces indigo.

The trunk, which is exceedingly straight, is employed for rafters to sheds and houses which have pent roofs; it is also split into excellent laths, which are very strong, and never liable to be pierced by worms. A pectoral and antiscorbutic decoction is extracted from the flowers.

The nut or fruit is of different sizes, and of an oval form, spherical or turbinated, according to the species to which it belongs. The largest nuts do not exceed the size of a large pigeon's egg. The bunches generally contain a hundred and fifty; and when the number rises to two hundred and fifty, which is sometimes the case, they are thinned from time to time for the use of persons who set no value on these nuts unless when they are fresh.

The areca-tree begins to produce fruit in its seventh year; but it is never in full bearing till the age of ten. Vigorous trees give annually six, seven, and sometimes ten bunches.

The Hindoos, as well as all the people of Asia from Arabia to China, make a general use of the areca-nut along with the leaves of betel, which by some nations is called *tamboul*, and by the Moguls *pane*. This aromatic plant is so well known that it is needless to describe it: I shall therefore confine myself to giving some details respecting its use, and the properties ascribed to it.

Betel acts a distinguished part in all companies: at courts as well as in the towns, and even in the most wretched hovels, to be deprived of it would to the Indians be a misfortune. At all visits betel is served up; and when friends meet they mutually offer to each other this drug. The Hindoos consider it as a great uncivility to speak to a person of dignity or consideration without chewing this

 mixture:

mixture: it is composed of the betel leaves, areca cut very thin, a little lime spread over the leaves, cardamom, fine spiceries, and cachou, rolled up in small cornets in a leaf of betel. The Indians ascribe to this preparation, which gives to the saliva and lips a very bright rose colour, the property of allaying hunger, perfuming the breath by correcting the humours of the breast and stomach, and of facilitating digestion. This mastication, in their opinion, prevents also perspiration, or speedily restores it; preserves from megrim and pains of the head; strengthens the gums, and secures the teeth from rottenness: in a word, it inspires gaiety, removes spasms and attacks of the nerves, prevents suppression of the menses, and maintains the tone of the fibres. According to my experience, all these ideas are well founded.

That substance which we call *cachou* and the Indians *catecambé*, of which the Portuguese have made *catecambré*, a word adopted by all the Europeans, though corrupted, is the inspissated juice of the areca-nut. Naturalists have entertained a variety of opinions on this object of natural history. In speaking of this drug, which has many properties with which we are unacquainted, I shall endeavour to remove all uncertainty by making known the process for preparing it, and the manner in which the Hindoos extract that concrete juice of the areca known under the name of *cachou*. The process, as I saw it practised in different parts of the peninsula of India, in Ceylon, and even in Pegu, where immense quantities of it are made, is as follows:

The areca-nuts, very fresh, are cut into three or four small pieces with a kind of shears named *katipak*, which signifies the areca-knife: they are then put into a very large glazed earthen-ware pot, as a copper vessel would be dangerous, and one of iron would give to the cachou a black colour and a ferruginous taste. About a third of the quantity of water which the pot is capable of containing is put into it: this water is as much impregnated with selenite as possible, and about twelve or fifteen pounds of the bark of the *kutai babala*, a prickly plant of the family of the *mimosa* and genus of the *acacia*, is infused in it over a moderate fire for twenty-four hours. From this tree the Indians extract a gum similar to that known in Europe under the name of gum arabic. A shrub of the same kind is cultivated in the gardens in the south of France, and is so well known that it is needless to describe it.

As soon as the pieces of areca have been thrown into the pot it is covered, and the cover is luted with clay or paste. After

After strong ebullition of two hours, the fire is lessened till it is nearly extinguished, and it is then kept at that degree for five or six hours. When the pot is completely cold, it is unluted, and the areca is taken out with a large shovel pierced with holes; after which it is suffered to drain on a hurdle of bamboo. The Hindoos in this operation use only utensils of wood, on account of the sour quality of this nut. When the pieces have been well drained, they are exposed to the sun. This kind of areca, which the inhabitants of the upper part of Hindostan, where this palm is not found, call *chikui-soupari*, that is to say, *gummy areca*, is preferred in the use of betel to the raw nut.

The whole aqueous part is evaporated over a slow fire till the juice is inspissated to the consistence of an extract, and till it has such adhesion that it can be held in the hand. It is then taken out to be formed, by kneading, into small pieces as large as the fist, which are dried in the shade that they may not crack and break.

These pieces in several of the dialects of Hindostan are called *batai*, a word to which is joined that of *cambe*; so that the whole signifies a lump of the juice of the areca.

The *catecambre*, to use the expression generally employed by the Europeans, though faulty, receives a preparation at Goa, Batavia, and Macao, which we endeavour to imitate. The Portuguese call it *cachoudé*, from which we have made the word *cachou*. It is obtained in these places by combining the *catecambre* with a proportional quantity of sugar, cinnamon, coco-nut milk, musk, and sometimes a very small quantity of essence of roses.

This paste of the *cachoudé* is of a black colour, and has a sweet perfume: it is formed into square tablets of different sizes, and is a very important object of commerce to the town of Goa. The European women, habituated to the use of betel, and the Mogols, prefer it to crude cachou or catecambre. The Hindoos make no use of it: they employ only the latter, after having purified it with the betel, either as a topic or internally.

Catecambre is useful in many arts, and even in medicine, in which it is employed on various occasions.

The condensed juice of the areca inspissated with gumben, furnishes a very good resin, which the fishermen employ for the preservation of their nets and fishing-lines. It preserves wood from worms.

It is used with astonishing success for burns, against apthæ, and in general all kinds of ulcers and fungous excrescences; in a word, for deafness, by diluting it with human milk, which is injected into the ears. The efficacy of this remedy has been proved to me by repeated experiments. In a word, all the medical properties of this substance, when taken internally, are so well known to the Europeans that it is needless to enumerate them. The Hindoos, who ascribe to it the same virtues, apply it to the same purpose.

Artists who paint cotton cloth, and dyers, employ it with great advantage for several purposes relative to their arts. The former use it as the base of the composition of a gum varnish, which they apply to those parts of the cloth which are not to be painted. To explain this process it is necessary to observe, that the painters of chintz do not use blocks for imprinting the colours; they are applied with a brush, or the cloth receives the red and blue colours by immersion; a method of working very different from that of the Europeans, and of which we have no idea. I am convinced of what I advance, either by visiting our manufactories, or reading the works which treat of this art in our country, and which speak of the processes used in India. I have examined in particular the *Annales des Arts et des Manufactures**, where it is said "that the Indians apply the red colour, by immersing the cloth first in a mordant, &c." This is not correct; for this colour is always applied, as I have said, by immersion, and warm. It is very surprising that we should have ideas so incorrect on the methods and processes used in the arts by these people, for more than three centuries that we have had an opportunity of being better acquainted with them.

It is with the catecambre also that they compose the mordant which fixes on cloth the gold and silver leaf applied to it. This kind of chintz is made at Mazulipatnam; and it is impossible to describe the richness, elegance, and strength of this work. These cloths may be washed without hurt to the gilding, in the same manner as the other Indian stuffs are washed without injuring the brilliancy of the colours. This art is valuable, and we have not attempted to imitate it. The dyers extract also from the catecambre, combined with the juice of other plants, lilac mordoré, puce, and maroon colours, which are employed for dyeing silk, woollen, and cotton stuffs.

It is employed with such success in the art of tanning, that in five days leather is perfectly tanned and prepared. The English, for some years past, bring it from India for their tanneries: they use it with great advantage in order to simplify their labour and to improve their leather.

* No. 37.

XVII. *Ex-*

XVII. *Experiments on preserving Potatoes. By* J. De Lancey, *Esq. of the Island of Guernsey*.*

Early in March 1803, I observed my winter's stock of potatoes, which I had dug in October 1802, sprouted from the mildness of the weather in this island: it occurred to me, that, by putting them under ground, vegetation might be retarded. I accordingly took indiscriminately from my pile about three dozen, and in my court-yard dug a hole two feet and a half deep, under the protection of a south-west wall, where the rays of the sun prevail for a few minutes only during the day at any season of the year; then, with three pantiles, one at bottom, I laid most of the potatoes in the hole, and placed the other two tiles over them in form of the roof of a house: they not containing all, I threw the remainder carelessly into the hole (having no great confidence in my experiment), covering the place over to its usual level. Business calling me from home during part of the summer, I neglected looking after my small deposit: but, on the 21st of January 1804, nearly eleven months after covering them, I had the curiosity to examine them; when, to my astonishment, I found them (two or three excepted, which were perforated by the ground-worm, though firm) all perfectly sound, without having in the least vegetated, and in every respect fit for the purpose of sets and the use of the table, as I have boiled a few, and found them similar in taste and flavour to new potatoes. I further pledge myself that they were perfectly firm. I have still some of them by me, for the inspection of my friends, who all agree with me that they are so.

Guernsey, Jan. 24, 1804.

J. De Lancey.

Sir,

I have received the favour of your letter of the 7th inst. conveying the thanks of the society, for my experiments in the preservation of potatoes, which is highly gratifying to my feelings. I avail myself of the opportunity of a friend going to London, to send three of the potatoes as a confirmation of their being fit for sets, as they are actually sprouting. I have still a few left, which I shall plant.

The potatoes I send, I pledge myself to you are of the growth of 1802, when I first dug them out of the ground: neither have they been under the ground since January 21,

* From *Transactions of the Society of Arts*, &c. 1804.

1804,

1804, but lain in a closet. I have buried some others of the last year's growth, with a few carrots and parsnips, in a similar manner to my former experiments, the result of which I shall make known to the society.

Guernsey,
May 17, 1804.

I remain, sir,
Your obedient servant,
J. DE LANCEY.

Charles Taylor, Esq.

The above potatoes were examined before a committee of the society on the 30th of July 1804, and found to be in a state fit for vegetation.

CHARLES TAYLOR, Secretary.

XVIII. *Processes for preparing Lake from Madder. By Sir* H. C. ENGLEFIELD, *Bart.**

THE want of a durable red colour, which should possess something of the depth and transparency of the lakes made from cochineal, first induced me to try whether the madder root, which is well known to furnish a dye less subject to change by exposure to air than any other vegetable colour, except indigo, might not produce something of the colour I wanted.

Several of the most eminent painters of this country have, for some time, been in the habit of using madder lakes in oil pictures; but the colours they possessed under this name were either a yellowish red, nearly of the hue of brickdust, or a pale pink opake, and without clearness or depth of tint, and quite unfit to be used in water-coloured drawing, which was the principal object of my search.

My first attempts were to repeat the process given by Margraf in the memoirs of the Academy of Berlin; but the colour produced by this mode was of a pale red, and very opake, although the eminent author of the process states the colour he produced to be that of "*le sang enflammé*," which probably means a deep blood colour. It may, however, be observed, that colours prepared with a basis of alumine will appear much deeper when ground in oil than they do in the lump, the oil rendering the alumine nearly transparent. This advantage is, however, lost in water colours. On examining the residuum of the madder

* From *Transactions of the Society of Arts*, &c. 1804. The society voted their gold medal to sir H. C. Englefield for this communication.

root,

root, after it had been treated in Margraf's method, it appeared tinged with so rich a red, that it was obvious that by far the greater part of the colour still remained in it, and that the most powerful and beautiful part. To extract this, several ineffectual trials were made, which it would be useless to enter into; but, on attentively examining the appearances which took place on infusing the madder in water, I began to suspect that the red colouring matter was very little, if at all, soluble in water, and that it was only mechanically mixed with the water when poured on the root, and suspended in it by the mucilage, with which the root abounds.

A very small quantity, therefore, can be obtained by any infusion or decoction, as the greater part sinks down on the root, or remains with it on the sieve, or in the bag, through which the infusion or decoction is passed to render it clear. I therefore was induced to try whether, by some merely mechanical means, I could not separate the colouring matter from the fibrous part of the root. In this attempt my success was fully equal to my hopes; and, after several trials, I consider the process I am now about to describe, as the most perfect I have been able to discover.

Process 1.

Enclose two ounces, troy weight, of the finest Dutch madder, known in commerce by the name of crop madder, in a bag capable of containing three or four times that quantity, and made of strong and fine calico. Put it into a large marble or porcelain mortar, and pour on it about a pint of cold soft water. The Thames water, when filtered, is as good as can be used; it being very nearly as pure as distilled water, at least when taken up a very little way above London. With a marble or porcelain pestle, press the bag strongly in every direction, and, as it were, rub and pound it as much as can be done without endangering the bag. The water will very soon be loaded with the colouring matter, so as to be quite opake and muddy. Pour off the water, and add another pint of fresh water to the root, agitating and triturating it in the manner before described; and repeat the operation till the water comes off the root very slightly tinged. About five pints of water, if well agitated and rubbed, will extract from the root nearly the whole of its colour; and if the residual root be taken out of the bag and dried, it will be found to weigh not more than five drachms apothecaries weight; its colour will be a kind of light nankeen, or cinnamon, and it will have entirely

tirely lost the peculiar odour of the root, and only retain a faint woody smell.

The water loaded with the colouring matter must be put into an earthen or well tinned copper, or, what is still better, a silver vessel, (for the use of iron must be carefully avoided through the whole,) and heated till it just boils. It must then be poured into a large earthen or porcelain bason, and an ounce troy weight of alum dissolved in about a pint of boiling soft water must be poured into it, and stirred until it is thoroughly mixed. About an ounce and a half of a saturated solution of mild vegetable alkali should be gently poured in, stirring the whole well all the time. A considerable effervescence will take place, and an immediate precipitation of the colour. The whole should be suffered to stand till cold; and the clear yellow liquor may then be poured off from the red precipitate. A quart of boiling soft water should again be poured on it, and well stirred. When cool, the colour may be separated from the liquor by filtration through paper in the usual way; and boiling water should be poured on it in the filter till it passes through of a light straw colour, and quite free from any alkaline taste. The colour may now be gently dried; and when quite dry it will be found to weigh half an ounce; just a fourth part of the weight of the madder employed.

By analysis, this colour possesses rather more than 40 per cent. of alumine. If less than an ounce of alum be employed with two ounces of madder, the colour will be rather deeper; but if less than three quarters of an ounce be used, the whole of the colouring matter will not be combined with alumine. On the whole, I consider the proportion of an ounce of alum to two ounces of madder, as the best.

Process 2.

If, when the solution of alum is added to the water loaded with the colouring matter of the root, the whole be suffered to stand, without the addition of the alkali, a considerable precipitation will take place, which will be of a dark dull red. The remaining liquor, if again heated, will, by the addition of the alkali, produce a rose-coloured precipitate of a beautiful tint, but wanting in force and depth of tone.

This is the process recommended by Mr. Watt, in his Essay on Madder, in the *Annales de Chymie, tome* 7; and this latter colour is what may, perhaps with propriety, be called *madder lake*. But, although the lighter red may be excellent

excellent for many purposes, yet I consider the colour produced by the union of the two colouring matters, as given in the first process, as far preferable for general use, being of a very beautiful hue when used thin, and possessing unrivalled depth and richness either in oil or water, when laid on in greater body.

If but half an ounce of alum be added to the two ounces of the root, the first precipitate will be nearly similar to that when an ounce is employed; but the second, or lake precipitate, will be less in quantity, and of a deeper and richer tint. In this case the whole of the colouring matter, as before observed, is certainly not combined with the alumine; for, on adding more alum to the remaining liquor, a precipitate is obtained of a light purplish red. In this process, when two ounces of madder and an ounce of alum are used, the first precipitate has about 20 per cent. of alumine, and the second, or lake precipitate, about 53 per cent.; but these proportions will vary a little in repetitions of the process.

Process 3.

If the madder, instead of being washed and triturated with cold water, as directed in the foregoing process, be treated in exactly the same manner with boiling water, the colour obtained will be rather darker, but scarcely of so good a tint; and the residuum of the root, however carefully pressed and washed, will retain a strong purplish hue; a full proof that some valuable colour is retained in it, probably fixed in the woody fibre by the action of heat. Mr. Watt, in his excellent Treatise on Madder above mentioned, observes, that cold water extracts the colour better than hot water; and I have reason to suspect that a portion of that colouring matter, which produces the bright red pigment, distinguished before by the name of madder lake, remains attached to the root when acted on by boiling water.

Process 4.

If to two ounces of madder a pint of cold water be added, and the whole be suffered to stand for a few days (three or four days) in a wide-mouthed bottle, lightly corked, in a temperature of between 50° and 60°, and often shaken; a slight fermentation will take place, the infusion will acquire a vinous smell, and the mucilaginous part of the root will be in a great degree destroyed, and its yellow colour much lessened. If the whole be then poured into a calico bag, and the liquor be suffered to drain away without pressure, and then the root remaining in the bag be heated

with

with cold water, &c. exactly as directed in the first process, the red colouring matter will quit the root with much greater ease than before fermentation. It will also be equal in quantity to that afforded by the first process, but of a much lighter red. This difference of tint appears to be owing to a destruction of a part of the lake by the fermentation of the root; for if the colours from the fermented root be obtained separate, as in Process 2, the first precipitate will not sensibly differ from that obtained from the unfermented madder, but the second, or lake, will be of a very light pink. This process, then, is not to be recommended.

Spanish and Smyrna Madders.

Spanish madder affords a colour of rather a deeper tone than the Dutch madder, but it does not appear to be of so pure a red as the Zealand crop madder.

The Smyrna madder is a very valuable root. The colour produced from it by Process 1, is of a deeper and richer tint than any I have obtained from the Dutch madder. The quantity produced from two ounces is only three drachms twenty-four grains: but this is not to be wondered at; for as this madder is imported in the entire root in a dry state, and the crop madder of Zealand consists principally of the bark, in which probably the greatest part of the colouring substance resides, there is every reason to think that the Smyrna madder really contains a greater proportion of colour than the Zealand in equal weights of the entire root.

The products of Process 2, prove that the lake of the Smyrna madder is more abundant in quantity and of a richer tone than that of the Dutch root; for, from two ounces of Dutch madder the first precipitate was two drachms, and the lake was two drachms and forty-eight grains; whereas, from two ounces of the Smyrna root the first precipitate was one drachm and twenty-four grains, and the lake was two drachms and twenty-four grains. The proportion of the lake to the other colour is therefore much higher in the Smyrna than in the Dutch root.

Fresh Madder.

The colour may be prepared from the recent root; and it will be of a quality equal, if not superior, to any other. The difficulty of procuring the fresh root has prevented me from making as many experiments on it as I could have wished. I procured, however, a small quantity of the best roots packed in moss from Holland, and the following process answered perfectly well.

Eight

Eight ounces of the root, having been first well washed and cleaned from dirt of all kinds, were broken into small pieces, and pounded in a bell-metal mortar, with a wooden pestle, till reduced into an uniform paste. This paste being inclosed in a calico bag, was washed and triturated, as described in the first process, with cold water. About five pints seemed to have extracted nearly the whole of the colour. To the water thus loaded with colour, and boiled as before, one ounce of alum, dissolved in a pint of boiling water, was added, and the alkali poured on the whole till the taste of the mixture was just perceptibly alkaline. The colour thus obtained, when dry, was of a very beautiful quality.

The success of this experiment, which was twice repeated with the same result, has led me to hope that it is not impossible that the mode of obtaining the colour from the fresh root here described, may be productive of advantages for more extensive use than I had in view when first I attempted to obtain a pigment from madder. Many tracts of land in this country are as well adapted to the growth of this valuable article as the soil of Holland can be; and the cultivation of it, which has more than once been attempted to a considerable extent, has been laid aside, principally from the expense attendant on the erection of drying-houses and mills, and the great expense and nicety requisite for conducting the process of drying. But should the colour prepared in the mode just described be found to answer the purposes of the dyers and calico-printers, the process is so easy, and the apparatus required for it so little expensive, that it might be in the power of any grower of the root to extract the colour: besides which, another great advantage would be obtained; the colour thus separated from the root may be kept any length of time without danger of spoiling, and its carriage would be only one-fourth of that of the root. I am, moreover, thoroughly inclined to believe, that in the present mode of using the root, a very considerable part of the colour is left in it by the dyers; and, should this prove to be the case, an advantage much greater than any hitherto adverted to may arise from the process here recommended.

Should it be attempted to obtain the colour from the fresh root, on an extensive scale, I should recommend that the root be first reduced to as uniform a pulp as possible, by grinding or pounding. To this purpose it is probable that the cider-mill would answer perfectly well; and its extreme simplicity is a great recommendation. For the purpose of

trituration,

trituration, bags of woollen, such as are used in the oil-mills, would probably answer as well as calico, and they would be much cheaper and more durable. A large vat, with stampers, would be easily constructed, by those who are conversant in mechanics, for the holding them and pressing them in water; and when the colour was boiled and precipitated, the flues of the boilers might easily be formed into convenient drying-tables, without any additional expense of fuel. The part of the process which I consider as of the greatest importance, and as being the essential advantage of my methods over all those which have come to my knowledge, is the trituration or pressing of the root in water; and I believe that the colouring matter of the root has not been hitherto considered as so nearly insoluble in water as I have reason to think it is.

It were much to be wished that in the present advanced state of chemistry some skilful analyser would investigate the properties of this very useful root, in which perhaps it will be found that there are three, if not four, different colouring substances. Such are the processes and views, which I have thought it not improper to submit to the consideration of the Society of Arts, &c.

I have only now to describe the specimens which accompany this paper; assuring the society that they have been all prepared by my own hands entirely, and that I am therefore responsible for their having been produced by the processes stated, without the addition of any foreign matter whatever, excepting the cake ground up with gum, and the bladder of oil-colour, which were prepared from the colour which I gave him, by Mr. Newman, of Soho-square, whose skill and fidelity are too well known to need any testimony in their favour.

It may be proper to add, that all the colours produced from the Dutch madder were prepared from the same parcel of crop madder, in order that the differences in them might proceed from the processes, and not from a variation in the qualities of the root, which, in different specimens, will produce different shades of colour under the same mode of treatment.

1. Dutch madder, treated by Process 1st.
2. Ditto .... Process 2d.
3. Ditto .... Process 3d.
4. Ditto .... Process 4th.
5. Dutch madder, two ounces; alum, half an ounce; treated by Process 2.

6. Dutch

6. Dutch madder, two ounces; alum, one ounce; fermented two days, and then treated by Process 2.
7. Produce of Process 1, ground in gum by Mr. Newman.
8. Produce of Process 1, ground in oil by Mr. Newman.

S—1. Smyrna madder, by Process 1.
S—2. Ditto .... Process 2.
S—3. Ditto .... Process 3.
S—4. Ditto .... Process 4.

Certificates accompanied the foregoing description, from Mr. Cotman and Mr. Munn, testifying the merits of sir H. Englefield's madder lakes, as water-colours; and also from Messrs. West, Trumbull, Opie, Turner, Daniel, and Hoppner, speaking greatly in its favour, where it has been tried in oil-colours.

XIX. *A new Process for separating Gold and Silver from the baser Metals**.

HITHERTO this process has always been, as far as I have understood it, attended with considerable difficulty in the execution; but, by that which I am about to describe, is done with exact certainty. It was discovered and communicated to me by a gentleman in this neighbourhood. The process consists in mixing not less than two parts of powdered manganese with the impure or compound metal, which should be previously flattened or spread out so as to expose as large a surface as possible, and broken or cut into small pieces for the convenience of putting the whole into a crucible, which then is to be kept in a sufficient heat for a short time. On removing the whole from the fire, and allowing it to cool, the mixture is found to be converted into a brownish powder, which powder or oxide is then to be mixed with an equal proportion of powdered glass, and then submitted in a crucible to a sufficient heat, so as to fuse the whole; when the perfect metals are found at the bottom in a state of extreme purity; a circumstance of no small importance to the artist and the chemist; the latter of whom will find no difficulty in separating the one from the other with so little trouble compared with the usual processes, that I have no doubt it will always be practised in preference to the cupel.

* Extracted from a Communication by Dr. William Dyce, of Aberdeen, inserted in the twenty-second volume of the Transactions of the Society of Arts, &c.

XX. *Twenty-first Communication from Dr.* THORNTON, *relative to Pneumatic Medicine.*

March 15, 1805.
No. 1, Hinde Street, Manchester Square.

To Mr. Tilloch.

DEAR SIR,

I HAVE the honour to inclose you the following remarkable case *cured* by the inhalation of vital air.

A Deviation from the common Course of Nature.

Mary Tame, æt. 16, residing at No. 17, East-street, when fourteen years of age, instead of being regular in the usual way, had a copious discharge of blood from both breasts. These discharges, for nearly the space of two years after, came on regularly once a fortnight, or three weeks, attended with violent pains in the back and loins, and continued the regular period of three days. The quantity of blood so discharged was about the same as under the usual circumstances. It distilled gradually from the nipples as milk from an overloaded breast, but without pain. At this period the face appeared turgid with blood. I witnessed myself this discharge of blood from the breasts, and have no doubt of the reality of so extraordinary a phænomenon. Having first invited the blood from the superior to the inferior parts by aloetic cathartics, I next ordered the inhalation of vital air with tonics; and this phænomenon has not again occurred, it is now four months.

Observations on this Case by Dr. Thornton.

1. Each part of the body obeys its adapted stimulus learned from experience. Thus the eye is stimulated by light, the ear by sound, the stomach by food; and the most diffusible stimulus is the oxygen in the arterial blood. Thus, if the liquid in the bladder escape into the cavity of the abdomen, it excites the highest derangement, although a proper stimulus to that reservoir. Thus, if water, or even milk, be injected into the veins in a small portion, according to the quantity is the derangement of the frame; and if jalap or emetic tartar be injected into the circulation, each will be determined to the respective organs, as though they had been received into the stomach and bowels. Thus it is, that rhubarb and aloes stimulate the lower parts of the intestinal tube, especially the rectum, inviting the blood to the aorta descendens.

2. The

2. The blood, being then properly propelled throughout the whole frame, whose energies were increased by bark, serpentaria, myrrh, and afterwards steel,—every organ resumed its proper functions, and the aberration ceased.

3. Mr. Morton*, a gentleman whose mind rises much superior to the delight of low persons, has certainly misunderstood the science of pneumatic medicine when he attempted to hold it forth to ridicule on the stage. To wipe away, as far as my voice reaches, the *odium* he would attach to the practice, I shall beg leave to refer the philosophic world to what I published in the year 1799.—*Vide* Philosophy of Medicine, vol. i. p. 545, fourth edition.

Dr. Brown's golden Maxim.

"As the most healthy state of man is occasioned not by the operation of any *one*, or of *a few exciting powers*, but by the *united operation of them all*; so neither is its re-establishment to be effected but by the same *united operation of all the remedies*, the last of which come to be the ordinary means of the support of the healthy state."

Upon this principle, my practice is, in all *asthenic* diseases requiring more than the usual routine, to endeavour for the stomach to be braced and strengthened by bark, myrrh, steel, or zinc; the blood improved, and hence the whole vascular system, by the inhalation of vital air; the mind to be exalted with the hopes and novelty of cure; a generous mode of living enforced; and thus every energy of the frame to be roused into action. But the public mind has been long poisoned by the doctrines of *specifics*; and as "what is good for every thing is good for nothing," for *quackery* advertises the same *specifics* for every disease, so no credit will be given by many to the healing powers of the constitution, and less to those means which act *on the constitution*, and thus *on a variety of diseases of the same class*: but in the issue, "*truth and science will prevail*:" and as constitutions are differently affected by the same means, hence the necessity of *discrimination* in the practitioner, and hence our prophecy, that the extinction of *quackery* is at no great distance in an enlightened age. Steering is very simple; move the rudder ever so little to the right or left, and the ship turns in a contrary direction; put it straight, and the ship moves straight: but God has so connected mankind, that even the conduct of this simple

* The wit aimed at by Mr. Morton, in his School of Reform, is by the introduction of one Dr. OXYGEN, who gives his patient, by mistake, instead of a certificate of Cures, the bills of *Mortality*!

process

process requires some experience: and it will be found to be the same with engraving, writing, tuning of instruments, hair-dressing, and *physic*."

4. So far, therefore, is the application of *vital air* from deserving to be branded on the stage as quackery, that it most perfectly accords with the Brunonian system, now almost universally received.

5. Perhaps of all remedies for the cure of diseases, when properly administered, this is the most harmless and efficacious. Some have occasionally had recourse to it for five years past, and one gentleman, in an obstinate disease, daily, for six months.

6. I shall conclude, therefore, these remarks with saying, that however it may be estimated by Mr. Morton and others, the philosophic world will, I am sure, wish to see this remedy continued; and I shall content myself with their approbation, and a consciousness of the integrity of my own motives.

XXI. *Communication from Mr.* Ince, *Surgeon, relative to Pneumatic Medicine.*

March 15, 1805.
No. 29, York Buildings, New Road.

To Mr. Tilloch.

SIR,

I would thank you to insert the following cure in your Magazine.

A Case of Ulcerations in the Leg, cured by Vital Air.

Mrs. Mead, æt. 45, living at Kinsbray, near Edgware, had five large ulcers in the left leg, which extended along the calf to the ancle, and had resisted every attempt made to cure them for two years. She was advised by Dr. Thornton to inhale the vital air, and place herself under my management. He ordered her bark, steel, with myrrh, as medicine, and the common unguents were employed to the ulcers, and occasionally a weak solution of oxygenated silver. The ulcers in a few days, from an ichorous discharge, put on an healthy appearance, and the cure of the ulcerations was perfected in less than three weeks. Her limb has since remained sound; it is now upwards of six months, and her health is completely re-established.

I have the honour to be, sir,
Your obedient humble servant,
Henry Robert Ince.

XXII. *Ex-*

XXII. *Extract of a Memoir on the Temperature of the Water of the Sea, both at the Surface and at different Depths, along the Shores and at a Distance from the Coast. By* M. F. Peron, *Naturalist on the French Expedition to New Holland*.*

"Of all the experiments in natural philosophy," says M. Peron, "there are few the results of which are more interesting and more curious than those which form the subject of this memoir. The meteorologist must derive from them valuable data in regard to atmospheric observations in the middle of the ocean: they may furnish to the naturalist knowledge indispensably necessary in regard to the habitation of the different tribes of marine animals; and the geologue and philosopher will find in them the most certain facts in regard to the propagation of heat in the middle of the seas, and of the physical state of the interior parts of the globe, the deepest excavations of which can scarcely go beyond the surface. In a word, there is no science which may not derive benefit from the results of experiments of this kind. How much then ought we to be surprised that they have hitherto excited so little attention!"

Proceeding then to an account of the observations which may be made at the surface of the sea, and which he himself pursued from lat. 49° north to lat. 44° south, repeating them four times a day,—at six in the morning, at noon, at six in the evening, and at midnight,—M. Peron deduces from them the following results:—"The temperature of the surface of the sea, colder at noon than the atmosphere, and warmer at midnight, is nearly in equilibrium with that of the morning and evening, in such a manner, however, that the mean term of a given number of observations is more considerable for the water of the sea."

By a very happy application of these first results M. Peron easily proves, that the supposed heating of the waves is a mistake of sensation produced by the more considerable cooling in a given time of the atmosphere than of the waves. The proof he has adduced seems to be as simple as it is incontestable. This prejudice, which is as old as Aristotle, and which the incomplete experiments of Forster and Irving did not admit of being entirely rejected, notwithstanding the supposition of a principle contrary to

* From the *Journal de Physique*. Brumaire, an 13.

those advanced by sound philosophy, will in future be entirely proscribed; and M. Peron substitutes in its stead this consequence of the experiments which he made on this subject.

The *relative* temperature of the water of the sea increases during its agitation, but its *absolute* temperature always decreases.

The second section of M. Peron's memoir contains an account of experiments which may be made at great depths. The author here establishes a great distinction between experiments of this kind made along the coasts, and those repeated in the open sea at a great distance from the continents and large islands. From his examination of experiments of the first kind, those made along the coasts by Saussure and Marsigli in the Mediterranean; by Donati in the Adriatic; and by himself in the sea which washes the western coast of New Holland, it results that, *cæteris paribus*, the temperature of the sea along the coasts is greater at equal depths than in the middle of the ocean; that it seems to increase as one approaches the shores; and that these writers themselves furnish objections against the uniform temperature of 10°, which has hitherto been admitted as the mean temperature of the interior part of the globe either in its solid or liquid part.

For the above experiments, and those about to be mentioned, M. Peron employed an apparatus, invented by himself, which appears indeed to be superior to all those hitherto employed for the same purpose. By arranging successively around his thermometer a stratum of air, glass, charcoal, wood, tallow, and resin, he was able to unite under a very small volume all those bodies which are the worst conductors of caloric, and in such an order, that this property of being a bad conductor necessarily became still less; M. Peron having set out from this principle, that caloric, as well as electricity, can with the greater difficulty penetrate a stratum of a given thickness, as the bodies which compose it are more different in their nature. This part of the author's labour has been universally approved.

The author then proceeds to the temperature of the sea at great depths:—"We have now arrived," says he, "at the third and ninth part of the experiments which might be attempted on the heat of the sea water. It is also the most delicate and the most interesting, in consequence of the valuable data it may furnish us in regard to the internal physical state of the globe at depths which cannot be reached in the solid part." He then gives the result of the experiments

ments which he made successively in the neighbourhood of the equator at the depth of 300, 500, 1200, and 2144 feet.

This consequence, which no doubt is new and very interesting, results, namely, that the temperature of the water of the sea decreases in proportion to the depth. The difference obtained by M. Peron in his last observation at the depth of 2144 feet, was 19° of Reaumur between the temperature of the surface and that at this depth.

Having given the result of his particular observations, the author examines the experiments of the same kind which were made before. "If we except," says he, "the celebrated traveller whose return has excited universal joy among all the friends of science, and who attended also to this object, but whose results and apparatus I am still unacquainted with *, three persons only have made accurate observations in the open sea on the temperature of the waters, viz. Irving, Forster, and myself. By a very uncommon accident, our experiments were repeated at three of the most opposite points of the globe. By Irving, during the voyage of the honourable Mr. Phipps, afterwards lord Mulgrave, to the North Pole; in the expedition of captain Cook to the South Pole, they were continued by Forster to the 64th degree south, beyond which no navigator had been able to advance; and I myself, placed, as I may say, between these extremes, made all my experiments in the neighbourhood of the equator. It would certainly be difficult to find any other fact in physics where so many points of comparison can be enumerated; and yet we shall find the results of these different experiments reproduced, every where analogous to those which I shall here exhibit."

In Forster's experiments, indeed, we find that the temperature of the sea decreases successively from the 16th of Reaumur to the term zero of the same thermometer, and it continually decreases the greater the depth. The ingenious experiments of Dr. Irving reproduce the same results with still more interest, since at the depth of 3,900 feet he obtained two degrees below zero of Reaumur's scale.

M. Peron then takes a rapid view of the very incomplete experiments of Ellis, Wallis, Bradley, and Baldh, and the anonymous ones collected by Kirwan: he is satisfied with observing, that they all concur to confirm the principal results of his own experiments, and those of Forster and Irving. He concludes with a general view of the same re-

* Mr. Humboldt was still at Bourdeaux.

sults, and of the geological consequences which may be deduced from them.

The temperature of the sea water decreases according to the depth. All the results of the observations hitherto made on this point, concur in proving that the deepest gulphs of the sea, as well as the summits of the highest mountains, are continually covered with ice, *even under the equator:* whence it must necessarily follow that a very small number of animals and vegetables can live there, if any exist at all. "Analogous results have proved," continues the author, "that a similar cooling existed at great depths in the principal lakes of Swisserland and Italy. The observations of Georgi, Gmelin, Pallas, Ledyard, and Patrin, in Siberia, and those of that accurate observer Saussure, prove that the case in regard to the bosom of the earth has always been the same when experiments have been made at the bottom of mines. Similar results were obtained in America by Shaw, Mackenzie, Umfreville, and Robson. Ought not so many facts united to leave us in some uncertainty in regard to this theory, so generally admitted, of an interior central fire which maintains a uniform and constant temperature of 10° in the whole mass of our globe, whether solid or liquid? Shall we not one day be obliged to recur to this old principle, so natural, and so agreeable besides to all the phænomena which daily take place before our eyes? The only source of the heat of our globe is that great luminary by which it is enlightened: without it, without the salutary influence of its rays, the whole of our earth, soon congealed in every point, would be only an inert mass of ice. The history of the winter of these polar regions would then be that of the whole planet."

However singular this last consequence of M. Peron may appear, however contrary it may be to our present ideas in regard to the internal state of our globe, it must be allowed that the facts collected by this naturalist in support of his opinion are so numerous, and there prevails so much agreement in all the results obtained by observers, so different in so many different places, and at periods so distant, and with apparatus so little susceptible of comparison, that no objection can be made to it by the respectable body before whom it is laid.

In the last place, the experiments of M. Humboldt, entirely analogous to those of M. de Peron, to whom the Prussian traveller was eager to pay a public tribute of praise, give it a new degree of weight.

"This

"This consequence of M. Peron," say the commissioners of the Institute, "appears to us the more probable, as it now proves the origin of those mountains of ice which in the polar regions have hitherto impeded the progress of the European navigators: it makes us readily comprehend how masses of ice, detached from the depths of the sea to float at the surface, can constitute in these regions projecting mountains of ice which simple congelation could never effect under that form."

This ingenious theory, therefore, of an interior central fire maintaining a uniform temperature of about 10 degrees throughout the whole mass, whether solid or liquid, of our globe, experiences at present the fate reserved, soon or late, for almost all human theories. The calculations of Leibnitz, who first conceived it; the eloquence of Buffon, who decided his triumph, ought however, it would seem, to have secured to it a longer and more peaceable existence.

We shall terminate this extract with the opinion given on this subject by the commissioners of the Institute charged to give in a report upon it. "The memoir of M. Peron," say they, "seems to us to deserve great attention from philosophers: it is written with method, precision, and clearness. The experiments, of which the author gives an account, seem to have been made with that care and attention which are capable of ensuring the exactness of the results which they have furnished. We are therefore of opinion that this memoir deserves the approbation and even the praises of the class, and that it ought to be printed among those *des Savans Etrangers*. We will venture to add, that this is not the only claim of M. Peron to the gratitude of all those who are fond of the sciences; his labours during his voyage will considerably tend to enlarge the boundaries of the natural sciences."

XXIII. *An Analysis of the magnetical Pyrites; with Remarks on some of the other Sulphurets of Iron.* By CHARLES HATCHETT, *Esq. F.R.S.**

§ I.

OF the various metallic sulphurets which constitute one of the grand divisions of ores, none appear to be so universally dispersed throughout the globe as the sulphuret of

* From the *Transactions of the Royal Society of London for* 1804.

iron, commonly called *martial pyrites*; for the species and varieties of this are found at all depths, and in all climates and soils, whether antient, or of alluvial and recent formation. It is remarkable also, that, under certain circumstances, this sulphuret is daily produced in the humid way; an instance of which, a few years back, I had the honour, in conjunction with Mr. Wiseman, to lay before this society *; and although, in regard to pecuniary value, the pyrites of iron may be considered as comparatively insignificant, yet there is every reason to believe, that in the operations of nature it is a substance of very considerable importance.

§ II.

The species and varieties of martial pyrites are in general so well known, and have been so frequently and accurately described, as to figure, lustre, colour, and other external characters, that it would be totally superfluous here to give any detailed account of them. One of the species, however, merits peculiar notice, as possessing the remarkable property of strong magnetic polarity; and, although it has been described by modern mineralogists †, it does not appear to have been as yet subjected to any regular chemical examination; so that, whether it be a sulphuret of iron inherently endowed with the magnetical property, or a sulphuret in which particles of the ordinary magnetical iron ore are simply but minutely interspersed, has to this time remained undecided.

This species is known by the name of *magnetical pyrites*, and is called by the Germans *magnet-kies*, or *ferrum mineralisatum magnetico-pyritaceum*.

It is most frequently of the colour of bronze, passing to a pale cupreous red.

The lustre is metallic.

The fracture is unequal, and commonly coarse-grained, but sometimes imperfectly conchoidal.

The fragments are amorphous.

The trace is yellowish gray, with some metallic lustre.

It is not very hard; but, when struck with steel, sparks are produced, although with some difficulty.

It is brittle, and is easily broken.

This pyrites has been hitherto found only in some parts of Norway, Silesia, Bavaria, and especially at Geier, Mef-

* *Transactions of the Royal Society of London for* 1798, p. 567.

† Kirwan, vol. ii. p. 79. Widenmann, p. 792. Emmerling, 2d edit. tome ii. p. 286. Karsten, p. 48. Brochant, tome ii. p. 232.

fersdorf, and Breitenbrunn in Saxony; but, having received some specimens from the right honourable Charles Greville, F.R.S., I was struck with their resemblance to the pyrites of Breitenbrunn, which happened at that time to be in my possession; and, upon trial, I found that they were magnetical, and agreed with the latter in every particular. Their magnetic power was such as strongly to affect a well-poised needle of about three inches in length; a piece of the pyrites, nearly two inches square, acted upon the needle at the distance of four inches.

The powder (which is blackish gray, with but little metallic lustre) is immediately taken up by a common magnet; but the pyrites does not act thus on the powder, nor on iron filings, unless it has been placed for some time between magnetical bars; then, indeed, it acts powerfully, turns the needle completely round, attracts and takes up iron filings, and seems permanently to retain this addition to its original power.

In the specimens which I obtained, the north pole was generally the strongest.

This pyrites was found in Wales, about the year 1798, by the honourable Robert Greville, F.R.S., who sent the specimens above described to his brother the right honourable Charles Greville, with the following account:

"It is found in great abundance in Caernarvonshire, near the base of the mountain called Moel Elion, or probably with more accuracy Moel Ælia, and opposite to the mountain called Mynydd Mawr. These mountains form the entrance into a little close valley, which leads to Cywellin lake, near Snowdon, a little beyond the hamlet of Bettws.

"The vein appears to be some yards in depth and breadth, and seems to run from north to south, as it is found on Mynydd Mawr, which is across the narrow valley, and opposite to Moel Ælia."

Mr. Robert Greville, in another part of his letter, states that copper ore has been worked in several of the adjacent places, and that, many years ago, captain Williams, of Glan yr Avon, employed some miners at the place where this pyrites is found, but the undertaking proved unproductive. Yellow copper ore is certainly in the vicinity; for some portions of it were adhering to the specimens which have been mentioned; and I shall here observe, that the stone which accompanies the magnetical pyrites is a variety of the lapis ollaris, or pot-stone, of a pale grayish green, containing smooth cubic crystals of common pyrites.

§ III.

From the appearance of those parts of the magnetical pyrites which have been exposed to the weather, it seems to be liable to oxidizement, but not to vitriolization.

The specific gravity, at temperature 65° of Fahrenheit, is 4518.

When exposed to the blowpipe, it emits a sulphureous odour, and melts into a globule nearly black, which is attracted by the magnet.

500 grains, in coarse powder, were exposed, in a small earthen retort, to a red heat, during three hours. By this operation the weight of the powder was very little diminished; neither was there any appearance of sulphur in the receiver, which, however, smelt strongly of sulphureous acid.

500 grains of the same were put into a flat porcelain crucible, which was kept in a red heat, under a muffle, during four hours. The powder then appeared of a dark gray, with a tinge of deep red, and weighed 432·50 grains. The loss was therefore 67·50 = 13·50 per cent.; but, upon examining the residuum, I found that only part of the sulphur had been thus separated.

The magnetical pyrites, when digested in dilute sulphuric acid, is partially dissolved, with little effervescence, although there is a very perceptible odour of sulphuretted hydrogen.

The solution is of a very pale green colour.

Pure ammonia produced a dark green precipitate, tending to black; and prussiate of potash formed a very pale blue precipitate, or rather a white precipitate mingled with a small portion of blue. The whole of the latter, however, by exposure to the air, gradually assumed the usual intensity of Prussian blue; and the blackish green precipitate, formed by ammonia, became gradually ochraceous. These effects, therefore, fully prove, that the iron in the solution was, for the greater part, at the minimum of oxidizement, so as to form the green sulphate and white prussiate of iron *; and, consequently, that the iron of the magnetical pyrites is either quite, or very nearly, in the state of perfect metal.

This pyrites, when treated with nitric acid of the specific gravity of 1·38, diluted with an equal quantity of water, is at first but little affected; but, when heat is applied, it is dissolved with much effervescence, and discharge of nitrous gas: the effervescence, however, is by no means so violent

* *Recherches sur le Bleu de Prusse*, par M. Proust. *Annales de Chimie*, tome xxiii. p. 85.

as

as when the common pyrites are treated in a similar manner. It is also worthy of notice, that if the digestion be not of too long duration, a considerable quantity of sulphur, in substance, is separated; whilst, on the contrary, scarcely any can be obtained from the common pyrites, when treated in a similar manner; although I shall soon have occasion to prove that the real quantity of sulphur is much more considerable in the latter than in the former.

As soon as muriatic acid is poured on the powder of the magnetical pyrites a slight effervescence is produced, which becomes violently increased by the application of heat; a quantity of gas is discharged, which, by its odour, by its inflammability, by the colour of the flame, by the deposition of sulphur when burned, and by other properties, was proved to be sulphuretted hydrogen.

During the digestion sulphur was deposited, which so enveloped a small part of the pyrites as to protect it from the further action of the acid.

The solution was of a pale yellowish green colour. With prussiate of potash it afforded a pale blue precipitate, or rather a white precipitate mixed with blue; and with ammonia it formed a dark blackish-green precipitate, which gradually became ochraceous; so that these effects corroborated the conclusions which were founded on the properties of the sulphuric solution, namely, that the iron contained in the pyrites is almost, if not quite, in the metallic state.

Other experiments were made: but, as they merely confirm the above observations, I shall proceed to give an account of the analysis.

§ IV.

Analysis of the magnetical Pyrites.

A. 100 grains, reduced to a fine powder, were digested, with two ounces of muriatic acid, in a glass matrass placed in a sand-bath. The effects already described took place, and a pale yellowish green solution was formed. The residuum was then again digested with two parts of muriatic acid mixed with one of nitric acid; and a quantity of pure sulphur was obtained, which, being dried, weighed 14 grains.

B. The acid in which the residuum had been digested was added to the first muriatic solution; some nitric acid was also poured in, to promote the oxidizement of the iron, and thereby to facilitate the precipitation of it by ammonia, which was added after the liquor had been boiled for a considerable time. The precipitate thus obtained was boiled with lixivium of potash; it was then edulcorated, dried, made red-hot with wax in a covered porcelain crucible, was completely taken up by a magnet, and, being weighed, amounted to 80 grains.

C. The lixivium of potash was examined by muriate of ammonia, but no alumina was obtained.

D. To the filtrated liquor from which the iron had been precipitated by ammonia, muriate of barytes was added until it ceased to produce any precipitate: this was then digested with some very dilute muriatic acid; was collected, washed, and, after exposure to a low red heat for a few minutes in a crucible of platina, weighed 155 grains. If, therefore, the quantity of sulphur converted into sulphuric acid by the preceding operations, and precipitated by barytes, be calculated according to the accurate experiments of Mr. Chenevix, these 155 grains of sulphate of barytes will denote nearly 22·50 of sulphur; so that, with the addition of the 14 grains previously obtained in substance, the total quantity will amount to 36·50.

E. Moreover, from what has been stated it appears that the iron which was obtained in the form of black oxide weighed 80 grains; and, by adding these 80 grains to the 36·50 of sulphur, an increase of weight is found = 16·50. This was evidently owing to the oxidizement of the iron, which, in the magnetical pyrites, exists quite, or very nearly, in the metallic state, but, by the operations of the analysis, had received this addition. The real quantity of iron must, on this account, be estimated at 63·50.

100 grains, therefore, of the magnetical pyrites yielded

Sulphur	A.	14	}	36·50 grains.
	D.	22·50		
Iron	E.	=		63·50
				100·

This analysis was repeated in a similar manner, excepting that the whole was digested in nitric acid until the sulphur was entirely converted into sulphuric acid. To the liquor which remained after the separation of the iron by ammonia, muriate of barytes was added, as before, and formed a precipitate which weighed 245 grains. Now, as the sulphuric acid in sulphate of barytes is estimated by Mr. Chenevix at 23·5 per cent., and the sulphur which is

 required

required to form the sulphuric acid contained in 100 parts of sulphate of barytes at 14·5 *, it follows, that 245 grains of dry sulphate of barytes contain sulphuric acid equal, very nearly, to 36 grains of sulphur; so that the two analyses corroborate each other. The proportion of sulphur in the magnetical pyrites may therefore be stated at 36·50, or indeed at 37 per cent. if some small allowance be made for the occasional presence of earthy particles; a minute portion of quartz having been found, by the last analysis, after the complete acidification of the sulphur.

The increase produced, by the operations of the analysis, in the weight of the iron, arose, as I have already remarked, from the addition of oxygen; for the iron, as obtained by the analysis, was in the state of black oxide; but in this, and indeed in all pyrites, it undoubtedly exists very nearly, or quite, in the state of perfect metal. Now the black oxide of iron, called *protoxide* by Dr. Thomson †, has been proved by Lavoisier and Proust to consist of 100 parts of metallic iron combined with 37 of oxygen, thus forming 137 of black oxide: the exact proportion of oxygen is therefore 27 per cent., and 80 grains of this oxide must contain 21·6 of oxygen. But, in the above analyses of the magnetical pyrites, the increase of weight did not amount to more than 16·5; and we may therefore conclude that, in all probability, a quantity of oxygen = 5·1 was previously combined with some part, or with the general mass, of the iron in the pyrites. A small part of the above-mentioned increase of weight must likewise have arisen from another cause; for, although the true proportions of the black oxide of iron are 27 of oxygen and 73 of iron, (so that 100 parts of the latter absorb 37 of the former,) yet, in actual practice, it is difficult to obtain it exactly in this state, and there is commonly a small excess of weight: this I have repeatedly observed in many experiments, some of which were purposely made. When, for instance, 100 parts of fine iron wire were dissolved in muriatic acid, and afterwards precipitated by ammonia, edulcorated, dried, and made red-hot with a small quantity of wax in a covered porcelain crucible, the weight, instead of 137, usually amounted to 139 or 140. The quantity of wax employed certainly did not afford a ponderable quantity of coal or other residuum; but the real cause of the increase of weight appears to be the air, which can scarcely be completely excluded, and which,

* Transactions of the Royal Irish Academy, vol. viii. p. 240.
† System of Chemistry, 2d edition, vol. i. p. 147.

after

after the wax is burned, combines with the superficial part of the oxide, and converts a portion of it into the red or peroxide; so that the surface in the crucible appears brown when compared with the interior.

To this cause, therefore, I am inclined also to attribute a small part of the increase observed in the weight of the iron obtained by the preceding analyses.

§ V.

Before I make any observations on the nature of the sulphuret which has been proved to constitute the magnetical pyrites, it may be proper to state some comparative analyses which I have made of several of the common pyrites; and, as the method employed was precisely the same as that which has been described, all that seems to be requisite is to give an account of the results.

In each analysis the whole of the sulphur was converted into sulphuric acid, which was precipitated by barytes; and, in the selection of the specimens, great attention was paid to take the internal parts of the fragments, and not to make use of any which exhibited an appearance of decomposition, or of extraneous substances.

The iron was, as before, reduced to the state of black oxide; and the addition of weight in each separate analysis corresponded, within a few fractional parts, with the proportion of oxygen requisite to form into black oxide a given quantity of metallic iron, equal to that which in each pyrites was ascertained to be the real proportion, by deducting the quantity of sulphur from the total quantity of each pyrites. The iron, therefore, in these is completely metallic, and as such is stated in the following results.

No. 1. Pyrites in the form of dodecaedrons with pentagonal faces. - - Specific gravity 4830.	Sulphur	52·15
	Iron	47·85
		100·
No. 2. Pyrites in the form of striated cubes.	Sulphur	52·50
	Iron	47·50
		100·
No. 3. Pyrites in the form of smooth polished cubes, found in the lapis ollaris which accompanies the magnetical pyrites. - - - - Specific gravity 4831.	Sulphur	52·70
	Iron	47·30
		100·

No. 4.

No. 4. Radiated pyrites. - - Specific gravity 4698.	Sulphur 53·60 Iron 46·40 —— 100·
No. 5. A smaller variety of radiated pyrites. Specific gravity 4775.	Sulphur 54·34 Iron 45·66 —— 100·

Considering the difference in the figure, lustre, and colour of these pyrites, I expected to have found a much greater difference in the proportions of their component ingredients; but, as the results are the average of several experiments, I have not any reason to doubt their accuracy.

The pyrites crystallized in regular figures, such as cubes and dodecaedrons, according to the above analyses, contain less sulphur and more iron than the radiated pyrites, and perhaps than others which are not regularly crystallized. This difference, however, is not considerable; for the dodecaedral pyrites, which afforded the smallest quantity of sulphur of any of the regularly crystallized pyrites, yielded 52·15; and the radiated pyrites, No. 5, gave 54·34: the difference, therefore, is only 2·19. So that the mean proportion of sulphur in all the pyrites which were examined is 53·24 per cent.; and, taking the proportion of sulphur in the magnetical pyrites at 36·50 or 37, the difference between this and the mean of the common pyrites will be 16·74 or 16·24. The magnetical pyrites, therefore, is quite distinct, as a sulphuret of iron, from the common martial pyrites; and in the following observations I shall prove that a sulphuret consisting of the proportions last mentioned has till now been unknown as a product of nature.

§ VI.

Although pyrites is one of the most common of mineral substances, yet the discovery of its real nature is comparatively of a late date; for it appears that even Agricola (whose knowledge of mineral bodies was certainly great, considering the state of science in his time) was not acquainted with its characteristic ingredient, namely, iron. According to Henckel, this was first noticed by our countryman Martin Lister, a member of this learned society, who says, "*Pyrites purus putus ferri metallum est.*"

From the time of Henckel, pyrites seems little to have attracted the notice of chemists, until Mr. Proust, the learned

learned professor of chemistry at Madrid, published two memoirs, in which he states that there are two sulphurets of iron, the one being artificial and the other natural. The first is the sulphuret which is formed in laboratories, by adding sulphur to red-hot iron, or by exposing both of them to heat in a retort. This is distinguished from the second sulphuret (which is the common martial pyrites) by its easy solubility in acids, especially in muriatic acid, by the formation of sulphuretted hydrogen gas during the solution of the sulphuret in the last-named acid, by its colour, and by its inferior density.

According to Mr. Proust, the first or artificial sulphuret is composed of 60 parts of sulphur, combined with 100 parts of iron; whilst the second sulphuret, or common pyrites, consists of 90 parts of sulphur and 100 of iron.

He moreover observes, that the sulphur of the first sulphuret is difficultly separated; but that the excess which is in the second sulphuret, or common pyrites, is easily expelled, and is that portion which is obtained by distillation, the residuum being then reduced to the state of the first sulphuret *. 100 parts, therefore, of this substance, are composed of 62·50 of iron and 37·50 of sulphur; and 100 parts of common pyrites are, according to this statement, composed of 52·64 of iron and 47·36 of sulphur.

These proportions Mr. Proust considers as the minimum and maximum of the sulphurets of iron. For the latter he allows some variation; but the composition of the former he regards as fixed by the invariable law of proportions †; although he observes, that it has not as yet been discovered in the mineral kingdom ‡.

In support of these assertions Mr. Proust states,

1. That the pyrites found near Soria, when distilled in a retort heated to redness, afforded nearly 20 per cent. of sulphur.

2. That the residuum of the above distillation had lost the external characters and chemical properties of pyrites, and had assumed those of the artificial sulphuret of iron.

* *Journal de Physique*, tome liii. p. 89, and tome liv. p. 89. From pp. 91 and 92 of tome liv. it is evident that the author does not mean to assert that the first sulphuret contains 60 per cent. of sulphur; but that 100 parts of iron are combined with 60 of sulphur, and form 160 of the sulphuret. In like manner, when 90 of sulphur are united with 100 of iron, a substance analogous to common pyrites is formed, which weighs 190 grains or parts.

† *Journal de Physique*, tome liii. p. 90.

‡ "La regne minéral, jusqu'ici, ne nous a point encore présenté le fer sulfuré au minimum."—*Journal de Physique*, tome liv. p. 93.

3. That

3. That when to this residuum a quantity of sulphur was added, and the whole was distilled in a degree of heat not too great, the 20 per cent. of sulphur, which had been separated by the first distillation, was by this again restored; and the mass in the retort thus recovered nearly the original colour, lustre, and chemical properties of the pyrites.

4. That, by adding sulphur to iron filings, or fine iron wire, heated to a low red in a retort, a compound is obtained, in which the proportion of sulphur amounts only to about 20 or 30 parts; but, if this compound is again treated with sulphur in a red heat, a sulphuret is formed, which is readily dissolved in acids, and plentifully affords sulphuretted hydrogen gas.

This is the real minimum of the sulphurets of iron, fixed by the invariable law of proportions (according to Mr. Proust) at 59 or 60 of sulphur and 100 of iron, the former being (as I have already observed) in the proportion of 37·50 per cent.

5. and lastly, That when this sulphuret is again mixed and distilled with sulphur, (due attention being paid to the degree of heat,) the product is found to have assumed most of the chemical and external properties of the natural common pyrites, density alone being excepted.

The application of the above observations to the principal subject of the present paper is sufficiently obvious; for, when it is considered that the magnetical pyrites is so different from the common pyrites in colour, hardness, solubility in sulphuric acid, and more especially in muriatic acid, with the copious production of sulphuretted hydrogen gas; when, by analysis, it has been found to consist of 36 or 37 of sulphur, combined with about 63 of metallic iron; and, when the artificial sulphuret of iron which has been lately described is proved to agree with the magnetical pyrites in the nature and proportions of its component ingredients, and in every one of the above-mentioned properties; it is evident that the magnetical pyrites is identically the same with this sulphuret, which hitherto has remained undiscovered in nature, and has only been known as a product of our laboratories. In order, however, more fully to satisfy myself, I made experiments on the artificial sulphuret, which I formed with sulphur and fine iron wire.

This substance agreed, in all the properties which have been noticed, with the magnetical pyrites; and the precipitates obtained by adding prussiate of potash, and ammonia, to the muriatic and sulphuric solutions, were precisely similar.

milar. The specific gravity was 4390, whilst (as I have already remarked) that of the magnetical pyrites is 4518.

§ VII.

So far, therefore, as can be proved by similarity in chemical properties and analysis, the magnetical pyrites is indisputably a natural sulphuret, completely the same with that which till now has been only known as an artificial product; but, that the mind may be perfectly satisfied, another question must be solved, namely, How far do they accord in receiving and retaining the property of magnetism? Common pyrites do not appear to affect the magnetic needle; or, if some of them slightly act by attraction, (which, however, I never could perceive, nor recollect to have read in works expressly relating to magnetism,) yet they do not possess, nor appear capable of acquiring, any magnetic polarity. As, therefore, the iron of pyrites is undoubtedly in the metallic state, and in a considerable proportion, the destruction of this characteristic property of metallic iron must be ascribed to the other ingredient—sulphur.

But we have lately seen, that a natural combination of iron with 36·50 or 37 per cent. of sulphur, is in possession of all the properties supposed hitherto to appertain (in any marked degree) almost exclusively to the well known magnetic iron ore; and that the combination alluded to is strictly chemical, and not (as at first might have been imagined) a mixture of particles of magnetic iron ore with common pyrites *.

This is certainly very remarkable; and it induced me to examine the effects produced by sulphur on the capacity of metallic iron for receiving and retaining the magnetic properties. I therefore prepared some sulphuret of iron by adding a large quantity of sulphur to fine iron wire in a moderate red heat.

The internal colour and lustre of the product were not very unlike those of the magnetical pyrites; and, after the mass had been placed during a few hours between magnetical bars, I found that it possessed so strong a degree of polarity as to attract or repel the needle completely round upon its pivot; and, although several weeks have elapsed

* This has been sufficiently proved by the facts which have been stated; I shall however add, that upon digesting a mixture of the powder of common pyrites and iron filings in muriatic acid, I only obtained hydrogen gas, exactly as if I had employed the iron filings without the pyrites.

since

since it has been removed from the magnetical bars, it still retains its power with little diminution; like the magnetical pyrites, however, in its natural state, it is not sufficiently powerful to attract and take up iron filings.

But this sulphuret did not contain so much sulphur as the magnetical pyrites; I therefore mixed some of it, reduced to powder, with a large quantity of sulphur, and subjected it to distillation in a retort, which was at length heated until the intire bulb became red.

The sulphuret by this operation had assumed very much the appearance of the powder of common pyrites in respect to colour; but in its chemical properties, such as solubility in muriatic acid, with the production of sulphuretted hydrogen gas, as well as in the nature of the precipitates it afforded with prussiate of potash and with ammonia, it perfectly resembled the magnetical pyrites. Moreover, by analysis, it was found to consist of 35 parts of sulphur and 65 of iron; and although (being in a pulverulent state) its power, as to receiving and retaining the magnetic property, could not so easily be examined, yet, by being powerfully attracted by the magnet, with some other circumstances, there was every reason to conclude that in this respect also it was not inferior.

Another portion of sulphuret was formed as above described; it was placed between magnetical bars, and, in like manner, received and retained the magnetic power.

It is certain, therefore, that when a quantity of sulphur equal to 35 or 37 per cent. is combined with iron, it not only does not prevent the iron from receiving the magnetic fluid, but enables it to retain it, so that the mass acts in every respect as a permanent magnet.

Black oxide of iron, by one operation, does not appear to combine with sulphur so readily as iron filings; a second operation, however, converts it into a sulphuret, very much resembling that which has just been described, including the chemical as well as the magnetical properties; but undoubtedly by these processes it is progressively converted, perfectly or very nearly, into the metallic state.

Iron combined with a larger proportion of oxygen, such as the fine gray specular iron from Sweden, will not form a sulphuret by the direct application of sulphur in one operation; although it becomes of a dark brown colour, partly iridescent, and is moderately attracted by a magnet.

50 grains of the magnetical pyrites, reduced to powder, and mixed with three times the weight of sulphur, were distilled in a retort until the bulb became moderately red-hot.

 After

After the distillation the pyrites weighed 54·50; consequently, the addition of sulphur was 9 per cent., making the total = 45·50 or 46 per cent. The powder was become greenish yellow, very like that of the common pyrites: it did not afford any sulphuretted hydrogen when digested in muriatic acid; but it nevertheless was partially dissolved, and the solution, when examined by prussiate of potash, and by ammonia, was not different from that of the crude magnetical pyrites.

The powder which had been distilled with sulphur, and which had thus received an addition of 9 per cent. to its original quantity, was still capable of being completely taken up by a magnet.

From the whole of the experiments which have been related, it is therefore evident, that iron, when combined with a considerable proportion of sulphur, is not only still capable of receiving the magnetic property, but is also thereby enabled to retain it, and thus, as I have already remarked, becomes a complete magnet; and it is not a little curious, that iron combined, as above stated, with 45 or 46 per cent. of sulphur, is capable of being taken up by a magnet, whilst iron combined with 52 per cent. or more of sulphur, (although likewise in the metallic state,) does not sensibly affect the magnetic needle; and hence, small as the difference may appear, there is reason to conclude that the capacity of iron for magnetic action is destroyed by a certain proportion of sulphur, the effects of which, although little if at all sensible at 46 per cent., are yet nearly or quite absolute, in this destruction of magnetic influence, before it amounts to 52. But what the exact intermediate proportion of sulphur may be which is adequate to produce this effect, I have not as yet determined by actual experiment.

As carbon acts on soft iron, (which, although it most readily receives the magnetic influence, is unable to retain it so as to become a magnet without the addition of a certain proportion of carbon, by which it is rendered hard and brittle, or, in other words, is converted into steel,) so, in like manner, does sulphur seem to act; for it has been proved, by the preceding experiments, that the brittle mass formed by the union of a certain proportion of this substance with iron, whether by nature or by art, becomes capable of retaining the magnetic virtue, and of acting as a complete magnet.

This remarkable coincidence in the effects produced on iron by carbon and sulphur, induced me to try the effects of phosphorus; and my hope of success was increased by the

the remark of Mr. Pelletier, who says, that "the phosphuret of iron is attracted by the magnet *;" and therefore, although certain bodies may be thus attracted, without being capable of actually becoming permanent magnets, I was desirous to examine what might be the power, in this respect, of phosphuret of iron.

I therefore prepared a quantity of phosphuret of iron in the direct way, viz. by adding phosphorus, cut into small pieces, to fine iron wire made moderately red-hot in a crucible. The usual phænomena took place, such as the brilliant white flame, and the rapid melting of the iron, which, when cold, was white, with a striated grain, extremely brittle, hard, and completely converted into a phosphuret. The fragments of this were powerfully attracted by a magnet; and, after I had placed two or three of the largest pieces, during a few hours, between magnetical bars, I had the pleasure to find that these had become powerful magnets, which not only attracted or repelled the needle completely round, but were able to take up iron filings, and small pieces, about half an inch in length, of fine harpsichord wire; and, although they have now been removed from the magnetical bars more than three weeks, I cannot discover any diminution of the power which had thus been communicated to them.

The three inflammable substances, carbon, sulphur, and phosphorus, which, by their chemical effects on iron, in many respects resemble each other, have now therefore been proved alike to possess the property of enabling iron to retain the power of magnetism: but I shall consider this more fully in the following section.

[To be continued.]

XXIV. *Observations on the Change of some of the proximate Principles of Vegetables into Bitumen; with analytical Experiments on a peculiar Substance which is found with the Bovey Coal.* By CHARLES HATCHETT, *Esq. F.R.S.*

[Continued from page 51.]

§ V.

DR. MILLES, in his remarks on the Bovey coal, (which I have several times had occasion to notice in the course of this paper,) states, that "amongst the clay, but adhering

* "Le phosphure de fer est attirable à l'aimant." *Annales de Chimie*, tome xiii. p. 114.

 to

to the coal, are found lumps of a bright yellow loam, extremely light, and so saturated with petroleum, that they burn like sealing-wax, emitting a very agreeable and aromatic scent *."

This substance I also observed when I visited the Bovey coal-pits in 1794 and 1796. At that time, however, it was scarce, and I could only procure one small specimen, which is now in the British Museum; but from a cursory examination of it, I was convinced that it was a peculiar bituminous substance, and not loam impregnated with petroleum, as Dr. Milles had supposed. I could not then conveniently make a regular analysis of it, and therefore contented myself with briefly describing it in a note annexed to my paper on bituminous substances †.

Lately, however, my friend John Sheldon, esq. of Exeter, F.R.S., obligingly sent me several pieces of it, together with specimens of the different kinds of Bovey coal which have been mentioned; and thus I was enabled fully to ascertain its real nature and properties.

Description of the Bitumen from Bovey.

It accompanies the Bovey coal in the manner already described, and is found in masses of a moderate size.

The colour is pale brownish ochraceous yellow.

The fracture is imperfectly conchoidal.

It appears earthy externally, but when broken exhibits a slight degree of vitreous lustre.

The fragments are irregularly angular, and completely opaque at the edges.

It is extremely brittle.

It does not apparently become softened when held for some time in the hand, but emits a faint resinous odour.

The specific gravity at temperature 65° of Fahrenheit is 1·135.

Some specimens have dark spots, slightly approaching in colour and lustre to asphaltum; and small portions of the Bovey coal are commonly interspersed in the larger masses of this bitumen.

When placed on a heated iron, it immediately melts, smokes much, burns with a bright flame, and yields a very fragrant odour, like some of the sweet-scented resins, but which at last becomes slightly tainted with that of asphaltum.

* Philosophical Transactions, vol. li. p. 536.

† Transactions of the Linnean Society, vol. iv. p. 139.

The

The melted mass, when cold, is black, very brittle, and breaks with a glossy fracture.

Experiments.

A. 100 grains of this bitumen, when distilled until the bulb of the retort became red-hot, afforded, Grains.

1. Water slightly acid - - -	3
2. Thick brown oily bitumen, very similar to that which was obtained from the Bovey coal, but possessing slightly the odour of vegetable tar -	45
3. Light spongy coal - - -	23
4. Mixed gas, composed of hydrogen, carbonated hydrogen, and carbonic acid, (by computation,)	29

The coal yielded about three grains and a half of ashes, which consisted of alumina, iron, and silica, with a trace of lime.

B. The bitumen was not affected by being long digested in boiling distilled water.

C. By digesting 100 grains in lixivium of pure potash, a brown solution was formed; this was saturated with muriatic acid, and a brown resinous precipitate was obtained, which weighed 21 grains.

D. A portion was digested in nitric acid: at first much nitrous gas was evolved, and, after the digestion had been continued for nearly 48 hours, a part was dissolved, and formed an orange-coloured solution, which did not yield any precipitate when saturated by the alkalis or by lime; the colour only became more deep, and, by evaporation, a yellow viscid substance was obtained, which was soluble in water. The above nitric solution possessed every property of those nitric solutions of resinous substances which I have mentioned in a former paper*.

E. The benzoic and succinic acids were not obtained from this substance by any of the methods usually employed.

F. Alcohol almost immediately began to act upon this bitumen; and, being added at different times, gradually dissolved a considerable part of it. The solution was reddish brown, and had a resinous odour; by the addition of water it became milky, and, by evaporation, afforded a dark brown substance which had every property of resin, whilst the residuum left by the alcohol possessed those properties which characterize asphaltum.

The following analysis was then made to discover the proportions of the component ingredients.

* Philosophical Transactions for 1804, p. 198.

Analysis of the Bitumen from Bovey.

A. 100 grains, reduced to a fine powder, were digested, during 48 hours, with six ounces of alcohol, the vessel being placed in sand moderately warmed. A deep reddish brown tincture was thus obtained; and the operation was again twice repeated, with other portions of the same menstruum, until it ceased to act upon the residuum.

The whole of the spirituous solution (which had been cautiously decanted) was then subjected to a very gradual distillation in an alembic, and yielded a brown fragrant resin which weighed 55 grains.

B. The residuum, which could not be dissolved by alcohol, was digested in boiling distilled water; but this did not act upon it: the whole was therefore collected on a filter, was gradually dried, without heat, by mere exposure to the air, and then weighed 44 grains.

These 44 grains consisted of a light, porous, pale brown substance, which, being melted, formed a black, shining, brittle mass. It burned with the odour of asphaltum, but rather less disagreeable, owing most probably to a small portion of the resin which had not been completely extracted by the alcohol. It was insoluble in water and in alcohol, but was readily dissolved by heated fat oils; and in every other particular was found to possess the properties of asphaltum.

The 44 grains of asphaltum, when burned, left a residuum, which weighed 3 grains, and consisted of alumina, silica, and iron.

By this analysis it appears that the bitumen which accompanies the Bovey coal is a peculiar and hitherto unknown substance, which is partly in the state of vegetable resin, and partly in that of the bitumen called asphaltum, the resin being in the largest proportion; as 100 grains of the above-mentioned substance afforded,

Resin - -	55
Asphaltum -	41
Earthy residuum	3
	99.

Thus we have an instance of a substance being found under circumstances which constitute a fossil, although the characters of it appertain partly to the vegetable and partly to the mineral kingdom.

§ VI.

§ VI.

The powerful action which alcohol exerts on most of the resins may justly be regarded as forming a marked distinction between those substances and the bitumens. But, as some of the bitumens are acted upon by alcohol in a slight degree, I was desirous to ascertain whether a small portion of resin was contained in any of these; or, if that was not the case, I wished to determine the nature of the substance which could be separated, although very sparingly, by this menstruum. I therefore made the following comparative experiments on the soft brown elastic bitumen from Derbyshire; on the genuine asphaltum; on very pure cannel coal; and on the common pit coal.

100 grains of each were digested with three ounces of alcohol, in matrasses placed in warm sand, during five days, some alcohol being occasionally added, to supply the loss caused by evaporation. After the above-mentioned period had elapsed, the liquid contained in each matrass was poured into separate vessels.

1. The alcohol which had been digested on the elastic bitumen was not tinged, nor, when spontaneously evaporated, did it leave any film or stain on the glass.

2. From asphaltum the alcohol had extracted a yellow tincture, which, in some situations, appeared of a pale olive colour, and, being spontaneously evaporated, a thick brown liquid was deposited, in small drops, on the glass; these drops did not become hard after two months, and possessed the odour, and every other property, of petroleum. The asphaltum had lost in weight about one grain and a half.

3. The cannel coal had communicated a pale yellow tint to the alcohol, which, in the manner above described, was ascertained to be caused by petroleum; but, from the smallness of the quantity, the weight could not be determined.

4. The alcohol which had been digested on pit coal had not assumed any colour; but, by spontaneous evaporation*, it left a film on the glass, which, by its odour, was also found to be petroleum.

By these experiments we find that the action of alcohol on the bitumens is very slight; and that the small portion which may thus be extracted from some of them is petroleum. In these, the process of bituminization (if I may be allowed to employ such a term) appears to have been completed, whilst in the Bovey coal, and especially in the sub-

* Spontaneous evaporation, by exposure to the air, was employed in these experiments for reasons which must be sufficiently obvious.

stance which accompanies it, nature seems to have performed only the half of her work, and, from some unknown cause, to have stopped in the middle of her operations. But, by this circumstance, much light is thrown on the history of bituminous substances; and the opinion, that they owe their origin to the organized kingdoms of nature, especially to that of vegetables, which hitherto has been supported only by presumptive proofs, seems now, in a great measure, to be confirmed, although the causes which operate these changes on vegetable bodies are as yet undiscovered.

Many facts indicate, that time alone does not reduce animal or vegetable bodies to the state of fossils. In this country, there are numerous examples of large quantities of timber (even whole forests) which have been submerged prior to any tradition, and which nevertheless completely retain their ligneous characters *. Other local causes and agents must therefore have been required to form the varieties of coal and other bituminous substances. In some instances (as in the formation of Bovey coal) these causes seem to have acted partially and imperfectly, whilst, in the formation of the greater part of the pit coals, their operation has been extensive and complete.

In the pit coals, the mineral characters predominate, and the principal vestige of their real origin seems to be bitumen; for the presence of carbon in the state of oxide cannot alone be considered as decisive.

Bitumen, therefore, with the exuviæ and impressions so commonly found in the accompanying strata, must be more immediately regarded as the proofs in favour of the origin of pit coal from organized bodies; and, considering the general facts which have been long observed, together with those lately adduced respecting the Bovey coal, and the substance which is found with it, we seem now to have almost unquestionable evidence that bitumen has essentially been produced by the modification of some of the proximate principles of vegetables, and especially resin.

Modern chemistry had comparatively made but a small progress when the illustrious Bergmann published his Dissertation entitled *Producta Ignis subterranei chemice considerata*; for at that time the extent and power of chemical action in the humid way were very imperfectly understood. In that

* Phil. Trans. for January 1671. Phil. Trans. vol. xix. p. 526. Ibid. vol. xxii. p. 980. Ibid. vol. xxiii. p. 1073. Ibid. vol. xxvii. p. 298. Ibid. for 1799. p. 145.

part,

part, however, of the above work where he speaks of the fossil wood of Iceland, called *surturbrand*, he evidently appears doubtful how far volcanic fire may have acted upon it; although he conceives that, in the formation of it, there has been some connection with volcanic operations. His words are: "Quid de ligno fossili Islandiæ sentiendum sit, gnaro in loco natali contemplatori *decidendum relinquimus*. Interea, ut cum vulcani operationibus nexum credamus, plures suadent rationes, quamvis hucusque modum ignoremus, quo situm texturamque adquisiverunt hæc strata." It certainly was very natural that Bergmann should entertain this opinion in respect to the surturbrand; and it is remarkable that the leaves contained in the schistus lately described are of the same nature, and are found in the same country. The leaves also described by Mr. St. Fond are likewise found in a country which, according to him, was formerly volcanic. Were these substances, therefore, never found but in countries which either actually are or were volcanic, we should be almost compelled to believe, with the Swedish professor, that the operations of subterraneous fires have been concerned in the formation of these bodies, or rather in the conversion of them into their present state.

But similar substances are found in countries where not the smallest vestige of volcanic effects can be discovered, and Devonshire most undoubtedly is such; yet, nevertheless, the Bovey coal is there found similar to the surturbrand in most of the external, and, from experiments which I made some years ago, I believe I may say, chemical properties; to which must be added, that both these substances perfectly resemble each other by forming regular strata *.

Moreover, the half charred appearance of Bovey coal, and of surturbrand, cannot be adduced as any proof that the original vegetable bodies have been exposed to the partial effects of subterraneous fire; for at this time we know that the oxidizement of substances is performed at least as frequently and as effectually by the humid as by the dry way. It would therefore be superfluous here to enter into an elaborate discussion to prove that coal and bitumen, with much greater probability, have been formed without the intervention of fire; and I am the less inclined to say more upon this subject, as I have already published some considerations on it in a former paper †.

* Transactions of the Linnean Society, vol. iv. p. 138. Von Troil's Letters, p. 42 Opuscula Bergmanni, tome iii. p. 239.

† Transactions of the Linnean Society, vol iv. pp 141, &c.

Before

Before I conclude, I must beg leave to observe, that as the substance which is found with the Bovey coal is, in every respect, so totally different from any of the bitumens hitherto discovered, it seems proper that it should receive some specific name; and, as it has been proved to consist partly of a resin and partly of a bituminous substance, I am induced to call it *retinasphaltum* *, a name by which a full definition of its nature is conveyed.

I have lately seen, in No. 85 of the *Journal des Mines*, p. 77, an account of a peculiar combustible fossil, found near Helbra, in the county of Mansfield, and described by Mr. Voight, in his *Versuch einer Geschichte der Steinkohle, der Braunkohle*, &c. p. 188. This substance is of an ash-coloured gray, passing to grayish white; it is found in a bed of bituminous vegetable earth, which has apparently been produced by the decomposition of fossil wood. The purest specimens are in the form of nodules: the fracture is earthy; it is opaque, soft, brittle, and is very light. When applied to the flame of a candle, it burns and melts like sealing-wax, at the same time diffusing an odour which is not disagreeable. This substance appears to accord in so many properties with the retinasphaltum of Bovey, that I cannot but suspect it to be of a similar nature; and I have little doubt that, by a chemical examination, it will be found to consist partly of resin and partly of bitumen.

XXV. *Experiments and Reflections of Dr.* Joachim Carradori de Prato *on the apparent Repulsion between some Kinds of Fluids observed by* Draparnaud †.

The observations which M. Draparnaud published in the *Annales de Chimie* ‡ are not new, and the consequences which he deduces from them are false. Several years ago § I observed that fluids are impelled by others on the surface of the water; and I have proved that these repulsions are only apparent, and are owing merely to the different degrees of attraction which these fluids experience from the surface of the water. I have several times in dif-

* From ῥητίνη, resin; and ἄσφαλτος, bitumen.

† *Annales de Chimie*, No. 152.

‡ Memoire sur les Mouvemens que certains Fluides reçoivent par le Contact d'autres Fluides, an 11, no. 141.

§ Giornale Fisic Medic. di Pavia 1793: Ann. Chim. di Pavia; Opuscoli Scelti di Milano.

ferent

ferent journals *, and particularly in my answers to Prevost †, and in some letters written to professor Brugnatelli, insisted on the real explanation of the phænomena of this kind; proving, by decisive experiments, that these movements, thought to be the effect of a repulsive power, arise all from the same principle, that is to say, the *attraction of surface*; whence it results, that one fluid being attracted more than another, retires from the surface on which it had extended itself, and obeys its own cohesion or force of aggregation, and concentrates itself.

I have lately resumed this subject, and have exhibited it in a clearer point of view, in the Transactions of the Italian Society of the Sciences, proving, with the greatest rigour, that it is the attraction of the surface which gives rise to the pretended repulsions of some fluids on the surface of fluids, and of some fluids on the surface of solids.

Professor Brugnatelli, extending my experiments on the attraction of surface, spoke of the repulsions recently observed by M. Draparnaud; for he remarked, that several fluids thrown in drops on the smooth surface of solids repel oil, spirit of wine, oil of turpentine, and ether ‡.

M. Draparnaud says that alcohol or spirit of wine expels water and other liquids from the bottom of vessels, because there is a continual emission of subtle particles, which, forming an atmosphere, produce the removal of the water, as Prevost said of odoriferous atmospheres: and, according to him, all volatile bodies are capable of doing the same at the common temperature of the atmosphere, since he is of opinion that they act mechanically, that is to say, by means of the impulsion of their emanations.

But I shall beg leave to oppose to him some facts, and some reasoning to throw light on this truth. Water, indeed, retires from the surface of the vessel to which spirit of wine is applied; but it is not true that it is expelled by a repulsive force. It is equally false, that the space abandoned by the water, when the experiment is made, is perfectly dry, as M. Draparnaud says; but the water is succeeded by a light stratum of spirit of wine, which soon evaporates. Water, as well as the other fluids, adduced by Draparnaud, retire, because they are obliged to give up the surface to the spirit of wine, which has a greater attraction for it than they, and seizes on it with more energy: being thus abandoned

* Giorn. Italiani et Journal de Physique; Annales de Chimie.
† Ann. Chim. di Pavia, tom. xix; Annales de Chimie, no. 143.
‡ Ann. di Chim. di Pavia, tom. xviii.

doned to themselves, they become concentrated. A drop or two of spirit of wine, indeed, poured, in a gentle temperature, on a porcelain dish for example, is seen to extend itself, and to cover the said surface like varnish; which is not the case on pouring out a drop or two of water, because it has not the same attraction of surface. The integrant moleculæ of the water, which have more affinity of aggregation or cohesion, than of attraction for the surface of the supposed body, do not become flat, or dilate in the same manner.

It is so true, that spirit of wine or alcohol attaches itself more strongly than water to the surface of vessels, that if a drop or two of this fluid be thrown on a porcelain dish; and if, after it has extended itself, forming as it were a disk, some drops of water be thrown on it, and forced to take the place occupied by the spirit of wine; it will be seen that the water, not being able to detach the alcohol, will be obliged to pass over it, and the alcohol will remain always fixed at the surface of the dish.

But I can produce an easy experiment, which is directly opposite to the opinion of Draparnaud. I fixed, in the middle of a porcelain saucer, a small ball of soft wax, and formed in it a cavity with the head of a large pin. I then poured into the saucer such a quantity of water as to rise above the edges of the cavity, but not to enter it. The vessel being thus prepared, I dipped a reed of straw in the spirit of wine, and removed a drop of the fluid to the cavity of the ball in such a manner that it was filled with it. In this manner, a drop of spirit of wine remained surrounded by water almost in contact with it, and continued also below the level of the water. It is certain that, if spirit of wine were capable of exercising an expansive force by means of the particles it emanates, it must have produced it in this case; but I saw no movement of repulsion in the water which was around the drop of alcohol. The water always remained tranquil and motionless, as if it had been close to a fluid not of a volatile nature.

But when the water had risen above the sides of the small cavity of soft wax, it rushed into it to come to a level; and I saw the small bodies which floated on the surface of the water remove from the said cavity, while the water rushed into it. This is a proof that spirit of wine, like other oily fluids, has the faculty of spreading itself over the surface of the water before it becomes mixed with it.

I have indeed observed, that spirit of wine applied to the surface of water contained in a dish, on which is spread out

out a drop of oil, expels it, assuming its place, and obliges it to concentrate itself. In like manner, if a little cotton dipped in spirit of wine, or a drop of that fluid, be applied to the surface of water on which float small bits of gold or silver leaf, they are seen to recede. These small bodies recede also sometimes from the surface of the water where they are placed, on the approach of a small bit of cotton well dipped in spirit of wine: but they do so faintly, and not with that velocity as when a little cotton dipped in ether* is applied; because spirit of wine, both in the fluid state and state of vapour, on being applied to the surface of the water, has the property of diffusing itself over it like oily substances.

But if a drop of the milky juice of the tithymalus be previously applied to the surface of the water, and if small bits of gold or silver leaf be thrown over it, and if it be then touched as usual with a little cotton dipped in spirit of wine, or if a drop or two of the same fluid be poured over it, the supernatant small bits of metal will not be seen to exhibit the same phænomena as before, because the spirit of wine traverses the surface of the water occupied by another fluid, which has a greater attraction for it. The case is the same when there is applied to the surface of the water any fluid exceedingly volatile and oily, when it has been preoccupied by the juice of the tithymalus; but this juice, as soon as it touches the surface of the water †, expels from it all the oils most volatile, and the most odoriferous, and obliges them to concentrate themselves at the extremities of the vessel under the form of small globules.

If these repulsions are occasioned by the impetuous efflux of volatile and odoriferous emanations, why has the milky juice of the tithymalus, which is neither volatile nor odoriferous, the faculty of expelling from the surface of water the most volatile and most odoriferous fluids? However, if a drop of spirit of wine be placed gently in the middle of a dish, and the vessel be then moistened with water in such a manner that the water shall approach only within the distance of two lines of the said drop, it will be seen, before it dilates, to exercise a repulsion on the water which surrounds it, chiefly when it approaches near to it; and, in my opinion, this effect is owing to the vapours of the spirit of wine, which act at a distance; not because the water is

* See my answers to Prevost, in which it is seen that ether is a fluid which approaches nearer than spirit of wine to the nature of oils.

† Memoir on Attraction of Surface, in vol. xi. of the Transactions of the Italian Society of the Sciences.

expelled

expelled by a mechanical movement, but because, in striking the surface of the dish, they extend themselves over it, and displace the water. If it then happen that the drop of spirit of wine begins to touch the surrounding water, an agitation is immediately seen to arise, by which the water is repelled with great vivacity, and the drop of spirit of wine, animated with a new expansive force, bursts its limits, extends itself, and makes the water fly before it. The case is the same nearly with a small bit of camphor. If a small bit of this substance be placed in a pretty large dish, and covered with water to the height of a line, in such a manner that the bit of camphor may touch the bottom of the dish, the water will be seen in a kind of contest around the camphor, and the water will seem to be kept at a distance by an expansive force. All this in my opinion is the effect of the attraction of surface of the spirit of wine and of the oil of the camphor for the water. The oil of camphor, indeed, excited to dilate itself by the attraction of the surface of the water, evaporates with astonishing speed, and in a little time is consumed. The case is the same with spirit of wine and oil of camphor; they rush on the water, extending themselves over its surface with astonishing speed; whence arises a dispersion of the water, and adhesion of the spirit of wine to the bottom of the vessel. The accelerated evaporation of these fluids can be ascribed to no other cause than to this force; that is to say, the attraction of surface, by which the cohesion of the integrant parts is overcome, and consequently the expansive force of the small volatile parts which compose these fluids is increased; but I have sufficiently explained, in another place, all these phænomena in regard to the movements of camphor on water*.

A drop of volatile alkali or ammonia, says Draparnaud, does not expel water from the bottom of a vessel like spirit of wine, because ammonia has a great affinity for water. But cannot the same be said of spirit of wine? This repulsion, however, ought to take place when the water surrounds a drop of ammonia, as near as possible, but without touching it; which is not the case.

A drop of ammonia in the middle of a stratum of spirit of wine does not expel it, and does not form the circle of recession; but a drop of spirit of wine in the middle of a

* The Medico-Physical Journal of Pavia, Ann. Chim. di Pavia: Opusc. scelti di Milano, and in some letters addressed to professor Brugnatelli, Ann. Chim. di Pavia; and Memoir on Attraction of Surface, vol. xi. of the Italian Society.

stratum of ammonia expels it around, and forms a circle. This shows, according to Draparnaud, that the expansive force of spirit of wine is greater than that of ammonia.

But I remark that ammonia has no attraction of surface, or at least very little with the bottom of vessels, and, on the contrary, that alcohol has a great deal. If a drop of ammonia be poured on a porcelain saucer, or on a piece of glass, and one of spirit of wine, the former remains concentrated, and the other dilates itself. This is the reason why spirit of wine expels ammonia on the bottom of vessels, and that ammonia does not expel spirit of wine.

Moreover, if the expulsion of the ammonia depended on the mechanical impression of the emanations of the spirit of wine, it ought scarcely to manifest itself; for the force of the emanations of the spirit of wine ought to be weakened by the force of the emanations of the ammonia, but it manifests itself with the same promptitude as that of water. It is observed also, that some fluids almost equally volatile and odoriferous expel each other when applied in succession to the same surface. For example, essential oil of turpentine expels naptha, and ether expels essential oil of turpentine.

If the opposite forces destroyed each other, how could this happen? But the case is so, because essential oil of turpentine has more attraction of surface than naptha, and ether more than essential oil of turpentine.

But there is one observation of Draparnaud which deserves to be discussed. He has remarked that ammonia expels oil from the surface of vessels, though it expels neither water nor spirit of wine. I have remarked also, that the approach alone of a drop of ammonia to the surface of oil, manifests there an evident commotion, as if it were breathed upon. It appears then that the emanations of ammonia render themselves by these means manifest to the sight, that is to say, in consequence of the expulsive force or mechanical shock of the oil.

I do not pretend, nor have ever pretended, that there can be no emanations of volatile bodies capable of rendering themselves sensible to the sight in this sense, but only to show that several phænomena which are considered as the effects of repulsion, occasioned by the expansion of volatile bodies, do not depend on that cause, but are the effects of attraction of surface, and that there are no means of rendering the emanations of odoriferous bodies sensible to the sight, as Benedict Prevost thinks. But before

fore we decide in regard to the effect of ammonia, let us pay attention to the following remarkable observations.

Throw small bits of gold or silver leaf on the surface of oil contained in a goblet, and then bring near to it a drop of ammonia, a commotion will be observed in the surface of the oil, and in the small bits of metallic leaf which float on it: if the drop of ammonia be applied to the surface of the oil, the small bodies will fly still more, and the fluid will be seen to spread itself over the surface of the oil in the most visible manner, while it produces in it an agitation.

If this operation be performed on water, that is to say, if after throwing on the surface of water contained in a similar vessel very light bodies, such for example as bits of metallic leaf or raspings of cork, a drop of ammonia be brought near or applied, no movement will take place. The same thing will happen if spirit of wine, or any other fluid, not oily, be used in the place of water; but if instead of these supernatant bodies there be on the water a drop or two of oil, the latter will experience a commotion. On the drop of ammonia being brought near, in a perpendicular direction, to the oil which floats on the water, if the oil be entirely in the form of a drop, it causes it to dilate, and if it be spread over the surface of the water, it divides and is dispersed. If an orange skin be squeezed over the surface of the water, and if a drop of ammonia be then applied, a slight agitation will be manifested in all the oily points with which the surface of the water is interspersed.

It appears then from these experiments, that ammonia renders sensible to the sight the emanations on oil, not by mechanical impulse, but by a physical action, because it does not manifest itself on other fluids.

It is beyond all doubt that the shock or expansive force of ammoniacal emanations ought to act without distinction on all bodies, and communicate to them all the same impulse when they can easily move; and a drop of ammonia brought near to the surface of spirit of wine ought to produce in it a commotion equal to that which it communicates to the oil, because it is equally light, and may be also lighter than oil. I have found also that ammonia applied to the smoke of a candle, which bends itself on the least breath of air, does not make it move in the least. The effect of the ammonia on the oil cannot therefore be ascribed to a mechanical action.

But the following is a proof which admits of no reply:—If raspings of cork be thrown upon water, and if a drop of ammonia

ammonia be then brought near, no movement is produced; if a few more raspings of cork be rubbed with the fingers dipped in oil, and then thrown on the surface of the water, in another glass, on approaching another drop of ammonia, all these small parts will move in a wonderful manner. If the farina of wheat be thrown into another glass of water, the approach of a drop of ammonia will not cause these small moleculæ to move; but if the farina of almonds, which is oily, be thrown into the water, it will cause them to move, and precipitate them in an instant to the bottom. The same experiment repeated a thousand ways, will always confirm my conclusion, that is to say, that the action of ammonia is rendered sensible only on oils, and on all oily matters, or matters imbibed with oil.

I think then I have proved that the repulsion exercised by ammonia over oil is not the effect of the force of its vapours or emanations; and I am of opinion that it ought to be ascribed to the attraction of surface possessed by the ammonia in the state of fluid, as well as of vapour, with oil itself, together with a chemical attraction which results from the changes which the oil undergoes when exposed to the effluvia of ammonia. This phænomenon, in my opinion, may be explained like that of a drop of spirit of wine exposed in the middle of a stratum of water, that is to say, that the repulsive force which ammonia seems to exercise over oil, arises from the expansion of the ammonia, or from its vapours on oil by means of the attraction of surface.

If a drop of ammonia, indeed, be thrown on the bottom of a vessel, and if a very little oil be poured around it in such a manner as to surround the drop of ammonia, if the oil be extended with the finger, and ammonia be applied, the oil will be seen to recede; but when it touches it, the drop of ammonia will then break its limits, extend itself over the oil, and disperse with surprising velocity.

The antients would have ascribed it to an antipathy between the ammonia and the oil; but these chimerical ideas have been banished by the light of experimental philosophy. It does not appear that now the repulsions between the different fluids can be maintained, since I have established the laws of *the attraction of surface*, which I have observed *.

* See my Memoir on the Attraction of Surface, *loc. cit.*

XXVI. *A new Electrical Phænomenon. Communicated by a Correspondent.*

To the Editor of the Philosophical Magazine.

SIR,

THE following remarkable result in electricity occurred some time since. If you think it worthy of insertion in your excellent publication, it is at your service.

Having accidentally placed a shilling between the ball of my discharger and the coating of a charged jar, I was surprised to find, on making the discharge, that the shilling adhered to the side of the jar. Imagining that this effect might have proceeded from some foreign matter lodged between the shilling and the coating, I removed it, and carefully wiped both. On repeating the experiment the effect was the same as before. That part of the coating where the piece was taken from sometimes had a small hole in it, with a bur protruding outwards, something similar to that produced on a card through which a small jar is discharged. I at first imagined this effect to have been an amalgamation, or rather a fusion, of the two metals. Repeating the experiment with two pieces instead of one, they both adhered as before, as did likewise three and four. Trying it with five, they fell. The jar that was made use of for these experiments did not contain more than a quart; and not having a much larger one at hand, I cannot tell what the effect would have been had I used one four or five times as big. The same experiment being repeated with gold, brass, copper, &c., the result was the same. I cannot however reconcile the idea of amalgamation or fusion taking place in the experiments with the two and three pieces, &c., and am therefore totally at a loss to account for this strange phænomenon. Some of your correspondents may, perhaps, Sir, offer some theory on this curious experiment, which I should be very happy to see, being but a young and inexperienced electrician.

I am, Sir,

Your obedient servant,

C. R.

LETTER

LETTER V.

XXVII. WRIGHT *on measuring the Meridian*—WRIGHT, WREN *and* WILKINS *on an Universal Measure*—J. BAPTISTA PORTA *on the Reflection of Heat, Cold and Sound from concave Mirrors.*

Ego sanè non minoris æstimo, imò multò magis admiror, inventorem lyræ primum, quam vel centenos artifices alios, qui, sequentibus sæculis, professionem istam ad summam perfectionem deduxerunt.

G. GALILÆI *Syst. Cosm.* ed. 1699. p. 388.

SIR,

IN addition to my four communications, on the invention of the telescope, &c., I intended to have offered you some reflections on the adoption and execution of the methods lately taken in France, for establishing a natural standard of weights and measures. But, after a good deal of thought, and a careful perusal of the Report of the Commissioners in the *Mémoires de l' Institut* for 1799, the subject appears to me to present such ample scope for *mere opinion*, that I find it would be impossible for me to state my doubts, without exciting controversy. Those doubts arose in my mind, upon reading the third Dialogue in *Galileo's Systema Cosmicum*; *Jurin's* annotations on the 4th chapter of the *Geographia Generalis* of *Varenius*; and the 20th proposition of the 3d book of the *Principia*, edition *second*; not to mention the late correction of the admeasurements of *Maupertuis* &c. by M. *Swanberg* and other Swedish astronomers, which I have not seen. Having no wish to propagate my scepticism, or to render it incurable by contestation, I shall content myself with offering you the two following extracts; leaving you and your intelligent readers to compare them with the Report just mentioned, and to draw your own conclusions. It will also be amusing to bring that elaborate Report into comparison with the performances of ingenious *individuals* on the same subject; for example, with *Whitehurst's* Attempt towards obtaining invariable Measures, London 1788; *Essai sur les Poids et les Mesures*, par M. *Berthoud**, *Paris* 1792; and *Sir G. Shuckburgh's* Memoir on Weights and Measures, in the Philosophical Transactions for 1798. It has been said, that our great *individual*, *Johnson*, did more for the English language, than some

* Author of a copious, and, as I am told, a very good, book on clock- and watch-work, lately published at Paris, in 3 vols. 4to.

 foreign

foreign *academies* for the languages which they were established to improve.

The first extract I have to offer is taken from the 88th and 89th pages of Certain Errors in Navigation detected and corrected, by *Edw. Wright*, a work to which that science owes many of its best improvements. This book was first printed in the year 1599, but "written many years before*." The second edition, in which I have also read the following passage, appeared in 1610, and the third, from which I now transcribe it, in 1657. Of the value of this now almost forgotten work, we may judge from *Halley's* recommendation of it, near a century after it was first published, as "a book well deserving the perusal of all such as design to use the sea†." *Mr. Wright* is chiefly known as the inventor of the true construction of what is called *Mercator's*, but which better deserves the name of *Ptolemy's*, chart‡. His genius, however, was not confined to mathematical speculations; for it appears, from a Latin paper, preserved at Cambridge, and quoted by *Dr. Hutton* §, that *Wright* was the first undertaker of the canal called The New River, to which a great part of London owes that abundant supply of water, which excites the admiration of strangers. But the learned gentleman is mistaken in reckoning among *Wright's* works, the Haven-finding Art, which he only translated from the Dutch. This appears from the dedication of a copy now before me, printed in 1599; from which we also learn that our countryman, *Robert Norman*, had, some years before, discovered the magnetic dip. In 1593 and the following year, *Wright*, by observing the greatest and least heights of the pole-star, with a brass quadrant of six feet radius, determined the true latitude of London to be 51° 32′, instead of 51° 45′, which it had till then been reckoned. This was a wonderful performance, at a time when instruments were so imperfect, and when the refraction had been but just detected by *Tycho;* and was by no means fully ascertained; for that noble astronomer was much mistaken with regard to its quantity ‖. On *this* occasion, I hope to be excused

* See Dr. *Hutton's* Mathem. and Philos. Diction. article *Wright*.

† See the *Miscellanea Curiosa*. vol. ii p. 20; also *Hodgson's* System of the Mathematics, printed in 1723, vol. i. p. 254.

‡ See the preface to the Errors in Navigation, and the "Plat of all the World," at the end of the 3d edition.

§ Dictionary, art. *Wright*.

‖ *Vide Horroccii Opera Posthuma*, pp. 51, 70.; *Wolfii, Elem. Astron.* §§ 346. 350. *Blair's Hist.* of Geogr. p. 169.

for

for adding, that the latitude of Paris was not settled seventy years after *Wright* had ascertained that of London. For *M. Auzout* (to whom, or to *Kirch*, the invention of the micrometer is ascribed by those who are ignorant of the anterior claim of our *Gascoigne**), in a letter to *Louis* XIV. in 1664, says, "*Mais, Sire, c'est un malheur*, &c. But, Sire, the misfortune is, that there is not in Paris, nor, as far as I know, in your whole kingdom, an instrument on which I could depend, in taking the exact height of the pole†." Thus, Sir, your ingenious correspondent, the Rev. Mr. *Toplis*‡, appears to be perfectly in the right, when he alledges that, if our neighbours have lately overtaken, for I would gladly hope they have not yet distanced, us in the race of science, it can only be because they are publicly encouraged and supported in their arduous pursuits, and we are *not*. But of this more, perhaps, on some future occasion. It is high time to come to the immediate object of this letter.

The marginal title of this curious passage of *Wright* is, "A most exact way to find the quantitie of the earth's semidiameter."—The paragraph itself is as follows: "This angle" (the Dip of the Horizon, owing to the elevation of the observer's eye above the surface of the sea) "may otherwise be found, the quantitie of the earth's semidiameter being first known, which is to be done divers waies; but they may be all reduced to two heads or kinds, whereof the first requireth the certain measure of some arch of the Meridian to be first given, which is also divers waies to be performed. But the best and perfectest way of all others (viz. of exactly measuring the size of the whole earth) is to observe so exactly as is possible the Summer solstitiall Altitude of the Sun at two places, so farr distant asunder, and lying so neer North and South each from other, with so direct and faire a way betweene them as conveniently may be chosen. Suppose, for example, *Portsmouth* and *Barwick*, or some other place in the furthest parts of *Scotland*; for the further these places are each from other, the more perfectly may this businesse be performed. Then measure, and plat down so truly as is possible, all the way betweene those two places, with all the turnings and windings, ascents and descents that are therein; out of which

* See Phil. Trans. no. 25 29.; *Saverien, Dict. Univ. de Math. et de Phys.* art. *Micrometre*: *Harris's Lex. Tech.* art. *Micrometer.*
† See *Astron. de M. De la Lande*, t. 2. p. 842. ed. 1.
‡ See our xxth vol. p. 25.

the arch of the great circle, or shortest distance betwixt them, together with the angle of declination thereof from the true meridian line truly found by observation at either of those places, may most exactly be knowne: whereby (with helpe of the doctrine of right angled sphæricall triangles) the difference of the latitudes of those two places, in miles and furlongs, &c. may easily appeare; which compared with the difference of the latitudes of the same places, found by observation of the Sun, in degrees and minutes, &c. will shew how many miles and furlongs answer to one or more degrees of the meridian: and so the whole circumference, diameter and semidiameter of the earth, will easily and more truly be found, then any other way yet used for this purpose. But meanes convenient for the triall hereof have hitherto been wanting, and so I must omit it, till some better opportunity, if any shall befall hereafter, by the bounty of any such as are of more ability to bear the charge hereof.

"Yet besides our purpose now in hand, this would bee the best ground that can be, both for the making and continuing of a Standard, and all other measures thereon depending at a certainty for ever; insomuch that although all the Standards, weights and measures in the world were lost, they might, notwithstanding, upon record of such observation and means, as here we have mentioned, be again restored much more perfectly, then by the ordinary way of beginning all our measures from a barly grain taken out of the midst of the Ear, whereof there is no such certain determinate bignesse that can be set down, but that they may be something greater in one Ear then another; neither can there be any certain rule or reason given how to know which Ear to chuse rather then other for this purpose. And if any error be committed herein, though insensible (which cannot be avoided) yet in going about to make other greater measures by often taking this least, and so proceeding *a minimis ad maxima**, so often as you take your first or least measure, so often doe you increase and multiply your error; which though at first it seem very smal and scarcely perceivable, yet commeth at the last to be very notorious and intollerable. But the other way I here speak of, taking the length of all England, or of the whole Iland, for our first measure, and out of it by subdivision, dividing all the rest, although wee may erre something, in taking the length hereof (which notwithstanding,

* From the least to the greatest.

I dare

I dare undertake, may be so handled, that it shall not be so much as the thousand part of the whole distance between the two places, before mentioned) yet because we proceed *a maximis ad minima*, so still dividing, and the more diminishing this error, the further we proceed; it will in the end, when we come to our ordinary measures most in use, become very insensible, and not worth the regarding."

A "natural standard, or universal measure" is the *only* subject of my next extract, which is taken from pages 191 and 192 of the Rev. *Dr. Wilkins's* "Essay towards a real Character, and a philosophical Language*." This work was printed in 1668, in which year the Doctor was appointed Bishop of Chester, but written some time before; for the truly learned and ingenious author, in his dedication to Lord *Brouncker*, President of the Royal Society, says that when it "was done in writing, and the impression of it well nigh finished, it happened (among many other better things) to be burnt in the late dreadful fire," (in 1666) "by which all that was printed, excepting only two copies, and a great part of the unprinted original, was destroyed."

"Measures of magnitude," says Dr. *Wilkins*, "do comprehend both those of length, and of superficies or area, together with those of solidity, both comprehended in that which is adjoined, viz. the word CAPACITY, *hold*, *contain*. The several nations of the world do not more differ in their languages, than in the various kinds and proportions of these measures. And it is not without great difficulty, that

* From *La Vie de M. Leibnitz*, prefixed to that great man's *Essais de Theodicée*, by the *Chev. de Jaucourt*, Amst. 1747, p. 101. we learn that the celebrated *Dr. Hook* was delighted with this work of Wilkins; but that *M. Leibnitz* was not very well pleased with it; having had a plan of his own, for a real or universal character, expressive of all languages, but which never appeared. In the same place, we are told of a well written anonymous paper, on the same subject, which appeared in the year 1720, in the 2d vol. of the *Journal Literaire*. Some other attempts have been made; the last, I believe, by my ingenious friend *Dr. James Anderson*, in the Manchester Transactions, I think, or in his miscellany, the Bee, printed at Edinburgh, or perhaps in both. It seems probable, that the idea was suggested to Dr. Wilkins by "the art of short-hand, which," as he says in his dedication, "is in its kind an ingenious device, and of considerable usefulness, applicable to any language, much wondered at by travellers, that have seen the experience of it in England: and yet though it be above three score years, since it was first invented, 'tis not to this day (for ought I can learn) brought into common practice in any other nation," *Mr. Locke* also expressed his surprise, many years afterwards, in his tract on education, that short-hand had never come into use on the continent; in some parts of which, however, it is now almost as much practised as it is in this island; though it be no where cultivated so much as it deserves.

the measures observed by all those different nations, who traffic together, are reduced to that which is commonly known and received by any one of them; which labour would be much abbreviated if they were all of them fixed to any one certain standard; to which purpose, it were most desirable to find out some *natural standard*, or *universal measure*, which hath been esteemed by learned men as one of the *desiderata* in philosophy. If this could be done in longitude, the other measures might be easily fixed from thence.

" This was heretofore aimed at and endeavoured after in all those various measures derived from natural things, though none of them do sufficiently answer this end. As for that of a barley-corn, which is made the common ground and original of the rest, the magnitude and weight of it may be so various in several times and places, as will render it incapable of serving for this purpose; which is true likewise of those other measures, an inch, palm, span, cubit, fathom, a foot, pace &c.; none of which can be determined to any sufficient certainty.

" Some have conceived that this might be better done by subdividing a degree upon the earth; but there would be so much difficulty and uncertainty in this way as would render it unpracticable. Others have thought it might be derived from the quicksilver experiment; but the unequal gravity and thickness of the atmosphere, together with the various tempers of air in several places and seasons, would expose that also to much uncertainty *.

" The most probable way for the effecting of this, is that which was first suggested by Dr. *Christopher Wren*, namely, by vibration of a pendulum; time itself being a natural measure, depending upon a revolution of the heaven or the earth, which is supposed to be every where equal and uniform. If any way could be found out to make longitude † commensurable to time, this might be the foundation of a natural standard; in order to which,

" Let there be a solid ball, exactly round, of some of the heaviest metals; let there be a string to hang it upon, the

* Since Bishop *Wilkins* wrote the above, *Halley*, *Condamine*, *Godin*, and others, have ascertained that, at and near the equator, there is little or no variation in the height of the barometer, except during hurricanes. See Philos. Trans. No. 110; and *Templeman's* Extracts from the *Mem. de l'Acad. R. des S.* p. 312.

† The learned author, by longitude means length; for longitude, when it signifies an arch of the equator, between the first meridian and any other, may be said (loosely not mathematically) to be commensurable to time; since 15 degrees of longitude answer to an hour, &c.

smallest,

smallest, limberest, and least subject to retch: let this ball be suspended by this string, being extended to such a length, that the space of every vibration may be equal to a second minute of time, the string being, by frequent trials, either lengthened or shortened, till it attain to this equality: these vibrations should be the smallest, that can last a sufficient space of time, to afford a considerable number of them, either 6 or 500 at least; for which end, its passing an arch of five or six degrees, at the first, may be sufficient. The pendulum being so ordered as to have every one of its vibrations equal to a second minute of time, which is to be adjusted with much care and exactness; then measure the length of this string from its place of suspension to the centre of the ball; which measure must be taken as it hangs free in its perpendicular posture, and not otherwise, because of stretching: which being done, there are given these two lengths, viz. of the string, and of the radius of the ball, to which a third proportional must be found out; which must be, as the length of the string from the point of suspension to the centre of the ball, is to the radius of the ball, so must the said radius be to this third: which being so found, let two-fifths of this third proportional be set off from the centre downwards, and that will give the measure desired. And this (according to the discovery and observation of those two excellent persons, the Lord Viscount *Brouncker*, President of the Royal Society, and *M. Huygens*, a worthy member of it) will prove to be 38 Rhinland inches, or, which is all one, 39 inches and a quarter, according to our London standard.

" Let this *length* therefore be called *the standard*; let one tenth of it be called a foot; one tenth of a foot, an inch; one tenth of an inch, a line. And so upward, ten standards should be a perch; ten perches a furlong; ten furlongs a mile; ten miles a league, &c.

" And so for measures of *capacity*: the cubical content of this standard may be called the bushel; the tenth part of the bushel, the peck; the tenth part of a peck, a quart; and the tenth of that, a pint, &c. And so for as many other measures upwards as shall be thought expedient for use.

" As for measures of *weight*; let this cubical content of distilled rain water be the hundred; the tenth part of that, a stone; the tenth part of a stone, a pound; the tenth part of a pound, an ounce; the tenth of an ounce, a dram; the tenth of a dram, a scruple; the tenth of a scruple, a grain, &c. And so upwards; ten of these cubical measures may be called a thousand, and ten of these thousands may be called a tun, &c.

"As for the measures of *money*, 'tis requisite that they should be determined by the different quantities of those two natural metals which are the most usual materials of it, viz. gold and silver, considered in their purity without any allay. A cube of this standard of either of these metals may be called a thousand, or a talent, of each; the tenth part of this weight, a hundred; the tenth of a hundred, a pound; the tenth of a pound, an angel; the tenth of an angel, a shilling; the tenth of a shilling, a penny; the tenth of a penny, a farthing.

"I mention these particulars, not out of any hope or expectation that the world will ever make use of them, but only to show the possibility of reducing all measures to one determined certainty."—Thus far bishop *Wilkins*.

The above extracts contain, as far as I know, the *earliest* sketches of the ingenious methods therein proposed; and our neglect of such suggestions of our own countrymen, has been very properly rewarded by our obliging neighbours, who, as in other instances, have done our nation the honour to adopt and combine them, without distressing our modesty by an acknowledgment. I have no room or time, at present, to expatiate on this becoming and *characteristic* exercise of politeness. But I cannot dismiss the subject, without adding a few explanatory remarks, which historical justice seems to require.

I apprehend that few philosophers in this country, and still fewer on the continent, know to whom they really are indebted for the proposal of a subdivision of the meridian as an universal standard, or the application of the seconds pendulum to the same valuable purpose. To say nothing *here* of the comparative merits of these methods, or of the combination of both, I believe the following passage from the French *Encyclopedie*, contains the generally received opinions on this matter. "*Mouton, astronome de Lyon*, &c.* That is, "*Mouton*, an astronomer of Lyons, proposed as an universal measure, a geometrical foot, *virgula geometrica*, of which a degree of the earth" (*meridian*) "contained 600,000; and to preserve the length of it to perpetuity, he remarked that a pendulum of this length made 3959$\frac{1}{5}$ vibrations in half an hour: *Observ. Diametrorum*, 1670, p. 433. *Picard* proposed a similar idea in 1671. *M. Huygens*, who, in 1656, had conceived the application

* *Encyclopédie méthodique. Mathématiques*, art. *Mesure*, p. 388.

application of the pendulum to clocks, spake of it, in like manner: *Horolog. Oscillat.* 1673, part i. p. 7, and part iv. p. 151; and the Royal Society of London proposed to adopt it." The learned Encyclopedists then go on to mention the similar proposal of *Amontons* in 1703, and others of a later date, particularly that of *M. Condamine*, who in 1747 very philosophically recommended the equatorial pendulum, as preferable to all others, for an universal standard. *M. Berthoud*, in his late excellent piece above quoted, assigns the same date (1673) to the proposal of *Huygens*, in p. 151; and, in the title of his 2d article, which is "*Moyens d'etablir*, &c. A way to establish an universal and perpetual measure, by a pendulum, proposed by *Huygens* in 1673."

Thus it appears that *Wright* proposed the derivation of an universal standard from the mensuration of the meridian in 1599, and *Mouton* not till 1670; and that *Sir Christopher Wren* recommended the pendulum some years *before* 1668; *Mouton* in 1670; and *Huygens* not till 1673. *How many* years before 1668 *, I cannot say; for *Sir Christopher* did not publish any of his numerous discoveries himself; but many of them were recorded or epitomized in the Philosophical Transactions, and in the works of *Wallis* and others. Not having the early volumes of the Transactions at hand, I have searched in vain for *Sir Christopher's* proposal, now in question, throughout the first seven volumes of the *old* Abridgement, which for want of a good index (for it has several bad ones) is mere "confusion worse confounded."

Thus the *mere date* of *Wilkins's* "Real Character," though a *reprint*, carries *Wren's* claim decisively beyond those of both *Mouton* and *Huygens*. I may add, as the book is before me, that *Dr. Sprat* includes, in a catalogue of the original discoveries of *Wren*, "a natural standard of measure from the pendulum;" for he says "it was never before attempted †." *Dr. Derham* is equally explicit in favour of *Wren*. His words are: (The pendulum) "to be, as *Sir Christopher Wren* first proposed, a perpetual and universal measure and standard, to which all lengths may be reduced, and by which they may be judged of in all ages and countries.

* I might say *before* 1666, when *Wilkins's* first impression was burnt.

† *Sprat's* Hist. of the R. Society, pp. 247. 314, edit. 2d. 1703. This *history* contains scarcely any *dates*; but in his 120th page the author says he was interrupted in writing it by the plague in London in 1665, and the fire in 1666. Dr. *Hutton* says, in his art. *Wren*, that *Sprat* brings down the Society's Transactions to 1665, when it had existed about twenty years, though only about five with a charter.

tries. For, as our Royal Society, *M. Huygens* and *Mountonus* have proposed, after *Sir Christopher Wren*, this horary foot, or tripedal length, which vibrateth seconds, will fit all ages and places. But then respect must be had to the centre of oscillation, which you have an account of in *M. Huygens's* aforesaid book *De Horol. Oscill.*"—" published at Paris 1673 *." Now *Wilkins*, *Sprat*, and *Derham*, (who wrote his " Artificial Clock-maker in his juvenile years †") were cotemporaries of *Huygens*, *Wren*, and *Mouton*, and appear to be very impartial, dispassionate writers. Their testimonies, therefore, added to the *date* of *Wilkins's* book, establish, beyond all doubt, *Wren's right to be remembered, as the first proposer of the pendulum for an universal standard. Huygens's* discoveries on the pendulum, were numerous and important; but assuredly this was not one of them. The truth is, that that justly distinguished Hollander and his cotemporaries, especially in this country, (which, according to *Leibnitz* ‡, then enjoyed its Augustan age,) made so many discoveries about the same time, and often on the same subjects, that their claims are apt to be confounded, when, as in this case, they are perfectly distinct.

But, as we must not love our countrymen and their fame better than truth, I think it my duty to add, for the information of persons unacquainted with the history of the mathematics, that *Wilkins*, who, in the foregoing extract, recommends the decimal division of weights and measures, was by no means the first who made this most wise and important proposition. *John Muller*, commonly called Regiomontanus, or rather his master *Purbach*, actually introduced *that* division of the integer when they transformed the tables of Sines from the sexagesimal to the decimal scale about the middle of the fifteenth century: so far is this arrangement from being recommended by novelty to those light minds who make *this* the god of their idolatry! These ingenious German mathematicians were followed, at a considerable interval of years, by our no less ingenious, but now forgotten, countrymen, *Buckley and Recorde*; and afterwards by the famous French philosopher *Ramus*. But *Simon Stevin*, master of mathematics to the renowned prince *Maurice* of Nassau, and inspector of the dykes of Holland, was the first European who generally applied de-

* Artif. Clock-maker, pp. 108. 114. edit. 4. printed in 1759.

† Preface to the 3d and 4th editions.

‡ *Lett. à M. l'Abbé Conti*, in *Recueil de Pieces, sur la Philos. &c.* tom. ii. p. 76. edit. 2.

cimals

cimals to measures in his Practical Geometry, published early in the seventeenth century*. I say the first European; for, according to father *Noel*, the decimal division of weights and measures has long been established in China†.

I am, &c.

*D.

P. S. Having little prospect of addressing you again for some time, I shall take the liberty to subjoin a short extract from the *Magia Naturalis* of *J. Baptista Porta*, first published in the year 1594‡. Though I have proved in my former letters, I believe to general satisfaction, that this learned Italian did not invent the telescope, I by no means insinuated that he was destitute of original genius. This work shows the contrary, and that he both encouraged and practised physical experiments with great success; for his *Magia* contains nothing of what we now call magic, but the name, and somwhat of the legendary spirit.

"*Calorem, frigus et vocem speculo concavo reflectere.*

"Si quis candelam in loco, ubi spectabilis res locari debet, apposuerit, accedet candela per aerem usque ad oculos, ut illos calore et lumine offendet. Hoc autem mirabilius erit, ut calor, ita frigus reflectitur, si eo loco nix objiciatur, si oculum tetigerit, quia sensibilis, etiam frigus percipiet. Sed res admirabilior est, quod idem speculum, non solum calorem et frigus, sed vocem refringet, atque echi officio fungitur; reflectitur enim vox a polita, tersaque speculi superficie, rectius et integrius, quam a quovis pariete." (*J. B. Portæ, Mag. Nat. lib.* 17. *cap.* 4. *edit. Rothomagi* (*Rouen*) 1650, p. 557.) The literal translation of this passage (which it will be remembered was written before the thermometer was invented) is as follows:

"*To reflect heat, cold, and the voice, from a concave mirror.*

"If any one put a candle in the situation where a thing to be viewed ought to be placed, the candle will come, through the air, to the eyes, so as to offend them with light and heat. But it is more wonderful, that as heat is reflected, so is cold, if snow be exposed in that place, and touch the eye, this organ, because sensible, will also perceive cold. It is, however, still more wonderful, that the same speculum will not only reverberate heat and cold, but the voice,

* *Wolfii. Elem. Geomet.* § 27. ed. 2. *Hutton's* Dict. articles *Decimals, Muller, Purbach, Stevin*

† *Observ. Mathem. Phys. in India et China, factis.* c. vii. p. 104.

‡ See *Stone's* Mathem. Diction. art. *Telescope.*

and

and produce the effect of an echo; for the voice is reflected, from the polished and smooth surface of the speculum, more directly and entirely than from any wall."

The reflection of heat from a concave mirror is acknowledged to be of very remote antiquity. Not so what is called the reflection of cold. This discovery seems to be generally ascribed to one of our cotemporaries on the continent: with what justice the foregoing extract shows. The experiment, indeed, was successfully repeated, seventy years after *Porta* had put it in print, by the Academy *del Cimento*; it being the ninth of their Collection of Experiments, published at Florence in 1666. The reflection of sound from concave mirrors, is also a very old discovery. This was most probably the principle of the talking brazen head, which popular tradition, in the southern part of this island, ascribes to *Roger Bacon*, in the northern, to *Michaël Scot*, and in foreign countries, to other *cunning men*. It was no doubt the true secret of the enchanted head in *Don Quixote*, and of the 88th of the Century of Inventions, published, almost 150 years ago, by the *Marquis of Worcester*, who was unfortunately regarded by most of his cotemporaries as little superior, in sobriety of mind, to the knight of La Mancha.

Though I have no time for further remarks, I cannot help asking, Whether, if it be true, as it very probably is, that cold is the mere privation or abstraction of heat, the expression "reflection of cold," be not an absurdity, both in grammar and physics? Is it not like ascribing a *positive* effect to a *mere negation?* or like saying, that *all things* were made by *nothing?* Perhaps the best answer which could be made to these queries would be to say, That as we are entirely ignorant of the intimate essences of things, it cannot be expected that our language should always apply with strict propriety to phænomena which depend on those unknown intimate essences. For physics, I apprehend, are as far from being a *science*, strictly so called, in the present period, as when *Locke*, above a century ago, gave his reasons for "suspecting that Natural Philosophy was not capable of being made a science." See § 10. ch. 12. b. 4. of the Essay on Human Understanding, a work which deserves the serious attention of such of our present experimenters as are fond of being called philosophers and men of science.

XXVIII. *A new Process for rendering Platina malleable. By* Alexander Tilloch. *Read before the Askesian Society in the Session* 1804-5.

The methods hitherto employed for bringing this metal into a malleable state, may be comprehended under one or other of the three following processes.

1. To dissolve the crude platina in nitro-muriatic acid, precipitate by muriate of ammonia, wash and dry the precipitate, and then expose it, mixed with arsenic, to such a degree of heat as may volatilize the latter, leaving the platina in a spungy form; which, by gentle hammering, and repeated exposures to a high degree of heat, is at length rendered solid and malleable.

2. To mix the pure precipitate with twice its weight of mercury, and bring the whole into the state of an amalgam, which is then moulded into the form of bars, and by exposure to heat freed from the mercury, and then hammered, gently at first, into a solid form.

3. To expose the precipitate *per se* in a crucible to such a heat as may agglutinate the particles, which are then brought into closer union by gently pressing, and at last hammering the mass.

I purposely avoid a more minute detail of these processes, as they must be well known to all the members of this society; and will be in a great measure superseded by my new process, which is as follows.

Dissolve, precipitate, and wash the platina in the usual manner; and then, instead of mixing it with a volatile metal, or exposing it *per se* to heat in an earthen crucible, envelope the precipitate (previously heated to drive off the adhering ammonia) in a piece of platina, already malleable, and spread out by means of a flatting-mill. Nothing more is then necessary, but to expose repeatedly the malleable platina, and its contents, to a sufficient temperature, and hammering between each exposure, till the whole is brought into a compact state.

The best way to inclose the precipitate in the malleable platina is, by rolling up the latter into the form of a tube, filling this with the precipitate, well rammed in, and then closing the ends, by hammering them in, before exposure to the fire.

When a sufficient heat is obtained, apply the hammer at first only on the side where the malleable platina overlaps, not all round the tube. By this means its capacity is lessened, and the contents are soon welded, and brought into union with the tube, after which it may be worked into the form of a bar, or any other shape wanted.

XXIX. *De-*

XXIX. *Description of an improved Mill for grinding Painters' Colours.* By Mr. JAMES RAWLINSON, *of Derby**.

SIR,

I HAVE herewith sent a model of a machine for grinding paint, hoping that the Society for the Encouragement of Arts, &c. may not think their time entirely lost in examining if it has any merit; and if they should be of opinion that it has sufficient merit to recommend it to the public, it cannot fail of receiving that attention, from the sanction of their approbation, which my recommendation could not procure for it.

The hitherto very unmechanical, inconvenient, and highly injurious method of grinding poisonous and noxious colours, led me first to imagine a better might easily be contrived for that purpose. It must be obvious to every person, that the method hitherto adopted of grinding colours on an horizontal marble slab, with a small pebble muller, requires the body of the person who grinds to bend over that slab, and consequently his head; which causes him constantly to inhale the noxious and poisonous volatile parts of the paint, which is not unfrequently ground with oil saturated with litharge of lead; and if we may judge from the very unhealthy appearance of these men, accustomed to much colour-grinding, it should seem the bad effects of this employment require a speedy remedy.

The machine, of which I now send the society a model, has not only the advantage of being an effectual remedy of this extensive and severe evil to recommend it, but it grinds the colour much easier, much finer, and much quicker, than any method hitherto adopted. Having occasion for a considerable quantity of colour-grinding in the profession in which I am engaged, and that in the finest state possible, and having made use of this machine for several years, and being more and more convinced of its utility, I thought it my duty to present it to the Society of Arts, hoping that it might not be altogether unworthy of their attention. The roller of the machine that I use is sixteen inches and a half in diameter, and four inches and a half in breadth. The concave muller that it works against, covers one-third of that roller: it is therefore evident, that with this machine

* From *Transactions of the Society of Arts*, &c. 1804.—The silver medal of the Society and ten guineas were voted to the author for this communication.

I have

I have seventy-two square inches of the concave marble muller in constant work on the paint, and that I can bring the paint much oftener under this muller in a given space of time, than I could by the usual method with the pebble muller, which is seldom more than four inches in diameter, and consequently has scarcely sixteen square inches at work on the paint, when my concave muller has seventy-two. I do not mean to say that a roller, the size of that which I now use, is the largest which might be employed; for truly I believe that a roller two feet in diameter, with a concave muller in proportion, would not be hard work for a man; and then the advantage to the public would be still further increased.

This machine will be found equally useful for the colours ground in water, as for those ground in oils; and I doubt not but the great importance of this simple machine will be very soon generally experienced in all manufactories where colours are used. The labour necessary with this machine, in grinding colours exceedingly fine, is very easy. It is useless to enter into any minute description in this place, as a bare inspection of the machine must sufficiently explain itself.

To the colourman it would evidently be an essential saving of labour, and consequently of expense, which will probably have some weight as a recommendation; and the advantages to the colour-grinder have been already stated.

I am, sir, your very obedient servant,

JAMES RAWLINSON.

Charles Taylor, Esq.

SIR,

I WAS duly favoured with your letter of the 3d instant; and in reply to the questions that the committee have proposed, I have made a rough sketch of the machine, with letters of reference, as supposing this may better explain the process. Plate IV. fig. 1. A is the roller or cylinder made of any kind of marble: black marble is esteemed the best, because it is the hardest, and takes the best polish. B is the concave muller covering one-third of the roller, and of the same kind of marble, and is fixed in a wooden frame *b*, which is hung to the frame E at *ii*. C is a piece of iron, about an inch broad, to keep the muller steady, and is fixed to the frame with a joint at *f*. The small binding-screw, with the fly-nut, that passes through the centre of the iron plate at *c*, is for the purpose of laying more pressure on the muller, if required, as well as to keep it it steady. D is a taker-off, made of a clock-spring about half an inch broad, and fixed similar to a frame saw in an iron frame *k*, in an inclined position to the roller, and turning on pivots at *dd*. G is a slide-board to draw out occasionally, to clean, &c. if any particles of paint should fall from the roller, and which also forms itself for the plate H, to catch the colour on as it falls from the taker-off. F is a drawer, for the purpose of containing curriers shavings, which are the best things for cleaning paint mills. E is the frame.

Previous to the colour being applied to the mill, I should recommend it to be finely pulverized in a mortar, covered in the manner of the chemists when they levigate poisonous drugs *. This process of dry-grinding is equally necessary for the marble slab now in use; after which it should be mixed with oil or water, and with a spatula or palette-knife put on the roller, near to the top of the concave muller, and the roller turned round, which takes the colour under the muller without any difficulty, and very few turns of the roller spread it equally over its surface. When it is perceived sufficiently fine for the purpose required, it is very easily taken off by means of the taker-off described, which must be held against the roller, and the roller turned the reverse way, which cleans it very quick and very completely; and the muller will only require to be cleaned when you desist, or change the colour. It is then turned back, being hung on pinions to the frame at *ii*, and cleaned with a palette-knife or spatula very conveniently. Afterwards, a handful of curriers shavings held on the roller, with two or three revolutions, cleans it effectually; and there is less waste with this machine than with any marble slab.

As to the quantity ground at once on this mill, it must be regulated by the state of fineness to which it is required to be ground. If it is wanted to be very fine, a smaller quantity must be put on the roller at a time; and as to time requisite for grinding a given quantity of colour, this will also depend on the state of fineness to which it is ground. I have observed that my colour-grinder has ground the quantity of colour which used to serve him per day, with this machine, in three hours, and, as he said, with ease.

* Or rather in an improved mill, used at Manchester by Mr. Charles Taylor, for grinding indigo in a dry state, of which I have annexed a drawing, and reference, to render the whole business of colour-grinding complete.

The colour also was much more to my satisfaction than in the former way, and attended with less waste.

I have mentioned the pulverizing the colours in a covered mortar, which would prevent waste, and prevent the dust and finest parts of noxious colours from being injurious to the grinder. In some manufactories, where large quantities of colours, prepared from lead, copper, and arsenic, are used, this precaution is particularly necessary. I do not mean to say that my machine is intended to supersede the paint mill now in use for coarse common colours. It is intended for no such purpose; but to supersede the use of the very awkward and unmechanical marble slab now in use, and on which all the colours for china manufactories, coach-painters, japanners, and colour-manufacturers for artists, &c. &c. are now ground.

Several of the colour-manufacturers have expressed to me their great want of such a machine; and that I had no desire of troubling the public with a machine that would not answer, is evident, from my having used it several years before I presumed to recommend it to their attention. Being therefore now completely convinced of its utility, and hoping that it might relieve a number of my fellow-creatures from a dangerous employment, I have ventured to commit it to the protection of the Society of Arts, hoping, through their means, to see its ultimate success. And, further to give the society the most complete assurance in my power, I have annexed the opinion of a very ingenious and mechanical friend of mine, who has frequently seen it work. If any other questions should occur to the committee, that may be in my power to explain, I shall gladly do so.

I am, sir, your most obedient servant,

JAMES RAWLINSON.

Charles Taylor, Esq.

P. S. When the colour is ground, I recommend the following mode of tying it up in bladders, in preference to the usual method. Instead of drawing the neck of the bladder close, in the act of tying it insert a slender cylindrical stick, and bind the bladder close around it. This, when dry, will form a tube or pipe, through which, when the stick is withdrawn, the colour may be squeezed as wanted, and the neck again closed by replacing the stick. This is not only a neater and much more cleanly mode than the usual one of perforating the bladder, and stopping the hole with a nail, or more commonly leaving it open, to the prejudice of the

 colour;

colour; but the bladder, being uninjured, may be used repeatedly for fresh quantities of colour.

N. B. The barrel of a quill may be tied, in place of the stick, into the neck of the bladder, with its closed end outwards, which will keep the colour secure in travelling, and when used, the end of the quill being cut off, it may afterwards be closed by a stick.

XXX. *Improved Mill for grinding Indigo, or other dry Colours**.

PLATE IV. fig. 2. L represents a mortar made of marble or hard stone: one made in the common way will answer.

M, a muller or grinder, nearly in the form of a pear, in the upper part of which an iron axis is firmly fixed, which axis, at the parts NN, turns in grooves or slits, cut in two pieces of oak projecting horizontally from a wall, and when the axis is at work, are secured in the grooves by iron pins, OO.

P, the handle, which forms a part of the axis, and by which the grinder is worked.

Q, the wall in which the oak pieces NN are fixed.

R, a weight, which may occasionally be added, if more power is wanted.

Fig. 3. shows the muller or grinder, with its axis separate from the other machinery: its bottom should be made to fit the mortar.

S is a groove cut through the stone.

On grinding indigo, or such substance, in a dry state, in this mill, the muller being placed in the mortar, and secured in the oak pieces by the pins, the indigo to be ground is thrown above the muller into the mortar; on turning the handle of the axis, the indigo in lumps falls into the groove cut through the muller, and is from thence drawn under the action of the muller, and propelled to its outer edge within the mortar, from whence the coarser particles again fall into the groove of the muller, and are again ground under it; which operation is continued till the whole of it is ground to an impalpable powder: the muller is then easily removed, and the colour taken out.

A wood cover, in two halves, with a hole for the axis, is usually placed upon the mortar, during the operation, to prevent any loss to the colour, or bad effect to the operator.

* From *Transactions of the Society of Arts*, &c. for 1804.

XXXI. A

XXXI. *A new and most accurate Method of Banking the Balance of a Time-keeper. By Mr.* W. Hardy, *of Islington**.

SIR,

This letter is accompanied with a drawing, a description, and a model, of a more perfect mode of banking the balance of a time-keeper, than any that has yet appeared; and its application to a time-keeper is a matter of such real importance, that the most accurate, without this most necessary appendage, is liable to such derangement, that from the most trivial cause it is in one moment rendered useless.

To preserve the good qualities of the time-keeper, on which often the strength, the wealth, the grandeur, and safety of this great empire depend, I deem it necessary that my invention should be laid before the Society of Arts, as the means of its being more generally known; and I hope that I show proper respect to the society, when I assure you that I do not offer any crude idea, neither could I think of giving you any trouble until I had fully verified the utility of my contrivance by several years' trial. As I can produce the testimony of some of the most eminent watchmakers in favour of my invention, I look forward with some degree of confidence, in expectation of obtaining the approbation of the society.

It was at first imagined that a banking to a watch with a free escapement was quite unnecessary, as the limits of banking were so great as to admit of almost twice 360, or 720 degrees; but on trial the balance was frequently found to exceed this quantity, and that a very slight motion given to the time-keeper (particularly when the axis of the balance became the axis of that motion) was sufficient to alter the strength and figure of the pendulum spring, and position of the pieces in respect of the balance wheel, so as to change the rate of the time-keeper; and, what was worse, require a new adjustment of the balance, to accommodate itself to the changes made in the spring, and other parts connected with it. Hence it became necessary that some means should be used to stop the balance at certain limits beyond its natural arch of vibration; and various attempts have been made to effect it. One way is, by a moveable piece on the axis of the balance, which banks against a pin, yet so as to suffer

* From *Transactions of the Society of Arts*, &c. for 1804.—A bounty of thirty guineas was voted to Mr. Hardy by the Society for this communication.

the balance to vibrate more than 360 degrees. Another method is to have a piece moveable on a centre in one of the arms of the balance, and applying itself as a tangent to the pendulum spring, which passes through a hole in the piece. It has also a knee, which almost touches the plate, and just passes free of a pin placed in it. But when the balance vibrates so as to approach its utmost limits, the action of the spring, while in a state of unwinding, throws the piece outward, so as to fall in the way of the pin, and stop the balance from proceeding further. Another mode is by a straight spring, screwed upon the plate, having a hook at the end of it, into which a pin placed in the balance strikes, when, as before, the pendulum spring, in unwinding, touches the straight spring, and moves it a little outwards. There is also a way of banking by means of a bolt, which is thrown back by the pendulum spring, and made to fall in the way of a pin placed in the rim of the balance. These are the principal modes of banking now in use, and they do not differ materially from one another in principle. But the weight and friction of so many pieces on so delicate an organ as that of a pendulum spring, are perhaps nearly as hurtful to the time-keeper as the injury it may sustain when it is left without any banking whatever.

I am, sir, your most obedient servant,

WILLIAM HARDY.

Charles Taylor, Esq.

In figures 1 and 2 (Plate III.) the same letters are placed, to signify the same things. AA is the balance to which the pendulum spring is fastened in the usual way. In one of the crosses of the balance is placed a pin P, which stands a little way above its surface; and when the balance is caused to vibrate a complete circle, the pin in its motion will describe the dotted circle POQ, and just pass clear of the inside of a projection formed on a cock B, which is fastened on the plate by means of a screw. At about one-fourth of a turn of the pendulum spring, reckoned from its stud E, is placed a very delicate tapering piece of steel S, having a small hole in it, through which the pendulum spring passes; and it is fastened to it by means of a pin, and stands perpendicular to the curve of the spring. Let the balance be at rest, as represented in fig. 1, the banking-pin at P, and the banking-piece at *s*. Suppose the balance is made to vibrate from P towards O, when P arrives at the banking-piece *s*, it will pass it without touching, because its extremity *s* lies wholly within the circle traced out by the

the banking-pin. But when the banking-pin P has arrived at Q, the banking-piece *s* will have advanced to *t*, by the pendulum spring winding itself up into the figure represented by the dotted curve; and when the banking-pin P (now at Q) returns back to P, and passes on from P towards Q, to approach B, and so complete the other half-arch of its vibration, before P can arrive at the banking-cock B, the pendulum spring will have unwound itself into the figure described by the dotted curve, and the banking-piece *s* will have advanced into the position at *r*, just touching the banking-cock. Its extremity *r*, however, being thrown beyond the dotted circle, must necessarily fall in the way of the banking-pin, which arrives there almost at the same moment, and is opposed by it, without the slightest shock to the pendulum spring. The model renders any further explanation unnecessary.

WILLIAM HARDY.

XXXII. *Proceedings of Learned Societies.*

ECONOMICAL SOCIETY OF LEIPSIC AT DRESDEN.

On a request by Count von Reisch, this society has proposed the two following prize questions:

1st, To determine the means, established by experiment, of extirpating from fields of oats and barley the wild radish (*Raphanus Raphanistrum*), with instances of these means proving successful. The prize is 5 Fredericks of gold.

2d, To invent a handmill of a simple construction, easy to be moved, and which will not cost more than forty rix-dollars. The inventor must send a model and scale. The prize is 8 Fredericks of gold. The papers, written in the German language, must be transmitted with a sealed device to the secretary of the society at Dresden, before the end of April 1805.

XXXIII. *Intelligence and Miscellaneous Articles.*

ORIGINAL VACCINE POCK INSTITUTION, No. 44, Broad-street, Golden-square.

Quarterly Court.

The following Resolutions, on the authority of a public institution, must serve to tranquillize many families disturbed by prevailing ill-founded reports; and the notice of the

the privilege of letters to and from the establishment must be especially acceptable.

Among the resolutions were the following:

1. Resolved, That it appears from the numerous reports that have been transmitted or attested by the members of the medical establishment from abroad, from our own country, and from their own experience, that the proportion of failures in the cow-pock inoculation to give security against the small-pox, which have been published, does not amount to more than 50 out of 250,000 vaccinated persons.

2. Resolved, That it does not appear on examination of the published reports of these failures, and the investigation of many of them by the medical establishment of this institution, that TEN have been substantiated by admissible and adequate evidence.

3. Resolved, That it seems more than probable, that all or many of even the admitted of failure, according to the evidence produced, are liable to be deceptions, on the same grounds as in the asserted cases of the occurrences of the small pox, subsequent to the small pox.

4. Resolved, That, considering that the cow pock inoculation has been the practice of producing an affection which practitioners in the first instances in general had not previously seen, and the history of which was so little known, and considering the greater deceptions than in the small pox inoculation to which practitioners are exposed, it was to have been expected that a much greater proportion of supposed failures would have occurred.

5. Resolved, That it does not appear that a single instance has occurred of the small pox, subsequent to the cow pock, during more than five years practice at this institution; for, on inquiry, two instances which were said to be such were found to be inadmissible cases: viz. one of them on account of the supposed cow pock preceding being only a local affection; and in the other, that it was only proved that there was a local affection from the variolous inoculation.

6. Resolved, That the numerous instances of exposure of vaccinated persons to the small pox since the commencement of the practice in January in 1799, and likewise of repeated re-inoculation with small pox matter at this institution, and which have been communicated, establish the fact, that a person who has really gone through the cow pock is incapable of the small pox, on as firm ground as the fact of variolous inoculation giving security against the small pox.

7. Re-

7. Resolved, That considering the novelty of the practice of vaccine inoculation, and that it has not been performed in many instances, after such a mode as might give the greatest chance of security; it is advisable to take precautionary measures with many who have been inoculated, or who shall undergo the practice in future.

8. Resolved, That the tests of patients who have been inoculated being secure, are, exposure to effluvia and contact with persons in the small pox; inoculation with small pox matter, and re-inoculation with vaccine matter. But, for reasons set forth in a memoir read at the quarterly meeting by Dr. Pearson, the repetition of re-inoculation with vaccine matter is a preferable test; for it does not appear, from abundant evidence brought forward by the experience of Dr. Pearson, that a person who has gone through the cow pock is susceptible of it a second time.

9. Resolved, That such practitioners as are desirous of seeing proofs of the proposition last stated, that a second inoculation for the cow pock is an equally decisive test of the question of the susceptibility of a vaccinated person to take the small pox as inoculation with variolous matter, be invited to attend at the institution, for that purpose.

10. Resolved, That although it is probable, from the amount of the deaths by the small pox in the bills of mortality in two preceding years, viz. in 1803, of 1202; and in 1804, of 622, that the proportion of deaths by that disease has been diminished by vaccine inoculation; yet it does not appear justifiable to draw this conclusion positively at present—because, in former years, previously to the new practice, even a still smaller proportion occurred by small pox, viz. in 1795, there were 1040; in 1797, there were only 522; and in 1799, there were 1111: therefore that it will require at least five successive years of vaccine practice to draw a just inference.

11. Resolved, That Dr. Pearson be requested to allow the memoir on the state of the practice of vaccination, and on the conduct of it, to be printed, in order to quiet the minds of many families disturbed by the late unfavourable reports.

12. Resolved, That the medical establishment continue their practice of registering their observations, as the most likely means to reduce to certainty the vaccine practice as a prophylactic of the small pox.

13. Resolved, That although the conduct of this institution, under the economical management of the treasurers, Thomas Payne and John Heaviside, Esqrs. and the trustees,

Wm.

Wm. Bosville, Wm. Noble, and Charles Binny, Esqrs. has been such, that the subscriptions hitherto have been sufficient to defray the expenses, without requesting additional aid from the present supporters; yet, to accomplish the objects of the institution to their full extent, it will be requisite that further contributions be requested from the public, and that the present subscribers particularly be respectfully solicited to use their interest for that purpose.

The number inoculated since the last report amounts to 2337.

Subscribers of ten guineas are Life Governors; of two guineas annually are Electors, and of one guinea annually are Governors.

All persons, with or without letters of recommendation, are admitted for inoculation every Tuesday and Friday, at one o'clock.

Subscriptions will be thankfully received by Messrs. Devaynes and Co. Pall Mall, and by Mr. Sancho, at the Institution.

NOTE—*Provincial subscribers and correspondents are informed, that permission has been liberally granted by their Lordships the Postmasters-general for letters to come and return postage free, provided they are addressed to Mr. Sancho, Secretary to the Original Vaccine Pock Institution, Broad-street, Golden-square, and are sent under cover to Francis Freeling, Esq. General Post Office,* with this indorsement—"On the business of the Broad-street Vaccine Institution."

By order, WILLIAM SANCHO, Secretary.

METALLIC NATURE OF OCHROIT.

M. Gehlen, of Berlin, has received from Messrs. Hisinger and Berzelius, a memoir on the analysis of the ochroit of Klaproth. They consider the new substance contained in this fossil as a metallic oxide, and they give to the metal the name of *Cerium*, from the planet Ceres. They have, however, judged of the nature of it only from the phænomena of the oxidation exhibited by the substance, for hitherto they have not been able to obtain it in a metallic state.

CHARACTERS OF PURE NICKEL.

M. Richter is employed in examining the nature of nickel. In its state of purity, this metal is exceedingly malleable; it is also almost as brilliant as silver, and more susceptible of attraction by the magnet than iron. He asserts,

serts, that in the purest state in which it has been hitherto obtained it contains still a great deal of copper. M. Richter has discovered a sure method of freeing it from that metal.

Purified oxides of nickel are of a much livelier green colour than common oxides, and their solution in ammonia is of a very pale blue colour.

ALKALINE METALLIC SOLUTIONS PRECIPITATED BY OTHER METALS, AND BY PHOSPHORUS.

Klaproth has found that solutions of metallic oxides in alkalies are as easily precipitated in the metallic state, by other metals soluble in the same salts, as also by phosphorus, as acid metallic solutions are. He makes a very ingenious application to analysis of tin ores, according to a method which he indicates in his (Beitraege) collections. In this process, tungsten is separated by zinc from tungstate of ammonia, under the form of black flakes.

DECOMPOSITION, BY BOILING WATER, OF SUCCINATE OF IRON OXIDATED AT A MINIMUM.

Bucholz, in examining M. Gehlen's method of separating iron and manganese by the help of succinate of potash, has found that succinate of iron, oxidated at *a minimum*, is entirely decomposed by boiling it with distilled water, so that the water dissolves the acid with an inappreciable quantity of oxide. The same chemist is employed in examining uranium and its combinations.

GALVANISM.

Brugnatelli, in a letter to M. van Mons, says, Volta is still employed on electricity. He has lately constructed different piles, composed merely of saline substances of a different nature, with solutions of which he impregnated disks of bone.

I have lately, adds he, gilt in a complete manner two large silver medals, by bringing them into communication, by means of a steel wire, with the negative pole of a Voltaic pile, and keeping them, one after the other, immersed in ammoniuret of gold newly made and well saturated *.

* The result here detailed reminds me of one somewhat similar, which took place during some experiments performed some years ago at the Askesian rooms. Some gold leaf was put loose upon a new piece of copper coin, which was then brought into the circuit of the pile; a part of the gold was inflamed, and other portions adhered to the surface of the copper as completely as if they had been attached by any common gilding process. EDIT.

NEW METAL IN PLATINA.

I have seen with pleasure, says Brugnatelli, in a letter to the same, that Fourcroy and Vauquelin have found a new metal in platina. I must observe that I obtained separately a long time ago the substance which gives colour to solutions of platina. I enlarged, by eight or ten parts of water, the solution of that crude metal, and added to it a solution of muriate of ammonia. The mixture at first did not become turbid, but after some minutes, the sides and bottom of the jar were covered with the red matter in shining moleculæ, and similar to that of which I send you a specimen.

ASTRONOMY.

M. Harding, of Lilienthal, near Bremen, has discovered a new planet, to which he has given the name of Juno. While comparing with the heavens the fifty thousand stars observed by Messrs. Lalande, he saw one of the eighth magnitude, which appeared to him to have a motion of its own. He observed it several days, and soon found that it was a planet.

On the 5th of September, its right ascension was 1° 52′.

Its north declination 0° 11′.

M. Burckhardt observed it on the 23d of September, at 359° 7′, and 4° 6′, and thence concluded that the duration of its revolution is five years and a half.

Its inclination is 21°.

Its excentricity is a quarter of its radius.

Its mean distance from the sun is three times that of the earth, that is to say, it is about a hundred millions of leagues; it is consequently a little farther distant from the sun than Ceres and Pallas, which are only ninety-six millions of leagues.

Its diameter has not yet been measured, but it appears like a star of the eighth magnitude.

Its size appears nearly equal to that of Ceres, or of the planet discovered by Piazzi. As astronomers daily observe it, more precise elements of it may be obtained. Juno is the 12th planet discovered within a small number of years. Herschel discovered Uranus, and its six satellites; he discovered also two new satellites to Saturn; Piazzi discovered Ceres; Olbers discovered Pallas; and Harding has discovered Juno.

M. Piazzi, the astronomer, of Palermo, in a letter to M. Delalande, says, that he has observed in the fixed stars a change of one, two, and three seconds, according to the situation

situation of the earth in its orbit. This effect of the annual parallax, respecting which astronomers have disputed so much for a century past, is an interesting fact: it thence follows that the distance of the stars is not seven millions of millions of leagues.

GEOLOGY.

The following authentic account of an ascent to the summit of one of the highest mountains in the Tyrol, has been published in the Vienna court gazette:—"For some years past, doctor Gebhard has been employed in exploring the Tyrol in all directions by the order of his royal highness the archduke John, who exerts himself with so much zeal and makes so many sacrifices to promote the good of his country. One of the most interesting consequences of this measure, which promises to furnish abundance of matter to geology, botany, mineralogy, and natural history in general, is the late ascent to the summit of the Orteler, the highest mountain in the Tyrol, which is covered with eternal snow and ice. By his highness's orders, Dr. Gebhard proceeded to Glurus in the Vintschgau, and thence examined all the valleys which obtain their water from the Orteler, in order to ascertain the most favourable point for ascending the mountain; but he began to doubt of the possibility of accomplishing this enterprise, when a hunter of chamois goats, from the village of Passayer, a man habituated to the dangers of these precipices, offered to become his guide. Dr. Gebhard added to him as companions two boors from the Ziller valley, who had attended him during his excursions among the mountains, and one of whom possessed sufficient knowledge to observe two barometers which they carried with them.

About two o'clock in the morning, September 27, they set out from Drofui, and between 10 and 11 reached the very summit of the mountain. But they could scarcely remain here four minutes. These they employed in observing the barometer; and about eight in the evening returned to Drofui half benumbed, and, at first, deprived of the power of speech. Without resting more than the above four minutes, they had wandered during seventeen hours over rocks, snow, and ice, in many places at the hazard of their lives. Both the barometers observed on the summit were exceedingly good, and agreed. Corresponding observations were made at Mals. The height of the mountain above Mals is therefore known, but the elevation of Mals above the sea has not yet been calculated. It may however be estimated, that the summit of the Orteler is at least 19,200 Paris feet above the level of the Mediterranean.

His royal highness has caused huts and places of shelter to be erected below and above the glaciers, roads to be cut out in the rocks, and ropes to be extended along them, in order to open a safe passage for the friends of geology, and those fond of the sublime beauties of nature, to the summit of a mountain, next to Montblanc, the highest in Europe.

The ingenious and profound researches by which Cuvier was able to discover and restore entirely the fossil skeletons of several animals found in the quarries of Montmartre, and of whichan alogous ones exist, are well known. The method by which he effected this restoration has been confirmed in a striking manner, by the discovery he has made of a skeleton of the opossum, an animal the genus of which is now confined exclusively to America. All the bones of this skeleton, and those in particular by which it is characterized in the most striking manner, were not at first discovered in the stone; but the relations which M. Cuvier knew to exist between the different organs, and which he calls the *zoological laws*, enabled him to judge from what he saw of what he did not see. Such is the certainty of these relations, that M. Cuvier was able to predict, that in searching further in the quarry the two characteristic bones of this species, those which serve to support the edges of the bag in which the opossum carries its young, would be found. Experience confirmed what theory had foreseen.

This fact is no less curious than embarrassing to the geologues. M. Cuvier observes, that it entirely overturns almost all their systems in regard to fossil animals:—"Hitherto," says he, "they would see in the fossil bones of the North the animals of Asia only. They allowed, also, that the animals of Asia had passed over to America, and had been there buried, at least in the north; but it would seem that the American genera never quitted their native soil, and that they never extended to those countries which form at present the old continent. This is the second proof I have discovered of the contrary."

BOTANY.

E. Rudge, Esq. F.R.S. and F.L.S. is about to publish in a few days the first fasciculus of a splendid work, entitled *Plantarum Guianæ Rariorum Icones et Descriptiones hactenus ineditæ*. The plants from which the figures are taken, formed a part of that superb collection of natural history consigned by order of the French Government from Cayenne

Cayenne to the National Museum at Paris, and which was captured on its passage by two British privateers, in September 1803. It will comprise upwards of one hundred new plants.

METHOD IN WHICH SNAILS BREATHE.

I am ignorant, says Giobert, whether you know, that according to the experiments of Spallanzani, it appears to be proved, that snails absorb oxygen, not only by other organs than the lungs, but also through their shells, and that this absorption continues some time after their death: even when the shell of a snail has been freed from the animal it contained, it seems to continue to absorb oxygen.

INUNDATION OF THE TYBER.

A letter from Rome, dated February 21, says, Andrew Vinci, hydraulic engineer, has published the result of his observations on the last inundation of the Tyber; whence it appears that the waters rose this year forty-two Roman palms above their usual level, and, on the whole, higher than in all the inundations which have before taken place. Monsignor Naro, president of the department of waters, has ordered that an inscription shall be placed on the shore to transmit to posterity the remembrance of this terrible inundation. The greatest remembered was that of the year 1750: the one this year exceeded it by four palms. On the 31st of January the water covered all the neighbouring plains, penetrated to all the lower parts of the city, and inundated a great portion of them: the Rue de la Cours, the places Navone and De la Rotonde, the church in the latter, and all the adjacent quarters, were covered with water: in that of the Jews, the water rose to the first stories. The waters did not retire within their usual bed till the day of the Purification of the Virgin.

MECHANICS.

M. Regnier, an ingenious mechanist, has invented a meridian which may be placed in the window of an apartment. It is so constructed that it may remain exposed to the open air without any covering. It consists of a quadrant furnished with a lens, and a plate of brass in the plane of the meridian with a black horse-hair, which when it breaks lets go the catch of a hammer which strikes on a bell. When the faintest ray of the sun appears, the hair crisps and breaks: a ray less brilliant than that which makes the shadow on a sun-dial appear distinctly, is sufficient for this purpose, and the mechanism is sufficiently strong to strike noon on a large bell.

METEOROLOGICAL TABLE
By Mr. Carey, of the Strand,
For March 1805.

Days of the Month.	Thermometer. 8 o'Clock, Morning.	Thermometer. Noon.	Thermometer. 11 o'Clock, Night.	Height of the Barom. Inches.	Degrees of Dryness by Leslie's Hygrometer.	Weather.
Feb. 26	44°	51°	44°	·82	33°	Fair
27	43	51	43	·60	7	Cloudy
28	44	49	36	·46	27	Fair, with wind
March 1	36	42	37	·50	24	Hail showers
2	33	42	37	·95	7	Fair, snow in the night
3	37	46	44	30·14	22	Fair
4	47	54	45	·01	25	Small rain
5	46	52	37	29·92	42	Fair
6	38	51	37	30·00	42	Fair
7	37	43	36	·22	23	Cloudy
8	35	42	32	29·98	32	Fair
9	30	39	33	·66	17	Fair
10	32	40	32	·52	30	Fair
11	30	47	38	·90	33	Fair
12	49	59	49	·98	35	Fair
13	48	60	49	30·01	51	Fair
14	49	59	48	29·70	40	Fair
15	44	53	40	·84	33	Cloudy
16	38	53	44	·93	27	Fair
17	45	54	44	·82	42	Fair
18	46	47	42	·98	16	Rain
19	38	51	44	30·18	55	Fair
20	40	43	40	·10	6	Rain
21	39	47	40	·05	25	Fair
22	40	46	41	29·93	20	Fair
23	38	47	40	30·05	31	Fair
24	38	47	43	·20	25	Fair
25	31	37	34	·01	34	Fair
26	32	48	34	29·86	30	Fair

N. B. The barometer's height is taken at noon.

XXXIV. *An Account of the Aërial Voyage undertaken at Petersburgh on the 30th of January* 1804. *Read before the Academy of Sciences by the Academician* SACHAROF.

HITHERTO aërial voyages have been undertaken merely for the gratification of the public. Since the invention of balloons, no learned society, or man of science, has undertaken such excursions in order to make physical observations. Men eminent for their scientific acquirements seldom embark in them merely on account of the advantage resulting from them. They always represent them as more dangerous than they are in reality, in order to excite greater admiration of their intrepidity, and by these easy means to prevent others from acquiring the same celebrity. The Imperial Academy of Sciences at Petersburgh, considering the advantages which might result from an aërial excursion of this kind, resolved to cause one to be undertaken for the purpose of making scientific researches. The principal object of this voyage was to ascertain exactly the physical state of the atmosphere, and the component parts of it, at different determinate heights. The academy had entertained an opinion, that the experiments made by De Luc, Saussure, Humboldt and others, on mountains, must give other results than those made in the open air; that this difference might arise from the attraction of the earth and the decomposition of organized bodies; and that by these means the law which accurately determines the height of the atmosphere might perhaps be found. The academy afterwards requested the academician Lowitz, who undertook to make the proposed experiments in the atmosphere, to confer on this subject with professor Robertson. Mr. Robertson declared he would consider it as a particular honour to be of any service to the academy in this respect; that he would with pleasure accompany this philosopher; and that the balloon he had constructed at Petersburgh was at the service of the academy for that purpose: he only requested that the academy would defray the expense which would arise from filling the balloon with hydrogen gas. The academy thanked Mr. Robertson for the zeal he had manifested, and set apart a certain sum for carrying this aërial voyage into effect. While preparations were making for this excursion, and while the aëronauts were waiting for a favourable wind, Mr. Lowitz fell sick, and the president, Nicolai Nikolayevitsch Novossilzof, proposed to me to supply his place. As this proposal showed that particular confidence was

was placed in me, I embraced it with pleasure; and, after the accomplishment of the excursion, I now have the honour of laying before the academy the following account of the experiments and observations I made.

The experiments proposed by the academy, which were to be made at the greatest distance from the earth, have been already described by several aëronauts, but have been either doubted or entirely rejected: as for example, the faster or slower evaporation of fluids; the decrease or increase of the magnetic force; the inclination of the magnetic needle; the increase of the power in the solar rays to excite heat; the greater faintness of the colours produced by the prism; the existence or non-existence of the electric matter; some observations on the influence and changes which the rarification of the air occasions in the human body; the flying of birds; the filling with air, flasks exhausted by Torricelli's method, at each fall of an inch in the barometer; and some other chemical and philosophical experiments.

The instruments I carried with me for these experiments were:

1st, Twelve flasks in a box with a lid.
2d, A barometer and thermometer.
3d, A thermometer.
4th, Two electrometers, with sealing-wax and sulphur.
5th, A compass and magnetic needle.
6th, A watch that beat seconds.
7th, A bell.
8th, A speaking-trumpet.
9th, A prism of crystal.
10th, Unslaked lime, and some other things for chemical and philosophical experiments.

But as no means have hitherto been found of ascertaining with certainty over what part of the earth a balloon is hovering, and to what quarter it is driven by the wind, especially when there are clouds below it, by which means terrestrial objects cannot be seen, and where the aëronaut in his car (where he is not sensible of the motion of the balloon) cannot discover the direction of it for want of fixed objects of comparison, I employed the two following methods to ascertain to which side it was impelled by the wind:

1st, I fixed perpendicularly, in an aperture made in the bottom of the car, an achromatic telescope, which showed me very distinctly those terrestrial objects over which the balloon happened to be, and to which side it directed its course. 2d, I laid together, cross-wise, two sheets of black paper;

paper; that is to say, I bound together two surfaces at right angles, fastened them with thread, and suspended it from the car with a piece of packthread. This light body showed me, as will be hereafter mentioned, better than I could have believed, all the variations in the direction of the balloon; on which account I shall call it the *way-wiser.*

The balloon was filled with hydrogen gas in the Garden of the first corps of Cadets, whence it ascended in the presence of a great many persons of distinction, the members of the Academy of Sciences, and various men of science. The decomposition of the water was effected by sulphuric acid and iron filings, mostly from cast iron. The chemical apparatus consisted of twenty-five vessels, from each of which a tin-plate tube was conveyed to a tub. For separating the carbonic acid gas, unslaked lime was thrown into water. Into each vessel were put three pood of iron filings with fifteen pood of water, and three pood of sulphuric acid were poured over them. The balloon began to be filled at eleven in the morning; and, though the operation was completed at four in the afternoon, the experiments to serve as a point of comparison with those made in the higher regions of the atmosphere retarded our voyage till a late period. The balloon contained 9000 cubic feet of hydrogen gas.

	Pood*	Pounds
It weighed, with its whole apparatus -	5	2
Mr. Robertson and myself - -	8	10
The instruments and other apparatus for experiments - - - -	1	1
Clothing - - - -	0	18½
Bottles with water and provisions - -	0	21½
Ballast taken in - - - -	2	30
Total of the weight - -	18	3

The balloon, which in order to try its strength was first filled with common air, was thirty English feet in diameter, and perfectly round; but in the air, as it was not entirely filled with hydrogen gas, but sufficiently so for the voyage, it appeared to be elongated.

The wind was north-east, and favourable for our purpose; but, that I might ascertain the direction of it more accurately, we let off a small balloon before our departure at about seven o'clock. At first it was driven by the north-

* A pood is about forty pounds.

east wind towards the land side; but when it rose to a greater height it appeared to change its direction, and proceed straight towards the sea. Nevertheless we did not suspend our aërial voyage; but, having put into the car every necessary, placed ourselves in it. But as one of the most important experiments in my opinion was to collect air in the exhausted flasks which I took with me, at different heights, at each fall of an inch in the barometer, which rendered a gradual and slow ascent of the balloon necessary, we added so much ballast to that already taken in, after we had seated ourselves in the car, that the balloon was not able to raise us up. About fifteen minutes after seven, when the barometer stood at 30 inches English, and the thermometer indicated 19 degrees of heat, we threw out a handful of the ballast, which consisted of sand. The balloon immediately began very slowly to rise, but sunk down again over the Neva after it had attained to a considerable height. The reason of this, in all probability, was, that the balloon had been surrounded by a very warm atmosphere at the earth, by which means the gas in it occupied more space, and was the cause of its greater lightness; but at a height where the air, particularly over the Neva, was colder, where the matter of heat was absorbed by the watery vapours which arose, and where the hydrogen gas, on cooling, contracted, by which the balloon became smaller and heavier in regard to the more rarified air, it must necessarily lose some of its power to ascend, and consequently fall a little. But after a small quantity of ballast was thrown out, the balloon again rose. The telescope, fixed in the bottom of the car, clearly showed me the places over which we were. The balloon, according to appearance, took its direction towards the land side. About 31 minutes after seven, when the barometer had fallen to 29 inches, and the thermometer indicated 18 degrees of heat, I filled the first flask with air; the second I filled at 37 minutes past seven, the barometer being at 28 inches, and the thermometer at 17 degrees of heat. I filled the third flask at 42 minutes past seven, at which time the barometer stood at 27 inches, and the thermometer had fallen to 15 degrees. At this time, or at this height, I experienced a heaviness in my ears, but in conversing I heard as well as before. During the continuation of our voyage the balloon turned round several times. This always took place gradually, slowly, and almost imperceptibly. The direct motion of the balloon during a perfect calm, and when there is no apparent motion in the air, is not perceptible. In consequence of the

the fog I could not see distant objects, such as Lake Ladoga, Cronstadt, &c. I here threw out the paper way-wiser I had made; by means of which I observed, not only here, but during the rest of the voyage, that it showed much quicker than the barometer, the direction and also the sinking and rising of the balloon; for as soon as the balloon fell, the way-wiser, as it was much lighter than the balloon, and found more resistance in falling, flew up and rose almost up to it, so that it was necessary to pull it down when the balloon rose: it was below suspended from the thread in a diagonal direction, and followed us in such a manner, that a person habituated to such observations could easily determine with a compass, from the position of the way-wiser, the true direction of the balloon. As we found ourselves, with a north-east wind, over the islands at the mouth of the Neva, Mr. Robertson was afraid, in consequence of the changed direction of the small balloon which was let off from the Garden of the Cadets, that the wind might drive us out to sea; for it is well known that in the atmosphere there are several currents of air which have a contrary course, and which in all probability produced the before-mentioned cruciform turning of the balloon. Not being accustomed to this cruciform movement, I was not able, by the way-wiser, to determine the real direction of the balloon, and on this account Mr. Robertson suffered to escape a considerable quantity of gas; on which we again fell till the barometer stood at 29 inches, about 50 minutes past seven.

At this height the heaviness in my ears went off, and I experienced in them no more heaviness. Having continued our voyage along the coast a good way behind Katerinenhof, we began again, on my earnest request, to ascend. About 25 minutes past eight the barometer stood at 26 inches, and the heat was equal to $14\frac{1}{2}$ degrees. Here I filled the fourth flask with air. About 31 minutes past eight we found ourselves over the water, at a height where the barometer stood at 25 inches, and the heat had decreased to 13 degrees. At this height we could see the circles produced in the water by the fall of some bottles which I threw down. The north-east wind still appeared to be favourable to us, and about 45 minutes past eight we found ourselves entirely over the terra firma. Here we could see at one view the Newski islands at the mouth of the Yamelianofka, and the whole of that river. As we were now at a distance from the sea, and Mr. Robertson saw no further danger, he began to throw out his ballast, of which little remained, in order to rise as high as possible; so that at about 9 minutes after nine the barometer had fallen to 24 inches, and the thermometer indicated 9 degrees. Here I filled the sixth flask with air. About 20 minutes past nine we were at a height where the barometer stood at 23 inches, and the heat was 6½ degrees. At this height I filled the seventh flask with air, and suffered to escape two canary birds and a dove. One of the canary birds, when let loose from the cage, would not fly; but when thrown into the air, it fell down with precipitation. The dove also, when thrown from the car, flew down almost in a curved line to a village that lay below us. When we had thrown out almost the whole of our ballast, with a view to rise to as great a height as possible, I threw out my great coat and the remains of my supper, which I had eaten with the greatest appetite, some necessaries for my experiments which I had carried with me, and also some instruments; on which we began to ascend. I here made an experiment on the power of hearing by means of the bell; which I also threw down, as I did not observe any perceptible difference, in consequence perhaps of the air not being perceptibly more rarified. About 30 minutes past nine the barometer had fallen to 22 inches, and the thermometer indicated 4½ degrees of heat. I now filled the eighth flask with air. Before this I suffered the other dove to escape, or rather threw it from the car, as it sat on the edge of it and would not fly away. For two or three minutes it flew around the car at the distance of thirty fathoms, and again perched upon it. I then took it in my hand, without its making any resistance or showing the least fear, and threw it down; but it flew violently round in a circular manner, either because it was not able to rise, or because it saw no objects before it. At this height I made experiments on the electric matter and the magnet; but in consequence of the instruments, and particularly the dipping needle, being deranged by throwing out the ballast, and the lateness of the hour, I was not able to make any others.

At this height we saw the sun, but only one half; and on account of the thick fog which took place, I cannot say whether the other half was concealed by the horizon or by a cloud. The earth, covered with this fog, seemed to be involved in a smoke-coloured atmosphere, through which objects could not be clearly distinguished by the help of the telescope.

At this height the effect of the electric matter was perceptible; for when sealing-wax was rubbed with a piece of cloth,

cloth, it put in motion Bennet's electrometer. But as the magnetic needle which I took with me for the purpose of examining the inclination was spoilt, I was desirous of trying whether the magnetic power had as much influence over iron as at the earth. With this view I placed a common magnetic needle on a pin, and, to my great astonishment, saw the north pole of it rise considerably, while the south pole sunk down, making an angle of eight or ten degrees. I repeated this several times; and, to be more certain, I gave the needle to Mr. Robertson, that he might make the same experiment. The result, however, was always the same. The magnetic needle, which I have still in my possession, stands at present horizontal. Experiments in regard to the attraction of the magnetic needle, and some others, I was not able to make. At this height I did not experience the smallest change in regard to myself, except that my ears seemed, as it were, benumbed. My pulse beat as on the earth, that is, 82 times in a minute; and my breathing was neither accelerated nor impeded, that is to say, I breathed 22 times in a minute. In a word, I was exceedingly tranquil and cheerful, and experienced no change or uneasiness. At that time there were white clouds at a great height over us, but the heavens in general were clear and bright; yet though the sky was so clear I could observe no stars. I now proposed to Mr. Robertson to continue our voyage the whole night, in order that we might see the sun rise, and to make some other experiments; but ignorance of the local situation of the country, the almost total consumption of our ballast, and the continual, though slow, sinking of the balloon, prevented him from acceding to my proposal. While we were flying over several villages and rivers, I took my speaking-trumpet, and, directing it towards the earth, called out as loud as I could. Contrary to expectation, I heard, after a considerable interval, my words clearly and distinctly repeated by an echo. I then called out again; and each time the echo repeated my words. I observed that the sound was reverberated in ten seconds; but I could not remark the height of the barometer, because we had begun to make preparations for descending to the earth: and to effect this as slowly as possible, for the sake of security, we tied all our instruments and warm clothing into a bundle and let it down, together with the anchor, by a rope. The balloon, which was driven by the wind with considerable force, and wich fell with great rapidity, was so light when the bundle touched the earth, that it drew up the rope, and endeavoured again to ascend.

In the mean time Mr. Robertson gradually suffered the gas to escape, and the balloon descended slowly, and touched the earth so softly, that we did not experience the least shock; though the contrary is for the most part the case when balloons are suffered to descend, and in consequence of the violence with which they touch the earth great danger is experienced. We descended safe to the earth, at 45 minutes past ten, on the estate of counsellor Demidof, in a field almost opposite to his house; and his boors and servants assisted us to arrange and pack up the balloon. By the bundle being dragged on the earth, the greater part of the instruments were spoilt. Of the eight flasks filled with air brought from the atmosphere, four only were fit for being subjected to experiment; namely, numbers 1, 4, 6, and 7; but I did not venture to examine them. In the rest, after the necks were inverted under the quicksilver, none of the latter ascended; from which it appears that they were not sufficiently stopped.

The aërial voyage, set on foot by the academy, being thus ended, though I made experiments on the electric matter and the magnet, filled the flasks with air at different heights, made observations on myself and on the direction of the balloon during my voyage, I must confess that I am not able from these first experiments to draw any certain conclusions; because the small height to which the balloon rose, contrary to my wish; the consumption of the ballast by the balloon's twice rising; the lateness of the time; the short duration of the voyage, and other circumstances, were the principal causes which prevented me from making all the experiments appointed by the academy, and from making them with that accuracy which is necessary to deduce from them any well founded physical conclusions.

But I hope I shall have an opportunity of repeating all these experiments with greater accuracy. For, since I have experienced the nature of a voyage of this kind, I have no doubt that I shall be able to direct a balloon; to make observations in general on the filling of one, which may be of great use to the aeronaut during his voyage in the air; and to make some improvement in the method of throwing out ballast, or lightening the balloon; and in making experiments. But on this subject I shall have the honour of giving the academy further information.

XXXV. *A*

XXXV. *A brief Account of the Mineral Productions of Shropshire. By* Joseph Plymley, *A. M. Archdeacon of Salop, and Honorary Member of the Board of Agriculture**.

There are mines of lead ore, of a good quality, on the western side of this county, which have been very productive. The bog mine, in the parish of Wentnor, and the white grit mine, in the parishes of Shelve and Worthen, adjoin the Stiperstones: they are high hills, with bare and ragged summits, resembling the ruins of walls and castles: they are a " granulated quartz, much harder than common sandstone, but apparently not stratified †." The bog mine has been worked to the depth of 150 yards; a solid lump of pure ore of 800 lb. has been gotten up there: the vein is in some parts three feet thick, and generally bedded in white spar. One ton of this ore will run 15 cwt. of lead, besides slag. Dr. Townson says, " these mines are in argillaceous schistus, and produce galena lead ore ‡, sometimes spatous § lead ore, and blende ||." The ores at the white grit mine are the common galena and the steel-grained ores; sometimes the white spatous ore, and considerable quantity of black jack ||. The ores from this mine are not smelted separately; they differ much in their product, and little experiment has been made to ascertain it. I have been informed that they produce from 10 to 13 cwt. of lead, besides slags, from a ton of ore, and rarely more ¶. At Snailbach, in the neighbourhood of the same hills, but nearer Shrewsbury, lead has been gotten for a long time. " The vein was in some parts four yards wide. The vein-stones are heavy spar, mixt with calcareous spar and quartz. The ore here is the common galena and the steel-grained, and sometimes the white spatous ore **." It has been " worked

* From *Plymley's General View of the Agriculture of Shropshire.*

† Dr. Townson.

‡ This is lead mineralized by sulphur, and is the most common lead ore. It is sometimes called potters' lead ore.

§ This term is not in Nicholson's Dictionary, or in the octavo edition of Kirwan: it means lead ore crystallized in the form of spar.

|| Tracts and Observations in Nat. Hist. &c. p. 184.

¶ Mr. Pennant, in his Welsh Tour, vol. i. p. 447, says, " the lamellated, or common kind of lead ore, usually named potters' ore, yields from 14 to 16¾ cwt. of lead from 20 cwt. of the ore; but the last produce is rare."

** Dr. Townson's Tracts, &c. p. 183.

to the depth of 180 yards. The matrix of the ore is crystallized quartz and carbonate of lime. The ore is, 1. Sulphuret of lead, both galena and steel ore, which latter contains silver: 2. Carbonate of lead, crystallized: 3. Red lead ore*: 4. Blende, or black jack †." Lead ore has been met with in many other places in this part of the county. As far west as Llanymynach lead is found in small quantities, and copper, which the Romans are supposed to have worked to a great extent. Tools, judged to be Roman, have been found in these mines, and some of them are preserved in the library of Shrewsbury free-school. In this hill the lead is met with in bellies of ore; that is, a small string leads often to a body of ore about four or five yards in diameter, but from which there is no vein issues that may lead the miner to the other bodies of ore remaining in the hill. Calamine, also, is here met with. The rock at Pimhill is strongly tinctured with copper. Symptoms both of copper and lead appear also in the Cardington hills, many miles south-east of the spot we are speaking of, and not very far south of the centre of the county. "Lead is also found at Shipton, in the road from Wenlock to Ludlow, but never yet in sufficient quantities to reward the adventurers ‡." Full as far north of the centre, it is reported, in a MS. history of Bradford North (A.D. 1740), that "Henry Tenison, esq. got copper ore in his estate about Red Castle; but it lay so deep that it turned to little account:" and I believe we may apply the following paragraph, from the same MS., to many adventures in mining in this and other counties; for the author proceeds to say, that "the Rev. Mr. Snelson expected to find this hidden treasure at Weston, but had his labour for his pains, and his expense for his trouble."

Coal of an excellent quality is gotten on the eastern side of the county, particularly in the parishes of Wellington, Lilleshall, Wrockwardine, Wombridge §, Stirchley, Dawley,

* Mr. Aikin says this ore was discovered in these mines by Raspe, a German. Mr. Nicholson, in his Chemical Dictionary, 1795, remarks that this ore had not then been found, except at Catharineburgh, in Siberia. I do not know that these two red lead ores have been ascertained to be precisely the same, or that any difference between them has been discovered.

† *Vide* Aikin's Tour, p. 203.

‡ Mr. William Reynolds.

§ In this parish Mr. W. Reynolds, about ten years ago, put in practice an idea he had conceived some years before, of uncovering the strata of ironstone and coal which lay near the surface, so as to get the whole of the ley, Little Wenlock, Madeley, Barrow, Benthall, and Broseley, and which "promise a lasting and plentiful supply* for the great iron manufactures in that neighbourhood, for domestic use, and as an export to other counties by the river Severn, on or near the sides of which they lie." South of these works, and on the other side of Bridgenorth from them, coal appears again. It may be found in most parts of the hundred of Stottesden; but the roads in general are an obstruction to its being removed. South again of these, and of the Clee hills, are very valuable coal-works, in some of which the canal, or kennel coal, is found. Mr. Pennant, in his Voyage to the Hebrides, remarks, that the name is probably *candle* coal, from giving a light that supersedes, in poorer houses, the use of candles; and the bishop of Llandaff, in his Chemical Essays, has the same idea, supported by the circumstance, that in the northern counties candles are called cannels. The south-west parts of this county have not yet been proved to contain coal; and the inhabitants purchase, at a great expense of land carriage, coal from the Clee hills, or from collieries in the west parts of Shropshire: such there are west and south-west of Shrewsbury. Again, on the west and north-west borders of the county, coal of a good quality is gotten. Out of fifteen hundreds, the following large proportion of ten are known to produce coal: viz. Oswestry, Ford, Shrewsbury, Bradford South, Brimstry, Wenlock, Cundover, Munslow, Overs, and Stottesden. Mr. William Reynolds has favoured me with the following lists of strata in five different collieries in the eastern district. His name will add an interest and value to the communication in the opinion of all those who have the pleasure of knowing him.

Strata in Lightmoor Wimsey Pit.

	Yds.	Ft.	In.
A good loam, and mixed soil - -	6	0	0
Pale blue clunch - - -	16	0	0
Dark gray rock, not very strong - -	5	0	0
Sky blue clunch - - - -	2	1	6
Three stinking coals, divided by pale blue earth, two inches between each - -	1	1	6

the strata of ironstone and coal, clay, &c. to a certain depth; when, in the old method, large quantities both of ironstone and coal were unavoidably lost, and which never afterwards would be of any use to the proprietor or occupier of the mines. This method is now followed in other works, where the strata lie sufficiently near the surface.

* Edw. Harries, esq.

Strong

	Yds.	Ft.	In.
Strong clod mingled, pale blue and red -	16	0	0
Brown rock, called the stinking coal rock, -	7	1	0
Three stinking coals, divided by pale blue earth, four or five inches between each - -	3	0	0
Blue clunch - - - -	4	2	0
Red clunch, pale - - -	4	0	0
Rough rock, so called from being full of dark brown hard pebbles and ironstone -	7	0	0
Bind, a pale blue clod - - -	14	0	0
Stone clod, ditto, in which lies a bed of ironstone called ballstone - - -	5	0	0
Black slate - - - -	0	1	0
Coal called top coal, exceeding good fuel -	1	1	0
Top coal tough, a dark blue earth, and a very heaving measure - - -	0	1	0
Clod called the foot coal - - -	0	1	0
Slumbs, black slaty earth, and a heaving measure - - - -	2	0	0
Coal called the three-quarter coal - -	0	2	0
Rotch, dark gray hard rock - -	0	2	0
Coal called the double coal - -	1	0	0
Dark gray clod, will fire from its own nature	2	0	0
Coal called yard coal - - -	1	0	0
Black, a black slate coal and rock mixed -	2	1	6
Clod, a pale white, in which lies a bed of ironstone called - - - - -	2	0	0
Flan, a dark slate - - -	0	0	6
Coal called upper flint coal - - -	1	1	6
Upper flint, a dark gray rock - -	7	1	0
Pinny measure; a pale blue clod, in which lies a large quantity of small balls of ironstone called pennystone - - -	5	1	6
Stinking coals; three beds divided by three or four inches of dark brown earth - -	0	1	9
Pale blue clod - - - -	2	0	0
Coal called the silk coal - - -	0	1	2
Clunch, of a dark blue - - -	5	1	6
Coal called the silk coal, divided by a few inches of gray earth - - -	0	1	6
Clunch of a dark blue, with coal in the middle, seventeen inches thick: the coal is called silk coal - - - - -	3	1	10
Coal called the two foot coal (feet) - -	0	2	0
Lintseed earth; dark brown, a very shuttle measure	0	1	2
A black slate - - - -	0	0	6

Coal

	Yds.	Ft.	In.
Coal called the best coal - - -	0	1	6
Black bass, or slate - - -	0	0	6
Coal called the middle coal - -	0	2	9
Dark brown stony clod - - -	1	0	6
Coal called clod coal - - -	0	1	8
Clod, of a pale blue - - -	1	1	10
Coal called little flint coal - - -	0	2	2
Little flint; a rock of a dark gray, mixed with pebbles and ironstone - - -	16	0	0
	154	1	4
Die earth, a pale blue hard clunch: this measure continues the same to the depth of more than - - - - -	100	0	0

So far I have proved on the rise of the work. How much deeper it is, we know not.

Strata at Wombridge, at the Pit next the Engine.

	Yds.	Ft.	In.
Earth and catbrain, of various thicknesses -	4	0	0
Top rock - - - -	7	0	0
Bind bass - - - -	0	1	6
Bind - - - -	4	0	0
Ballstone and earth - - -	2	2	0
Short earth - - - -	3	0	0
Top coal bass - - - -	0	1	0
Top coal - - - -	1	2	0
Top coal and poundstone - -	0	1	0
Slums - - - -	0	1	6
Foot coal - - - -	0	1	0
Three-quarter coal - - -	0	2	3
Rock - - - -	1	1	4
Double coal - - - -	2	0	0
Double coal poundstone - - -	0	1	6
Yellow stone, earth and stone - -	2	0	0
Yard coal - - - -	1	0	0
Yard coal poundstone - - -	0	1	0
Quiest-neck - - - -	0	1	0
Blue flatstone, earth and stone - -	1	1	6
Pitcher basses - - - -	1	1	6
Flint coal rock - - - -	3	2	0
Flint coal roof - - - -	3	0	0
Flint coal - - - -	1	1	6
	43	2	7

Strata

Strata in Madeley Field.

	Yds.	Ft.	In.
Suppose the soil, clay or sand, may be, in general, about - - - - -	8	0	0
Stinking coal rock - - -	7	0	0
Ditto clod, blueish-gray - - -	1	0	0
First stinking coal - - -	0	2	0
A tough pricking - - -	0	0	4
Second stinking coal - - -	0	0	4
A strong clod, darker than the first - -	3	0	0
Freestone rock, containing plum-puddingstone	7	0	0
A clod much like the first - - -	1	0	0
Top coal - - - -	1	0	0
Basses or blacks - - - -	1	2	0
Blackstone, earth and ironstone - -	0	1	0
Bottom coal - - - -	1	0	0
Great flint and ironstone - - -	5	1	6
Prenny measure and ditto - - -	2	0	0
Third stinking coal - - -	0	1	0
Pricking - - - -	0	0	2
Upper clunches - - -	3	0	0
Sill coal or big coal - - -	0	0	7
Two foot rock - - -	6	0	0
Two foot coal - - - -	0	1	6
Lower clunches - - - -	2	1	6
Little ganey coal - - - -	0	1	0
Pricking - - - -	0	1	0
Ganey stone - - -	0	0	9
Ganey coal - - - -	0	1	6
A clunch - - - -	2	0	0
Best coal - - - -	1	0	0
A bass - - - -	0	0	4
Middle coal, or randles - - -	0	2	0
A clod - - - -	0	0	6
Clod coal - - - -	0	1	8
Pricking - - - -	0	0	6
Clod coal, poundstone - - -	1	1	0
The hard-man, with little flint coal—ironstone in it - - - -	0	2	6
Little flint coal - - -	0	2	0
Little flint coal, rock with crawstone in it, and its measure a little coal for a pricking half inch thick - - - -	7	0	0
	67	2	8

Underneath

Underneath is a clayey earth called die earth, of an unknown thickness.

N. B. This measure is found to consist of stratifications, and appears to have been lifted up like the upper measures; and though this circumstance is not perceived at first, or when it is exposed to the day, yet, on sinking some yards into it, it is very perceptible.

Strata in Slaneys Dawley Deep Work.

	Yds.	Ft.	In.
Soil and loose rock - - -	3	2	0
Yellow, blue, and red stuff, with stones -	5	1	6
White clunch, with pieces of white rock -	10	0	0
Gray rock - - - -	1	1	6
Yellow cloddy stuff - - -	5	1	6
White clunch, or rocky stuff - -	3	0	0
Gray rock - - - -	3	2	5
White clunchy stuff - - -	1	1	6
White rock - - - -	0	1	6
Pitchy rock - - -	14	2	0
Bass and coal - - -	0	0	6
Blue tough stuff - - -	0	1	0
Coal - - - -	0	1	5
Blue clunchy stuff - - -	6	0	5
Red ditto ditto - - -	2	0	0
Blue ditto ditto - - -	1	0	8
Red ditto ditto - - -	2	2	0
Blue ditto ditto - - -	9	2	8
Coal - - - -	0	0	6
Blue clunch - - - -	0	2	6
Fleece of white rock (casing) - -	0	0	6
Blue clunchy hard stuff - - -	8	1	8
Coal - - - -	0	2	0
Blue clunchy stiff hard stuff - -	4	1	1
Red ditto, very strong - - -	2	1	9
Hard, very hard white rock - -	0	1	9
Mingled red and white strong stuff - -	2	2	1
Very hard white rock - - -	1	1	10
Rock, red and white, hard - -	3	2	11
Ditto, very hard and white, with spar -	0	0	6
Hard white rock - - -	4	1	0
Yellowish stuff, called the callimancha earth	5	0	5
White rock - - - - -	0	1	7
Mingled red and white, and grayish stuff -	3	2	9
Bass - - - -	0	2	0
Stone clod - - - -	0	2	6

Ironstone,

	Yds.	Ft.	In.
Ironstone, supposed the logs - -	0	0	5
Clod - - - -	0	1	8
Coal, mixed with rock - - -	0	2	0
Flint coal, or bottom coal - - -	0	1	3
	116	0	3

We see then, that in the first-mentioned coal pit, no coal was found within much less than 30 yards of the surface, and that then three small layers of bad coal only were gotten: that after sinking near 24 yards deeper, three other layers of the same coal were procured, but that the first vein of good coal lay 92 yards beneath the surface: that this vein was 4 feet thick: that none of the veins appear to have been more than 5 feet thick: and that in 154 yards, and more, regularly worked, or above 254, taking in the whole experiment, 13 yards 2 feet of coal were found. In the second pit specified, the coal appears to have been met with in little more than 21 yards from the surface. One of the veins proved 6 feet thick; and in sinking somewhat less than 44 yards, above 7 yards thickness of coal was discovered. In the third pit specified, the sulphureous or bad coal was met with in 16 yards from the surface, and good coal in less than 28 yards; no vein exceeded 3 feet; and the aggregate in almost 68 yards was not quite nine yards of coal. In the fourth pit specified, the first unmixed coal was 50 yards from the surface; and in sinking above 116 yards, it does not appear that here was any vein thicker than 2 feet; and the aggregate of unmixed coal measured only 5 feet 2 inches in thickness.

[To be continued.]

XXXVI. *On Metallic Sulphurets. By Professor* PROUST*.

METALS, says Berthollet, may combine in proportions exceedingly various with sulphur; and the combinations they thus form have different properties, according to their proportions, &c. Considering the generality with which Berthollet establishes this opinion, there is reason to be astonished that he should have neglected to lay before the reader the facts on which it seems to rest. Silver, mercury, platina, copper, antimony, arsenic, lead, tin, bismuth, &c. do

* From *Journal de Physique.*

do not, however, afford one example of variable sulphurations. Iron, hitherto, is the only metal which appears capable of being sulphurated in two proportions, and these, instead of having any thing variable, are on the contrary constant and fixed, as are those of its oxidation.

"I am in opposition to Proust, who pretends that sulphur has been fixed for iron, by the invariable law of proportions, at 60 per cent."

This result, however, is as certain as invariable, whatever be the number of times the trial is made: he himself gave this opinion, to which Berthollet refuses his assent.

He says, "Pyrites may contain a variable surplus, as far as twenty parts and more, &c."

I cannot discover a similar variation*. Iron is either at 60, or at 90, or 100. The first sulphuret is that which we usually make in our laboratories, for the decomposition of water; and the second is pyrites itself. In a word, the case with sulphuration of this metal is the same as with oxidation. The principle which presides at one of these combinations, presides certainly at the other; and if neither nature nor art exhibit to us any where intermediate states between these terms, we ought not to be forward to admit variable sulphurations.

"If heat can more easily expel this sulphur, considered as foreign, this is a common property, &c."

Sulphur separated from iron by the action of fire cannot be qualified with the name of foreign, because it is a necessary element of a combination, which a high temperature destroys, to reduce it to another which can support it. The sulphur which we extract by distillation, from an argil, a sulphate, a stony concretion, &c. is foreign to their essence, but the same cannot be said of a pyrites. If I made use of these expressions, it was contrary to my intention.

"This chemist admits that black copper is sulphuret dissolved by copper. This solution exhibits in reality successive proportions of sulphur and copper, &c."

This manner of speaking, employed by Berthollet, ought to excite surprise: it tends to throw obscurity on distinctions which are however clear. When sulphur is prepared in a copper crucible, a sulphuret of 28 per cent. is obtained, and copper holding in solution variable quantities of that sulphuret: the latter may be separated from the copper

* *Journal de Physique*, p. 90. vol. liv.

without decomposing it. Is this then a simple solution of sulphur in copper? No one will suppose it.

"He pretends that a dose of sulphur invariably fixed by nature, attaches itself to antimony, and that man can neither increase nor diminish it. He fixes this proportion at 25 per cent."

It is not I, but nature, or whatever power you will, which places a barrier between it and the efforts of every chemist who might propose to make sulphuret of antimony beyond or within this proportion: I have not therefore assigned it any law of my invention; I have only verified it. I have followed this precept, which Berthollet himself traces out to us in his profound work. When a substance, therefore, says he, combines with another, we must determine the proportions, examine the properties, &c. Such indeed has been the constant object of the efforts of chemists since the time when they found that this determination was one of the most important bases of the history of combinations, and of the science of analysis. No one, however, will doubt, that nature cannot abandon her compounds to the chance of the variable proportions, which Berthollet has chosen as the basis of his system; but it is no less true, that in proportion as the sphere of sulphurets extends, we do not see that the new facts which each day accumulates are of a nature to strengthen it.

"He has however found sulphurets of antimony which had an excess of sulphur. Sulphurets of copper, of lead, &c., are also found mixed with a like excess." But if it can be taken away without changing their appearance, without taking any thing from the characters and qualities which distinguish these sulphurets, I shall say that this sulphur is foreign to them. The same thing cannot be said of a pyrites, from which has been taken the sulphur, which makes the difference between sulphuret at a *minimum*, and that at a *maximum*. That there should be sulphur mixed with sulphurets, without making part of their constitution, is not surprising. We see it every day mixed in the same manner with argil, alum, sulphate of lime, &c.

"He has combined oxide of antimony with different proportions of sulphuret, and he had mixtures which may be represented by this formula: oxide + 1 + 2 + 3, &c. of sulphuret of antimony: Has it not thereby formed real combinations? &c."

I shall reply to this, that solutions begun, or which have not

not reached the term of saturation of which they are thought to be capable, ought to be considered otherwise than terminated combinations; but to elucidate my idea, I have denoted these solutions as I should denote those of sugar and water: it is water + 1 + 2 + 3, &c. of sugar.

I cannot see, indeed, that one can form clearer ideas of the solutions of sulphuret of antimony in its oxide. All chemists have hitherto thought that this glass, this liver, this crocus, were sulphurated oxides. The object of my labour was to undeceive us on this point; to show that it was necessary to renounce these sulphurated oxides, which we admit only on hearsay, in order to receive in their stead, a new kind of combination, no doubt, but which is fully proved to exist. This combination indeed is repugnant to the ideas of Berthollet: he endeavours to place it in the family of the oxides simply sulphurated; but it is no less certain that it exists such as I have announced it, and that it has over that of sulphurated oxides, whose existence is now destroyed, the advantage of giving us the most natural solution of those thousand-and-one antimonial problems, the ridiculous nomenclature of which maintained the confusion of our ideas, and covered the history of antimony with profound obscurity. Berthollet adds, repeating my expressions: "I do not see how this saves the oxides of that metal from the suspicion of being able to unite with sulphur in all doses, and without regard to the invariable laws of proportion; but he must however admit, that these laws are not invariable, and must limit his apothegm, in regard to the proportions of the sulphuret of antimony with its oxide."

This paragraph requires that I should divide my answer into two parts. I will then first observe, that Berthollet, by introducing here the solution of sulphur in an oxide, when the question is merely that of a sulphuret, changes his subject: for the solution of sulphur, and that of the sulphuret, in the same excipient, are no more comparable than those of sulphur and sulphuric acid in the same liquor.

I will next say in reply, that not only the solubility of a metallic sulphuret in its oxide saves the latter from the suspicion of being able to unite with sulphur in all doses, which among us, the old disciples of Macquer, Rouelle, &c., was an error difficult to be eradicated; but it saves it also from another, which it is of no less importance to explain, that of dissolving a metal, and in all sorts of proportions, since indeed it exists as such in crocus and ruby. I shall

 therefore

therefore beg Berthollet to make himself for a moment author of the doctrine which he combats, and ask him what he would think of a chemist, who, for the good of the contrary hypothesis, should employ himself in arranging on one side all the considerations which he could deduce from the metal which ought to throw light on the nature of livers of antimony, to arrange then, exclusively, the latter, on the sulphur they contain? Why, would he say, are you silent in regard to that metal which lies close to sulphur, and which can so well remove whatever is difficult to be conceived in the solution of the latter by an oxide? Each of us then resuming the hypothesis he defends, I will answer the objection of Berthollet, by begging him not to forget, that if in the crocus there is sulphur in all doses, it is to saturate this sulphur that there is metal also found in all doses. This is what has obliged me not to range in the same line the sulphurated oxides of antimony, if any remain, with oxides holding in solution sulphuret, which will hereafter supply their place.

In regard to the nature of these combinations, the aspect under which I have presented them is far from furnishing limits to my apothegm, to deduce from it arguments against the law of proportions. He ought to have determined, that oxide of antimony may attain the term of its saturation by dissolving sulphuret, and thus to have discovered, that he cannot thence adduce an appearance and characters which warrant the constancy of this saturation, as generally happens to all the combinations which range themselves under the law of proportions. If the case with an oxide, in the power it has of dissolving, were the same as that of an acid which retains its liquidity, nothing would be easier than to resolve the question, and I should have employed myself on it. But when an oxide of antimony, to which is added a little sulphuret, has assumed the colour and transparency we require in it, we stop it there, without paying attention to the weight and measure, because it is in this state that we wish to have it. This is glass of antimony; a new dose of sulphuret makes it crocus; a greater makes it hepar, and so on; that is to say, the old chemists, without paying regard to a theory, the knowledge of which was reserved for posterity, broke down the solution of sulphuret in its oxide, and extracted from the crucible, as one may say, each of the fractions to fill the repositories of medicine with their livers, their magisteries, their rubies, and their diaphoretics, from Basil Valentine down to Lemery. Such, in my opinion, is the whole history of antimony. To a pound of of potash, add an ounce of arsenic, it will not be saturated; if you add two and a third, the case will be the same, and so on: but till the point of this saturation be discovered, I must repeat to them, your arsenical potash hitherto has been nothing but potash + 1 + 2 + 3 of arsenic; but as I have not yet had time to verify whether the combination will obey, as there is no reason to doubt, the law of relations, we must not be too urgent to deduce from them conclusions. To conclude, these are results so variable, that they annihilate your laws of proportion, and render your apothegms illusory. Besides, Berthollet is too just not to allow, that the series of the numbers by which I have endeavoured to represent the solutions of sulphuret of antimony in its oxide, has not the least relation with what I have hitherto called proportion in combinations.

XXXVII. *An Analysis of the magnetical Pyrites; with Remarks on some of the other Sulphurets of Iron.* By CHARLES HATCHETT, *Esq. F.R.S.*

[Concluded from p. 147.]

§ VIII.

FROM the whole which has been stated we find,

1. That the substance called magnetical pyrites, which has hitherto been found only in Saxony and a few other places, is also a British mineral, and that, in Caernarvonshire, it forms a vein of considerable extent, breadth, and depth.

2. That the component ingredients of it are sulphur and metallic iron; the former being in the proportion of 36·50 or 37, and the latter about 63·50 or 63.

3. That the chemical and other properties of this substance are very different from those of the common martial pyrites, which, however, are also composed of sulphur and iron, varying in proportion, from 52·15 to 54·34 of sulphur, and from 47·85 to 45·66 of metallic iron: the difference between the common pyrites which were examined being therefore 2·19, and the mean proportions amounting to 53·24 of sulphur, and 46·75 of iron; consequently, the difference between the relative proportions, in the composition of the magnetical pyrites and of the common pyrites, is nearly 16·74 or 16·24.

4. That, as the magnetical pyrites agrees in analytical

 results,

results, as well as in all chemical and other properties, with that sulphuret of iron which hitherto has been only known as an artificial product, there is no doubt but that it is identically the same; and we may conclude that its proportions are most probably subjected to a certain law, (as Mr. Proust has observed in the case of the artificial sulphuret,) which law, under certain circumstances, and especially during the natural formation of this substance in the humid way, may be supposed to act in an almost invariable manner.

5. That in the formation of common martial pyrites there is a deviation from this law, and that sulphur becomes the predominant ingredient, which is variable in quantity, but which, by the present experiments, has not been found to exceed 54·34 per cent.; a proportion, however, that possibly may be surpassed in other pyrites which have not as yet been chemically examined.

6. That iron, when combined naturally or artificially with 36·50 or 37 of sulphur, is not only still capable of receiving the magnetic fluid, but is also rendered capable of retaining it, so as to become in every respect a permanent magnet; and the same may, in a great measure, be inferred respecting iron which has been artificially combined with 45·50 per cent. of sulphur.

7. That, beyond this proportion of 45·50 or 46 per cent. of sulphur, (in the natural common pyrites,) all susceptibility of the magnetic influence appears to be destroyed; and, although the precise proportion which is capable of producing this effect, has not as yet been determined by actual experiment, it is certain that the limits are between 45·50 and 52·15; unless some unknown alteration has taken place in the state of the sulphur, or of the iron, in the common martial pyrites.

8. That, as carbon, when combined in a certain proportion with iron, (forming steel,) enables it to become a permanent magnet, and as a certain proportion of sulphur communicates the same quality to iron, so also were found to be the effects of phosphorus; for the phosphuret of iron, in this respect, was by much the most powerful, at least when considered comparatively with sulphuret of iron.

9. and lastly, That as carbon, sulphur, and phosphorus, produce, by their union with iron, many chemical effects of much similarity, so do each of them, when combined with that metal in certain proportions, not only permit it to receive, but also give it the peculiar power of retaining, the magnetical properties; and thus henceforth, in addition to that carburet of iron called steel, certain sulphurets and phos-

 phurets

phurets of iron may be regarded as bodies peculiarly susceptible of strong magnetical impregnation.

Having thus, for the greater perspicuity, reduced the principal facts of this paper into a concise order, I shall now make some general observations.

It is undoubtedly not a little singular, that a substance like the magnetical pyrites, which, although not common, has been long known to mineralogists, should not hitherto have been chemically examined, especially as mineralogical authors have mentioned the analysis of it as a desideratum. The result of this which I have attempted, proves that it is really deserving of notice; for thus we have ascertained, that the sulphuret of iron hitherto known only as an artificial product, is also formed by nature, and that the composition of this last agrees with those proportions of the artificial sulphuret which have been stated by Mr. Proust.

But from this sulphuret or magnetical pyrites I have not, by analysis, as yet been able to discover any regular or immediate gradations into the common pyrites; for the least proportion of sulphur in these amounted to 52·15, and the greatest proportion to 54·34; so that, between the magnetical and the common pyrites, the difference is considerable, in the proportions of their component substances, as well as in their physical and chemical properties; whilst the difference which I have hitherto been able to detect in the proportions of some of the common pyrites, (very dissimilar in figure, lustre, colour, and hardness,) has only amounted to 2·19.

Mr. Proust, in a general way, considers common pyrites to differ from the first sulphuret, or that composed of 60 parts of sulphur and 100 of iron, (= 37·50 per cent.) by containing a further addition of half the above quantity of sulphur, or 90 parts of sulphur and 100 of iron, (= 47·36 per cent.;) but this opinion he appears to have formed in consequence of results obtained by synthetical experiments made in the dry way. Now, when we consider how difficult it is to regulate the high degrees of temperature, and what a numerous chain of alterations in the relative order of affinities most commonly result from alterations in these degrees of heat, it seems to me that we cannot rely, with absolute certainty, on synthetical experiments made in the above way, unless they are corrected, and contrasted with analytical experiments made on the same substances. But it does not appear, from the two memoirs published by Mr. Proust, to which I have so frequently alluded, that that gentleman did more, in respect to analysis, than distil

 the

the cubic and dodecaedral pyrites found near Soria, from which he obtained about 20 per cent. of sulphur; and, having observed that the residuum possessed the properties of the sulphuret which has been commonly prepared in laboratories, he concluded that the sulphur obtained from the pyrites is the excess of that proportion which is requisite to form the sulphuret, the proportions of which, therefore, he by synthesis ascertained to be, as I have above stated, = 37·50 of sulphur, and 62·50 of iron, or 60 of sulphur combined with 100 of iron; and lastly, having formed 318 grains of this sulphuret from 200 grains of iron filings, he distilled the sulphuret with an additional quantity of sulphur in an inferior degree of heat, and obtained 378 grains of a substance which, excepting density, was similar to the common martial pyrites *.

It is however to be regretted, that Mr. Proust did not make a regular analysis of the pyrites of Soria, and of the residuum after distillation; for (unless these pyrites are very different from those which I have examined) he would most probably have found the proportion of sulphur greater than that which he has assigned to natural pyrites in general. This, at least, there is great reason to suppose, if we allow that most or all of the pyrites have been formed in the humid way, by which, we may conceive, a larger proportion of sulphur may be introduced into the compound than can take place in high degrees of temperature. And this opinion is corroborated by the results of my analyses; for, instead of finding the general proportions to be 47·36 of sulphur and 52·64 of iron, the mean result of these analyses is very nearly the reverse, being 53·24 of sulphur and 46·76 of iron.

Mr. Proust is also of opinion, that the pyrites which contain the smallest quantity of sulphur are those which are most liable to vitriolization; and, on the contrary, that those which contain the largest proportion, are the least affected by the air or weather †. This opinion of the learned professor by no means accords with such observations as I have been able to make; for the cubic, dodecaedral, and other regularly crystallized pyrites are liable to oxidizement, so as to become what are called hepatic iron ores, but not to vitriolization; whilst the radiated pyrites (at least those of this country) are by much the most subject to the latter effect; and therefore, as the results of the preceding ana-

* *Journal de Physique*, tome liv. p. 92.
† *Ibid.* tome liii. p. 91.

lyses

lyses show that the crystallized pyrites contain less sulphur than the radiated pyrites, I might be induced to adopt the contrary opinion. But I am inclined to attribute the effect of vitriolization observed in some of the pyrites, not so much to the proportion, as to the state of the sulphur in the compound; for I much suspect that a predisposition to vitriolization in these pyrites is produced by a small portion of oxygen being previously combined with a part, or with the general mass of the sulphur, at the time of the original formation of these substances, so that the state of the sulphur is tending to that of oxide, and thus the accession of a further addition of oxygen becomes facilitated. We have an example of similar effects in phosphorus, when (as is commonly said) it is half burned, for the purpose of preparing the phosphorus bottles; and the propensity to vitriolization, observed in many of the half roasted sulphureous ores, appears to me to arise from this cause, rather than from the mere diminution of the original proportion of sulphur, or the actual immediate conversion of part of it into sulphuric acid; nevertheless, I offer this opinion, at present, only as a probable conjecture, which may be investigated by future experiments and observations.

The magnetical properties of the sulphuret of iron, which forms the principal subject of this paper, must be regarded as a remarkable fact; for I have not found, in the various publications on magnetism which I have had the means of consulting, even the most remote hint, that iron, when combined with sulphur, is possessed of the power of receiving and retaining the magnetic fluid; and, judging by the properties of common pyrites, we might have supposed that sulphur annihilated this power in iron, as indeed seems to have been the opinion of mineralogists, who have never enumerated magnetical attraction amongst the physical properties of those bodies; and, although Werner, Widenmann, Emmerling, and Brochant, have arranged the magnetical pyrites with the sulphurets of iron, yet the magnetical property could not with certainty be stated as inherent in the sulphuret; for, at that time, this substance had not been subjected to a regular chemical analysis, and the magnetical property might therefore be suspected to arise from interspersed particles of the common magnetical iron ore. This probably has been the opinion of the abbé Haüy; for, in his extensive Treatise on Mineralogy, lately published, I cannot find any mention made of the magnetical pyrites, either amongst the sulphurets or amongst the other ores of iron.

In

In the mineral kingdom a great variety of substances, and even some of the gems, exert a feeble degree of attraction on the magnetic needle, and sometimes also acquire a slight degree of polarity *; but, as this wonderful property has only been observed conspicuously powerful in one species of iron ore, this has been always emphatically called the *magnet* †, and is said to consist of metallic iron combined with from 10 to 20 per cent. of oxygen.

From the facts, however, which have been recently stated, we now find that there is another natural substance, apparently very different from the magnet in chemical composition, but nevertheless approaching very nearly to it in power, which is found in several parts of our globe, and particularly in a province of this kingdom, where it constitutes a vein, running north and south, of considerable extent, and several yards in width and thickness.

From the experiments also which have been made on the artificial preparation of this substance, we find that it is capable of receiving the magnetic properties when the proportion of sulphur amounts to 37 per cent., and is still powerfully attracted when a much larger quantity of sulphur is present. There is, however, some point at which all these effects cease; and this point appears to be when the sulphur is in some proportion between 45 or 46 and 52 per cent. The preceding experiments have also proved, that iron, when combined with phosphorus, likewise possesses the power of becoming a magnet to a very remarkable degree; and, by the similarity, in this respect, of the carburet of iron called steel, to the above sulphuret and phosphuret, a very remarkable analogy is established between the effects produced on iron by carbon, sulphur, and phosphorus.

Carbon, when combined in a very large proportion with iron, forms the carburet of that metal called plumbago; a brittle substance, insoluble in muriatic acid, and destitute of magnetical properties. But smaller proportions of carbon, with the same metal, constitute the various carburets included between black cast iron and soft cast steel ‡; bodies which

* Cavallo on Magnetism, p. 73.

† In a future paper it is my intention to give an account of some comparative analyses of the varieties of this substance.

‡ "When the carbon exceeds, the compound is carburet of iron, or plumbago; when the iron exceeds, the compound is steel, or cast iron, in various states, according to the proportion. All these compounds may be considered as subcarburets of iron."—Thomson's System of Chemistry, vol. i. p. 165.

Mr. Mushet, in the following table, exhibits the proportion of charcoal which are more or less brittle, soluble in muriatic acid, and more or less susceptible of magnetical impregnation, some of them form the most powerful magnets hitherto discovered.

Sulphur, in like manner, combines with iron in a large proportion, forming the common pyrites, which are brittle, almost or quite insoluble in muriatic acid, and devoid of magnetical properties. Sulphur, in smaller proportions, forms sulphurets, which are also brittle, but are soluble in muriatic acid, and strongly susceptible of magnetical impregnation.

Phosphorus also, when combined with iron, makes it brittle, and enables it powerfully to receive and retain the magnetical properties; so that, considering the great similarity which prevails in other respects, it may not seem rash to conclude, that phosphorus, (like carbon and sulphur,) when combined with iron in a very large proportion, may form a substance incapable of becoming magnetical, although, in smaller proportions (as we have seen,) it constitutes compounds which are not only capable of receiving but also of retaining the magnetical properties, even so far as, in some cases, to seem likely to form magnets of great power; and, speaking generally of the carburets, sulphurets, and phosphurets of iron, I have no doubt but that by accurate experiments we shall find that a certain proportion of the ingredients of each constitutes a maximum in the magnetical power of these three bodies. When this maximum has been ascertained, it would be proper to compare the relative magnetical power of steel (which hitherto has alone been employed to form artificial magnets) with that of sulphuret and phosphuret of iron; each being first examined in the form of a single mass or bar of equal weight, and afterwards in the state of compound magnets, formed, like the large horse-shoe magnets, by the separate

coal which disappeared during the conversion of iron to the different varieties of subcarburet known in commerce.

" Charcoal absorbed.		Result.
1-120dth	- -	Soft cast steel.
1-100dth	- -	Common cast steel.
1-90th	- -	The same, but harder.
1-50th	- -	The same; too hard for drawing.
1-25th	- -	White cast iron.
1-20th	- -	Mottled cast iron.
1-15th	- -	Black cast iron.

" When the carbon amounts to about 1-60th of the whole mass, the hardness is at the maximum."—Thomson, vol. i. p. 166; and Phil. Mag. vol. xiii. pp. 142 and 148.

arrangement

arrangement of an equal number of bars of the same substance in a box of brass.

The effects of the above compound magnets should then be tried against others composed of bars of the three different substances, various in number and in the mode of arrangement; and, lastly, it would be interesting to make a series of experiments on chemical compounds, formed by uniting different proportions of carbon, sulphur, and phosphorus, with one and the same mass of iron. These quadruple compounds, which, according to the modern chemical nomenclature, may be called carburo-sulphuro-phosphurets, or phosphuro-sulphuro-carburets, &c. of iron, are as yet unknown as to their chemical properties, and may also, by the investigation of their magnetical properties, afford some curious results. At any rate, an unexplored field of extensive research appears to be opened, which possibly may furnish important additions to the history of magnetism, a branch of science which of late years has been but little augmented, and which, amidst the present rapid progress of human knowledge, remains immersed in considerable obscurity.

XXXVIII. *Account of an Aërostatic Voyage performed by M.* Guy-Lussac, *on the 29th of Fructidor, Year* 12; *and read in the National Institute, Vendemiaire 9th, Year* 13 *.

The author, after giving an account of the instruments he took with him for his observations, and the changes which he introduced in them in consequence of the observations made during his first voyage, says: All our instruments being ready, the day of my departure was fixed for the 29th of Fructidor. I, indeed, ascended that day from the *Conservatoire des Arts et Metiers*, at 40 minutes past nine, the barometer being at 76·525 centimetres, the hygrometer at 57·5°, and the thermometer at 27·75°. M. Bouvard, who makes meteorological observations every day at the observatory of Paris, thought the atmosphere full of vapours, but without clouds. Scarcely had I risen a thousand metres when I indeed saw a light vapour dispersed throughout the whole atmosphere below me, and through which I observed distant objects confusedly.

* From the *Journal de Physique.*

When

When I reached the height of 3032 metres, or 1555 toises, I began to make my horizontal needle oscillate, and I obtained 20 oscillations in 83″, while at the earth, under the same circumstances, 83·33″ would have been necessary for the same number *. Though my balloon was affected by the rotary motion which I experienced in my first voyage, the motion of the needle allowed me to count twenty, thirty, and even forty oscillations.

At the height of 3863 metres, or 19,821 toises, I found that the inclination of my needle, taking a mean of the amplitude of the oscillations, was sensibly 31°, as at the earth. A great deal of time and patience was necessary to make this observation, because, though carried away by the mass of the atmosphere, I felt a light wind, which continually deranged the compass; and, after several fruitless attempts, I was obliged to renounce making any more observations. I am of opinion, however, that the observation I here present deserves some confidence.

Some time after I wished to observe the dipping needle; the following was the result:—The dryness, favoured by the action of the sun in a rarefied air, was so great, that the compass was so far deranged as to make the metallic circle on which the divisions were traced out to bend, and become warped. The motions of the needle could not be performed with the same freedom; but, independently of this disappointment, I remarked that it was very difficult to observe the declination of the needle with this apparatus. It happened, indeed, that when I placed the compass in such a manner as to make the shadow of a horizontal thread, which served as a style, coincide with a fixed line, the motion I gave the compass communicated one to the needle; and, when the latter had attained nearly to a state of rest, the shadow of the style no longer coincided with the fixed line. It was still necessary to put the compass into a horizontal position; and during the time which this operation required, every thing was again deranged. Without persisting to make observations in which I could place no confidence, I gave them up entirely; and, free from every other care, I directed the whole of my attention to the oscillations of the horizontal needle. I am, however, convinced, in acknowledging the faults of my compass, that it is possible

* Though I here indicate hundredth parts of a second, it may be readily conceived that I was not able to observe fractions so small; but they were given to me by division, because at the earth I made commonly thirty oscillations which required 126·5″.

to

to employ one fitter for the purpose, which would determine the declination with more precision. I shall observe, that to attempt this experiment I had let down other needles, separately, in linen bags to the distance of fifteen metres below the car.

That the whole of the results I obtained may be better seen at one view, I have collected them in a table added to the end of this memoir; and they are such as they occurred to me, with the corresponding indications of the barometer, the thermometer, and the hygrometer. The heights were calculated, according to the formula of Laplace, by M. Gouilly, engineer of bridges and causeways, who was so kind as to take this trouble. As the barometer did not sensibly vary on the day of my ascent, from ten o'clock till three, to calculate the different heights at which I made observations, we took the height of the barometer, 76·568 centimetres, which was the height at the earth at three o'clock; a height which, agreeably to the observations made by M. Bouvard at the observatory, is greater by 0·43 millimetres than that observed at the moment of our departure. The heights of the barometer in the atmosphere were reduced to those which would have been indicated by a barometer at a constant level placed under the same circumstances, and for each height was taken the mean between the observations of two barometers. The temperature at the earth, having varied between ten and three o'clock, it was supposed constant and equal at 30·75° of the centigrade thermometer.

If we now cast our eyes on the table it will be seen that the temperature follows an irregular law in regard to the corresponding heights; which no doubt arises from this,—that, having made observations sometimes in ascending and sometimes in descending, the thermometer must have followed these variations too slowly. But if we consider only the degrees of the thermometer which form a decreasing series, we shall find a more regular law. Thus the temperature at the earth being 27·75, and at the height of 3691 metres 8·5°, if we divide the difference of the heights by that of the temperatures we shall first obtain 191·7 metres, or 98·3 toises, of elevation for each lowering of temperature. Performing the same operation for the temperatures 5·25° and 0·5, as well as for those of 0·0° and — 9·5°, we shall find in both cases 241·6 metres, or 72·6 toises of elevation for each degree of lowering in the temperament, which seems to indicate, that towards the surface of the earth the heat follows a less decreasing law than in the upper

upper parts of the atmosphere, and at greater heights it follows a decreasing arithmetical progression. If we suppose that from the surface of the earth, where the thermometer was at 3·75°, to the height of 6977 metres, or 3580 toises, where it fell to — 9·5°, the heat decreased as the heights increased, an elevation of 173·3 metres, or 88·9 toises, will correspond to each degree of the lowering of temperature.

The hygrometer had a very remarkable progress. At the surface of the earth it was only 57·5°, while at the height of 3030 metres it marked 62°. From this point it continually fell till the height of 5267 metres, where it indicated only 27·5°, and thence to the height of 6884 metres it gradually rose to 34·5°. If we wish from these results to determine the law of the quantity of water dissolved in the air at different elevations, it is evident that attention must be paid to the temperature, and by adding this consideration it will be seen that it follows an exceedingly decreasing progression.

If we now consider the magnetic oscillations, it will be remarked, that the time for ten oscillations, made at different heights, is sometimes above and sometimes below that of 42·16″, which they require at the earth. Taking a mean of all these oscillations made in the atmosphere, ten oscillations will require 42·20″, a quantity which differs very little from the preceding; but if we consider only the last observations made at greater heights, the time for ten oscillations would be a little below 42·16″, which would indicate, on the other hand, that the magnetic force has a little increased. Without wishing to draw any consequence from this slight apparent increase, which may arise from the errors committed in experiments of this kind, I must conclude that the results I have presented confirm and extend the fact observed by M. Biot and myself, and which, like universal gravitation, proves that the magnetic force does not experience any sensible variation at the greatest heights to which we can attain.

The consequence we have deduced from our experiments may appear a little too precipitate to those who reflect that we were not able to make experiments on the inclination of the magnetic needle. But if it be recollected that the force which makes a horizontal needle oscillate, necessarily depends on the intensity and direction of the magnetic force itself, and that it is represented by the cosine of the angle of the inclination of the latter force, no one can help concluding with us, that, since the horizontal force did not

vary,

vary, the magnetic force ought not to have varied either; unless we choose to suppose that the magnetic force could vary exactly in a contrary direction, and in the same ratio, as the cosine of its inclination; which is in no manner probable. We should have besides, in support of our conclusion, the experiment of the inclination made at the height of 3863 metres, or 1982 toises, which proves that at this height the inclination did not vary in a sensible manner.

When we reached the height of 4511 metres, I presented to a small magnetic needle, and in the direction of the magnetic force, the lower extremity of a key. The needle was attracted, and then repelled by the other extremity of the key, which I made to descend in a direction parallel to itself. The same experiment, repeated at 6107 metres, was attended with the same success; a new and very evident proof of the action of terrestrial magnetism.

At the height of 6561 metres, or 3353 toises, I opened one of my two glass balloons, and at that of 6636 metres, or 3405 toises, I opened the second: the air entered into both with a hissing noise. At length, at 11 minutes after three o'clock, the balloon being completely full, and having no more than 15 kilogrammes of ballast, I resolved to descend. The thermometer was then at 9·5° below the temperature of melting ice, and the barometer at 32·88 centimetres; which gives for my greatest elevation above Paris 6977·37 metres, or 3579·9 toises; or 7016 metres, that is, 3600 toises above the level of the sea.

Though well clothed, I began to feel cold, especially in the hands, which I was obliged to keep exposed to the air. My respiration was sensibly confined, but I was still far from experiencing any uneasiness so disagreeable as to oblige me to descend. My pulse and respiration were very much accelerated: breathing, therefore, very frequently in very dry air, it need excite no surprise that my throat should be so dry as to make it painful for me to swallow bread. Before I set out I had a slight head-ache, arising from the fatigue of the preceding day, and being up all night, and it continued the whole day without its appearing to increase. These are all the inconveniences I experienced.

A phænomenon which struck me at this height was to see clouds above me, and at a distance which appeared to be considerable. In our first ascent the clouds were not sustained at a greater height than 1169 metres, or 600 toises; and above, the heavens were exceedingly pure. The colour of them in the zenith was even so intense that it might be compared to Prussian blue; but in the last voyage I could not see clouds below me. The sky was much filled with vapours,

pours, and its colour dull. It is, perhaps, needless to observe, that the wind on the day of our first ascent was north-north-east, and that on the last it was south-west.

As soon as I perceived that I began to descend, I thought only of moderating the descent of the balloon, and rendering it exceedingly slow. At 45 minutes past three my anchor touched the earth, and became fixed; which gives 34′ for the time of my descent. The inhabitants of a small neighbouring village soon ran up to me; and while some of them took pleasure in drawing towards them the balloon, by pulling the rope to which the anchor was fixed, others, placed below the car, waited with impatience till they could reach it with their hands, in order to deposit it on the earth. My descent then took place without the least shock or accident; and I do not think that there could be one more fortunate. The small village at which I descended is called Saint-Gourgon: it is six leagues north-west from Rouen.

When I arrived at Paris, my first care was to analyse the air I had brought back. All the experiments were made at the Polytechnic School, under the inspection of Messrs. Thenard and Gresset; and I depended as much on their judgment as on my own. We observed, in turn, the divisions of the eudiometer without communicating with each other; and we did not write them down till we perfectly agreed. The balloon, the air of which was introduced at the height of 6636·5 metres, or 3405 toises, was opened under water, and we all judged that it had filled at least the half of its capacity; which proves that the balloon had well preserved its vacuum, and that no foreign air had entered it. We intended to weigh the quantity of air which remained in the balloon to compare its capacity; but, as we could not at that time find what was necessary, and being very impatient to ascertain the nature of the air contained in it, we could not make the experiment. We first employed Volta's eudiometer, and analysed it comparatively with atmospheric air collected in the court before the Polytechnic School. The comparative analysis of these two airs is as follows:

Analysis of the Atmospheric Air.		Analysis of Air collected at the Height of 6636 Metres.	
Exp. I.	Measures.	*Exp.* I.	Measures.
Atmospheric air - -	3	Air - - - -	3
Hydrogen gas - - -	2	Hydrogen gas - -	2
Residuum after combustion -	3·04	Residuum - - -	3·05
Exp. II.	Measures.	*Exp.* II.	Measures.
Atmospheric air - -	3	Air - - - -	3
Hydrogen gas - - -	2	Hydrogen gas - - -	2
Residuum - - -	3·05	Residuum - - -	3·04

At the same time a measure of very pure oxygen gas required 2·04 measures of hydrogen gas; and as this result differed only 0·01 from that found by experiments made on a very large scale, and with a great deal of care, on the composition of water, it appears that great confidence may be placed in our results. They prove, then, that atmospheric air, and air taken at the height of 6636·5 metres, are exactly the same, and that they contain each 0·2149 of oxygen. In analysing the last air by hydro-sulphuret of potash, we found 0·2163 of oxygen. I cannot present the result of the comparative experiment made on atmospheric air, because we were not able to collect it; but the proportion of oxygen I have indicated is still a little greater than that given by the combustion of hydrogen gas, and it is comprehended between the limits of the variations which have been found for the composition of the atmosphere at the surface of the earth, and which have not prevented us from considering it as constant.

The identity of the analyses of the two airs made by hydrogen gas proves directly, that the air I brought back contained none of the latter gas. I, however, still ascertained in it, by burning with the two airs, a quantity of hydrogen gas, smaller than that which would have been necessary to absorb the whole of the oxygen gas; for I saw that the residuums of the combustion of the two airs with hydrogen gas were exactly the same.

Saussure junior found also, by making use of nitrous gas, that air collected on the Col-du-Geant contained, within a hundredth part, as much oxygen as that of the plain; and his father confirmed the presence of the carbonic acid on the summit of Mont Blanc. Besides, the experiments of Messrs. Cavendish, Macartney, Berthollet, and Davy, have confirmed the identity of the composition of the atmosphere over all the surface of the earth. We may therefore conclude, in general, that the constitution of the atmosphere is the same from the surface of the earth to the greatest heights to which it is possible to attain.

Such are the two principal results of my last voyage. M. Biot and myself confirmed the fact we observed in regard to the sensible permanence of the intensity of the magnetic force as one recedes from the surface of the earth; and I think, also, I have proved that the proportions of oxygen and azote, which constitute the atmosphere, do not sensibly vary in very extensive limits. There still remain a great many things to be cleared up in regard to the atmosphere, and we wish the facts we have collected may prove sufficiently interesting to the Institute to induce it to make us continue our experiments.

TABLE OF THE OBSERVATIONS.

Temperature expressed in degrees of the centigrade thermometer.	Mean of the indications of the two hygrometers.	Mean height of the barometer in the atmosphere, reduced to that of a barometer at a constant level.	Corresponding heights in metres above Paris.	Corresponding heights in toises above Paris.	Number of the magnetic oscillations.	Duration of the oscillations in seconds.	Oscillations reduced to the common number 10.	Corresponding times.
		Cent.						
27·75°	57·5	76·525	0 0	0 0	30	126·5″	10	42·16″
12·50	62·0	53·81	3032·01	1555·64	20	83·3	10	41·5
11·00	50·0	51·43	3412·11	1750·66				
8·50	37·8	49 68	3691·32	1893·92				
10·50	33·0	49·05	3816·79	1958·29	10	42·0	10	42·0
		45·28	4511·61	2314·84	30	127·5	10	42·5
12·0	30·9	46·66	4264·65	2188·03	30	125·5	10	41·8
11·0	29·9	46·26	4327·86	2220·51	20	86·0	10	43·0
8·25	27·6	44·04	4725·90	2428·89	20	84·5	10	42·2
6·50	27·5	43·53	4808·74	2467·24	30	128·5	10	42·8
8·75	29·4	45·28	4511·61	2314·84	30	127·5	10	42·5
5·25	30·1	42·49	5001·85	2566·32				
4·25	27·5	41·14	5267·73	2702·74	40	169	10	42·2
2·5	32·7	39·85	5519·16	2831·74				
0·5	30·2	39·01	5674·85	2911·62				
1·0	33·0	41·41	5175·06	2654·68	30	126·5	10	42·1
— 3·0	32·4	37·17	6040·70	3099·32				
— 1·0	32·1	36·96	6107·19	3133·44	20	84·0	10	42·0
0·0	35·1	39·18	5631·65	2889·45	30	127·5	10	42·5
— 3·25	33·9	36·70	6143·31	5151·97	20	82·0	10	41·0
— 7·0	34·5	33·39	6884·14	3532·07	20	83·5	10	41 7
— 9·5		32·88	6977·37	3579·9				

Observations.—The first line represents the observations made at the earth before our departure. All the heights ought to increase at least 39 metres, or 20 toises, if we wish to reckon from the level of the sea.

XXXIX. *On*

XXXIX. *On disclosing the Process of Manufactories.*

To Mr. Tilloch.

SIR, Newcastle, Feb. 17, 1805.

PERMIT me to entreat the attention of some of your numerous correspondents towards a question which must certainly be interesting to every manufacturer, but of which no regular discussion has yet been offered :—" Is it proper or improper to lay before the public a full and impartial statement of the various processes of our manufactories ?" I shall state such reasons as have offered themselves to me why they should be displayed; but I am principally anxious to receive further information on a subject that appears to me peculiarly interesting.—The first argument I shall adduce is that of Mr. Boyle, as quoted by Dr. Johnson in the 201st number of the Rambler. " The excellency of manufactures, and the facility of labour, would be much promoted if the various expedients and contrivances which lie concealed in private hands were by reciprocal communication made generally known ; for there are few operations that are not performed by one or another with some peculiar advantages, which though singly of little importance, would by conjunction and concurrence open new inlets to knowledge, and give new powers to diligence."—The second is the very considerable improvements that have taken place in the few manufactories which have yet been under the influence of chemical inquiry ; thus realizing, but on a very extensive scale, the suggestions of Mr. Boyle : so far, therefore, as we are to be guided on the one hand by experience, and on the other by the influence of scientific inquiry, on liberal display, will the argument be in our favour.—In the third place, I would observe, that as many very valuable discoveries are owing to chance, those with whom they originate are frequently, perhaps, incapable of improving them to the extent they would admit of in the hands of men of science ; and thus by a spirit of monopoly, preclude even themselves from the advantageous cultivation of such discoveries, merely lest others might enjoy them also. If, again, we consider the rapid progress that has been made of late years in every department of useful and practical knowledge, we must attribute it entirely to those liberal communications that have been made by men whose attention has been immediately directed to the promotion and improvement of every thing valuable to the public. Again, The profits of every business depend on the regularity and

 knowledge

knowledge with which it is conducted: but how is the last to be enjoyed without resources to apply to? and how much more easily would it be obtained if science could regulate and simplify the combinations of the manufacturer!—To these may be added, that if to accomplish by every thing employed its utmost possible use, nay, if even to draw advantage from the very waste and refuse of every manufactory be a favourite principle with the conductors of each, to take the most accurate and powerful mean to effect it ought certainly to be as strong an object with them. Is it not also obvious, that to discard all mystery and quackery, and fairly to disclose each process, is to invite the attention of men of science and research to extend any advantage gained by chance or otherwise, and discover yet greater powers of utility, in the various substances employed?—The origin, progress, present state, and hints for the improvement of our "arts of life," would certainly be worthy the contemplation of our most able chymists, and are subjects that have appeared of such importance to a neighbouring nation, that many of their most eminent men have been employed in such a work; and some volumes of the Encyclopédie Méthodique are dedicated to such information, with plates too, in many cases, displaying even the most minute work-tools employed in each.

The history and detail of manufactories conducted in each place, ought, I presume, to form a principal object with the writers of local histories; yet very few of these gentlemen are enabled to obtain such accounts as they can depend on, from the selfish and monopolizing spirit of manufacturers in general.

To these various advantages an objection may be offered, that display is placing objects of taxation in the hands of ministers.—Be it so.—Display will make it easier to collect the tax;—will make it more certain, and, it may be, *less oppressive*. If to these be added the above advantages, it may fairly be presumed that discovery, which may lead to improvement, is the most advantageous track to be pursued.—But, my dear Sir, I beg your pardon: on this subject I do not mean to offer my own opinion, so much as to solicit information from that of others.

I am truly yours,

JOHN CLENNEL.

P. S. How far literary pursuits are compatible with the duties of the commercial man, or the manufacturer, seems a question so completely decided in the affirmative, in the

 first

first volume of the Manchester Memoirs, by Mr. Henry, in the second volume of the same work by Dr. Barnes, and in the hundredth number of the Lounger, that the above paper assumes the principle as being fully established.

XL. *An Essay on Medical Entomology. By* F. Chaumeton, *Physician to the Army**.

In his tam parvis tamque nullis quæ ratio? quanta vis? Plin.

When we cast our eyes on the immense quantity of volumes which have entomology for their object, one is inclined to believe that insects have been sufficiently considered under every point of view. Naturalists, philosophers, and physicians, seem to have united their efforts to give a most complete history of them. Some have endeavoured to trace out their elegant forms and varied shades, and others have carefully studied and described their wonderful metamorphoses. The latter have exhibited the interesting view of their habits and manners, and have presented us with some of them as models; the former have acquired more right to the public gratitude, by pointing out those insects which it is necessary to destroy, either because they contain a poisonous liquor, or on account of the destruction which they occasion. It must indeed be confessed, that useless and hurtful insects are far more numerous than those from which society derives real advantages. We must not, however, forget, that the class of insects furnishes us with honey, silk, cochineal, &c., and that medicine obtains from it efficacious aid against human infirmities. It is under the latter point of view that I propose, in this essay, to examine entomology.

The antients were satisfied with distributing insects into different groupes, according to the diversity of their residence; and as they did not assign precise characters to the species they described, it is very difficult, and often impossible, to form exact ideas of them.

It was not till towards the middle of the sixteenth century that the learned Conrad Gesner endeavoured to clear up the confusion which prevailed in zoology; and his labours have been a fruitful mine to his successors. Aldrovandus, Swammerdam, Ray, and Lister, followed worthily in his steps; but it was reserved to the immortal Linnæus

* From the *Journal de Physique*, Fructidor, an 12.

to

to place entomology, as well as all the other branches of natural history, on an unshaken base. Attempts have been made, but in vain, to correct, reform, or improve his method, or to establish an opposite one. This frail structure broke to pieces against the sublime monument raised by the celebrated naturalist of Sweden.

Among the entomologists who have modified the system of Linnæus, Geoffroy perhaps is the only one who can be excused, probably because he has the least deviated from it. He thought it necessary to unite the neuroptera and the hymenoptera under the name of tetraptera, with naked wings, and he founded one of his principal divisions on the number of the joints of the tarsi. In reading his work, which is valuable on many accounts, it was regretted that specific names were not found in it. Fourcroy has completely supplied this deficiency in his excellent Parisian Entomology.

Olivier introduced some modifications in the system of Linnæus, and added to it an order, the orthoptera, which it might have done very well without.

Fabricius has struck out a new route, and asserted that it is the only real one. To hear him, one might say that nature has revealed to him her most secret mysteries. His classification, which is founded on the organs of manducation, requires that one should be always provided with a good microscope and a compass, to observe and measure the number, figure, proportion, and situation of all the parts of the mouth of insects, which in several circumstances it would even be ridiculous to attempt. The insurmountable difficulties which almost always accompany this method, are, however, only its least fault. There are seen in it, at every step, forced relations; and winged insects are confounded in a strange manner with the aptera.

Though Latreille has still increased the difficulties with which entomology has been filled by Fabricius, one cannot refuse to this modest naturalist the tribute of homage due to his knowledge, and desire to communicate it.

It would be superfluous to accumulate proofs to show the infinite distance which separates Linnæus from those who have pursued the same career. I should be afraid that the comparison would be injurious to him. Filled with admiration for this great man, I shall follow, with religious respect, the plan he has traced out.

Insects are small animals, which are indebted for their name to the divisions or rings of which their bodies are composed. At the anterior part of the head they have two

 articulated

articulated filaments, endowed with great mobility and exquisite sensibility: they are called antennæ.

The greater part of insects are winged; and in this case they have always six legs attached to their breast or thorax, and are subject to metamorphoses. Among the aptera there are some which have several hundreds of legs affixed to the whole length of their bodies, and they are not subject to transformation.

Insects respire by means of vessels with elastic sides, named *tracheæ*, which open outwardly by holes called *stigmata*, placed on the sides of their bodies, and which, according to Dumeril, may at the same time be the organs of smell.

They have no interior skeleton. Their skin, which performs the functions of it, is generally hard, corneous, and serves as a point of attachment to the muscles, which are often very strong.

They have no real heart, nor apparent vascular system. The different parts of their bodies are moistened by a whitish serous matter, the temperature of which is equal to that of the medium wherein they reside.

The presence or absence of wings, their number and texture, furnish simple and precise characters, by the help of which the class of insects is naturally divided into seven orders.

The first order contains the insects which have four wings, the lower two of which, thin and transparent, are covered by the upper ones, thick and strong, which envelop them like a sheath: on this account they have been called *elytra*, and the insects which bear them are distinguished by the name of *coleoptera*.

The second order comprehends insects with four wings, the two upper ones of which, short and semi-coriaceous, are covered by their interior edge, while the elytra of the coleoptera are merely brought together, and form a longitudinal suture at their point of contact. These insects have no jaws, and their beak is turned back on the breast. They are called *hemiptera*.

In the third order are ranged insects the four wings of which are coloured by scaly dust, and which have a trunk of greater or less length folded back in a spiral form. On account of the shining tints with which these insects are generally ornamented, they are distinguished by the name of *lepidoptera*.

The insects comprehended in the fourth order have four naked reticulated wings, and no sting in the anus: they have

have several traits of resemblance with the *neuroptera*, and are distinguished by the name of *hymenoptera*.

The sixth order is composed of the *diptera*, or insects with two wings.

The seventh order contains the *aptera*, or insects without wings.

FIRST ORDER.

COLEOPTERA.

SCARABEUS—*The Beetle.*—Of the numerous species of this genus, those are most useful which live in dunghills and feed on excrements. Of this kind are the *fimetarius*, the *stercorarius*, the *pilularius*, and *conspurcatus*. If eight ounces of these insects be digested in a pound of laurel oil, there will be obtained an ointment, or oil of beetles, the use of which is recommended in the treatment of sprains and contusions. If the virtues of this preparation be not entirely imaginary, I think they are very little superior to those of oil of laurel, the inutility of which is now universally admitted.

COCCINELLA—*The Lady-bird.*—These small insects are distinguished by the form of their body, which is hemispherical. Their thorax, as well as their elytra, which are smooth, is ornamented with beautiful colours, and often spotted or striped. Their antennæ are truncated, and terminated by a solid mass. They are less apparent than the maxillary feelers.

It is pretended that several species of coccinella, and particularly those with seven points, are a specific for the toothache. It is sufficient, it is said, to bruise the insect between the fingers, and to touch with them the gums and tooth of the patient. What is most wonderful is, that the fingers retain their anti-odontalgic property. Does not this ridiculous process bring to remembrance the cure of the king's-evil by the simple touch of kings and emperors, the magnetism of Mesmer, the metallic tractors of Perkins, and other juggling tricks, which are a disgrace to the noblest of sciences?

CHRYSOMELA—*Chrysomela.*—The same virtue is ascribed to some of the Chrysomelæ, and particularly that of the poplar, but with as little foundation.

CURCULIO—*The Weevil.*—We were acquainted with this insect only from its ravages (*C. frumentarius*, *granarius*, *paraplecticus*), till Ranieri-Gerbi published a very verbose and turgid description of a new species, to which he gave the title of *Curculio anti-odontalgicus*. The thistle which

which nourishes this valuable insect was not forgotten by the doctor.

To say that this discovery has given birth to, and served as a basis for, every thing written on the odontalgic property of the coccinellæ, chrysomelæ, weevils, and beetles, is sufficient to show the value that ought to be attached to it.

MELOE—*Meloe.*—The insects which constitute this genus have moniliform antennæ, the last joint of which is ovoid: the thorax is rounded; the elytra are soft and flexible; the head is bent and gibbous, and the claws double.

The MELOE PROSCARABEUS and the MELOE MAIALIS are both of a blackish blue colour. The latter has the edge of the segments of the abdomen of a copper colour. Both have the elytra short, and without wings. The antennæ of the males are swelled in the middle, and irregularly bent. These insects, which are seen creeping in the spring-time among the grass, feed chiefly on ranunculuses and hellebore, and diffuse over all their articulations, when touched, a yellow fœtid oil. They were considered by the antients as infallible remedies for the hydrophobia. They have even been much extolled by some of the moderns *. Unfortunately the praises so liberally bestowed upon it have not been justified by experience; and notwithstanding the multitude of recipes which have been boasted of for the cure of the bite of a mad dog, we scarcely know the means of palliating the dreadful symptoms of this horrid malady.

In consequence of the irritating quality possessed by the proscarabea and the may-bug, a place has been assigned to them in the materia medica. They are employed with success as rubefaciento: they might even be made a substitute, though a weak one, for the interesting species of which I am about to speak, in cases when it is impossible to procure the latter.

MELOE VESICATORIUS, LYTTA VESICATORIA *Fabr.*, CANTHARIS VESICATORIA, the *cantharides* of the shops, *Geoff.* These valuable insects are known by the superb golden green colour with which they are ornamented. Their elytra are of the same length as the body, and their antennæ are black and filiform. Cantharides live in great bodies in the warm and temperate regions, on ash, willows, &c. They diffuse to a great distance a strong and disagree-

* *Selle Handbuch der Med. prax. Andry des vers.* This author relates the history of a child six years of age, who having swallowed a meloe whole, bruised in brandy, died by an inflammation of the secreting and excreting organs of urine.

able

able odour. It is in the month of June, the period when they copulate, that they are collected, by shaking the trees on which they exist. They are killed by the fumes of vinegar; and, after being dried in the sun, are preserved in glass or earthen jars well closed.

We have a multitude of treatises on cantharides *, and yet there is no good analysis of these insects. Thouvenel has touched on this subject in a memoir on the nature of animal substances used in medicine, which would be a master-piece if the illustrious author had completed the interesting view he has so well sketched out. It results from his experiments, that an ounce of cantharides, treated in succession with water, alcohol, and ether, furnish three gros of a reddish yellow and very bitter extract, and give, by distillation, an acid liquor; twelve grains of an oily yellow matter, which seems to be the colouring principle of these insects; sixty grains of a concrete, oily, ceraceous, green substance, of an acrid savour, on which the odour of the cantharides seems to depend, and which is the principal seat of their virtues; in the last place, the half of their weight consists of a solid parenchyme, insoluble in water and alcohol †.

Cantharides are employed in medicine under different forms. Hippocrates administered three or four for a dose, after being deprived of their heads, feet, and wings, as not being of much efficacy. Cantharides whole are a medicine not very certain, the action of which varies according to the quality of the juices contained in the stomach. It is therefore infinitely better to reduce them to an impalpable powder, and to give the patient at first only one grain, and adhere to that dose, or repeat it as found necessary, as recommended by Werlhof.

The spirituous tincture of cantharides may be rendered more or less active, according as it is prepared with pure alcohol, or mixed with an equal quantity of water. In the first case, the liquor contains only the green caustic oleo-ceraceous matter; in the second process there is obtained an alcoholico-aqueous solution, less energetic than the preceding in the ratio of the extract found dissolved in it.

* By Alexander, Greenfield, Linnæus, Jager, Rumpel, Baldinger, Forster, Trelles, Guillot, &c.

† It is observed that dried and whole cantharides are frequently devoured by a kind of mite or acarus, which feeds on their parenchyme without touching the breast or the wings, in which the vesicant property chiefly resides. See *Les Instruct. de M. Parmentier*, among those published by the Council of Health of the Armies.

It

It is to cantharides that the vesicatory or blistering plaster is indebted for its properties. It is astonishing that a composition, in which the greater portion of the cantharides is enveloped and rendered inert by fat and resinous bodies, has not been long ago renounced. Being an enemy to all polypharmic mixtures, I am satisfied with disposing, in the form of plaster, a certain quantity of good leaven, which I besprinkle more or less with cantharides, according to the indication I wish to fulfil; and I take care to rub strongly the part on which I intend to apply this topic, after having moistened it with strong vinegar. This method is undoubtedly the best; nothing in it is useless; and I prefer it to blistering plaster, from which it differs only in its great simplicity.

Is it possible to read the enumeration of panaceas, polychrest remedies, specifics, &c. with which the materia medicas and pharmacopœias are filled, without exclaiming ironically, with the immortal Rousseau, That it is entirely malicious in men to be sick? Let us, however, confess, that there really exist noble remedies. *There are three which I could mention*; and cantharides certainly are among the number. To prove it, nothing is necessary but to take a cursory view of the different cases in which the application of them is requisite. To proceed with order in this examination I shall take as my guide the *Nosographie Philosophique*; and I shall frequently invoke the testimony of its celebrated author, whom I have always seen to unite precept with example.

The immense series of human infirmities commences with fevers; and the angiotenic, or inflammatory, occupy the first place. The regular course which nature follows in the development, progress, and termination of these fevers, announces a beneficent effort, which tends to remove some obstacle and restore interrupted equilibrium. We must be cautious, therefore, of perverting this salutary movement, and recollect that, if fever, under certain circumstances, is a mean of cure, it is chiefly to angiotenic fevers that this prerogative belongs. The pretended success, I had almost said the miracles, ascribed to Galen, Botal, Sydenham, and Brown, in consequence of copious evacuations of blood from their patients, do not impose on me, and I am far from approving, with Cullen, the conduct of Pringle, who caused bleeding to be succeeded by vesicatories, notwithstanding the fatal examples which ought to have made him proscribe this destructive treatment.

The

The course of the meningo-gastric or simple bilious fevers is also subject to a regular order. The best characterized are dissipated by diluting and acidulous beverages preceded by an emetic (antimoniated tartrite of potash).

The case is not altogether the same with adeno-meningian fevers, *mucous* or *pituitous.* Being produced by debilitating causes, they do not leave to nature strength necessary to re-act properly; which gives rise to frequent anomalies, to complications more or less fatal; in a word, to an inextricable variety of symptoms, which are renewed indefinitely, notwithstanding the best combined assistance. It was to remedy these accidents that Plenciz *, Sarconne †, Rœderer, and Wegler ‡, employed vesicatories, which are not indicated in simple adeno-meningian fevers.

The principal distinguishing signs of adynamic or putrid fevers are weakness and dejection. A manifest tendency to decomposition is observed in the bodies of individuals attacked by them. To reanimate a machine, the springs of which seem to have lost their action, speedy recourse must be had to tonics, and those must be chosen the energy of which is irrevocably confirmed. It is on this account that vesicatories, either fixed or changed, as circumstances may require, and seconded by vinous, alcoholic, and camphorated potions, perfectly answer the purpose proposed, and deserve, in every respect, the preference generally granted to them.

The extreme danger which accompanies ataxic fevers would be sufficient to authorise the denomination of *malignant*, by which they have long been distinguished, were this term less ambiguous, and did it not furnish arms to the detractors of medicine §. It is no longer, indeed, a simple prostration of strength. The disorder is not confined to weakening the vital principle and troubling some of its functions. It is immediately to the brain that ataxic fevers carry their fatal influence. Ought we then to be astonished at the alarming phænomena which succeed each other with prodigious rapidity, and against which the resources of art often fail? As long as the least hope exists, vesicatories are the sacred anchor, which one ought to trust to for a safe arrival in port. It will be proper to join with them some auxiliary means, but none can be substituted in their stead:

* Acta et Obs. Medica, Prag. 1783.

† Storia ragion de' mali, &c. Napoli 1764.

‡ Tract. de morbo mucoso. Gœtting. 1783.

§ Io batezzo di maligno
Ogni mal che non intendo. *Menage.*

stead: they are even the surest touchstone for distinguishing and measuring the vitality of our organs.

The yellow fever of America exhibits numerous relations with the jail and hospital fever, which is itself a complication of adynamic with ataxic fever *. In both, many patients have been indebted for their lives to vesicatories applied to the head, breast, abdomen, and limbs.

The eruption of the parotids in adynamic and ataxic fevers has been commonly considered as a metastasis, which must be favoured. Bang and Pinel think, on the other hand, that these tumors are almost always fatal, as they determine a sort of congestion towards the head. They endeavoured, therefore, to prevent or to dissipate them. Though the Danish physician employed several internal and external remedies, it may be easily perceived that vesicatories contributed, in a powerful manner, to the success he obtained.

The pernicious intermittent and remittent fevers, so well described by Torti and Alibert, have been classed among the ataxic by Pinel, who sees in their periodicity nothing but a generic character. Among the numerous varieties of these fevers the comatose is the only one which I have observed several times. The application of vesicatories at the moment of attack, lessened considerably the soporific state of three patients, and disposed them to take cinchona, to which they were indebted for their cure. The fourth was less fortunate: the coma, which produced a sudden exacerbation of a simple tertian fever, of which he had been ill ten days, approached near to a catalepsy, since the limbs preserved very exactly the situation which I gave to them. I applied large vesicatories to the thighs, and sinapisms to the soles of the feet. Neither of them made scarcely any impression; which destroyed all hope of my being able to administer cinchona, and consequently to save the patient. There was not, indeed, the slightest remission: the symptoms, instead of being mitigated, became more and more alarming, and in twenty-seven hours after the attack terminated in death. The lateral ventricles of the brain were distended by a great quantity of coagulated lymph.

The plague announces itself, like ataxic fever, by a profound lesion of sensibility: it would not even be distinguished from it, did not filthy exanthemata and frightful contagion impose on it a special type. It is, however, cer-

* An Outline of the History and Cure of the Fever, &c. by R. Jackson, Edin. 1798.

tain,

tain, that the plague may be considered as a very severe ataxic fever complicated with an affection of the glandular system. It is indebted to this double character for the denomination of adeno-nervous. It is here in particular that the organs which have fallen into a state of stupor and insensibility must be strongly excited. With what promptitude ought we not then to have recourse to vesicatories, sinapisms, and friction, with alcoholic solution of cantharides or with ammonia!

Ought we to unite phlegmasiæ with angiotenic fevers, or establish between them an immense line of demarcation, by placing them in different classes, as Pinel has done? The fear of losing sight of the principal object prevents me from discussing this interesting question, which does not appear to have been fully resolved.

To form an exact idea of phlegmasiæ, it is essential to fix our examination on those which attack the surface of the body, and the progress of which can therefore be very easily observed.

The prodigious quantity of nerves which spread themselves in the tissue of the skin communicate to it extreme delicacy, and such sensibility, that the slightest touch can excite in it the sweet emotions of pleasure or the acute sensations of pain. The nervous fibres, irritated by any cause, soon re-act on the ramifications of the sanguine and lymphatic vessels with which they are interwoven, and determine a considerable afflux of these two fluids. Do we not see all the symptoms which characterize inflammation successively develop themselves in erysipelas? and does not the action of vesicatories effect in a few hours what erysipelas effects more slowly: pain, redness, heat, tension, and accumulation of limpid serosity beneath the epidermis? Do not these effects announce a salutary effort of nature in the erysipelas as in angiotenic fevers? and ought they not to render the practitioner very circumspect in regard to the use of topics, and particularly repercussives? Do they not throw light also on the use of vesicatories, and prove the utility, and often the indispensable necessity, of attracting to the surface a phlegmasia which threatens an important organ? This simple, and, as I may say, mechanical explanation is founded on multiplied and incontestable facts. It embraces almost the whole of the doctrine of epispastics and consequently frees me from the necessity of entering into longer details on the employment of them in phlegmasiæ.

If the small-pox always passed regularly through their

periods

periods they would be attended with no danger, and, in the severest cases, would leave nothing behind them but a slight alteration in the features; but the adynamic and ataxic symptoms, which frequently render them complex, convert them into so destructive a malady, that they often resist the most active and best administered medicines. Inoculation had much lessened the ravages of this destructive scourge, and the immortal discovery of Jenner will extirpate the last roots of them.

The distinguishing signs of peripneumony and pleurisy are so uncertain that they have been doubted by some celebrated physicians *; they have been so often belied by cadaverous autopsia, my own experience has so many times proved their insufficiency, and the principles of the treatment are so identic, that I consider these two affections as inseparable, and I unite them, after the example of Cullen †, under the name of *pneumonia*.

In acute rheumatism nature is endowed with great energy, which it is sufficient to moderate by diluents and severe diet in order to obtain a speedy and happy termination. On the other hand, in chronic rheumatism the re-action is very weak; the limbs are in such an inert state that it is necessary to combat it by tonics given internally, and applied to the suffering parts: vesicatories, and friction with alcoholic solution of cantharides, have justly acquired the pre-eminence. The same means have sometimes produced excellent effects in white swellings of the joints, which often baffle the art of surgery.

Hemorrhages occupy the third class, and are distinguished into active and passive. Vesicatories are rarely indicated in either; and it is allowed to employ them only as revulsives in certain cases of obstinate hemoptysia.

Of all diseases neuroses are those which present to the philosophic physician the most afflicting spectacle, and that most worthy of his meditation. He rejects with disdain hypotheses more or less ingenious, and the arguments more or less captious, of the subtle metaphysician enlightened by the flambeau of analysis; he seeks only in the nervous system for the source of our mental faculties, since a slight wound of the organ of the brain is sufficient to render the mildest man furious, and to plunge the man of genius into the most deplorable state of idiotism.

* Morgagni De Sed. et Caus. Morb. Sarcone Istor. ragion. de' mali essem. a Napoli.

† Synops. nosol. Method.

The

The first order of the neuroses consists chiefly of those moral affections which under the name of *vesaniæ* torment the patients and excite despair in the physician. Spasms are classed after vesaniæ. The prognostic of them is equally fatal, and the cure equally doubtful. We are acquainted with no remedy for epilepsy, and tetanus kills almost all those whom it attacks *. Means, however, have been found to cure the tetanus of wounds arising from the sudden suppression of the puriform flux, by calling back suppuration by multiplied incisions, the affusion of warm oil of turpentine, cupping, or the application of vesicatories to the wound †.

Besides the universal empire which the nerves have over the animal economy, they exercise a particular influence on each function, which may be singly altered; and these local anomalies constitute the third order of the neuroses.

One of the finest attributes of the nervous system is, without contradiction, that of presiding over the act of reproduction. I shall not here trace out a list of the pretended aphrodisiacs, the remembrance of which I could wish to efface. It will be sufficient for me to observe that cantharides form the principal ingredient.

The premature death of Lucretius is ascribed by his biographers to an amorous philtre. The learned Paré relates, that a courtesan, having given a ragout, besprinkled with cantharides, to a young man she had invited to sup with her, he soon after experienced symptoms which terminated in his death.

In comatose affections, which form the fourth order of the neuroses, nature is oppressed but not exhausted. The object, then, is to remove the obstacles which oppose the development of the vital forces. Can the utility of cantharides in these critical circumstances be doubted, in which real too often succeeds apparent death?

Among the diseases of the lymphatic system, dropsies are those alone which allow the use of cantharides; but they must be administered with circumspection. Frederic II. king of Prussia, being attacked with the hydrothorax, of which he died after eleven months suffering, experienced some relief from the application of a vesicatory to the arm. Several examples attest in favour of alcoholic solution of cantharides, in the dose of six drops, in anasarca

* Heurteloup Précis sur le Tetanos des Adultes. Avert.
† Heurteloup ut supra, p. 34.

and ascites. I have hastened the cure of the latter by multiplied friction on the abdomen with the same solution.

MELOE CICHORII—*Mylabris cichorii* Fabr.; *Mylabre de la chicoreé* Cuv.—Its colour is black. The head and breast are velvety. The antennæ become larger towards the end; and the elytra are marked with three yellow bands. It appears that it was this insect, very common in the East, which the antients employed as a vesicatory*: it is still applied to this purpose in China.

[To be continued.]

XLI. *On the Use made of Zinc in China in regard to Coin.* *By* B. G. SAGE †.

ZINC, known in China and India under the name of *tutenag*, is employed there not only for alloying with other metals, but also by itself for making coin, as I have had occasion to ascertain, by trying a piece given to me by M. de Tersan. This coin was of the size of a franc, but not so thick. The centre exhibits a square hole three lines in diameter. On the two opposite sides there are Tartar characters. The two other sides have none. The reverse of this piece exhibits Chinese characters on the four faces of the square.

Having attempted to cut this piece with a pair of scissars, it broke: its fracture exhibited the colour and metallic facets of zinc: it showed also, like zinc cast into thin plates, a line which separates in two the plate of that metal. This stroke or line arises from the colour occupied by the centre of the cast zinc. This fracture of the coined zinc of China makes known that this semi-metal has been cast in order to be converted into money; for when the grain is compressed by the gradual pressure of the roller it ceases to be brittle, and exhibits no longer any grain. Zinc reduced to plates ceases also to emit the creaking noise of tin when an attempt is made to break it. This semi-metal, instead of breaking by the pressure of the roller, becomes more ductile the thinner the plates to which it is reduced.

The zinc of which this Chinese coin is made is exceedingly pure, and burns with the greatest activity at a degree of fire proper for fusing it and bringing it to a red heat: it is sufficient

* Imperati, Linnæus, and Spielman.

† From *Journal de Physique*, Fructidor, an 12.

ficient to bring it into contact with the air by removing the oxide or white calx with which it is covered.

The Chinese make a square hole in the centre of their coin, in order to file them on a packthread: by this precaution they prevent that infidelity too common in their commerce.

Having tried the silver which the Chinese employ for their jewellery, I found it to consist of one half copper.

XLII. *On the Use of the Amianthus in China.* By B. G. Sage*.

The antients, according to Pliny, made incombustible cloth of the amianthus. In the library of the Vatican there is shown a handkerchief said to be made of this cloth. As to the moderns, I do not know that they make any use of the amianthus; but I saw, twenty years ago, paper made of this fossil flax by M. Levrier de Lisle, proprietor of the paper manufactory of Montargis. This paper, of which I still have a sheet, has cohesion enough, but it is not so smooth as paper made of hemp. It does not yield under the pen, and, if the ink is well gummed, one may write on it with ease and neatness. This paper placed on burning coals is not destroyed: it assumes there a bright gray colour, which arises from the size being charred. The characters traced out with ink on amianthus paper appear red after they have been thus exposed to the fire. If mucilage of gum adraganth had been used instead of size to reduce into paste the amianthus which has been subjected to the mill, the paper resulting from this process would have more cohesion, and be more proper for resisting the action of the fire. It is to be wished that M. Levrier de Lisle had been encouraged; for paper of amianthus might be of great utility for preserving deeds, as it resists the activity of the fire, from which they would be completely protected were they put into cases made of amianthus pasteboard.

The Chinese know, as well as we do, that the most violent fire is necessary to vitrify it, and that it does not become altered in a common fire: they therefore employ it for making furnaces. One which I saw represented a cylinder nine inches in height and six in diameter: towards the middle was a circular projection destined to support the grate:

* From *Journal de Physique*, Fructidor, an 12.

grate: there were two doors to the ash-hole. This furnace was supported by a kind of round dish with octagonal edges, and raised on four small cubes. These edges were ornamented with a design exceedingly simple: it consisted of a continued series of circles, with small elevated points in the centre.

The outside and inside of this furnace were as smooth as a card: its fracture was like that of pasteboard. M. de Tersan, in whose possession I saw the remains of this furnace, said to me therefore, "I do not know how the Chinese can make furnaces of pasteboard to withstand fire." Having examined a fragment of this furnace, I found that it was entirely amianthus. But in what manner are the Chinese able to give it cohesion? There is reason to presume that they know, as well as we do, that mucilage of gum adraganth has the property of giving body to stony moleculæ, and of contracting with them such union that even fire is not able to destroy it. We have a proof of this in the cakes of ponderous spar, or sulphate of barytes, which form the Bologna phosphorus, after it has been calcined for several hours among coals, which destroy neither its form nor its solidity.

To form these cakes the ponderous spar is pulverized, and sifted through a silk sieve: it is then formed into a paste, with mucilage of gum adraganth, and made into balls, which being flattened are converted into cakes.

The amianthus, of which the Chinese furnaces are made, has been reduced to small parcels in a mill, and then mixed with a mucilage to form a paste. This paste the Chinese introduce into moulds, the form and polish of which it assumes, whilst its outside plainly exhibits the parcels of which it is composed. This furnace is of a gray colour inclining to red: it unites solidity to lightness, and becomes white by fire. In examining some Chinese productions I saw a kind of stuff resembling our drugget: its woof is only slips of paper. This stuff has pliability and strength, as may be easily perceived. As the Chinese have the art of making sheets of paper eighteen feet in length, it is not astonishing to see stuffs of this kind in pieces like the silk stuffs made in other countries.

XLIII. *On*

XLIII. *On the Property ascribed to Quicklime of increasing the Force of Gunpowder.* By M. Lemaistre, *Inspector-General of Gunpowder and Saltpetre**.

There was published, about eighteen months ago, in the first volume of the *Bibliotheque Physico-Economique,* a note announcing that Dr. Baini, a physician of Fojano in Tuscany, had found means to increase the strength of gunpowder one third, by adding three gros of pulverized quicklime to each pound of powder. It was asserted that the superiority of this gunpowder was attested by the Tuscan hunters.

This assertion has been again brought forward in the same journal †, and in a manner still more decisive. An anonymous subscriber, in a letter to the editor, enters into some details calculated to excite the attention of those employed in the manufactory of gunpowder to this subject.

The first notice of this circumstance had engaged my attention a year before; but in trials carefully made with Regnier's spring proof, the best then known, I did not obtain a satisfactory result: I even observed an inferiority in the charges mixed with quicklime in the proportion above indicated.

On account of certain circumstances I was obliged to defer any further experiments at that time, till the letter before mentioned induced me to resume the subject, and give my experiments all the extent possible, which I could easily do at Lafere, the place of my residence. As we have here a school of artillery, I engaged captain Charbonel, commandant of the sixth regiment of light artillery, in garrison here, to take a share in these trials along with me. Of eight pounds of very dry gunpowder, from the same barrel, four pounds were exposed for six days on the floor of a magazine in the polygon where we made our trials. The half of the remaining four pounds was mixed, as exactly as possible, with about a forty-third part of its weight ‡ of very fresh quicklime, speedily pulverized and sifted, in order to preserve it from the action of the air, always a little damp.

* From the *Bibliotheque Physico-Economique,* January 1805.

† No. I. Vendemiaire, an 13. p. 42.

‡ This proportion is that of three gros per pound of powder, as before mentioned.

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The half of the four pounds which had been exposed to moisture was also mixed with the same quantity of quicklime.

Our intention in regard to these different preparations of gunpowder was to ascertain whether the presence of quicklime added to its strength either as a fourth component part, and by a chemical action, or as an absorbent, by taking from the powder the humidity it might contain, which appeared to us much more probable. This we hoped to discover, on the one hand, by the comparative employment of the dry and pure powder, and of the dry powder mixed with quicklime: on the other, by the pure damp powder, and the same powder mixed with quicklime.

We used for our experiments an old brass mortar which had formerly served for trying common gunpowder. It was 7 inches 6 points in diameter, and had a cylindric chamber the charge of which was three ounces, and the globe 60 pounds.

The charges were weighed with the greatest exactness: the mortar, being pointed at an elevation of 45 degrees, was directed each time with such regularity that it deviated very little from the line of firing. The mean ranges given at each time of firing were as follows:

	Toises.	Feet.
Dry and pure gunpowder - - -	123	2
Dry powder mixed with quicklime -	115	1
Difference	8	1
Pure damp powder - - - -	119	1
Damp powder mixed with quicklime -	107	2
Difference	11	5

Not contented with these trials, we were desirous of repeating those I had made, eighteen months before, with Regnier's spring proof; and every thing was arranged for that purpose; when, on the first discharge with fine hunting gunpowder, or that from one of our powder manufactories, the spring broke, and consequently rendered the proof unserviceable. This accident, which took place when the spring was compressed to the 28th degree, as announced by the index, gives reason to suppose that it would have been much

much more so by this powder had it not broken, and furnishes a new proof of the superiority of the French gunpowder to the English, which, when tried several times by the same proof, gave only from 15 to 18 degrees.

Though the results of these proofs seem to indicate that in both cases the presence of the quicklime hurt the strength of the gunpowder, we are far from wishing to employ them to refute what has been announced on this subject. We are of opinion that it is too much connected with the public and private interest to be combated by our proofs alone, whatever care may have been employed in making them. We do not know whether we have omitted in these trials any circumstances necessary for obtaining the favourable results of Dr. Baini; but we are certain that we followed exactly the proportions and processes indicated in the notes before mentioned.

We therefore request all those to whom this point is of importance, and it must be so, no doubt, to a great number, to repeat and vary these trials, as we propose to do, in order that we may attain, if possible, to the results of the two philosophers here quoted, and to induce them to give some further details in regard to their experiments, by the help of which we may attain to the proposed end: they seem to be too much animated with a desire to promote the public good, to refuse it*.

These proofs induced me to try others, to ascertain whether the whole quantity of the charge of cannon, supposing it inflames entirely before it issues from the piece, is necessary for producing the greatest effect; and if it would not be possible, without hurting that effect, to substitute for the

* We think it our duty to quote here a passage from the numerous additions which M. Bornot, captain of artillery, had made to his translation of *Henry's Manual of Chemistry*:

" *Mixture of Quicklime with Gunpowder.*

" M. Griffith has confirmed, by a great number of experiments, that a mixture of gunpowder and quicklime, well dried and pulverized, in the proportion of two parts of gunpowder and one of quicklime, produced as much effect on blocks of granite as three parts of powder. A mixture in equal parts makes also an explosion, and may serve to establish the communication between the match and the charge, which is already a considerable saving. Dr. Baini has found means to increase a third the force of gunpowder by adding to it three gros of pulverized quicklime per pound. It is sufficient to stir the whole in a vessel until the surface no longer appears white."—*Note of the French editor.*

nucleus, or centre of the charges, a solid body*, a vacuity or vessel filled with any liquid. Some trials made with a six-pounder gave us results capable of exciting attention, and which will induce me soon to resume them.

XLIV. *Description of an improved Drawback Lock for House Doors, invented by Mr.* William Bullock, *of Portland-street* †.

SIR,

I have herewith sent, for the inspection of the society, an improved drawback lock for house doors, &c. which improvement is in latching the door; for it is well known, particularly in damp weather, that the air drawing through it rusts the head or bevel of the bolt, by which means it requires great force to shut the door, and occasions a disagreeable noise, besides shaking the building.

It has frequently happened that the house has been exposed to robbery from the door being left unlatched, when supposed to be fast. This improvement removes all those inconveniences, as it lets the bolt shoot into the staple immediately when the door closes, but not before; and the reliever works so very easy, that the door is made fast with one twenty-fourth part of the force required with locks upon the common construction.

By an experiment with the lock sent herewith, it will be proved that two ounces added to the reliever, will shoot the lock with more ease than three pounds will do applied to the bevel bolt; and if the lock is rusty, the advantage will be much more in favour of the new method. I flatter myself it will be of great utility to the public, as its construction is simple and cheap. It may be added to any old lock, as may be seen from that now sent. It may be advantageously applied to French windows and glass doors, as it prevents the door from being strained, or the glass broke, by the force applied to shut them. I have fixed several locks upon this new principle, which answer well;

* This, it is said, is already practised, with advantage, by some German miners.

† From *Transactions of the Society of Arts*, &c. vol. xix.—A bounty of fifteen guineas was voted to Mr. Bullock for this communication.

and

and if the invention meets with the approbation of the society, I hope to be rewarded according to its merit.

I remain, with respect, sir,

Your most obedient servant,

WILLIAM BULLOCK.

Mr. Charles Taylor.

Description of Mr. William Bullock's improved Drawback Lock. (*Plate V. Fig.* 1.)

A, is the new iron latch here affixed to an old common drawback house lock.

B, an iron pin at one end of the latch, on which pin it is moveable.

C, a projecting part of the latch, which, when the common spring bolt D of the lock is drawn back, in the usual manner, is forced into the nick on its higher part at E, by the spring F, underneath the latch.

The bolt D then remains within the lock, until, on closing the door, the reliever G gently presses on the lock box, fixed in the common way on the door cheek; which pressure draws the projecting part C out of the nick E, and permits the end of the bolt D, by the force of the spring G, to slide into the lock box, and fasten the door.

XLV. *Description of a Screw Press with an expanding Power.* By Mr. WILLIAM BOWLER, of *Finsbury-Street* *.

SIR,

THE screw- and spring-press which I have the honour to present to the inspection and for the approbation of the Society for the Encouragement of Arts, &c. will, I trust, be found in a superior degree adapted to the purpose of pressing bodies in general, but more particularly cheeses, apples, linen, &c. because such things require a firm and an unrelaxing pressure:—and this is a peculiar advantage incident to this machine; for after it is set, or the spring screwed well up, it will be found, that as the *article* pressed shrinks from it, so the spring, owing to its peculiar expanding power, gradually follows the object of its pressure, and hence continues to maintain an uniform and

* From *Transactions of the Society of Arts*, &c. vol. xxi.—A bounty of ten guineas was voted to the author by the society.

equal

equal action on the body on which it is placed. This, in cheese-making, will be found peculiarly advantageous; for it is from this very cause of want of sufficient pressing that cheeses are frequently so very bad. Were the curd entirely separated from the impure and contaminating mixture of the whey, which must be effected by the regular action of this machine, we should always have the cheese firm and wholesome; and, I have not a doubt, the press will be found equally useful in all other cases, and answer every purpose, even beyond expectation, to which it is adapted.

I have the honour to be, &c.

WILLIAM BOWLER.

Charles Taylor, Esq.

Reference to the Engraving of Mr. William Bowler's Screw Press. Plate V. Fig. 2.

AA, the two upright sides, or frames of the press.

B, the cross piece which connects them at the top, having a hole in its centre, for the screw.

C, a strong block of wood, into which the two sides of the press are firmly morticed.

D, the box, in which the article to be pressed is placed. This box has a number of holes in its bottom, through which the liquid matter when pressed out passes, and is discharged from the mouth of the spout E, a small hollow being left under the box, to allow its passage to the spout. A loose wooden cover fits into the box D, and upon it is fastened a stout piece of timber F, and an iron plate G, for the point of the screw of the press to act upon.

H, the male screw of the press, working in a female screw, in the centre of the strong cross piece I, which cross piece slides up and down in grooves within the two sides of the frame, one of which grooves is shown in the plate, and about half the length of the side piece.

K, the upper part of the iron screw, on which the handle L, which moves it, is placed upon a square. The iron of the screw is only wormed about half its length.

M, a strong spiral spring, made of iron wire, or iron rod, placed in the centre of the cross pieces B and I; this spring presses downwards against the cross piece I, forcing it as low down as the side grooves will permit. The male screw H lies within the circle of this spiral; and, when the screw is turned, passes through the female screw below it, and acts upon the iron plate G, under which the matter to be pressed is placed, by continuing to turn the screw. As it it meets with resistance at the point G, it gradually forces back the cross piece I, by means of the female screw within it, and compresses the spiral into a small space, between the two cross pieces, in which state it remains, till the article which is pressed in the box begins to give out a part of its contents. The spiral spring M, compressed as above mentioned, then begins to expand, and exerts a continued re-action upon the cross piece I, on the male screw H, the iron plate of which covers the article under pressure.

Fig. 3, is the male screw, separated from the other parts, to show how far the thread or worm extends upon it.

XLVI. *Geographical and Topographical Improvements proposed by* John Churchman, *Esq. Member of the Imperial Academy of Sciences at St. Petersburgh**.

SIR,

I request you to lay the following essay on the improvement of geography before the Society for the Encouragement of Arts; and, in so doing, you will much oblige

Your most obedient servant,

John Churchman.

Charles Taylor, Esq.

It appears to be a matter of much importance to the people of any country, at all times, whether in war or peace, to possess a complete knowledge of its surface. In war, such knowledge is absolutely necessary for defence; in peace, for improving the country to the best advantage.

Now, since geography may be improved, an easy and accurate method to lay down maps of mountainous countries and hilly estates will perhaps prove useful, as it will show at a single view the true shape and comparative height of the ground without the art of painting.

As mountains are apt to eclipse each other, a perspective view is seldom very extensive, the rules of which fall short of giving an accurate idea of any hilly country; because such a view, though strictly true in one particular place, is not so in any other. The altitudes of mountains appear in proportion to the distance from the eye, and no rule in geometry has been found sufficient to determine distances from any single station. Neither can a bird's-eye view of an estate ascertain the depth of valleys or the height of mountains. But the method here proposed will be found

* From *Transactions of the Society of Arts*, &c. vol. xxii.

equally capable of giving the true shape of any ground above or below water. It may be successfully applied to sea charts, and will prevent much confusion, arising from the tedious method of distinguishing soundings by a multitude of figures.

Explanation.

Suppose a full description is required of any island in the ocean. First, let an accurate map be laid down in the common way; and let the perpendicular height between the highest point of land and the ocean be divided into any number of equal parts. Suppose these equal divisions are 100, 200, 300, 400 feet above the low-water mark. From the different points of these several divisions let horizontal lines be run with a good theodolite, and spirit-level annexed, all round the island. If the work is well done, each line will end where it began; and if the bearings and distances of these several lines are truly laid down on the map, the crooked courses of them will clearly show the shape of the ground over which they pass. For example: if any horizontal line passes by the side of a steep hill, it will incline towards the ocean, or approach the next horizontal line below it. When the same line crosses a stream of running water or a valley, it will naturally bend up the side of the said stream until it can cross it without losing the level; or, in other words, it will bend towards the centre of the island. Hence, by a little practice, the shape of the several horizontal lines on the map will give as clear an idea to the mind of the shape of any country over which they pass, as a sight of the country itself can convey to the eye. But to obtain a mathematical and true knowledge of the altitude and declivity of any part of the country, we have the following proposition:

As the perpendicular height of any one horizontal line above another is to the radius, so is the horizontal distance between the horizontal lines measured on the map at any particular place, to the co-tangent of declivity at that place.

Note: If the horizontal distance between any two horizontal lines on the map is equal to the perpendicular height of any horizontal line above another, the angle of altitude, or declivity, of any hill will be 45 degrees.

The present improvement, which I believe to be entirely new, will be found to possess the following advantages:

1st. Military men are well acquainted with the many advantages always to be gained from the exact representation of high grounds. By this method we are able to give the

the angle of altitude, the angle of declivity, and perpendicular height of every hill; likewise the comparative height of different hills, the best route by which the high grounds may be gradually ascended, and where heavy burthens can be drawn up with most ease.

2dly. Experience has sufficiently shown that the inhabitants of low grounds are subject to different kinds of sickness, from which those living at places elevated to a certain degree are exempt. A map on this improved plan will point out the most proper situation for building dwelling-houses. It will be useful in botany, in discovering or cultivating some kinds of plants which flourish best at particular distances above the level of the ocean. It will trace the line of vegetation on the sides of lofty mountains whose tops are covered with eternal snow.

3dly. Some high lands are known to produce good grain, while low lands afford grass more abundantly; but most grounds produce good grass over which a moderate quantity of running water is conveyed. A plan of any country in this way will show all the ground that can be irrigated; where water-works may be erected; where navigable canals may be cut; and where highways and rail-roads may be laid out on the best and most level ground.

4thly. The subterraneous treasures of the mineral and fossil kingdoms are generally found in strata; and, if they are not truly horizontal, they make a certain angle with the horizon. A map on this projection may enable the mineralogist to follow any one stratum at places even far distant from each other.

PROBLEM.

To find the true declivity of any piece of ground in any map laid down on the principles of the present plan.

Example 1st, for D. See Plate VI.

As the perpendicular height, 4 feet	-	60206
Is to radius, 90°	- - -	10·00000
So is the horizontal distance, 4 feet	-	60206
		10·60206
To the co-tangent of the declivity, 45°	-	10·00000

Example 2d, for B.

As the perpendicular height, 4 feet	-	60206
Is to radius, 90°	- - -	10·00000
So is the horizontal distance, 8 feet	-	90309
		10·90309
To the co-tangent of the declivity, 26° 34′		10·30103

Example

Example 3d, for C.

As the perpendicular height, 4 feet	-	60206
Is to radius, 90°	- - -	10·00000
So is the horizontal distance, 18 feet	-	1·25527
		11·25527
To the co-tangent of the declivity, 12° 32′		10·65321

The annexed survey, Plate VI. of a small lake and artificial mountain in the garden of his excellency count de Strogonoff, near St. Petersburgh, has been closed by the tables of the difference of latitude and departure as follows:

		N.	S.	E.	W.
N. 30 E.	2½	2·2	—	1·2	—
N. 35 E.	2	1·6	—	1·1	—
N. 75 E.	2	·5	—	1·9	—
N. 55 E.	2	1·1	—	1·6	—
N. 45 E.	3	2·1	—	2·1	—
N. 52 W.	2	1·2	—	—	1·6
N. 59 W.	3	1·5	—	—	2·5
S. 56 W.	12	—	6·7	—	9·9
S. 60 E.	7	—	3·5	6·1	—
		10·2	10·2	14·0	14·0

XLVII. *Description of a Safety Valve, containing a Vacuum Valve in the same Hole of the Boiler*.*

In large boilers or coppers, where boiling fluids are inclosed, a safety valve is generally used to prevent their bursting, from an unexpected excessive force of the elastic steam, and, besides, a vacuum valve, to prevent their being compressed or crushed by the weight of external air, in the case of a sudden condensation of the vapours. These two valves are commonly fitted in two different holes in the boiler; but as a more simple, and consequently more eligible method, seems to be that of joining them together, I take the liberty to submit to the Society for the Encouragement of Arts, &c. the following contrivance for that purpose:

ab, Plate VII. fig. 1, is a common conical safety valve,

* From *Transactions of the Society of Arts*, &c. vol. xxii.—The silver medal of the society was voted to the author for this communication.

fixed

fixed in the boiler *cd*, having four openings, *ii*, which are represented in a plan view in fig. 2. *ef* is the metallic rod, bearing the weight KK, with which the safety valve is loaded, and extending itself under that valve to *f*: *gh* is the vacuum valve, consisting in a plane circular plate, with a brass tube sliding along the rod, and pressed by a spiral spring to the safety valve *ab* (against which it has been well ground in making it), closing in that situation the openings *ii*.

Such being the construction of the whole, it is evident, that when the elasticity of the steam increases, the two valves, joined together, with the holes *ii* shut, make but one, opposing to the elasticity of the steam an united resistance, which is regulated by the weight *kk*, in the common way; but, on the contrary, when by condensation of the vapours a vacuum is produced, the external air in pressing through *ii*, upon the vacuum valve *gh*, forces it down, and opens to itself a passage into the boiler.

The valve *gh* may easily be made conical, like the other, if that form should be preferred; but in different trials I have found planes, if well turned and ground together, join as perfectly as can be desired, being pressed by the united elasticity of the spring and the steam.

Fig. 3 is the same contrivance adapted to a new kind of safety valve or piston, which, though I originally intended it for the use of Papin's digesters of a new construction *, has been, in a larger size, applied by me even to steam engines, and is described in the Philosophical Magazine of December 1803 †.

I have lately begun, and shall pursue, a set of experiments, with the intention of regulating by this safety piston the quantity of admitted air to fire-grates, and to effect by that means a new mode of regulating the fire, and the elas-

* Nicholson's Journal, March 1804.

† The description of this contrivance being already published, it would be superfluous to repeat it. I only beg leave to add the following practical remark:—A metallic piston, if well turned and fitted into a cylinder of exactly the same kind of metal, will probably have the same degree of expansion, especially if hollow, and consequently will not increase its friction in any increased degree of temperature. But as in practice the cylinder is commonly exposed to a lower temperature than the piston, heated by the steam, a little increase of friction will take place by an increase of heat. To prevent the effect of this, I have found it useful to employ for the piston a metal of somewhat less expansive powers than the cylinder; and the expansion of red copper being to that of brass nearly as 10 to 11, I prefer making the piston of the former metal when the cylinder is made of brass.

ticity

ticity of steam in boilers, with less expenditure of fuel and of force than usual; of which idea a hint is given in the work and place above mentioned. The result of these researches I shall at some future period do myself the honour of communicating to the society.

XLVIII. *An Account of the Tea Tree.* By Frederick Pigou, *Esq.**

The Chinese all agree there is but one sort or species of the tea tree; and that the difference in tea arises from the soil and manner of curing †.

Chow-qua, who has been eight times in the bohea country, and who has remained there from four to six months each time, says, that many people, among their tea leaves, especially at Ankoy, near Amoy, put leaves of other trees; but that of these there are but two or three trees the leaves of which will serve that purpose; and they may easily be known, especially when opened by hot water, because they are not indented as tea leaves are.

He says, that bohea may be cured as hyson, and hyson as bohea, and so of all other sorts; but that experience has shown, the teas are cured as best suits the qualities they have from the soils where they grow; so that bohea will make bad hyson, and hyson, though very dear in the country where it grows, bad bohea. However, in the province of Tokyen, which may be called the Bohea province, there has since a few years some tea been made after the hyson manner, which has been sold at Canton as such.

The bohea country, in the province of Tokyen, is very hilly, and since some years greatly enlarged; the length of it is four or five days journey, or as much again as it formerly was. The extent of the soil that produces the best bohea tea is not more than 40 li, or about 12 miles; in circumference it is from 100 to 120 li. Not only the hills in this country are planted with tea trees, but the valleys also; the hills, however, are reckoned to produce the best tea; on them grow congo, peko, and souchong, in the valleys or flat parts of the country bohea. As to the true souchong, the whole place does not yield three peculs;

* From the *Asiatic Annual Register* for 1802.

† This fact is further confirmed by Lord Macartney and Sir George Staunton, who in their journey from Pekin to Canton passed through the centre of the tea country.—See *Macartney's Embassy to China*, vol. iii. page 296.

Youngshaw says, not more than 30 catty. The value of it on the spot is 1½ or two tales the catty, about ten or twelve shillings the pound. What is sold to Europeans for souchong is only the first sort of congo, and the congo they buy is only the first sort of bohea. Upon a hill planted with tea trees, one only shall produce leaves good enough to be called souchong, and of those only the best and youngest are taken; the others make congo of the several sorts, and bohea.

There are four or five gatherings of bohea tea in a year, according to the demand there is for it, but three or at most four gatherings are reckoned proper; the others only hurt the next year's crop. Of souchong there can be but one gathering, viz. of the first and youngest leaves; all others make inferior tea.

The first gathering is called tow-tchune, the second eurl, or gee-tchune, the third san-tchune. If the first leaves are not gathered, they grow large and rank, and are not supplied by the second leaves, which only come in their room or place, and so on.

The first gathering is reckoned fat or oily, the second less so, the third hardly at all so, yet the leaves look young. The first gathering is from about the middle of April to the end of May, the second from about the middle of June to the middle of July, the third from about the beginning of August to the latter end of September. Tea is never gathered in winter. The first gathering or leaf, when brought to Canton, commonly stands the merchants in

	11½	tales the pecul
the 2d	11	or less
the 3d	9	——

The method of curing bohea tea of these three growths is, according to Chow-qua, thus:

When the leaves are gathered, they are put into large flat baskets to dry, and these are put on shelves or planks, in the air or wind, or in the sun, if not too intense, from morning until noon, at which time the leaves begin to throw out a smell; then they are tatched *; this is done by throwing each time about half a catty of leaves into the tatche, and stirring them quick with the hand twice, the tatche being very hot, and then taking them out with a small short broom, if the hand is not sufficient. When taken out, the leaves are again put into the large flat baskets, and there rubbed by men's hands to roll them; after which

* Tatche is a flat pan of cast iron.

they are tatched in larger quantities, and over a cooler or slower fire, and then put into baskets over a charcoal fire, as is practised on some occasions at Canton. When the tea is fired enough, which a person of skill directs, it is spread on a table, and picked or separated from the too large leaves, yellow leaves, unrolled, broken or bad leaves.

Youngshaw says, bohea tea is gathered, sunned in baskets, rolled with the hand, and then tatched; which completes it.

Another says it is gathered, then put in sieves or baskets, about a catty in each, and those put in the air till the leaves wither or give, after which they are put into a close place out of the air, to prevent their growing red, until the evening, or for some hours; the smell then comes out of them. They are after this tatched a little, then rolled, and then tatched again; and about half a catty is tatched at one time.

Congo, says Chow-qua, is tatched twice, as is souchong; but Youngshaw says souchong and congo are not tatched, but only fired two or three times. The latter is most probable, but yet the former may be true; for as tatching seems to give the green colour to the leaves of the tea trees, so we may observe something of that greenness in the leaves of congo and souchong teas. Youngshaw further says, that the leaves of souchong, congo, hyson, and fine singlo trees are beat with flat sticks or bamboos, after they have been withered by the sun or air, and have acquired toughness enough to keep them from breaking, to force out of them a raw or harsh smell.

Souchong is made from the leaves of trees three years old, and where the soil is very good; of older, when not so good, congo is made. The leaves of older trees make bohea. The tea trees last many years. When tea trees grow old and die, that is, when the bodies of the trees fail, the roots produce new sprouts.

Peko is made from the leaves of trees three years old, and from the tenderest of them, gathered just after they have been in bloom, when the small leaves that grow between the two first that have appeared, and which altogether make a sprig, are downy and white, and resemble young hair or down. Trees of four, five, and six years old may still make peko; but after that they degenerate into bohea if they grow on the plains, and into congo if they grow on the hills.

Lintsessin seems to be made from very young leaves rolled up, and stalks of the tree; the leaves are gathered before they

they are full blown: this tea is never tatched, but only fired. Were the leaves suffered to remain on the trees until they were blown, they might be cured as peko, if longer, as congo and bohea. This tea is in no esteem with the Chinese; it is only cured to please the sight; the leaves are gathered too young to have any flavour.

Tea trees are not manured, but the ground on which they grow is kept very clean and free from weeds. Tea is not gathered by the single leaf, but often by sprigs. Tea in general is gathered by men; however, women and children also gather tea. Tea is gathered from morning till night, when the dew is on the leaves as well as when it is off.

Ho-ping tea is so called from the country where it grows, which is twelve easy days journey from Canton. This tea is cured after the manner of bohea, only in a more careless or slovenly way, on account of its little value, and with wood instead of charcoal fire, which is not so proper, and adds to the natural bad smell the tea has from the soil where it grows.

Leoo-ching (or Lootsia), the name of a place eight days journey from Canton: it may produce about 1000 peculs of tea in a year. This tea is cured as bohea, or as green, as the market requires, but is most commonly made to imitate singlo, which suits it best.

Honan tea grows opposite to Canton; it is cured in April or May for the Canton market, that is, for the use of the inhabitants of Canton, especially the women, and not for foreigners. There is but little of it, about 200 peculs. The worst sort of it remains flat and looks yellow: it is tatched once to dry it, but not rolled, and is worth three candarines the catty. The best sort is tatched once, and rolled with the hand, and tatched again; it is worth twelve candarines the catty. These teas are not, like the bohea, after they are tatched, put over a charcoal fire. The water of Honan tea is reddish.

Ankoy tea is so called from the country that produces it, which is about twenty-four days journey from Canton. When gathered, the leaves are put into flat baskets to dry like the bohea; they are then tatched, and afterwards rubbed with hands and feet to roll them, then put in the sun to dry, and sold for three or four candarines the catty. If this tea is intended for Europeans, it is packed in large baskets, like bohea baskets, and those are heated by a charcoal fire in a hot-house, as is often practised in Canton. Bohea tea is sometimes sent to Ankoy, to be there mixed with that country tea, and then forwarded to Canton.

The worst sort of Ankoy is not tatched; but Ankoy congo, as it is called, is cured with care, like good bohea or congo: this sort is generally packed in small chests. There is also Ankoy-peka; but the smell of all these teas is much inferior to those of the bohea country. However, Ankoy congo of the first sort is generally dearer at Canton than the inferior growths of bohea.

As tatching the tea makes it sweat, as the Chinese term it, or throw out an oil, the tatche in time becomes dirty, and must be washed.

If bohea is tatched only twice, it will be reckoned slovenly cured, and the water of the tea will not be green, but yellow; so that fine bohea tea must be cured as congo: the coarse is not so much regarded.

The ordinary tea used by common people in tea countries is passed through boiling water before it is tatched, notwithstanding which it remains very strong and bitter. This, father Lefebure says, he has often seen. Tea is also sometimes kept in the steam of boiling water, which is called by some authors a vapour bath.

Singlo and hyson teas are cured in the following manner: when the leaves are gathered, they are directly tatched, and then very much rubbed by men's hands to roll them, after which they are spread to divide them, for the leaves in rolling are apt to stick together; they are then tatched very dry, and afterwards spread on tables to be picked; this is done by girls or women, who, according to their skill, can pick from one to four catty each day. Then they are tatched again, and afterwards tossed in flat baskets to clear them from dust; they are then again spread on tables and picked, and then tatched for a fourth time, and laid in parcels, which parcels are again tatched by ten catties at a time, and when done put hot into baskets for the purpose, where they are kept till it suits the owner to pack them in chests or tubs, before which the tea is again tatched, and then put hot into the chests or tubs, and pressed in them by hand. When the tea is hot it does not break, which it is apt to do when it is cold. Singlo tea being more dusty than hyson tea, it is twice tossed in baskets, hyson only once.

It appears that it is necessary to tatche these teas whenever they contract any moisture; so that if the seller is obliged to keep his tea any time, especially in damp weather, he must tatche it to give it a crispness before he can sell it.

It is to be observed that the quantity of leaves tatched increases with the times of tatching; at first only half or three quarters of a catty of leaves are put into the tatches.

Tunkey singlo tea is the best, which is owing to the soil: it grows near the hyson country. Ordinary singlo tea is neither so often tatched or picked as the above described.

There are two gatherings of the singlo tea, the first in April and May, the second in June; each gathering is divided into three or more sorts; the leaves of the first are large, fine, fat, and clean; of this sort there may be collected from a pecul, from 40 to 55 catties, usually 45. The second sort is picked next, and what then remains is the third or worst sort.

Tunkey, like other singlo tea, is made into two or three sorts; the best is sometimes sold for hyson of an inferior growth.

Of hyson there are also two gatherings, and each gathering is distinguished into two or more sorts; but as great care is taken in gathering it, 60 catties may be chosen from one pecul, when only 45 catties can be chosen from singlo.

Hyson-skin, as it is called, has its name from being compared to the skin or peel of the hyson tea, a sort of cover to it, consequently not so good; it consists of the largest leaves, unhandsome leaves, bad coloured and flat leaves, that are amongst the hyson tea. This tea is known in London by the name of bloom tea.

Gomi (or Gobee) and Ootsien, are also leaves picked from the hyson leaves. Those called gomi are small and very much twisted, so that they appear like bits of wire. The ootsien are more like little balls.

There are many different growths of singlo and hyson teas, and also some difference in the manner of curing them, according to the skill or fancy of the curer: this occasions difference of quality in the teas, as does also a good or bad season. A rainy season, for instance, makes the leaves yellow: a cold season nips the trees, and makes the leaves poor.

Bing tea is so called from the man who first made that tea. It grows four days journey from the hyson country. The leaves of bing are long and thin, those of singlo are short and thick.

The tricks in tea are innumerable. In the bohea country when tea is dear (and probably they use the same method in all tea countries), they gather the coarse old leaves, pass them through boiling water, then cure them as other leaves are cured; after which they pound them, and mix them with other teas, putting five or six catties of this tea dust to ninety-five catties of tea.

To make bohea tea green.

For this purpose coarse Ankoy tea is generally taken: the leaves should be large. (Ankoy is no other than the tea tree from the bohea country propagated at Ankoy.) Take ten catty of this tree, spread it, and sweat the leaves by throwing water over them, either hot or cold, or tea water. When the leaves are a little opened and somewhat dry put them into a hot tatche, together with a small quantity of powdered chico, a fat stone, and tatche them well, then sift the tea, and it is done. If it happens not to be green enough tatche it again. It is the frequent tatching that gives the green colour to the tea leaves.

To make green bohea.

First water it to open the leaves, then put them in the sun to dry a little, then tatche them once, and proceed to cure them as bohea leaves, over a charcoal fire. This is seldom done, because it is seldom worth doing, green tea being generally the dearest: moreover, green tea does not make so good bohea as bohea does green.

Ho-ping tea, already described, and which is of the bohea kind, after being cured as bohea, is sometimes altered to green, and becomes like the leoo-ching before mentioned, and is sold at Canton to foreigners for singlo.

It is to be observed, that all these worked-up teas, as they may be called, and teas of improper growths, are more commonly mixed with true teas for the Europe market than sold separate by themselves; so that the proportions in which they are mixed make combinations without end. The differences to be observed in teas arise from the soils. The methods of curing owing to the skill of the curer, sometimes to his caprice; neglect in the curing; using bad fires; wood, and that green, instead of charcoal; sometimes straw or broom for bad teas; and to the seasons, which should not be too wet or too dry, too cold or too hot. The Chinese also sell at Canton all sorts of old teas for new, after they have prepared them for that purpose, either by tatching or firing, and mixing them with new teas.

Clean singlo tea is called Pi-cha, or skin tea. A custom formerly prevailed to put 15 or 18 catties of very bad singlo tea into the middle of a chest, which was covered on all sides by good tea; and this was done by the means of four pieces of board nailed to each other, making four sides, or a well for the chest, whereon good tea was spread, and also within two inches of the top, was drawn out. The good tea was called pi-cha, or the skin or covering to the bad, which

which the Chinese called the belly. This method of packing singlo tea has long since been discontinued.

The bohea country is about twenty-five easy days journey from Canton. The singlo about forty. The hyson much the same.

Bohea usually comes to Canton at the cost of	- - -	9 to 11 tales the pecul.
Singlo and second hyson	-	14 to 18
Hyson	- - -	30 to 38

Congo, peko, and souchong, very various.

To these prices must be added the charges of warehouse-room, packing, the duties on exportation, and the seller's profit, in a country where money is often 2 per cent. per month, and seldom less than 20 per cent. per annum.

Bohea, *Voo-yee*, the name of the country.

Congo, or *Cong-foo*, great or much care or trouble in the making or gathering the leaves.

Peko, *Pé-how*, white first leaf.

Souchong, *Sé-ow-chong*, small good thing.

Le-oo-ching, the name of a place.

Ho-ping, ditto.

Ho-nan, ditto.

Ankoy, ditto.

Song-lo, ditto.

Hyson, *He-Tchune*, name of the first crop of this tea.

Bing-min, name of the man who first made this tea.

Estimate of the quantity of tea made in China in a year, taken in 1756.

Singlo - -	50,000	*peculs.*
Hyson - -	4,000	
Lock-ann, small baskets	20,000	not exported, Bohea sort.
Mo-i-shan - -	2,000	not exported.
Bing-tea - -	2,000	
Phow-ge tea -	2,000	lumps, Bohea sort.
Bohea, including Congo, Peko, and Souchong	120,000 to 130,000	
Ankoy, Bohea, and Green sorts - -	50,000	
Openg - -	15,000	
Ing-aan - -	400	Bohea sort.
Cow-low, made either in Bohea or Singlo -	2,000	
Loot-sien -	2,000	true sort.
	279,400	

Loot-sien, true sort, is what really grows in the Loot-sien country. Some tea is planted near Loot-sien that passes for that tea, and that is the case in all the countries.

Besides the teas before enumerated, many other teas are planted, as in the Honan country, &c. the quantities they produce cannot be easily ascertained; but upon the whole, it is reckoned, that in ten parts, not above three are exported.

In one hundred Chinese, it is reckoned forty only can afford to drink tea; the others drink water only. Many, when they have boiled their rice, put water into the tatche in which the rice was boiled, to which some grains always adhere; the water loosens them, and is browned by the rice: that water they drink instead of tea.

The tea sent into Tartary is mostly green, perhaps in the proportion of seven to two.

Old bohea is reckoned good by the Chinese; in a fever they use it to cause perspiration, and put into it a black or coarse sugar, with a little ginger.

Old hyson, one or two cups made strong, removes obstructions in the stomach, caused by over-eating or indigestion. It is to be used if a weight is felt some hours after eating, and it will remove it.

XLIX. *An Account of the Hindu Method of cultivating the Sugar Cane, and manufacturing the Sugar and Jagary in the Rajahmundry District; interspersed with such Remarks as tend to point out the great Benefit that might be expected from increasing this Branch of Agriculture, and improving the Quality of the Sugar; also the Process observed by the Natives of the Ganjam District. By Dr.* William Roxburgh*.

No pursuit is more pleasing to the benevolent mind than such as tends to add a new source of happiness to men.

Amongst the natives of India, the transitions from one stage of improvement to another are so exceedingly slow, as scarcely to deserve the name, except it be the few who have benefited by the example of Europeans: they naturally possess a strong disinclination at departing from the beaten path established from time immemorial: however, when they see a certain prospect of gain, with little additional

* From the *Asiatic Annual Register* for 1802.

trouble,

trouble, they have frequently been known to adopt our practices. We ourselves ought more generally to keep in view, and to instil into their minds, this maxim, that every new proposition, merely on account of its novelty, must not be rejected, otherwise our knowledge would no longer be progressive, and every kind of improvement must cease.

At a period like the present, when the importation of East India sugar has become so much an object of importance to Great Britain, in consequence of the present state of some of the best of the West India sugar islands, every inquiry that may tend to open new sources from whence that wholesome commodity can be procured at the cheapest rate, is of national importance.

I believe there are few districts in the company's extensive possessions where there will not be found large tracts of land fit for the culture of sugar cane; but I know, from experience, the introduction of a new branch of agriculture amongst the natives to be attended with infinite trouble; therefore where we find a province or district in which the culture of the cane and making of sugar have been in practice from time immemorial, there we may expect, without much exertion, to be able to increase the culture, and improve, if necessary, the quality.

In the northern provinces, as well as in Bengal, Cadapah, &c. large quantities of sugar and jagary are made; it is only in the Rajahmundry and Ganjam districts of these northern provinces where the cane is cultivated for making sugars. I will confine my observations to the first, where I have resided between ten and eleven years.

This branch of agriculture, in the above-mentioned sircar, is chiefly carried on in the Peddapore and Pettapore, along the banks of the Elyseram river, which, though small, has a constant flow of water in it the whole year round, sufficiently large, not only to water the sugar plantations during the dryest seasons, but also a great variety of other productions, such as paddy, ginger, turmerick, yams, chillies, &c. This stream of water, during the dryest season, renders the lands adjoining to this river of more value, I presume, than almost any other in India, and particularly fit for the growth of sugar cane.

By the bye, permit me to observe, that of all the parts of India that I have seen, this seems the best suited for the culture of the mulberry and rearing silk-worms, as well on account of the cheapness of labour, and the general abundance of provisions for the natives, as for the soil, climate, and situation.

But

But to return to the culture of sugar: in these two zemindaries from 350 to 700 vissums, or from 700 to 1400 acres of land (the vissum being two acres) is annually employed for the rearing sugar cane, more or less, according to the demand for the sugar; for they could and would with pleasure, if they were certain of a market, grow and manufacture more than ten times the usual quantity; for it is very profitable, and there is abundance of very proper land: all they want is a certain market for their sugar.

Besides the above-mentioned, a third more may be made on the Delta of the Godavary.

From the same spot they do not attempt to rear a second crop oftener than every third or fourth year; the cane impoverishes it so much, that it must rest, or be employed during the two or three intermediate years for the growth of such plants as are found to improve the soil, of which the Indian farmer is a perfect judge: they find the leguminous tribe the best for that purpose.

The method of cultivating the cane and manufacturing the sugar by the natives hereabouts is, like all other works, exceedingly simple; the whole apparatus, a few pairs of buffaloes or bullocks excepted, does not amount to more than a few (15 or 20) pagodas; as many thousand pounds is generally, I believe, necessary to set out the West India planter.

The soil that suits the cane best in this climate, is a rich vegetable earth, which, on exposure to the air, readily crumbles down into a very fine mould: it is also necessary for it to be of such a level as allows of its being watered from the river by simply damming it up, (which almost the whole of the land adjoining to this river admits of,) and yet so high as to be easily drained during heavy rains. Such a soil, and in such a situation, having been well meliorated by various crops of leguminous plants, or fallowing, for two or three years, is slightly manured, or has had for some time cattle pent in it: a favourite manure for the cane with the Hindu farmer, is the rotten straw of green and black pessaloo (*phaseolus mungo max*). During the months of April and May, it is repeatedly ploughed with the common Hindu plough, which soon brings this loose rich soil into very excellent order. About the end of May and beginning of June the rains generally set in, in frequent heavy showers: now is the time to plant the cane: but should the rains hold back, the prepared field is watered, flooded from the river, and while perfectly wet, like soft mud, whether from rain or the river, the cane is planted.

 The

The method is most simple:—Labourers, with baskets of the cuttings, of one or two joints each, arrange themselves along one side of the field; they walk side by side, in as straight a line as their eye and judgment enable them, dropping the sets at the distance of about eighteen inches asunder in the rows, and about four feet row from row: other labourers follow, and with the foot press the set about two inches into the soft mud-like soil, which, with a sweep or two with the sole of the foot, they most easily and readily cover: nothing more is done. If the weather is moderately showery, till the young shoots are some two or three inches high, the earth is then loosened, for a few inches round them, with a small weeding iron, something like a carpenter's chisel: should the season prove dry, the field is occasionally watered from the river, continuing to weed, and to keep the ground loose round the stools. In August, two or three months from the time of planting, small trenches are cut through the field at short distances, and so contrived as to serve to drain off the water, should the season prove too wet for the canes; which is often the case, and would render their juices weak and unprofitable: the farmer therefore never fails to have his field plentifully and judiciously intersected with drains, while the cane is small, and before the usual time for the violent rains. Should the season prove too dry, these trenches serve to conduct the water from the river the more readily through the field, and also to drain off what does not soak into the earth in the course of a few hours; for they say, if water is permitted to remain in the field for a greater length of time, the cane would suffer by it, so that they reckon these drains indispensably necessary; and upon their being well contrived depend, in a great measure, their future hopes of profit. Immediately after the field is trenched, the canes are all propped: this is an operation I do not remember to have seen mentioned by any writer on this subject, and is probably peculiar to these parts. It is done as follows:

The canes are now about three feet high, and generally from three to six from each set that has taken root, and form what we may call the stool: the lower leaves of each cane are first carefully wrapped up round it, so as to cover it completely in every part; a small strong bamboo (or two), eight or ten feet long, is then stuck into the earth, in the middle of each stool, and the canes thereof tied to it; this secures them in an erect position, and gives the air free access round every part. As the canes advance in size, they continue wrapping them round with the lower leaves, as they

they begin to wither, and to tie them to the prop bamboos higher up, during which time, if the weather is wet, they keep the drains open; and if a drought prevails they water them occasionally from the river, cleaning and loosening the ground every five or six weeks. Tying the leaves so carefully round every part of the canes, they say, prevents them from cracking or splitting by the heat of the sun, helps to render the juice richer, and prevents their branching out round the sides: it is certain you never see a branchy cane here.

In January and February the canes are ready to cut, which is about nine months from the time of planting; of course, I need not describe it. Their height, when standing in the field, will now be from eight to ten feet (foliage included), and the naked cane from an inch to an inch and a quarter in diameter.

A mill or two, or even more, according to the extent of the field, is erected, when wanted, in the open air, generally under the shade of large mangoe trees, of which there are great abundance hereabout: the mill is small, exceedingly simple, and at the same time efficacious. The juice, as fast as expressed, is received in common earthen pots, strained, and put into boilers, which are, in general, of an oval form, composed of ill-made thick plates of country iron riveted together.

These boilers hold from 80 to 100 gallons; in each they put from 24 to 30 gallons of the strained juice; the boiler is placed over a draft-furnace, which makes the fire burn with great violence, being supplied with a strong draft of air through a large subterranean passage, which also serves for an ash-hole. At first the fire is moderate, but as the scum is taken off, a point they are not very nice about in these parts, as they look up to quantity more than quality, the fire is by degrees increased, so as to make the liquor boil very smartly: nothing whatever is added to help the scum to rise, or the sugar to gain, except when the planter wants a small quantity for his own or a friend's use: in this case they add about 10 or 12 pints of sweet milk to every 24 or 30 gallons, or boiler of juice, which no doubt improves the quality of the sugar; the scum, with this addition, comes up more abundantly, and is more carefully removed.

The liquor is never here removed into a second boiler, but is in the same boiled down to a proper consistence, which they guess at by the eye and by the touch; the fire is then withdrawn, and in the same vessel suffered to cool

a little:

a little: when it becomes pretty thick they stir it about with stirring-sticks for some time, till it begins to take the form of sugar; it is then taken out and put on mats made of the leaves of the palmira tree (*borassus flabelliformis*), where the stirring is continued till it is cold: it is then put up in pots, baskets, &c. till a merchant appears to buy it.

The Hindu name of this sugar is pansadarry; its colour is often fairer than most of the raw sugars made in our West India islands, but it is of a clammy, unctuous nature, absorbing much moisture during wet weather, sometimes sufficient to melt a great deal of it, if not carefully stowed in some very dry place where smoke has access to it.

Many of the planters prefer that sort of sugar which they call bellum, and Europeans jagary, because it keeps well during the wet weather if kept from the wet. It generally bears a lower price; yet they sav this disadvantage is often overbalanced by their being able to keep it, with only a trifling wastage, till a market offers, particularly when the planter has not an immediate market for his sugar; besides, canes of inferior quality answer for jagary when unfit for sugar.

The process observed for making jagary differs from the above described, in having a quantity of quicklime thrown into the boiler with the cane juice; about a spoonful and a half to every six or seven gallons of juice, or nine or ten spoonfuls in the boiler. Here they do not remove the scum, but let it mix with the liquor, and, when of a proper consistence, about four or five ounces of Gingeley oil (oil of the seeds of *sesamum orientale*,) are added to each boiler of liquor, now ready to be removed from the fire, and very well mixed with it: it is then poured into shallow pits dug in the ground; they are generally about three feet long, one and a half broad, and three inches deep, with a mat laid at the bottom, which is slightly strewed with quicklime; in a short time the liquor incorporates into a firm solid mass; these large cakes they wrap up in dry leaves, and put by for sale.

Their jagary is of a darker colour than their sugar, and contains more impurities, owing to the careless manner in which they prepare it, by allowing all the scum to reunite with the liquor.

The half vissum, or one acre of sugar cane, in a tolerable season, yields about ten candy of the above-mentioned sugar, or rather more if made into jagary: each candy weighs about 500 lb., and is worth on the spot, from 16 to 24 rupees, according to the demand. In the West Indies, the

the acre (so far as my information goes, and it is chiefly from Mr. Beckford's History of Jamaica,) yields from 14 to 20 cwt. of their raw sugar, worth on the island about 20l. currency: here the produce is more than double, but, on account of its inferior quality, and the low price it bears on the spot, the produce does not yield a great deal more money than in the West Indies: however, as here labour is incomparably cheaper, the Indian planter must make much larger profits.

The situation of all the sugar lands hereabout is exactly alike, being the middle of an extensive plain, adjoining to the aforementioned river; the soil in all is also much alike, so that the produce is nearly equal in all, when no unfavourable circumstances happen: this is further proved by the quantity of sugar a measure of juice will yield: here it is almost always, except in a very rainy season, or in laid down or wormy canes, about one-sixth part; that is, every six pounds, or three quarts of juice, yield one pound of sugar. In Jamaica, Mr. Beckford says, that, on an average, 1800 gallons of juice may be reckoned to yield an hogshead of sugar, weight 16 cwt., which is, within a trifle, one of sugar from eight of juice: this proves our juice to be one-fourth part richer than theirs. From the above calculations it is evident that our lands hereabout are better adapted for this species of culture than the lands in Jamaica: for here they not only yield a larger crop of canes, but the juice thereof is also richer; and were our planters here to bring the molasses, &c. into account, employed in the West Indies for the distillation of rum, their profits would be still greater; for at present such refuse they give to their cattle, or let their labourers carry away, or use as they think proper; and, by being so employed, I have no doubt but it is productive of more real good than if converted into ardent spirits: let it continue to be so employed, is my sincere wish; for the longer they are ignorant how to convert what is at present wholesome into a poison, the better it is for them; they have already too many ways of furnishing themselves with spirits, particularly near the residence of Europeans.

Here the canes, while growing, seem also subject to fewer accidents than in the West Indies. I will mention them briefly.

1st. A very wet season is the worst; it injures the canes greatly, rendering them of a reddish colour, yielding a poor unprofitable juice: here they reckon the small heavy pale yellow canes the best.

2d. Storms,

2d. Storms, unless they are very violent, do no great harm, because the canes are propped; however, if they are once laid down, which sometimes happens, they become branchy and thin, yielding a poor watery juice.

3d. The worm is another evil, which generally visits them every few years. A beetle deposits its eggs in the young cane; the caterpillars of these remain in the cane, living on its medullary parts, till they are ready to be metamorphosed into the chrysalis state. Sometimes this evil is so great as to injure a sixth or an eighth part of the field: but, what is worse, the disease is commonly general when it happens, few fields escaping.

4th. The flowering is the last accident they reckon upon, although it scarcely deserves the name; for it rarely happens, and never but to a very small proportion of some very few fields: those canes that flower have very little juice left, and it is by no means so sweet as that of the rest.

Say the average quantity of land employed for the growth of sugar canes in these parts, the zemindaries of Peddapore and Pettapore, independent of what is made on or about the islands formed by the mouths of the Godavary, is 550 vissums, equal to 110 acres, and to produce at the rate of 10 candy, or about 44 cwt., equal to $2\frac{1}{2}$ hogsheads per acre: the whole produce in hogsheads will annually be 27,500 of 18 cwt. each, which is fully one-fourth part of sugar produced in the island of Jamaica; and I know well, that the quantity might, with advantage to government, I was going to say,—but that must be left to be determined hereafter,—I will therefore say, with advantage to the zemindar, farmer, and labourer, be increased to any extent. All the security the planter wants, is a strict adherence to the agreement he makes with the zemindar for the land, and a certain market for his sugar, at even the lowest price stated. I observe that the farmer would require to have the agreement he makes for the rent of the land strictly adhered to, because the zemindar raises his demand if the crop is good; so that he will often, in a favourable season, make farmers of all denominations pay probably a fourth more than the original agreement. Such injustice they are obliged to put up with, as custom has rendered it common, and they have no idea of applying for redress; yet it no doubt damps the spirit of industry, and prevents the soil from any further improvement than the bountiful hand of Nature has bestowed on it, which, in these parts, is great indeed.

The planters in these parts very rarely take a second, or what

what they call carsy crop, from the same field; they say he is either a very poor or a very lazy farmer that does, because those canes yield less juice, and of an inferior quality, than plant canes: however, poverty obliges some to do so. This carsy crop is cut and manufactured in November, which is a busy season in the paddy fields, &c. as this is the time for reaping the coarse or early paddy and natcheny, and for sowing various sorts of small grain, consequently attending to the sugar works at that time of the year is inconvenient: besides, the rains are frequent during this month, which is another very great drawback attending this crop. The grand sugar crop fortunately happens during that time of the year (February, March, and April) when there is scarce any other sort of work in the field: consequently both humanity and policy plead in favour of an extended scale to this, or such other branches of agriculture as employ the labourers at a season when there is little or nothing else to do.

I could never learn that any one had ever depended on a third crop from the same field; for they say, if the second is so much inferior to the first, a third must be still worse; here hands are, or rather were, so numerous, and labour so cheap, that they find it much more profitable to plant every year.

In the Ganjam district, about Aska and Barampore, the natives make most excellent sugar and sugar-candy, but in small quantities. The sugar is in loaves, of a large grain, and often as perfectly white as what is called in England single refined sugar, and the sugar-candy is superior to any thing of the kind I ever saw.

Mr. Alex. Anderson, surgeon of the Madras establishment, when with the committee of circuit up there, was so obliging as to send me a very particular account of the method they follow in manufacturing their sugar and sugar-candy, of which the following is a copy:

Extract of a Letter from Alexander Anderson, Esq. Surgeon of the Madras Establishment.

Method of preparing the Sugar in the Ganjam District.

"After the cane is ready, it is cut in pieces of a foot or eighteen inches long, and on the same day it is cut, these pieces are put into a wooden mill, which is turned round by bullocks; on one side of the mill is a small hole sufficient to let the juice pass through, which is received in an earthen pot placed for the purpose. The juice is then strained

strained into other pots, containing about 24 quarts, and to each pot of juice is added about three ounces of quick-lime. It is then boiled for a considerable time, till, on taking out a little, and rubbing it between the fingers, it has a waxy feel, when it is taken off the fire, and put into smaller pots with mouths six inches in diameter. The mass may now be kept in this state for six or eight months or more, and it is necessary at any rate to do so for a month or six weeks. When the process is intended to be continued, a small hole is made in the bottom, through which the syrup drains off. It is then taken out of these pots and put into shallow bamboo baskets, that any remaining syrup may exude; after which it is put in a cloth, and the syrup is squeezed through the cloth, adding a little water to it occasionally, that it may be more perfectly removed; the sugar is then dissolved in water, and boiled a second time in wide-mouthed pots, containing only three seers, with not too fierce a fire, adding from time to time a little milk and water, and stirring it frequently; which is used by these people to clarify it, instead of eggs, which their religion forbids them to touch. The scum is removed as it is thrown up, and when it resumes the waxy feel on rubbing a little of it between the fingers, the process is finished, and the sugar put into small wide-mouthed pots to cool and crystallize; after which a small hole is bored for the purpose of draining off any little quantity of syrup that may still exude. The outside of the pots are now covered with cow-dung, and, for the purpose of making the sugar white, or removing any syrup or blackish appearance, the creeping vine, called in the Hindu *panicha-dub*, and in Telingas *necty-nas*, growing in tanks and marshy places. It is put on the top of the sugar in the pots, and renewed every day for five or six days: should the sugar, on taking it out of the pots, be blackish, or less pure towards the bottom of the loaf, being set upon this plant and renewed daily, will effectually remove that appearance. If it is wrapped in a wet cloth, and renewed twice a day, the sugar will also become white; it must be then thoroughly dried, and kept for use.

"To make sugar-candy, the sugar must be again dissolved in water, and boiled in the same manner as before, adding milk to it, in small quantities; the proportion three seer of sugar and half a seer of milk, with water to dissolve the sugar. It is then put into other wide-mouthed pots, with but three seer in each pot, putting thin slices of bamboo,

bamboo, or some dried date leaves, which prevents the sugar, as it candies, from running into large lumps.

"Here we see a very superior sugar, and sugar-candy of the first quality, manufactured in a simple but tedious manner, and at a most trifling expense; a few earthen pots are the only vessels or boilers they require: but it is not to be imagined that such would succeed if the work was carried on to any great extent. The iron boilers employed hereabout might be laid aside for those of copper, or of cast iron, from Europe, or not, as they like themselves, for it seems of no great consequence: but by having a greater number of them to pass through and be well clarified in, would render unnecessary the second process mentioned by Dr. Anderson, which, on account of its tediousness, must become very inconvenient: consequently, all that seems to be wanted to render the sugars made thereabouts fit for any market, is a boiler, or two or three more in each set, with wooden coolers, instead of losing time to let it cool in the boiler, as is the practice here at present, the addition of some quicklime, and probably alum, to the cane juice, and the subsequent claying of it in conical pots, as is done in the West Indies; for which process the natives of the Ganjam district substitute moist conserva for covering the sugar in the pots with, and wrapping the loaves, when not sufficiently white, in wet cloths, to extract the molasses.

"The rate of freight from India to England being so very high, renders it the more necessary to make the sugars for that market of a good quality, which can be done here at infinite less expense than in the West India islands, where labour is so exceedingly high.

"If the sugar cane can be cultivated with so much ease, and to such perfection, in this climate (which is considerably hotter than the West Indies), by simply burying the set about two inches in the level ploughed field, by which practice the superficial or horizontal roots must be near the surface, of course subject to great heats; I say, if this practice succeeds so well here, it may be presumed it would succeed equally well, if not better, in the West Indies, where the heats are never so great, of course the superficial roots of the cane less subject to be scorched.

"The present practice of digging large square holes to put the sets in, is, I am told, exceedingly laborious, and does not stand the planter in less than 10l. per acre, which is nearly double the whole expense of cultivating, from first to last,

last, an acre of canes, and manufacturing the sugar, in this district. Should the British legislature deem it proper to emancipate the slaves on those islands, the planter there may then be obliged to cultivate and plant his lands in the manner practised here, or as potatoes are planted with the plough in the fields in England; and there is scarce a doubt but that they would in either way succeed fully as well as by planting in holes.

"Should political motives prevent the importation of East India sugars into England, it is even then of infinite importance to the Company's territories to have the qualities of their sugars improved, so as to render unnecessary the importation of those of China and Batavia, large sums being annually thrown into those places for this commodity; while we, at the same time, possess every advantage for making this necessary article of the best quality, to the full in as high a degree as either the Chinese or Dutch: besides our own wants, we have every reason to imagine, that we might soon be able to supply the Malabar coast, Persia, and Arabia, with sugars; whereas, at present, they are chiefly supplied from China and Batavia."

L. *A brief Statement of some Particulars relative to the Sinking, &c. of William-Pit, near the Sea-shore, at Bransty, Whitehaven, the Property of Lord Viscount* LOWTHER.

ON Saturday the 23d of March, they got the main band seam of coal, about 11 feet thick (on the same day, coals were shipped at the North Wall) of very excellent quality, and at about 92 fathoms from the surface to the bottom of it. The coal lies immediately under an excellent reef of very hard white post, or freestone; containing little water. A considerable quantity of hydrogen gas (generally termed inflammable air) issues from it: but, from an excellent ventilation of atmospheric air, from the surface, improved by the rarefaction of a large fire or lamp, the inflammable matter is happily carried off.

In sinking through different posts of this freestone, several very strong seeds of such gas vented through the joints of the stone, which, when lighted by a candle, burnt very violently, and exploded to a large flame of fire; and would have continued so, if suffered. In pricking one of these seeds, the noise resembled that of a great waterfall;

and

and the strength of the inflammable air made the water fly up the pit for several yards.

This pit commands a most extensive field of coal, in three different workable seams (*see following thicknesses*), and when opened out, even by a consumption, from this pit alone, of a thousand waggons per week (a quantity that is capable of being far exceeded), will last for a great number of years; almost incalculable; a circumstance of the greatest consequence to the possessor and the public in general.

The diameter of the pit is 15 feet; hollow, and formed into three divisions; two for drawing coals at the same instant of time, and one for pumping water.

The regular sinking of this pit was only begun in May last; and, in 46 weeks, it has been sunk 92 fathoms, although eight weeks of that time were occupied in walling the pit sides with freestone and other casual things; so that only 38 weeks were employed regularly in sinking for the above distance; besides passing through from 20 to 30 fathoms of white post, and other metals almost equally hard.

The same sinkers, 20 in number (except one or two), have begun and ended the undertaking. The regularity, sobriety, and good order, that have throughout prevailed amongst them (so highly creditable to themselves) are unprecedented in this quarter; for every man has uniformly been ready for his work, at the time appointed, viz. to be 6 hours on, in 24; divided into 4 sets.

In addition to liberal prices having been paid them for their labour, as a further incitement to industry, four different premiums, of 16l. 20l. 24l. and 40l. were promised them, for sinking given distances in given time; the three last of which they have fully acquired, and received; and, as a proof of their having used their best endeavours, Lord Lowther has generously promised to pay the first also, when the pit is down; particularly as that fell short under unfavourable circumstances; unusually hard metals, and very heavy water intervening.

Before a stop crib and tight length could be got to collect it, and keep it from the bottom, the water was equal to 60 gallons a minute; all of which was drawn to the surface by tubs, and filled with pails by the sinkers. Yet, notwithstanding the rapidity of the motion, from the first to the last, scarcely the most trivial accident has been sustained by any of the people employed. The pit is clothed with wood from the top to the bottom, and is, in every part, as complete as it is possible to be made.

A very

A very extensive pumping engine is preparing for the lowest seams, connecting with the other extensive collieries, being the lowest level of all the collieries belonging to Lord Lowther; also machines for drawing the coals.

William-Pit is situtated about seven or eight hundred yards from the ships, and a waggon-road is preparing, which in several places is raising above the old surface 12 or 14 feet, in order to keep on the level line of the North Wall, or shipping place. When completed, one horse will convey two or three waggons at the same time; and, in addition to the convenience, will form a very handsome ornament.

In putting down this pit, the sinkers have filled into tubs, which have been drawn to the furnace by two gin-wheels and horses,

55,803 tubs of metal at 40 gallons each,
121,432 tubs of water at 60 ditto ditto,

exclusive of such water as hath been drawn from the tight tub, by engines and other means.

Depth of the most workable Seams.

	ft.	in.	
At about 72 fathoms, the Bannock-band Seam	7	8	thick.
92 do. Main-band Seam	11	0	
Purposed to be continued down to 137 do. Low Seam	7	6	

The vessel which took in the first coals from William-Pit is called the Lady Mount Stewart, Hugh Fergusson master, belonging to Bangor, in Belfast Lough, Ireland.

The weather was very fine; numbers of people were assembled upon and near the North Wall; and this first shipment of coals, from William-Pit, was announced by a discharge of cannon.

LI. *Proceedings of Learned Societies.*

ACADEMY OF SCIENCES AT BERLIN.

The following papers were read in this Society in the course of the half-year, beginning in July and ending December, 1804.

July 5th, Examination of some essential points in regard to aqueous solutions, together with observations on the same subject. By professor Bernoulli.

12th, Researches in regard to the principle of the beautiful, and its application to music. By the director Castillon.

19th, General considerations on the character of the English

English and the French literature during the reign of Louis XIV. By professor Ancillon junior.

26th, On the atmosphere, and its influence on the organism and diseases of the human body. By Hufeland.

Aug. 2d, Account of some late astronomical discoveries and observations, with intelligence from his own astronomical correspondence, and observations made at the observatory in 1803. By professor Bode.

9th, A public sitting. Discourse on the occasion by the director Merian. Ad Borussiam de regis die natali. Ode by professor Spalding. On the real and apparent course of the two new planets Ceres and Pallas, and their connection with each other, illustrated by drawings and a model, by professor Bode. Historical memoir on the town and castle of Copenick, by Erman. On the influence of the atmosphere and local situation on the life, health, and physical character of the inhabitants. By Hufeland.

Sept. 13th, Reflections on determinism and its two extremes. By Ancillon.

20th, Memoir on the Roman highways in the Alps, to serve as a supplement to the Essay of a History of the Alps, in three volumes, 1790 and 1791. By the abbé Denina.

27th, On an improved construction of the percussion machine. By professor Fischer.

Oct. 4th, On the resistance of the air, first memoir. By professor Burja.

11th, On the influence of the physical part of man on the intellect, and of the latter on the former. By Klein.

18th, Examination of the question, Are there triphthongs in the French language? By Bastide.

25th, Short account of a curious experiment lately made in France to enflame a sponge by compression of the air. By professor Fischer.

Nov. 1st, Observations on philosophical unbelief, second part. By Nicolai.

13th, Observations on some points of the Grecian chronology. By Trembley.

22d, First, Chemical examination of topases; 2d, Examination of some fossil elephant's teeth by fluoric acid. By Klaproth.

29th, On some points which occur in trigonometrical measurement. By Tralles.

Dec. 6th, On philosophical unbelief, third part. By Nicolai.

13th, On the temple of Solomon. By Hirt.

20th, On the effects of galvanism. By Hufeland.

SOCIETY

SOCIETY OF THE FRIENDS OF THE SCIENCES AT WARSAW.

This society has charged two of its members, Messrs. Carteau and Stacio, to undertake a mineralogical tour to the Carpathian mountains. Another member of the same society has already explored the eastern part of these mountains, in order to collect observations in mineralogy, geology, and oryctognosy. He is now engaged in a like tour through the mountains of Interior Austria, from which he will proceed to Upper Italy and the Swiss Alps. On his return he will go on a similar tour to the Caucasian mountains.

FRENCH NATIONAL INSTITUTE.

The medal founded by M. de Lalande for the best work on astronomy, was adjudged by the Institute, in the sitting of the 15th, to M. Harding, who discovered a new planet at Lilienthal, near Bremen, on the 5th of Sept. last. This able astronomer has been invited to Gottingen to take the direction of the observatory become celebrated by the observations of Tobias Mayer.

LII. *Intelligence and Miscellaneous Articles.*

PRODUCTION OF MURIATE OF SODA BY THE GALVANIC DECOMPOSITION OF WATER.

Our philosophical readers will agree with us in opinion, that the following interesting communication promises to lead to most important consequences:

To Mr. Tilloch.

" SIR, Cambridge, April 23, 1805.

" I take this opportunity of laying before the public, through the medium of your Magazine, if you think it worthy a place in that work, the following experiment:

" I took about a pint of distilled water, and decomposed one half of it by means of galvanism; the other half I evaporated, and I found to remain at the bottom of the glass a small quantity of salt, which upon examination proved to be muriate of soda, or common salt.—What induced me to try the experiment was this: I knew that when water was decomposed by means of galvanism, the water near one of the wires had alkaline, while that near the other had acid properties. This being the case, I inferred, that if an alkali and an acid were really produced, I should by decomposing a large quantity of water obtain a small quantity of some kind of neutral salt—as was actually the case on trying the experiment. The salt could not have been contained in the water before I made the experiment, because I used every precaution to have it free from impurities. I even took the trouble to repeat the experiment, though a tedious one, and I again obtained the same result.

"Should you think the above worthy of being laid before the public, I shall send you some more experiments which I am now trying on galvanism, together with some remarks on this; and which, I hope, will throw some light upon the subject. In the mean time I remain

"Yours, &c. &c.

"W. PEEL."

"P. S. A friend of mine just informs me that he has tried my experiment, and has succeeded in procuring the salt*."

VOYAGES AND TRAVELS.

Thomas Jefferson, Esq. President of the United States of America, writes to M. Faujas-Saint-Fond as follows:

"A journey undertaken for the purpose of making discoveries in this country, will probably procure us some new information in regard to the megalonix and other animals, either lost or now existing. The immediate object of it is to explore the river Missouri as far as its source; then to visit the nearest river situated to the west, and to descend thence to the Pacific Ocean; to give at the same time an exact geography of that interesting channel of communication across our continent. The labours and dangers of this journey; the strength of body and mind it requires; the knowledge of the manners of the savages, and the address to manage them, which are necessary, exclude from this enterprise men who have not applied to the sciences, and whose habits are not suited to a kind of life so active and perilous.

* We shall be glad to receive from Mr. Peel the communications which he has encouraged us to hope for. His interesting experiments may, perhaps, lead to some knowledge of the composition of soda, and the base of muriatic acid, discoveries which could not fail to prove highly useful. We would suggest to Mr Peel. that he may perhaps add to the interest of his investigation if he would take the trouble also to compose from its elements, hydrogen and oxygen, the water to be made use of in one of his experiments. In this case, from the difficulty of hitting exactly the due proportion of the two gases, it is probable the water so obtained would prove acidulous (we have never seen it otherwise in this experiment): if so, it might be advisable to neutralise, with great care, the free acid, employing for this purpose some other alkali than soda, or some simple earth; after which the water should be distilled from the neutral salt.—EDIT.

perilous. Captain Lewis, to whom I have intrusted it, possesses all the knowledge in anatomy requiste to fulfil that part; and though he is not absolutely a regular botanist, zoologist or mineralogist, he has observed so exactly the natural productions of this country, that he will not lose his time in noting down things with which we are already acquainted. He will attend to those only which are new in that part of the world. In particular, he will give us an account of its animals. This expedition, consisting of about twelve persons, will probably return about the end of 1805.

"I hope to be able next summer to send other travellers towards the principal branches of the Missisipi and the Missouri, the Red River to Arcansa, Padoruas, and the river Missisipi itself. The objects of these expeditions will be the same as those of that intrusted to Captain Lewis. They will require the same space of time, that is to say, two years. Several of these rivers extend 1000 or 1200 miles inland, reckoning from their sources, and into regions which have never been visited by white men. It would give me great pleasure if these travels should procure us materials for enlarging the boundaries of our knowledge, and give to our elder brethren in science a tribute of our gratitude for the information they have communicated to us."

Dr. Goldfuss, of Erlangen, will set out in the course of the present spring, on his travels in Africa; the expenses of which will be defrayed by the King of Prussia. He will remain a year at the Cape, and in the two following years will endeavour to penetrate as far as possible into the country, both on the eastern and western coast.

The Russian ships now on a voyage of discovery, of which some account has already been given in the Philosophical Magazine, have sailed from Kamtckatka in order to proceed to Japan.

An embassy is about to be sent by the Russian government to China. The choice of the persons who are to compose it is completed. Among those who are to accompany Count Golofkin in this mission are Schubert, the astronomer; General Suchtelen, as historiographer; and Ruttoffsky, as botanist and landscape painter. Mr. Schubert's son, an officer of engineers, forms also a part of the ambassador's suite. Great advantages, both in a commercial and scientific point of view, are expected from this embassy.

ANTIQUITIES.

ANTIQUITIES.

Last year some workmen, by command of the Neapolitan government, and particularly at the desire of the secretary Seratti, began to clear away the rubbish around the antient temple of Pæstum. In the course of this year the digging will be completed, and a description of all the remains of antiquity which have been discovered will be published. The well-known antique vase of Parian marble, the raised work of which represents Bacchus in his infantine state delivered by Mercury to a nymph to be educated, one of the most beautiful pieces of this kind, the work of Salpion the Athenian, which formerly served as a baptismal font in the cathedral of Gaetta, has been conveyed to the king's museum at Naples.

M. Petrini, who set on foot some researches at his own expense in the neighbourhood of Ostia, has found a sitting figure of the Tyber, which the Papal government has purchased from him for 7000 sequins.

BOTANY, GEOLOGY, &c.

The collection of plants and library of the late professor Wahl, of Copenhagen, will, in consequence of a resolution of his Danish Majesty, be given to the botanical garden. The most important manuscripts he has left behind him are a *Systema Vegetabilium*, in which all the plants known to him are described in systematic order, with their distinguishing characters; the third part of his work *Eclogæ Americanæ*, ready for the press, and of which the plates are engraven; his lecturess on zoology; the botanical terms of art and different branches of botany; also several drawings and scattered observations on the Danish and Norvegian zoology.

According to letters from M. Humboldt at Paris, to a friend at Berlin, he is at present employed in the following four works: A physical description of the equinoctial regions; a Flora of the same; the astronomical observations and measurements made during his travels between the tropics; and conjointly with Gay-Lussac, some treatises on eudiometry and the constitution of the atmosphere. The last, it is probable, will appear in French, the rest in German. He will soon undertake a tour to Italy with Gay-Lussac, and afterwards another to the most northern point of Norway.

FORMATION OF WATER BY COMPRESSION.

In the late sitting of the National Institute, M. Biot read a paper on the formation of water by compression alone. It is known that water is composed of two kinds of gas, oxygen and hydrogen, which may be combined together by means of the electric spark. M. Biot has succeeded in making this combination, independent of electricity, and in rapidly compressing a mixture of the two kinds of gas, inclosed in an air-pump. The compression, by bringing the particles of gas into intimate union, makes them throw out a quantity of heat sufficient to set them on fire. Some precautions must be taken in repeating this experiment, as it cannot be tried without danger. Out of three experiments which M. Biot made, there were two in which the tube of brass, which forms the pump, and the pump itself, which was of iron, were burst by the force of the explosion.

GALVANIC EXPERIMENTS.

Giobert, in a letter to M. van Mons, says, "I am at present employed on galvanic electricity. I do not admit the decomposition of water by the fluid of the pile. For, if it be pretended that the fluid transmits hydrogen from the one tube to the other, why not admit also that it transmits oxygen? And in this case, the gases come from the pile, and are not formed at the extremity of the wire where they are disengaged. In this case, the decomposition of water is effected in the pile, by means of the zinc; and this circumstance may be classed among the chemical phænomena best known. It can be easily ascertained that the gases may circulate along the wires of communication of the pile, by impregnating the interposed pieces with pure ammonia, and immersing the wires, and particularly that of the negative pole, in a solution of alum, which will be immediately precipitated by the ammonia, which will be conducted by the wire. In some experiments, I caused even indigo to circulate, by impregnating the pasteboard disks with a solution of that substance in sulphuric acid.

I found that the fluid of the pile burns atmospheric air, giving birth to the nitric acid. It burns also a mixture of hydrogen gas and oxygen. I believe that it decomposes carbonic acid. In some experiments, I saw that gas entirely disappear. The gas detonates, but I cannot yet determine whether it be in consequence of the gaseous oxide of carbon which is formed.

VOLCANOES.

Among the many curious facts which the celebrated Humboldt collected in the course of his travels, one of the most surprising is that which he lately communicated to the National Institute. Several of the volcanoes in the Andes throw up, from time to time, a muddy substance mixed with large quantities of fresh water; and what deserves to be particularly remarked is, an astonishing number of fish. The volcano of Imbaburn, near the town of Ibarra, threw up once such a quantity that the putrid effluvia proceeding from them produced diseases. This phænomenon, however, is not singular. The most remarkable circumstance is, that the fish are not injured. Their bodies appear to be very soft, but do not seem to have been exposed to a great heat. The Indians assert that fish still alive are found at the bottom of the mountain. These animals are ejected sometimes from the crater of the volcano and sometimes from lateral apertures; but they always come from the height of from twelve to thirteen hundred toises above the level of the plains. Humboldt is of opinion that these fish are bred in lakes in the interior of the crater. As fish of the same kind are found in the rivers and streams which flow at the bottom of the mountain, this circumstance is a strong confirmation of this opinion. They are the only animals in the kingdom of Quito which live at the height of 1400 toises. This species are entirely new to naturalists. Humboldt has assigned to them a place in the system, and calls them *Pimelodus Cyclopum*; that is, thrown up by the Cyclops, a denomination which refers to their origin. They will be found in the first number of his Zoological Observations, which will soon appear.

ETHER BY FLUORIC ACID.

M. Gehler, in a letter to M. van Mons, says, "Since my last on the formation of ether by fluoric acid, I have made an experiment which gave me very singular results. I subjected to distillation in a proper apparatus, 15 ounces of fluoric spar brought to a red heat, and pulverised with a mixture of 10 ounces of pure alcohol, and as much sulphuric acid, of 1·860. I distilled the whole to dryness. I obtained a large quantity of gas, which by the smell might have been taken for phosphorated hydrogen gas, and which burned with a blue flame, emitting some vapours of fluoric acid. The distilled liquid was rectified, making only the half to pass over, and mixed with an equal volume of

 water.

water. It did not become hot, remained perfectly clear, and floated on the water, without decreasing sensibly in quantity. It was consequently ether. As this liquid had a very acid odour and taste, I added to it a diluted solution of caustic soda, till the acid was saturated; in consequence of which, the ether, by the large quantity of silex which was separated, formed itself into a consistent jelly. It is singular, that the water did not decompose this combination, while it separated so easily the silex of the fluoric acid*.

The jelly was put into a retort, and distilled to dryness. The distilled fluid had a smell approaching near to that of sulphuric ether, and weighed 0·720; but its taste was bitter, and very much analogous to that of bitter almonds, though much weaker. I shall repeat this experiment, with the necessary precautions, to remove all suspicion that the sulphuric acid may have had an influence on the formation of the ether; and I confess that this suspicion, in my experiment, is not without foundation, considering the small space, in regard to its great weight, occupied by the fluated lime in the mixture of alcohol and sulphuric acid.

ASTRONOMY.

March 24, 1805.

There appeared, a few days ago, on the sun, a large spot with two nuclei, which I observed nine degrees to the north of the solar equator. It differs little from the spots which enabled me to determine the time of the sun's rotation, in the Memoirs of the Academy for 1776; and it seems to me to confirm the discovery I then made, by proving that there are in the sun points where large spots are formed, rather than in others. They are perhaps mountains, which attract and retain the scoriæ of that immense furnace†. The parallel, which is at nine degrees south from the solar equator, is the most fertile in large spots. These spots, with two nuclei, which have appeared at different periods, seem to me to destroy the system of volcanoes proposed by Dr. Herschel: there cannot be two volcanoes so near subsisting without mixture, and always separated by a line of light.

DELALANDE.

AYAPANA.

Bory de St. Vincent, in his *Voyage aux principales Iles des Mers d'Afrique*, relates that the captain of a Danish ship,

* The substance separated by water from the fluate of silex is a terrulous fluate of that earth, and the remaining liquid is fluate strongly acidulous.—*Note of M. van Mons.*

† Till we read this, we believed that all modern philosophers had given up the idea of the sun being a mass of fire! EDIT.

ship, in the year 1798, first brought this plant from Brazil to the Isle of France, as a panacea. It was immediately used against all kinds of diseases, and he extols its wonderful effects, that it removes consumption of the lungs, and that it was employed in the Isle of France as the surest means against the bite of serpents; yet it is known that no serpents are to be found in either of the Mascarhenas. "All errors," says Bory, "continue only for a time. This quackery also has ceased; the ayapana is as little a panacea as the German 'Forget me not.' Bory himself took the infusion of thirty leaves, for a catarrh, without the least effect. People in the Isle de France remember the ayapana only to laugh at the follies related of this plant, and the charlatan who introduced it is forgotten."

ON A LETTER IN OUR LAST NUMBER.

SIR,

In your last number, page 174, I used too strong a word, when I said that the Academy del Cimento had *successfully* repeated *Baptista Porta's* experiment on the reflection of cold. The fact is, that, not having had the Essays of that body at hand, I quoted from memory. But, as I have since met with the book, perhaps the best way of correcting the mistake, will be to subjoin their own brief account of the experiment.

"We were willing, say they, to try if a concave glass set before a mass of 500lb. of ice made any sensible repercussion of cold, upon a very nice thermometer of 400 degrees, placed in its focus. The truth is, it immediately began to subside; but, by reason of the nearness of the ice, 'twas doubtful whether the direct or reflected rays of cold were more efficacious. Upon this account, we thought of covering the glass, and (whatever be the cause) the spirit of wine did indeed presently begin to rise. For all this, we dare not be positive, but there might be some other cause thereof, besides the want of reflection from the glass; since we were deficient in making all the trials necessary to clear the experiment."—See the 9th "Experiment of Natural Freezing," at page 103, of the Essays of Natural Experiments, made in the Academy *del Cimento*, published in 1667, and translated by *Richard Waller*, F.R.S. London 1684. Yours, &c. *D.

INGENUITY OF THE SPIDER.

T. A. Knight, Esq. of Herefordshire, has, in a treatise on the culture of the apple and pear, introduced the following anecdote concerning this curious animal:—"I have frequently

frequently placed a spider on a small upright stick, whose base was surrounded by water, to observe its most singular mode of escape. After having discovered that the ordinary means of retreat are cut off, it ascends the point of the stick, and, standing nearly on its head, ejects its web, which the wind readily carries to some contiguous object. Along this the sagacious insect effects his escape, not, however, till it has previously ascertained, by several exertions of its whole strength, that its web is properly attached at the opposite end. I do not know that this instance of the sagacity of the spider has been noticed by any entomological writer; and I insert it here, in consequence of having seen in some periodical publication, a very erroneous account of the origin of the spider's threads which are observed to pass from one tree or bush to another in dewy mornings."

MALLEABLE PLATINA.

Our chemical readers will be gratified to be informed that this valuable and useful article can now be procured at a price that will put it in their power to employ it in utensils for various delicate purposes. The following articles, made of pure platina, may be had of Mr. Carey, mathematical instrument maker, No. 182, in the Strand.

Crucibles of various sizes, with or without covers, at 17s. 6d. per ounce, with a small addition for workmanship.—Evaporators, about 5 inches diameter, weighing between 3 and 4 ounces, at the same price.—Wire of various sizes, and laminated platina, at 16s.—Bars of malleable platina unmanufactured at 15s. per ounce. Other articles may be made in a short time, according to order, by furnishing Mr. Carey with a drawing or correct description.

LECTURES ON PHYSIC AND CHEMISTRY.

On Monday, June 3d, a Course of Lectures on Physic and Chemistry will recommence at the Laboratory in Whitcomb-street, Leicester-square, at the usual morning hours, viz. the Materia Medica and Therapeuticks, 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, of the College of Physicians, &c. &c.

Note.—The Practice of Vaccination will be taught at the Institution in Broad-street, Golden-square, and an account will be given of the practice on the patients in St. George's Hospital, as usual, every Saturday morning, at nine o'clock.

Proposals may be had at St. George's Hospital, and at 52, Leicester-square.

METEOROLOGICAL TABLE

By Mr. Carey, of the Strand,

For April 1805.

Days of the Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock, Night.	Height of the Barom. Inches.	Degrees of Dryness by Leslie's Hygrometer.	Weather.
March 27	33°	41°	33°	29·92	16°	Cloudy
28	32	40	32	30·11	21	Fair
29	34	39	38	·05	20	Cloudy
30	40	56	48	29·90	24	Showery
31	47	55	46	·85	20	Fair
April 1	46	56	45	·78	33	Fair
2	46	57	48	·98	51	Fair
3	47	56	46	·98	52	Fair
4	45	44	40	·42	0	Rain
5	39	42	41	·57	7	Stormy
6	39	45	42	·78	8	Rain
7	42	51	44	30·21	31	Fair
8	39	53	40	·34	27	Fair
9	38	54	42	·33	41	Fair
10	39	53	43	·17	34	Fair
11	41	55	45	29·93	51	Fair
12	45	61	45	·77	65	Fair
13	45	59	46	·62	55	Fair
14	47	58	45	·44	44	Fair
15	45	54	41	·42	37	Showery
16	42	48	40	·50	30	Cloudy
17	41	47	45	·80	26	Showery
18	45	54	44	·95	42	Fair
19	45	56	46	30·05	52	Fair
20	40	59	48	·19	50	Fair
21	51	62	46	·18	65	Fair
22	43	56	40	·06	39	Fair
23	39	48	40	29·99	29	Fair
24	38	53	42	·47	51	Cloudy
25	45	47	45	·34	20	Hail showers

N. B. The barometer's height is taken at noon.

LIII. *Essay on the Phænomena of the Electrophorus; with an Attempt to reconcile them with the Principles of the Franklinian Theory.* By SAMUEL WOODS, *Esq.* *Read before the Askesian Society in the Session* 1803-4.

IN the paper which during the last sessions I submitted to the society*, I endeavoured to offer a general view of the phænomena occasioned by the passage or accumulation of the electric fluid, arranging and comparing them with certain propositions which appeared to me to combine and include the leading principles of what is usually termed the Franklinian theory of negative and positive electricity. In this essay an examination into the appearances exhibited by the electrophorus was purposely omitted, both because the experiments recited by different observers were not perfectly consistent with each other, and involved the subject in considerable obscurity, and because the singularity of those appearances, in which all concurred, seemed to merit and demand a separate investigation: the present attempt, therefore, to collect, arrange, and explain them, may be deemed a supplement to the former paper.

The electrophorus is an instrument invented by an Italian philosopher, M. Volta, of Como, and consists of three parts; of two plates and an electric substance.

1st, The inferior plate; which at first was made of glass, but is now usually of metal or wood, covered with tinfoil, of a circular form, and carefully freed from points or edges.

2d, The electric substance †; which may be constructed of glass, or varnish laid on the inferior plate, or sealing-wax, or sulphur, or mixed substances yielding the negative electricity. Resinous electrics are best adapted for this purpose, because they are less rapidly affected by the humidity of the air, and retain their electricity much longer than glass. This substance most commonly is made to adhere to the surface of the plate; but it is much more convenient to have an independent cake, capable of entire separation.

* See Philosophical Magazine, vol. xvii. p. 97.

† The composition is usually equal parts of resin, shell-lac, and sulphur. M. Cavallo recommends the second sort of sealing-wax: others prefer a coating of sealing-wax dissolved in spirits of wine, or resin dissolved in oil of turpentine. The one I use is a cake about half an inch in thickness and twelve in diameter, made principally of shell-lac, with a small portion of Venice turpentine to assist its fusion, which is effected in an earthen vessel over a slow fire or sand heat, and then poured into an iron hoop resting upon a perfectly flat surface. This has the advantage of being very tough, and not easily broken.

 3d, An-

3d, Another plate of a circular form; made either of brass or of wood, or even pasteboard covered with tinfoil: this should be nearly of the same size, but rather smaller than the inferior plate, and must be furnished with a glass insulating handle, which by means of a brass or wooden socket is screwed into its centre.

For the sake of perspicuity it will be desirable to adopt some short and appropriate appellation to distinguish each of these parts from the others without circumlocution, as they must frequently recur in the course of our inquiry; and it will not perhaps be easy to improve the nomenclature of professor Robison in the Supplement to the *Encyclopædia Britannica*:

1. The inferior plate, which constitutes the bottom or support of the rest, and which in my apparatus is a flat brass plate, 12 inches in diameter, made to screw upon a glass insulating stand, we shall denominate—the *sole*.

2. The electric substance to be excited,—the *cake*.

3. The superior plate, 10 inches in diameter, with a glass handle attached, for the purpose of imposing it upon and removing it from the cake,—the *cover*.

To each of these plates a small wire is made to screw in, adapted to suspend a pair of pith balls, by which means the state of both sole and cover may be ascertained at the same time, and in favourable circumstances very minute changes may be detected.

The most obvious phænomena exhibited by this instrument are the following:

The cake in contact with the sole must be excited by friction, either with new flannel or dry warm silk, previously taking care to make the surface of the cake as dry as possible: then, by means of its insulating handle, impose the cover; then offer a conductor to the cover, and a spark will pass between them; after which if the cover be elevated or removed, by the extremity of its glass handle, from the electric cake, it will yield a strong spark to any conducting body. If the cover be replaced, a communication afforded with the ground, by touching it with the finger or otherwise, and again separating it, a second spark may be obtained. And this process, with fresh excitation, may be repeated for hours, if the apparatus be kept perfectly free from dust and moisture: and if these sparks be given to the knob of a jar, it will become charged with positive electricity.

It is evident, however, that these indications are not sufficiently decisive to furnish an accurate knowledge of the

different

different states and changes which the parts respectively undergo, or to afford data upon which to build an account of the rationale of its mode of operation: recourse must be had to more delicate tests, and the most convenient method is, to attach a pair of pith balls upon a projecting wire to each plate, by which means the state of both may be observed and ascertained at the same time. I shall now endeavour to exhibit a general view of all these changes, arranged in a tabular form.

Phænomena where two Parts only of the Electrophorus are made use of; viz. the Cake and the Sole, with Pith Ball Electrometer attached and insulated.

	Sole Electrometer.
No. 1. Cake excited on insulated stand, or excited cake imposed	Negative.
2. Ditto, removed	Positive.
3. While the excited cake remains imposed	Negative.
4. On the approach of any conductor	Balls close.
5. And on contact with the surface become	Positive.
6. Remove the conductor and	Negative state restored.
Touch the sole at any time, and the	Balls close, and remain neutral.

Phænomena where all the three Parts are employed: Sole not insulated, and Pith Ball Electrometer attached to the Cover.

	Cover Electrometer.
No. 7. Excited cake imposed on the sole; then impose the cover	Positive weakly.
8. Remove the cover	The positive divergence greatly increases.

Phænomena where all three Parts are used; viz. the Sole insulated, with Pith Ball Electrometer attached; the Cake and the Cover also with its Electrometer.

	Sole Electrometer.	Cover Electrometer.
No. 9. Excited cake imposed	Negative	
Impose the cover by its glass handle	Balls gradually close, or continue negative a short time; then close and become positive	Negative immediately: negative of the cover much stronger than the positive of the sole,
10. Remove the cover	Negative restored	Positive, but seldom any spark.
11. Replace the cover, still preserving its insulation	Positive	Negative.
12. Bring the hand, or any conductor, into contact with the cover while imposed	Balls remain positive	A spark passes, and balls remain neutral, or more frequently slightly positive,
13. Remove the cover, after being in contact or communication with the ground	Negative: will yield a spark, but not so strong as the cover	Strongly positive; yields a spark to considerable distance, and will charge a phial.
14. Replace the cover	Positive	Negative.
15. Make a communication between sole and cover	A slight shock may be perceived, and balls remain neutral	
16. Touch the sole at any time	Neutral	
17. Cover - - - - -	- - - - -	Neutral.

These experiments are the result of my own observation, and, I flatter myself, may be depended upon: they have all been repeated more than once; and indeed a considerable degree of care is requisite in ascertaining the kind of electricity indicated by the divergency of pith balls, as a stronger electricity in glass or wax will frequently attract a weaker of the same sort in these light bodies. I have found it most convenient to apply an excited stick of wax and glass alternately to the plate at some distance from the electrometer, and never to rest satisfied till both of these tests concurred in their results. By the use of two similar electrometers I have had great advantage in perceiving the changes produced in each of the metallic parts: and perhaps it may be in some measure owing to the employment of only one electrometer in experiments upon this instrument that so much uncertainty has prevailed, as I do not recollect to have met with any account where the state of sole and cover were ascertained by the same means and at the same time.

I now proceed to offer a general view of the observations I have met with on this subject.

The general result given by Adams (Essay on Electricity, p. 358,) is the following:

"By examining with pith balls it appears,

"1. That the cover acquires a weak positive electricity when imposed on excited cake. (See preceding experiment, No. 7.)

"2. That when the cover is touched by the finger it loses all its electricity. (See No. 17.)

"3. When the cover is touched by the finger, and removed from the cake, it becomes strongly positive. (See No. 8.)

In order to account for these appearances he offers the following considerations:

"The cake may be conceived to consist of several horizontal strata, so that the upper stratum, when excited, is insulated by the inferior strata. Now, insulated electrics produce the opposite electricity on bodies brought within the sphere of their action; *i. e.* insulated and excited glass produces negative, and wax positive, electricity on other insulated bodies: therefore the surface of the electrophorus cake should produce positive electricity in the cover, conformably to experience." But as it is not very obvious how the electricity should become stronger by removal out of the sphere of action of the excited electric, he adds: "electric bodies do not put the fluid in that degree of motion which is necessary to produce the spark, or exhibit the phænomena of attraction and repulsion, while they are in contact with conducting substances; which is the reason why the upper plate, *i.e.* the cover, exhibits no signs of electricity while it remains in contact with the under one, though they become sensible the instant it is removed from it."

If any one can understand or apply this confusion of ideas to elucidate the point in question, he must possess a larger portion of skill than I can pretend to claim. M. Cavallo observes, (Complete Treatise, vol. ii. p. 55.) that if the cake be accurately insulated, the cover acquires so little electricity that it can only be detected by the electrometer. This, however, as the editor of the *Encyclopædia Britannica* observes, is manifestly untrue; and it is difficult to imagine how so great a mistake should have occurred.

Other experiments mentioned by M. Cavallo accord with No. 1, 4, and 5, in imposing the cover, the sole electrometer before diverging with negative electricity closes, but again becomes negative. Comparing this with No. 9, it will appear to be correct, but not to represent the whole truth. In the results of No. 12 and 13, I am also confirmed by Cavallo. The theory of this author is comprised in a short compass, and, I believe, is not far wide from the truth: it does not, however, include the whole of the phænomena, and requires a more detailed application. He says, "the action of these places depends upon a principle long ago discovered, viz. the power of an excited electric to induce a contrary electricity in a body brought within its sphere of action. The metal plate therefore, when set upon the excited electric, acquires a contrary electricity by giving its electric fluid to the hand or other conductor, which touches it when set upon a plate electrified positive, or acquiring an additional quantity from the hand when upon a plate electrified negative." It is not, however, true, that a conductor in contact with an excited electric exhibits, while in contact, signs of the opposite electricity. The general appearances are thus recited and arranged in the Supplement to the *Encyclopædia Britannica*, article *Electricity*.

"1. If the sole has been insulated during the congelation of the electric (*i. e.* where the cake is melted into the sole and permanently annexed to it,) till all is cold and hard, the whole is found negatively electric, and the finger draws a spark from it, especially from the sole. If allowed to remain in this situation its electricity grows gradually weaker, and at last disappears; but it may be again excited by friction. If the cover be now imposed by its insulating handle,

handle, but without touching the cover, and again separated from the cake, no electricity whatever is observed in the cover."

Observation.—This last remark is not true, as will be seen by reference to experiments No. 9 and 10: it is true, indeed, that the electricity is seldom strong enough to yield a spark.

"2. But if the cover be touched while on the cake, a sharp pungent spark is obtained from it; and if at the same time the sole be touched with the thumb, a very sensible shock is felt in the finger and thumb. (See No. 12 and 15.)

"3. After this the electrophorus appears quite inactive, and is said to be dead, neither sole nor cover giving any sign of electricity." (See No. 15.)

This state of death or neutrality lasts, however, but a short time, especially in the cover, which soon occasions the pith balls to diverge negatively.

"4. When the cover is raised to some distance from the cake (keeping it parallel therewith), if it be touched while in this situation a smart spark flies to some distance between it and the finger; more remarkably from the upper side, and still more from its edge; which will even throw off sparks into the air if it be not rounded off. As this diminishes the desired effects, it is proper to have the edge so rounded. This spark is not so sharp as the former, and resembles that from any electrified conductor." (See No. 13.)

Some importance seems attached to the preservation of a parallel direction in elevating the cover; but I have never found any diminution of effect by removing the cover laterally, or in any other direction: I may remark, that the sensation occasioned by the passage of the spark is too indistinct to enable the operator to judge satisfactorily of the quality or kind of electricity.

"5. The electricity of the cover when thus raised is of the opposite kind to that of the cake, or positive. (See No. 13.)

"6. The electricity of the cover while lying on the cake, is the same with that of the cake, or negative. (See No. 9, 11, and 14.)

"7. The appearances recited under the propositions numbered 2, 3, 4, may be repeated for a long time without any sensible diminution of their vivacity. The instrument has been known to retain its power undiminished even for months. This makes it a sort of magazine of electricity, and we can take off the electricity of the cake and of the

 cover

cover as charges for separate jars; the cover when raised charging like the prime conductor of an ordinary electrical machine, and when set on the cake charging it like the rubber. This caused the inventor, M. Volta, to give it the name of *electrophorus*.

"8. If the sole be insulated before the cover is imposed, the spark obtained from the cover is not of that cutting kind that it was before; but the same shock will be felt if both cake and cover be touched together."

I understand this to imply, that when insulated the electricity of the cover becomes positive, or, instead of receiving a spark from the finger, yields one to it: if this be meant, it is contrary to fact. (See No. 9, in table of experiments.) If the sole be not insulated, the cover after imposing becomes weakly positive, (see No. 7,) and the spark between the cover and finger is scarcely perceptible.

"9. If the cover be raised to a considerable height, the sole will be found electrical, and its electricity is that of the cake, and not the same as the cover. (See No. 10.)

"10. After touching both sole and cover, if the cover be raised and again set down without touching it while aloft, the whole is again inactive.

"11. If both sole and cover be made inactive when in contact with the cake, they show opposite electricities when separated, the sole having the electricity of the cake.

"12. If both sole and cover be made inactive when separate, they both show the opposite to the electricity of the cake when joined."

I have sometimes observed each plate when thus situated assume the same electricity as the cake, but never both of them the opposite state.

These are the material facts upon this subject stated in the Supplement to the *Encyclopædia Britannica*, which is followed by an ingenious attempt to account for them in conformity to the principles of the Æpinian theory. Some of the data appear to me to be assumed without sufficient proof: but as in my former paper, to which this is a supplement, I declined the consideration of that theory, and confined myself to what is called the Franklinian hypothesis, I shall pursue the same course on the present occasion, especially as the theory above alluded to is involved in a great deal of mathematical and algebraical formulæ; and I cannot pretend to have studied it with sufficient attention to do justice to the reasoning brought forward in its support, or represent with perspicuity the explanations which it offers.

I shall

I shall close my account of the phænomena with the experiments of Mr. Morgan, which I have reserved for the last place, because it appears to me that in general his theory to explain them is the most intelligible of any.

"Let the cover be placed upon the excited cake, connecting the cover at the same time, by any conducting substance, with the ground: let the connection with the ground be suddenly broken, and the cover raised by its glass handle.

"1. A spark will strike to any conducting body brought near the cover. (See No. 13.)

"2. The cover will always be in the opposite state to the excited cake," *i. e.* while removed. (See No. 13.)

In the insulated electrophorus a pith ball electrometer attached to the sole.

"1. After the hand has been laid on the cover in contact with the sole, not the least signs of electricity are discoverable on the removal of the cover; *i. e.* in the sole.

"2. The same effect is produced by connecting the sole and cover with an insulated discharging-rod.

"3. The cover is then only charged when the communication between itself and the sole is continued to the ground: the sole electrometer does not separate till the cover is raised: remove the cover and the pith balls diverge; replace the cover undischarged, they instantly close, but when the cover is discharged and then replaced, the divergence is continued."

This is not consistent with experiments No. 9, 10, 11.

In attempting the explanation of these phænomena it is necessary to keep in mind that the effects are of a compound nature, combining the double operation of an electric, both excited and charged: it will therefore be desirable to consider the appearances separately of charged and excited electrics; and in the investigation of the first of these I avail myself of the observations of Mr. Milner,—in the second, of Mr. Morgan.

"1. Let a plate of crown glass be placed between two circular plates of brass rounded at the edges, and let the whole be insulated; the lower plate on a glass stand, with a brass chain to connect it, when wanted, with the table: let another insulated stem be appended to the upper plate. In the last place, bend a piece of brass wire into such a shape that it may stand perpendicularly on the upper plate; and let the upper extremity of this wire be formed into a hook, that it may at any time be removed by a silk string without destroying the insulation of the plate."

Observation.—It is obvious that this disposition of the apparatus

apparatus is conformable to that of an electrophorus: the glass representing the electric cake, and the upper and lower plate the cover and sole, all in their natural state.

"2. The glass being thus furnished with a metallic coating on each side, and having a proper communication with the ground, will admit of being charged; and both coatings may be separated and examined apart without destroying the insulation of either.

"3. The apparatus being thus disposed, communicate a strong charge to the glass by means of the bent wire; then remove the charging wire and the chain connected with the lower plate. On the approach of a finger to the upper coating a small spark will pass, and the same will happen to the under coating. This effect cannot be produced twice by two succeeding applications to the same coating; but in a favourable state of the atmosphere may be repeated some hundred times, by alternate applications to the two coatings, till the charge of the glass is gradually exhausted.

"4. Let the glass be again fully charged; touch the upper coating with the finger, and then, by its insulating stem, separate it from the upper and positive surface of the glass: this coating will then be found negative; *i. e.* opposite to the side of the glass with which it was in contact. This effect, on repetition, gradually diminishes; but on touching the coatings alternately two or three times, the negative power of the coating when separated is greatly increased, so as to yield strong negative sparks. The same circumstances will happen to the under coating; substituting, however, the positive for the negative effects.

"5. Each surface of the charged glass therefore, in consequence of a momentary interruption of the insulation, has the power of producing a contrary electricity in the coating in contact with it: more electrical matter must have passed away from the upper coating at the time of touching it than the same coating could receive from the upper surface of the glass, and therefore the upper coating, by losing some of its natural quantity, becomes negative: more electric matter must in the same manner have been added to the under coating, which becomes positive. The greatest degree of this influential power will be produced in either coating by taking care at the same time to bring the opposite coating into a like state of influential electricity.

"6. The glass being well charged, let a bent wire in the form of a staple be brought into contact with the upper and lower coating at the same time: by this a discharge will be effected, but the equilibrium will be only in part restored;

restored; for a considerable degree of attraction may be observed between the upper coating and the glass, which is frequently strong enough to lift a piece of plate glass weighing ten ounces. Neither coating will now show the least external sign of electricity when in contact with the glass; but on separation, carefully preserving the insulation, the upper coating is strongly negative, the under positive. Let both coatings be restored to their natural state by contact with a conductor, and then replace the glass between them: if the upper coating be touched and separated it will give no spark, but on touching the coatings alternately several times it will give a weak spark; and this may be repeated several times by only touching the upper coating. On a second application of the bent wire to both coatings, a second though much slighter discharge is perceptible, and the coatings are brought into the same electrical state as immediately after the first discharge. This may frequently be repeated, and a considerable number of strong negative sparks taken from the coating when separated from the positive surface of the glass. If the glass in replacing it between the coatings be reversed, the electrical powers of both coatings will be changed by the next application of the discharging-wire, and a succession of strong positive sparks obtained from the negative surface of the glass.

" 7. Hence it may be inferred that the charged glass was not restored to its natural state by the completion of the circuit, but that it had acquired a degree of permanent electricity.

" 8. The whole quantity of electric matter added to the glass in charging it, is evidently distinguishable into two parts: the first part, by far the most considerable, is readily communicated along the bent wire from one surface to the other; the second part appears more permanent, and remains still united with the glass. It appears, therefore, from the preceding experiments that professor Volta's electrophorus is in reality a resinous plate charged with permanent electricity by friction."

I should observe, that the above account of Mr. Milner's investigation is extracted from the *Encyclopædia Britannica*; but, though marked with inverted commas, is not precisely in the language of the ingenious author; the whole, extending to a very considerable length, has been condensed and abridged, but, I trust, without any misrepresentation of meaning. Let us now proceed to Mr. Morgan's examination of an excited substance.

" Let

"Let a cushion be prepared with a metallic covering at the back, and insulated by a glass stem; then excite the cylinder by means of this cushion, pursuant to the common method: no electrical signs will be discovered while the insulation is complete. Stop the motion of the cylinder, placing the finger in contact with the cushion; then remove the cushion from the excited cylinder, and it will give a spark: return it to the cylinder, and on removal it will repeatedly give a spark without any additional friction, attended by the same circumstances as have been described to take place in the electrophorus: now, by substituting a glass plate for the cylinder, and supposing the cushion to cover that plate, you form an electrophorus, without one circumstance of diversity from the common cylinder. Again, if after exciting the electrophorus you remove the cover and apply a number of metallic points connected with the ground to the excited surface, and afterwards replace the cover, no more sparks can be obtained without a fresh excitation. This is precisely similar to what is observed in working the cylinder; for as soon as the excited part passes the cushion, and is exposed to the action of a multitude of points, it is rendered incapable of producing electrical signs till it again comes into contact with the cushion."

It is obvious that the phænomena described, both with respect to charges and excited electrics, bear a striking similarity (as indeed might be expected) to those of the electrophorus. We will now endeavour to explain the process detailed in the table of phænomena.

I agree with Mr. Morgan that the general principle to which these phænomena ought to be referred is an increase or diminution of attractive force between the particles of bodies and particles of the electric fluid; or, in other words, an alteration of the capacity of bodies for the electric fluid, in consequence either of excitation or contact with an excited substance. If I were asked for the cause of this change of capacity, I should freely confess my ignorance; for I cannot easily suppose a chemical change to be produced, or any new arrangement of the parts created, by the mere contact of bodies. It will be necessary to recollect, what I believe was satisfactorily shown in my former paper, that the divergence of pith balls can only be depended upon as indicating a disposition to receive or to part with a portion of the electric fluid, or perhaps more properly an increased or diminished attraction for it, and ought not to be considered as any criterion of the absolute capacity of bodies.

When

When the cake is excited by friction, a change in its capacity may be conceived to take place, and it acquires through its whole substance a stronger attraction for the electric fluid than it had before, and of course will become disposed to receive an additional quantity. The sole is placed on an insulated stand, which, when the cake is imposed, participates in the disposition to receive; and the pith ball electrometer attached to it diverges with negative electricity. But it not only partakes of the character of the cake; the capacity of the sole thus in contact with the excited substance is augmented; and it does not merely operate as a conductor to convey the fluid to the cake, but obtains for itself, from contiguous bodies floating in the atmosphere, more than in its separate state it is capable of holding. On the removal of the cake, therefore, carefully avoiding to destroy the insulation of the sole, the attractive force of the sole is diminished. It is left in a plus or positive state, is disposed to part with its superfluous quantity, and the balls diverge with positive electricity.

While the excited cake remains imposed, and the sole electrometer indicates the negative electricity, a conductor is offered to the excited surface. The attraction of the cake becomes strongest on the upper side, because any supply is obtained with more facility by the opening of a communication with the universal store diffused in the ground. The sole electrometer closes, therefore, on account of the diminished activity of force on the under surface; and when the communication is complete, by the contact of the conducting substance, the sole acquires the same state, *i. e.* positive, and for the same reasons as when the cake is removed. On withdrawing the hand, or other conductor, the former state is restored.

When the sole is not insulated it is difficult, and frequently impracticable, to ascertain its state of electricity. The cover imposed by its insulating handle appears by its electrometer to be slightly positive; and the sole, by its attraction for the pith balls attached to the cover, indicates a negative state. I am at a loss to explain this circumstance, unless it be supposed that the force of attraction is principally exerted downwards in consequence of its uninterrupted communication with the ground: that the activity of the upper surface is soon neutralized by the imposition of the cover; and that the cover is brought into the state of the sole when insulated and the cover imposed, *i. e.* diverges with positive electricity; but in consequence of its increased capacity, arising from its contact with the excited electric, it does not show the whole amount of its superfluous acquisition till removed, when the positive divergence greatly increases.

When the sole is insulated with the excited cake imposed, the electrometer diverges as in the former instance, with negative electricity. Now impose the cover, and the electrometer connected with it indicates the negative electricity strongly, because the attraction is most eager and powerful at the upper or excited surface: the sole electrometer gradually closes; sometimes, however, continuing negative for some time, and then opens with positive electricity. This is precisely the state described by Mr. Brook in the act of charging a jar, both sides indicating a similar electricity: the negative of the cover appears much stronger than the positive of the sole, and, by making a cotemporaneous communication between the cover and sole, a sensation is felt in the thumb and finger resembling a shock. I am not, however, satisfied that any actual charge takes place in these circumstances: a charged insulated jar cannot be deprived of its charge without offering a conductor to each side; but in this case the shock is prevented by touching either the sole or the cover separately when a spark passes; and, on completing the circuit, another spark, but no shock-like sensation: the force of attraction being directed to the upper surface, of course produces a disposition to receive the fluid, or the negative state: the attractive force being diminished at the sole releases a portion of the fluid which is disposed to escape, and produces the positive state. The sole and cover being thus differently disposed, one to receive and the other to part with, if at the same moment the thumb be presented to one side and the finger to the other, a double spark will pass, and must occasion the sensation of a shock. The cover remains imposed, and in a negative state: on its removal it changes and becomes positive; for, having had its capacity enlarged by contact with the excited electric, it holds, when that contact is removed, a superabundant quantity: the attraction of the cake is redirected downwards, and the sole electrometer again becomes negative. Replace the cover, preserving its insulation, and the states are again reversed upon the same principles. Let a conductor be now brought in contact with the cover; the sole electrometer continues positive, and a spark passes between the cover and the conducting substance; and so greedy is the cover of the electric fluid, that the positive state is sometimes super-induced slightly; the cover, by its communication with the ground, has rapidly obtained all the fluid

 its

its increased capacity will enable it to hold: on its removal it yields to the hand the superfluous quantity it had previously obtained; and thus the process may be repeated till the surface of the electric becomes so much neutralized that its capacity is not increased by the contact. On the removal of the cover the sole electrometer becomes negative, and will receive a spark: and if, after the process above described be so often repeated that the cover will not any longer give a spark on removal; if the sole and cover be touched together, the attraction to the upper surface is restored in nearly its former vigour, and the cover on removal again yields positive sparks to a conductor.

Whenever the sole or cover is touched, the electrometer in either will of course become neutral, because the fluid is abstracted or supplied with the utmost facility, and its distinctive characters are lost in the general mass of circulation.

There are two objections to the foregoing theory which seem to require some solution.

1. When the cake, in consequence of excitation, acquires an increased attraction for the electric fluid, why is it not sooner rendered inert by the supply it may obtain by the contact of its surface with the particles floating in the atmosphere?

2. The transitions from the negative to the positive states, and *vice versâ*, are so rapid, that they can hardly be reconciled to the opportunities of supply or abstraction offered by a dry atmosphere.

In the first case, a moist state of the weather, or a room abounding with dust, will, in fact, rapidly destroy the effect of excitation: in a dry atmosphere it may be supposed that the uniform diffusion of the fluid is so much disturbed by friction that the interior particles are a long time before the equilibrium is restored, in consequence of the very slow and difficult transmission of the fluid through the pores of electric substances.

In the second case, these transitions may be effected without any material alteration in the absolute quantity of the fluid brought into action by a change of capacity or attractive force only.

I confide in the experienced candor and indulgence of the society to excuse the imperfections they will undoubtedly detect; but, as my object is the attainment of truth, I shall be satisfied with the hope, that if my paper does not produce conviction it will excite inquiry.

LIV. *A brief*

LIV. *A brief Account of the Mineral Productions of Shropshire. By* JOSEPH PLYMLEY, *A.M. Archdeacon of Salop, and Honorary Member of the Board of Agriculture.*

[Continued from p. 208.]

DR. TOWNSON, in his Tracts, p. 166, has given the strata of two other pits in this district, and has added to the colliers' names for the different measures his own definition of each. He observes, that "annually about 260,000 tons of coal are raised in this district;" a very large proportion of which are consumed in the adjacent iron-works, I presume; for I have understood, that in the Ketley iron-works they use at least six ton of coal out of every seven they raise. What I have called the collieries of the eastern district, comprehend pits on both sides the river Severn. The veins of coal in this district are equal in thickness, I believe, to most in this county, but very inferior to those of the Staffordshire works, from 15 to 20 miles east of these, where, I have been told, there is a bed of coal measuring 13 yards, or more. The next coal-works to be mentioned are those of the Clee Hill, from 20 to 30 miles south of those we have been describing*. Collieries, indeed, are now working at Billingsley, connecting them, in some measure, by their situation: and again, west of the eastern coal district, pits have been lately sunk with success. I am indebted to Dr. Townson's Tracts, before quoted, for the following lists of the strata in two of the Clee Hill collieries.

Strata found in sinking the deep Pit in the Southern Part of the Hill.

	Yds.	Ft.
Earth and sandstone rock - - - -	10	1½
Basalt, called here Jewstone - - -	64	1½
Sandstone rock, bind, clunch, and coal roof; dry clays - - - - -	23	0
The great coal - - - -	2	0
Coal bottom and ironstone roof: these are dry clays	1	1
Ironstone measure, a dry clay - - -	1	0½
Three-quarter coal - - - -	0	1½
Clumper, hard dry clay - - -	2	0
Smith's coal - - - -	1	2
The smith coal bottom; dry clay down to the four feet coal rock - - -	0	2
	107	1

* A coal pit is now (1802) worked on the summit of the Brown Clee Hill, within the encampment.

The

The strata in the water pit, which is about a quarter of a mile to the north-east of the preceding, are:

	Yds.	Ft.
Basalt, here called Jewstone - - -	48	0
Brown and white clunch, dry clay - -	6	0
Red rock, a yellowish sandstone - -	9	0
Bind and clunch, dry clays - - -	9	0
Pinny ironstone measure, dry clay - -	1	0
Clunch, dry clay - - - -	3	0
Brown rock, a yellowish sandstone - -	6	0
Tuff (plastic clay) and sand - - -	1	0
Black bind, a dry clay - - -	4	0
Rock, very coarse sandstone - - -	5	0
Strong clay - - - - -	1	0
Horse-flesh earth, a variegated red and white marl	6	0
Gray rock, sandstone - - - -	6	0
Bind, a dry clay - - - -	2	0
Great coal rock, whitish sandstone - -	6	0
Coal roof, dry clay - - - -	3	0
The great coal - - - -	2	0
Coal bottom pounsin*, a dry clay - -	1	0
Ironstone roof and measure, a dry clay -	1	1
Three-quarter coal, and bass - - -	0	2
Clumper, a hard dry clay - -	3	1
Smith coal, and clod in it - - -	1	2
Strong clunch, dry clay - - -	2	0
Flan and bass, hard dry clay - - -	0	2
Strong clunch, dry clay - - -	3	0
Four-foot coal, and bass - - -	1	0
Strong brown clunch, dry clay - -	1	0
Sunk into the four-foot coal rock - -	3	1
	137	0

In the first of these Clee Hill pits, then, we find the first strata of coal 98 yards below the surface; that the thickest vein is 6 feet; and that the aggregate of coal in 107 yards 1 foot, is 12 feet 6 inches. In the second pit they must sink 116 yards before coal is found, the vein of which is also 6 feet thick; and the other veins, which are not pure coal, measure in the aggregate 10 feet; so that in 137 yards there are only 16 feet of coals, and of these only six that are unmixed. Of the collieries in the west and north-west extremity of the county, the most considerable were those of

* "Poundstone is probably meant by this word, as it is the earth or stone lying immediately under the coal, and which, when it is a rock, occasions the colliers to pound or break their tools."—*Mr. William Reynolds.*

Llwyn y Main and Trevor Claudd, which appear to be nearly exhausted; but other collieries have been lately opened between Oswestry and Chirk Bridge. The colliers describe these veins as diverging rays from an ideal centre, marked here by the part of the horizon where the sun appears from eight to ten o'clock in the morning. To this ideal centre the Ruabon collieries dip from north-west to east on the north side the Dee. The Chirk collieries, from west to east on the south side the Dee, and between that river and the Ceiriog; and again, the Pen y bryn collieries, lately begun to be worked, and the only work of the three in Shropshire, dips from west to east on the south side the Ceiriog. These veins range up against a ridge of lime rocks that run from north to south-west. Those near Ruabon, as well as those on the south side the Ceiriog, are a strong bituminous coal, with the baking quality of the Newcastle coal, yielding a strong heat, but no bad smell, except the top coal. The veins between the Dee and Ceiriog are a lighter coal, burning more quickly, and the ashes are white. This difference is supposed, by the colliers, to arise from the less weight of water that is over these veins. Mr. Arthur Davies, of Oswestry, has favoured me with the following list of the strata in the engine-pit at Chirk Bank coal-work, and which is the deepest pit he has sunk.

	Yds.	Ft.	In.
Gravel - - - - -	24	0	0
Red clay - - - -	4	0	0
Delph - - - - -	2	0	0
Fine sandstone - - -	8	0	0
Tender coal - - - -	0	1	6
Clunch - - - - -	0	1	6
Blue bind - - - -	4	0	0
Freestone rock - - - -	15	0	0
Coal - - - -	1	1	0
Clunch and ironstone - - -	2	0	0
Blue bind, with ironstone - - -	14	0	0
Black shale - - - -	2	0	0
Coal - - - -	2	0	0
Gray rock and clunch - - -	1	1	6
Coal - - - -	2	1	0
Clunch - - - -	1	0	0
Dark gray rock - - - -	5	0	0
Blue bind - - - -	9	0	0
Gray stone mixed with ironstone - -	3	0	0
Coal - - - -	0	2	9
	102	0	3

We

We find then, in this pit, a vein of 7 feet thick, 1 foot thicker than any mentioned in the other Shropshire coal-works; and that in little more than 102 yards, 7 yards and 3 inches of coal are met with. Having given these specimens of the strata in the collieries on the east, south, and north-west borders of the county, I shall conclude with those in one of the deepest pits at Welbatch, the works there being the most considerable of what may be called the central collieries of this county.

	Yds.	Ft.	In.
Clay - - - -	2	0	0
Blue clod - - - -	10	0	0
Brown rock - - - -	3	0	0
Red measures - - - -	9	0	0
Gray rock - - - -	1	0	0
Red measures - - - -	2	0	0
Red clod - - - -	2	0	0
Coal - - - -	0	0	9
Blue clunch - - - -	2	0	0
Dark brown rock - - -	2	0	0
Gray rock - - - -	2	0	0
Light blue clod - - - -	4	0	0
Coal - - - -	0	1	0
Blue clunch - - - -	2	0	0
Gray rock - - - -	1	1	6
Blue clod - - - -	9	0	0
Coal - - - -	0	2	0
	52	2	3

We see, then, that in near 53 yards there is only 1 yard 9 inches of coal, and no vein thicker than 2 feet; but probably there are veins of more substance, whenever it shall be thought expedient to sink these pits deeper.

This county is also well supplied with lime, and in general the limestone is at no great distance from coal. It differs in colour, and in the quantity of flour or powder that it yields when slacked. The lime-works at Lilleshal are very considerable. There is plenty of limestone near the Wrekin and Coalbrook Dale; and it extends from Benthall Edge, (on the opposite side the Severn to Coalbrook Dale,) near to Wenlock, called there Wenlock Edge; and so, south-west, pointing towards Ludlow, it forms a ridge of rock, somewhat perpendicular on the north-west side. It is worked in various parts, and yields a large quantity of white powder, though these properties degenerate as it extends south, till it becomes too argillaceous to be very valuable. Lime is found also in the Clee hills; in a small degree in the south-west district; in many places south of Shrewsbury, but of a brown colour, and less pulverizing quality. West of Shrewsbury, it is gotten in considerable quantities in the parishes of Cardiston and Alberbury; and at Porth y wain and Llanymynach, on the west confines, is a hill of limestone of an excellent quality. At the east end of the Wrekin, and at some other lime-works, is a red lime that will set very hard in water. Mr. Smeaton discovered that lime, with a certain proportion of clay and iron, did best under water. And the colour of the lime here spoken of indicates its having these component parts. Much of the limestone of this county is near the surface; but near Leebotwood, about nine miles south of Shrewsbury, it "is covered by 20 yards of argillaceous strata *." "Limestone is also found near Caughley, under 20 yards of argillaceous and sandstone strata. It is a yard thick, but not worked †." Ironstone is found in the neighbourhood of Wellington, Coalbrook Dale, and Broseley. In and near the Clee hills it is also met with; and Dr. Townson has taken notice of a species of ironstone in the Llwyn y main colliery, near Oswestry, which he ascertained to be a mixture of spatous iron ore and the common argillaceous ironstone. He observes, that the best iron and steel, viz. those of Styria, are made of spatous iron ore; and therefore he judges that this may be found very valuable. Mr. William Reynolds informs me there is a very good stratum of spatous iron ore found at Billingsley, but that it is not worked.

This county is also well supplied with building stone; and its north district, which could be but little noticed for the subterraneous treasures we have been speaking of, stands pre-eminent for its quarry at Grinsell, seven miles north of Shrewsbury, where is a white sandstone, superior, perhaps, to any in the kingdom: the top rock lies in thin strata; the bed is 20 yards thick. There is plenty, also, of good red sandstone in the neighbourhood. The same may be said of the east side of the county; and near Bridgnorth beds of red sandstone are found under white sandstone; and again, beds of white sandstone under the red. This appears a singular division and alteration of the cements. Iron particles give their colour to the red stone; and it is on this account, probably, that the weather has more in-

* Dr. Townson's Essays, p. 187.
† Mr. William Reynolds.

fluence

fluence on it than on the white stone, the iron absorbing so much air as to lose its tenacious quality.

Further south, sandstone prevails; and Dr. Townson found at Orton Bank a stratum of the Bath and Portland stone between strata of common limestone.

In the west district is a siliceous grit, hard to work, but very good to build with; but the general stone is argillaceous. That nearest the surface is but in part indurated, and becomes friable, under a slight pressure, when exposed to the vicissitudes of weather. Very good stone slates, for covering roofs, are met with in the parish of Bettus, on the south-west confines of the county. And there is very good flag-stone in Corndon Hill, west of Bishop's Castle. In Swinny Mountain, near Oswestry, is a superior white sandstone, which works very well. Bowden quarry, in the hundred of Munslow, contains also very good white sandstone; and at Soudley, in the parish of Eaton, and franchises of Wenlock, is a very good stone-flag for floors. This brings us near some hills which have not hitherto been much mentioned, viz. the Lawley, and Caerdoc, or Caer Caradoc.

South of the Lawley is a ridge of useful coarse grit, or sandstone, of a yellowish white. But the Lawley is in part formed of a kind of granite, probably what mineralogists call secondary granite; but a greater part of the hill is composed of what forms the basis of what has been lately called toadstone, which, though wanting no explanation to a mineralogist, it may be well to give some popular idea to, by saying, it is entirely distinct from sandstone, limestone, or slate, and approaches the nearest, in outward appearance, to a basaltic rock, though probably very different in reality. The stone of the Caerdoc is chert and granulated quartz; and in some places the toadstone appears, which having, in part, lost its glands, becomes cellular, and which may have given rise to the opinion of its being lava. The Ponsert Hill partakes of the nature of the Caerdoc and Lawley. I am indebted to a conversation with Dr. Townson for whatever is scientific in the account of these two hills; and a more minute account of them, and of other hills in this county, will be found in his volume of Tracts, before quoted. Mr. William Reynolds informs me, that a part of the Caerdoc, towards the north-west end, contains the pistachio green actinolite of Dr. Townson, imbedded in what he calls a gray whack, and which actinolite, on examination, has been found to contain so much iron as to become strongly magnetic on exposure to heat, and the containing

 bed

bed forms a black glass. Mr. Aikin, in his Tour, p. 201, mentions the Longmount to be composed, so far as his observations extended, of a very shivery kind of schistus. It certainly presents that appearance on its east side, near the Strettons. But Dr. Townson says, the nature of the rock, in general, is "compound sandstone, *i. e.* a stone which, instead of being formed of grains of quartz, is formed of grains, or very minute fragments, of other kinds of stone. These, here, seem to be of an argillaceous and jaspideous nature, mixed with a few grains of feldspar*."

The Wrekin is chiefly composed, I believe, of a reddish chert. Mr. William Reynolds informs me, that prodigious masses of granulated quartz are imbedded in it, and much feldspar, and that a quantity of red mica is also found at the south-west end of the hill. The Stiper stones are a granulated quartz; and they are perhaps the highest ground in Shropshire, except the hills near Oswestry, and those are a coarse grained sandstone. Near the Cardington hills Mr. William Reynolds found a quartz † that he thought as good, or better, than the Carreg china of Caernarvonshire, which is exported for the use of the English potteries. He has since found a granulated quartz, in the Wrekin and Arcall hills, which seems likely to answer the same purpose for the pottery, and which has the convenience of being near established potteries, and a navigable river. With the same advantages, that near Cardington would be very valuable, as there is a steatitic clay there, which was long used in the Caughley china-works, at a considerable expense of land carriage. Pitchford, about seven miles south-east of Shrewsbury, is a red sandstone, approaching the surface in many places, and from which exudes a mineral pitch. The same substance is gathered from a well in the neighbourhood, and in some quantity in warm weather; but in winter very little is seen floating on the water. From the rock is extracted an oil called Betton's British oil. The experiment was first tried at Brosely (at a place still called the Pitch-yard), about fourscore years ago, or more, and an account of which was published in No. 228 of the Philosophical Transactions: from near that period the Pitchford rock has been gotten for that purpose, and sometimes 20 ton, or more, used in a year, for which the manufacturer paid 5s. per ton. It was carried from thence to Shrewsbury, where the oil was procured by distillation; but the process is kept

* Tracts, &c. p. 186.

† The first species, second family of the siliceous genus of Kirwan.

secret:

secret: a patent was obtained for the discovery by the late Mr. Betton; but his right to a patent was disallowed, by the decision of a court of law, some time after. The oil was used only medicinally, and has probably many of the properties of what is called Friar's balsam, and in quality and appearance has a near resemblance to oil of amber, and is often sold as such. When the manufacture was carried on in its greatest extent, I have understood that a considerable quantity of the oil was exported, and principally to Germany. It is still to be bought in Shrewsbury, from the preparer. It is also from a rock of red sandstone that the fossil tar spring, near Coalbrook Dale, issues. Mr. Aikin relates in his book, before quoted, p. 194, that this "spring was cut into by driving a level in search of coal; that the quantity that issued at first was to the amount of three or four barrels per day; but that, at present (1797), there seldom flowed more than half a barrel in the same period." And in 1799 Dr. Townson states the produce at only 30 gallons per week (now, 1802, it is about half that quantity), though, he imagines, other fissures, filled with the same substance, may be found, if there were a greater demand for it. The oil distilled from this tar exactly resembles Betton's British oil, and is used as a solvent for *caoutchouc*, (commonly known by the name of elastic gum, or Indian rubber,) which is now used as a varnish for cloth, and is particularly applicable to balloons. Near Jackfield, on the south side the river Severn, is carried on the manufacture of coal tar, for which lord Dundonald formerly obtained a patent. In coaking the coal, which is here done in close vessels, they obtain the volatile products which are raised in vapour by the heat of the operation of coaking, and condensed in a chamber covered with lead plates, over which water is constantly running. These products are a water and an oil; the former of which contains a portion of volatile alkali, and the latter is boiled down to the consistence of tar or pitch. The oil which is caught during the boiling down is used as a solvent for resin, and forms an excellent varnish for ships, or any wood-work exposed to weather. The MS. account of Bradford North mentions a salt spring at Smeithmore, in the lordship of Longford; and Dr. Townson states several springs of salt water to have been found in the neighbourhood of the tar spring; and that in the parish of Broseley, on the opposite side of the Severn, salt is said to have been made formerly from water taken out of pits still called the Salt-house Pits. At the Lyth, in the parish of Cundover, is a field the soil of which is impregnated with salt; and there is no doubt but this commodity could be gotten in this county, though its proximity to the extensive and established salt-works of Cheshire may prevent any profit from an adventure of this kind. At Kingley Wick, about two miles west of Lilleshall Hill, is a "spring of salt water that yields 4 or 5000 gallons in the 24 hours. It is an impure brine, but was formerly used: the salt pans and buildings are still remaining. It flows out of a reddish sandstone rock, which rests upon a reddish chert, like that of the Wrekin*. And at Admaston, near Wellington, only two miles from Kingley Wick, there is a salt medical spring, chalybeate and hepatic. There are two springs: the one containing carbonated iron and lime, selenite and sea salt; the other, hepatic air, aërated lime, selenite, and sea salt †. The MS. history of Bradford hundred, before quoted, says, "at Moreton Say is a mineral water that purges those who drink it." There is also a well, not far from the parsonage-house, that I am pleased to record, as it was fenced in under the directions of the late archdeacon Clive, and which continued to partake of the care and consideration he had for the things, as well as the persons around him. Dr. Darwin informs me that this spring is valuable as a strong chalybeate, but that it has no other peculiar qualities. There is a spring near Ludlow that contains a very little fixed air, some magnesia, a little lime, and a good deal of sea salt. Its strength is irregular as a medicine; it is sometimes about as active as sea water, I am told, but frequently weaker.

* This brine is now used for the making of soda at a work established at Wormbridge, on the banks of the canal there, as will be seen by the following note, which is one of many favours I have received from Mr. Dugard, of the Salop Infirmary.

"At Wormbridge, near Wellington, as well as at several other collieries in the neighbourhood, martial pyrites are found in considerable quantities. After being cleared from the coal (sulphureous coal) in which they are found, the lumps, which are perhaps from twelve to fourteen pounds weight each, are disposed in loose heaps, upon a bed, or large area, paved with bricks, and inclining from the circumference to the centre, to allow the water, with which the whole is repeatedly sprinkled, ultimately to flow into a large reservoir which is constructed at this place. The pyrites are thus exposed to the action of the air, as well as frequent waterings: the decomposition of them, produced by this process, forms sulphate of iron (martial vitriol) in considerable quantities, and was a few years ago evaporated and crystallized, and allowed to be, by the consumers, as pure a salt of iron as any ever made in Great Britain. The demand for it was greater than the work, in its infant state, could supply. It is now no longer carried on as a vitriol manufactory, but the acid obtained from the pyrites is wholly consumed in getting the soda from rock salt and the brine of Kingley Wick.

† Townson's Tracts, p. 179.

A pint

A pint is a usual dose; but very large quantities have been drunk without any fatal effects.

Between Welbatch and Pulley Common are two wells, called Hanley or Boothby Spa. The water of both is weak: the one contains sea salt, muriated lime, magnesia, and selenite; the other has, with these ingredients, a chalybeate. Near Sherlot Common, in the neighbourhood of Wenlock, is a strong chalybeate water. On Prolley Moor, near the western side of the Longmynd, is a spring that contains a small proportion of selenite and of sea salt; but muriated lime is the principal ingredient. It shows no appearance of iron with the usual test. I shall conclude this section with an account of Sutton Spa, near Shrewsbury; for the whole of which I am indebted to Dr. Evans; and if an obligation becomes lighter by being divided, I doubt not but the readers of the article will readily join in sharing its weight.

[To be continued.]

LV. *Extract from a Work, published by Professor* Proust, *entitled Researches on the Tinning of Copper, on Tin Vessels, and glazed Pottery; published at Madrid* 1803 *.

The author, in the introduction, says, that the motives which induced him to undertake this labour were the doubts spread abroad, two years before, among the public in regard to the salubrity of tinned copper, and the accounts of the disagreeable accidents arising from vessels badly glazed. Government, always attentive to every thing that can tend to calm the public mind, had recourse on this subject to sound chemistry; the only tribunal competent to banish doubts of this kind. Two problems were presented to the author to be resolved:

1st, Is the use of zinc advantageous or not, for tinning and for tin vessels?

2d, Can tinning, in consequence of the lead it contains, and sometimes in large quantities, expose the health of the public to the same dangers as glazing of a bad quality?

The author divides his work into three chapters, and each chapter into several paragraphs.

The first part, which may be considered as historical, is divided into four paragraphs.

In the first the author mentions the project which was presented

* From the *Journal de Physique*, Frimaire, an 13.

presented by M. Malouin to the Academy of Sciences at Paris in 1741, in regard to the employment of zinc for tinning iron and copper: the advantages he promised himself were only illusory, and his expectations have not been confirmed by time.

The second paragraph contains an account of a paper on tinning, presented to the same academy by J. B. Kemerlin in 1742. One may see there the examination of it by Messrs. Hellot and Geoffroy, who entertained an opinion contrary to the assertions of the author.

The same year the academy charged Hellot and Geoffroy to examine the alloys of zinc proper for making vessels. The inconveniences pointed out by the two academicians, as well as by many others, were verified by Proust; and all of them are inclined to proscribe such alloys. Having made a mixture of equal parts of lead and zinc, similar to that examined by the two commissioners, he obtained an alloy of a paste-like consistence, as easy to be cut with a knife as cheese, and difficult to be cast. M. Pierre Blanco, a very ingenious pewterer, seconded the labours of Proust. The first time he poured the alloy into the mould, it did not run sufficiently to fill it. He tried it a second time; and, when he thought he could draw it from the mould, it fell into pieces, as they had no cohesion. Being desirous to procure a piece well or ill moulded, he found himself obliged, at the third time, to cool his mould in cold water, and to employ double the time necessary to cast a piece of the same size with common alloys: the vessel obtained broke short, and was filled with defects which could not be remedied. A pound of alloy was employed, and the article weighed only nine ounces. The whole of the residuum was mere loss. The same article acquired in a month a dark colour, and at the end of six months was covered with oxide; inconveniences which do not take place in vessels of common tin. The author still continues to make several practical objections, to which no one has given an answer.

It is seen, therefore, that alloys of zinc are not so advantageous as some have imagined; and those who propose them have neither consulted chemistry nor practice. Before they were presented to government for its sanction, it was necessary to subject these alloys to the test of chemical agents: and this the author has not omitted.

1st, A plate of the alloy in question being brought into contact with vinegar, the latter contracted a very disagreeable metallic taste at the end of a day: on the third day, without

without being sweet, astringent, or bitter, it occasioned in the throat a very uneasy and disgusting sensation, and no doubt a small dose of it would have excited vomiting.

2d, A plate of the same alloy, of four inches' surface, boiled half an hour in vinegar, lost 16 grains of its weight.

3d, Vinegar being boiled in a vessel tinned with the same alloy, acquired the same taste as No. 1.

4th, A plate of the same alloy, exposed cold in distilled vinegar, exhibited the same phænomena as No. 1 and 3. This solution, when attentively examined, did not exhibit an atom of tin.

All these facts, which confirm those of the French academicians, prove that zinc is a metal exceedingly soluble in vinegar, very easily altered, and that solutions of it having been found noxious, it ought to be proscribed from our kitchens.

The subject of the third paragraph is the project of M. Doucet, who in 1778 presented to the Academy of Sciences at Paris a bar and pan made with a mixture of his invention. It was examined by Macquer and Montigni, who made a report on it. These two chemists, having more experience than Hellot and Geoffroy, analysed it chemically, and, having soon found that it had its inconveniences, it was rejected.

The alloy of Chartier, and the project of Lafolie, shared the same fate, as is seen by the report of the commissioners, and by the labours of the abbé Monges and of Bayen.

The alloy of M. Buschaendorf, of Leipsic, presented in 1802, and described in the *Annales des Arts et Manufactures*, forms the subject of the last paragraph. Proust subjected it to the same experiments as the preceding: he proves that it is attended with the same inconveniences, without having any of the qualities announced by Buschaendorf.

Part II.

On the old Method of Tinning.

This part consists of ten paragraphs. M. Malouin, while he proposes his mixture, does not condemn the old, but he mentions the dangers to which people are exposed by this kind of tinning. Kemerlin, Hellot, Geoffroy, Doucet, Chartier, Lafolie, Buschaendorf, and others, have done no more: but no one has hitherto proved the reality of these supposed dangers; and what is still more astonishing is, to see the inactivity of the chemists of Europe in realising or exploding a fact which is so interesting to society.

ciety. To decide the question in a peremptory manner, it was necessary to undertake a series of experiments which had before been neglected. To succeed in them it was previously necessary to examine the properties of some metals and oxides; and there are nine paragraphs employed in the examination of iron, antimony, mercury, lead, and zinc. This examination was requisite to answer all the objections which he proposed to resolve in the third part of this work.

PART III.

This part is divided into five paragraphs.

Paragraph I.

Experiments made on the old Method of Tinning.

Five plates of copper, each a foot square, were tinned, all the necessary precautions being taken. The object of the author was to ascertain the quantity of alloy they would take one with another.

The first took	-	144 grains.
The second	-	178
The third	-	200
The fourth	-	208
The fifth	-	230

The quantity of tinning which copper can take is exceedingly variable, and not subject to calculation: the alteration of the copper by tinning being in all points the same, the variations in the weight must necessarily depend on the more or less exact manner in which the workman removes the superfluous tinning; and one might be induced to believe that the artist has it in his power to give a tinning more or less abundant; but the tinning not alloyed with the copper ought not to be considered in the same manner as that which is alloyed. The author has proved, in general, that good tinning takes a grain of tin per square inch.

Paragraph II.

On the Duration and Causes of the Destruction of Tinning.

Tinning with pure tin has a silver white colour, and, in contact with vapours capable of attacking it, assumes a yellowish tint. That made with one-third, one-fourth, or one-half of lead, like the old tinning, has more brilliancy, and may be easily distinguished from the former.

The causes which destroy tinning are friction, caloric, and acids: the effects of all these causes vary according to an infinite number of circumstances, which are determined by the author as exactly as possible, and have taught him, that,

that, even supposing alloy to be made with one-half lead, no individual can swallow per day 1-20th grain of that metal; a quantity inappreciable in its effects, since we daily swallow a hundred times more when we eat game, without being incommoded by it. From these facts, and many others, it results, that if vessels of tinned copper occasion illness, they ought rather to be ascribed to the want of tinning than to the latter.

Paragraph III.

Of Tinning considered as soluble in alimentary Acids.

Eight saucepans, each capable of containing twenty ounces of water, were tinned with the following alloys:

The 1st, with pure tin.

2d, with tin having		0·05 of lead.	
3d,	-	-	0·10
4th,	-	-	0·15
5th,	-	-	0·20
6th,	-	-	0·25
7th,	-	-	0·30

8th, with equal parts of tin and lead.

Tinning with pure lead was impossible.

Into each of these pans there was put a pound of red wine vinegar, which was boiled till it was half consumed. The vinegar of each pan was poured into a glass vessel, and suffered to remain at rest for twenty-four hours. The vinegar was then poured off, and the precipitates were well washed: each portion of vinegar was mixed with an equal quantity of distilled water; equal parts of each were put into the vessels, and three rows were formed of eight vessels each. The vessels of the first and second rows contained vinegar; those of the third, sediments. Nearly four ounces of the sulphate of potash were poured into each vessel of the first row, and into those of the second and third row about four ounces of hydro-sulphurated water. In the first row no precipitate was observed, consequently there was no lead: in the vessels of the second row there was observed a slight chestnut-coloured sediment, which indicated the existence of tin. The sediments of the third row did not change colour, whence it was concluded that there did not exist in them any metallic substances. The vinegar, then, boiled in the tinned pans did not dissolve lead, but only a very small quantity of tin.

The sediments of the third row were, for the most part, composed of tartar and sulphate of lime. These two salts,

 in

in precipitating, might have carried with them a little lead; but they did not contain an atom of it.

The same experiments being repeated with very strong white wine vinegar, which was boiled till three parts of it were consumed, confirmed the preceding facts; with this only difference, that the tinning assumed the colour of lead, and readily yielded to the friction of the finger, coming off in the form of a gray powder, which was nothing else than very fine particles of lead. This phænomenon was more remarkable in the pan No. 8, though the quantity of that powder did not weigh half a grain. These facts were the less remarkable the nearer to the pan No. 1; so that with a little practice one might judge by these means of the quantity of lead and tin contained in tinning.

The vinegar formed zones of a very beautiful colour on the tinning of the pan No. 1. These facts may still serve to enable one to distinguish the quality of tinning. These experiments evidently prove that lead, which is very soluble in vinegar, loses that property when alloyed with tin. This is agreeable to chemical facts already known; for tin is more oxidable and soluble than lead, and the latter is precipitated from its solutions by tin, and this is the cause of the presence of the gray powder above mentioned; for vinegar, indeed, dissolves immediately a few particles of the lead in the tinning, but it is afterwards precipitated by the tin, and forms gray dust. All these facts, and many others explained by the author, prove that tinning, the half even of which is lead, cannot be dangerous in domestic purposes; and that, to be hurtful to the health by the contact of alimentary acids, it would be necessary that the pans should be pure lead, or tinned with that metal only, which is impossible.

Paragraph IV.

On Tin Vessels.

It was necessary to examine the action of vegetable acids on vessels of tin. For this purpose the author caused the following vessels to be made:

1st, Pure tin.		
2d, Tin having	-	0·05 of lead.
3d, Ditto	- -	0·10
4th, Ditto	- -	0·15
5th, Ditto	- -	0·20
6th, Ditto	- -	0·25
7th, Ditto	- -	0·30
8th, Ditto	- -	0·50
9th, Of pure lead.		

All

All these vessels were filled with boiling vinegar, which was left in them three days. The vinegar of the first eight vessels being subjected to the examination of re-agents, did not give the least signs of the existence of lead, but of some particles of tin. The vinegar in the ninth vessel was much saturated with lead.

The same experiments, repeated at three other times, with vinegar of greater or less strength, exhibited the same phænomena. In these cases it was observed that the first eight vessels had assumed the colour of lead, and exhibited the same phænomena as those indicated in regard to tinning in the preceding paragraph.

The author, after supporting his observations by those of Bayen and those of Vauquelin, deduces this consequence: Tin alloyed with lead is harder than when it is pure, and less susceptible of suffering its particles to be mixed with aliments. What have we to fear from such vessels? Small particles which may be detached by the fork or the knife? Such fears are groundless. Let us apply, then, to vessels of tin, in regard to their use, what we have said of tinning, that the fears entertained in regard to the employment of it are not proved by any facts well authenticated; and if the art of the pewterer is susceptible of improvement, either in regard to health or practice, it cannot be expected from mixtures which have always been rejected by sound chemistry. Besides, we know several other mixtures which might be tried before we have recourse to a metal so soluluble, and so difficult to be worked, as zinc.

Let us now form a parallel of the alloys we have examined, with those used by the pewterers.

Pure tin forms the first quality, which they employ for the best utensils and those most esteemed.

The second kind of mixture contains an eighth of lead, and serves for making common vessels.

The third kind contains 0·15 of lead, and is employed for drinking-vessels.

The first kind, which is the most common, contains 0·20 of lead, and is employed for making ink-stands and other small articles.

From what has been said it may be seen, that if pewterers employ sometimes for common vessels the fourth kind of mixture, the public can be exposed to no danger. The antients, who made so much use of tin vessels, have left us no certain facts which prove that the use of them was contrary to health, and medicine never proscribed them.

[To be continued.]

LVI. *A short Account of the Cause of the Disease in Corn, called by Farmers the Blight, the Mildew, and the Rust. By the Rt. Hon. Sir* JOSEPH BANKS, *Bart. K.B. P.R.S.**

BOTANISTS have long known that the Blight in Corn is occasioned by the growth of a minute parasitic fungus or mushroom on the leaves, stems, and glumes of the living plant. Felice Fontana published in the year 1767 an elaborate account of this mischievous weed†, with microscopic figures, which give a tolerable idea of its form; more modern botanists ‡ have given figures both of corn and of grass affected by it, but have not used high magnifying powers in their researches.

Agriculturists do not appear to have paid, on this head, sufficient attention to the discoveries of their fellow-labourers in the field of nature; for though scarce any English writer of note on the subject of rural economy has failed to state his opinion of the origin of this evil, no one of them has yet attributed it to the real cause, unless Mr. Kirby's excellent papers on some diseases of corn, published in the Transactions of the Linnean Society, are considered as agricultural essays.

On this account it has been deemed expedient to offer to the consideration of farmers, engravings of this destructive plant, made from the drawings of the accurate and ingenious Mr. Bauer, botanical painter to his majesty, accompanied with his explanation, from whence it is presumed an attentive reader will be able to form a correct idea of the facts intended to be represented, and a just opinion whether or not they are, as is presumed to be the case, correct and satisfactory.

In order, however, to render Mr. Bauer's explanation more easy to be understood, it is necessary to premise, that the striped appearance of the surface of a straw, which

* Copied, by permission, from the publication of the president of the Royal Society, with additional notes by the author, who has also kindly entrusted us with the original drawings, made by Mr. Bauer, of Kew, for the purpose of enabling our engraver, Mr. Lowry, to do complete justice to the merits of the originals. The time necessary for executing them in that masterly style in which we wish to present them to the public, puts it out of our power to give more than one of them with our present Number. The other we hope to be able to give with our next. —EDIT.

† Osservazioni sopra la Ruggine del Grano. Lucca, 1767, 8vo.

‡ Sowerby's English Fungi, vol. ii. tab. 140. Wheat, tab. 139. Poa aquatica.

may

may be seen with a common magnifying glass, is caused by alternate longitudinal partitions of the bark, the one imperforate, and the other furnished with one or two rows of pores or mouths, shut in dry, open in wet weather, and well calculated to imbibe fluid whenever the straw is damp*.

By these pores, which exist also on the leaves and glumes, it is presumed that the seeds of the fungus gain admission, and at the bottom of the hollows to which they lead (see Plate V and VI. fig. 1. 2.), they germinate and push their minute roots, no doubt (though these have not yet been traced), into the cellular texture beyond the bark, where they draw their nourishment, by intercepting the sap that was intended by nature for the nutriment of the grain; the corn of course becomes shrivelled in proportion as the fungi are more or less numerous on the plant; and as the kernel only is abstracted from the grain, while the cortical part remains undiminished, the proportion of *flour to bran* in blighted corn, is always reduced in the same degree as the corn is made light. Some corn of this year's crop will not yield a stone of flour from a sack of wheat; and it is not impossible that in some cases the corn has been so completely robbed of its flour by the fungus, that if the proprietor should choose to incur the expense of thrashing and grinding it, bran would be the produce, with scarce an atom of flour for each grain.

Every species of corn, properly so called, is subject to the blight; but it is observable that spring corn is less damaged by it than winter, and rye less than wheat, probably because it is ripe and cut down before the fungus has had time to increase in any large degree.—Tull says that "white cone or bearded wheat, which hath its straw like a rush full of pith, is less subject to blight than Lammas wheat, which ripens a week later." See page 74. The spring wheat of Lincolnshire was not in the least shrivelled this year, though the straw was in some degree infected:

* Pores or mouths similar to these are placed by nature on the surface of the leaves, branches, and stems, of all perfect plants, a provision intended no doubt to compensate, in some measure, the want of loco-motion in vegetables. A plant cannot when thirsty go to the brook and drink, but it can open innumerable orifices for the reception of every degree of moisture, which either falls in the shape of rain and of dew, or is separated from the mass of water always held in solution by the atmosphere; it seldom happens in the driest season, that the night does not afford some refreshment of this kind, to restore the moisture that has been exhausted by the heats of the preceding day.

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the millers allowed that it was the best sample brought to market. Barley was in some places considerably spotted; but as the whole of the stem of that grain is naturally enveloped in the hose or basis of the leaf, the fungus can in no case gain admittance to the straw: it is however to be observed that barley rises from the flail lighter this year than was expected from the appearance of the crop when gathered in.

Though diligent enquiry was made during the last autumn, no information of importance relative to the origin or the progress of the blight could be obtained: this is not to be wondered at; for, as no one of the persons applied to had any knowledge of the real cause of the malady, none of them could direct their curiosity in a proper channel. Now that its nature and cause have been explained, we may reasonably expect that a few years will produce an interesting collection of facts and observations, and we may hope that some progress will be made towards the very desirable attainment of either a preventive or a cure.

It seems probable that the leaf is first infected in the spring, or early in the summer, before the corn shoots up into straw, and that the fungus is then of an orange colour*; after the straw has become yellow, the fungus assumes a deep chocolate brown: each individual is so small that every pore on a straw will produce from 20 to 40 fungi, as may be seen in the plates, and every one of these will no doubt produce at least 100 seeds: if then one of these seeds tillows out into the number of plants that appear at the bottom of a pore in Plate V and VI. fig. 1, 2. how incalculably large must the increase be! A few diseased plants scattered over a field must very speedily infect a whole neighbourhood; for the seeds of fungi are not much heavier than air, as every one who has trod upon a ripe puff-ball must have observed, by seeing the dust, among which is its seed, rise up and float on before him.

How long it is before this fungus arrives at puberty, and scatters its seeds in the wind, can only be guessed at by the analogy of others; probably the period of a generation is short, possibly not more than a week in a hot season: if so, how frequently in the latter end of the summer must

* The abbé Tessier, in his Traité des maladies des Grains, tells us, that in France this disease first shows itself in minute spots of a dirty white colour on the leaves and stems, which spots extend themselves by degrees, and in time change to yellow, and throw off a dry orange-coloured powder, pp. 201-340.—*Additional note of the Author.*

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the air be loaded as it were with this animated dust, ready, whenever a gentle breeze, accompanied with humidity, shall give the signal, to intrude itself into the pores of thousands of acres of corn! Providence, however, careful of the creatures it has created, has benevolently provided against the too extensive multiplication of any species of being: was it otherwise, the minute plants and animals, enemies against which man has the fewest means of defence, would increase to an inordinate extent: this, however, can in no case happen, unless many predisposing causes afford their combined assistance. But for this wise and beneficent provision, the plague of slugs, the plague of mice, the plagues of grubs, wire-worms, chafers, and many other creatures whose power of multiplying is countless as the sands of the sea, would, long before this time, have driven mankind, and all the larger animals, from the face of the earth.

Though all old persons who have concerned themselves in agriculture remember the blight in corn many years, yet some have supposed that of late years it has materially increased; this however does not seem to be the case. Tull, in his Horsehoeing Husbandry, p. 74, tells us, that the year 1725 "was a year of blight the like of which was never before heard of, and which he hopes may never happen again;" yet the average price of wheat in the year 1726, when the harvest of 1725 was at market, was only 36*s.* 4*d.* and the average of the five years of which it makes the first, 37*s.* 7*d.*—1797 was also a year of great blight; the price of wheat in 1798 was 49*s.* 1*d.* and the average of the five years, from 1795 to 1799, 63*s.* 5*d.**

The climate of the British Isles is not the only one that is liable to the blight in corn; it happens occasionally in every part of Europe, and probably in all countries where corn is grown. Italy is very subject to it, and the last harvest of Sicily has been materially hurt by it. Specimens received from the colony of New South Wales show that

* The scarcity of the year 1801 was in part occasioned by a mildew which in many places attacked the plants of wheat on the south-east side only, but it was principally owing to the very wet harvest of 1800. The deficiency of wheat at that harvest was found, on a very accurate calculation, somewhat to exceed one-fourth; but wheat was not the only grain that failed; all others, and potatoes also, were materially deficient. This year the wheat is probably somewhat more damaged than it was in 1800, and barley somewhat less than an average crop. Every other article of agricultural food is abundant, and potatoes one of the largest crops that has been known; but for these blessings on the labour of man, wheat must before this time have reached an exorbitant price.—*Additional note of the Author.*

considerable mischief was done to the wheat crop there in the year 1803 by a parasitic plant, very similar to the English one.

It has been long admitted by farmers, though scarcely credited by botanists, that wheat in the neighbourhood of a barberry bush seldom escapes the blight. The village of Rollesby in Norfolk, where barberries abound, and wheat seldom succeeds, is called by the opprobrious appellation of Mildew Rollesby. Some observing men have of late attributed this very perplexing effect to the farina of the flowers of the barberry, which is in truth yellow, and resembles in some degree the appearance of the rust, or what is presumed to be the blight in its early state.

It is, however, notorious to all botanical observers, that the leaves of the barberry are very subject to the attack of a yellow parasitic fungus, larger, but otherwise much resembling the rust in corn.

Is it not more than possible that the parasitic fungus of the barberry and that of wheat are one and the same species, and that the seed is transferred from the barberry to the corn? Misletoe, the parasitic plant with which we are the best acquainted, delights most to grow on the apple and hawthorn, but it flourishes occasionally on trees widely differing in their nature from both of these: in the Home Park, at Windsor, misletoe may be seen in abundance on the lime trees planted there in avenues. If this conjecture is founded, another year will not pass without its being confirmed by the observations of inquisitive and sagacious farmers.

It would be presumptuous to offer any remedy for a malady, the progress of which is so little understood: conjectures, however, founded on the origin here assigned to it, may be hazarded without offence.

It is believed * to begin early in the spring, and first to appear on the leaves of wheat in the form of rust, or orange-coloured powder; at this season, the fungus will, in all probability, require as many weeks for its progress from infancy to puberty as it does days during the heats of autumn; but a very few plants of wheat, thus infected, are quite sufficient, if the fungus is permitted to ripen its seed, to spread the malady over a field, or indeed over a whole parish.

The chocolate-coloured blight is little observed till the

* This, though believed, is not dogmatically asserted, because Fontana, the best writer on the subject, asserts that the yellow and the dark coloured blight are different species of fungi.

corn

corn is approaching very nearly to ripeness; it appears then in the field in spots, which increase very rapidly in size, and are in calm weather somewhat circular, as if the disease took its origin from a central position.

May it not happen, then, that the fungus is brought into the field in a few stalks of infected straw uncorrupted among the mass of dung laid in the ground at the time of sowing? It must be confessed, however, that the clover lays, on which no dung from the yard was used, were as much infected last autumn as the manured crops. The immense multiplication of the disease in the last season, seems however to account for this; as the air was no doubt frequently charged with seed for miles together, and deposited it indiscriminately on all sorts of crops.

It cannot however be an expensive precaution to search diligently in the spring for young plants of wheat infected with the disease, and carefully to extirpate them, as well as all grasses, for several are subject to this or a similar malady, which has the appearance of orange-coloured or of black stripes on their leaves, or on their straw; and if experience shall prove that uncorrupted straw can carry the disease with it into the field, it will cost the farmer but little precaution to prevent any mixture of fresh straw from being carried out with his rotten dung to the wheat field.

In a year like the present, that offers so fair an opportunity, it will be useful to observe attentively whether cattle in the straw-yard thrive better or worse on blighted than on healthy straw. That blighted straw, retaining on it the fungi that have robbed the corn of its flour, has in it more nutritious matter than clean straw which has yielded a crop of plump grain, cannot be doubted; the question is, whether this nutriment in the form of fungi does, or can be made to agree as well with the stomachs of the animals that consume it, as it would do in that of straw and corn.

It cannot be improper in this place to remark, that although the seeds of wheat are rendered, by the exhausting power of the fungus, so lean and shrivelled that scarce any flour fit for the manufacture of bread can be obtained by grinding them, these very seeds will, except, perhaps, in the very worst cases*, answer the purpose of seed corn as well as the fairest and plumpest sample that can be ob-

* Eighty grains of the most blighted wheat of the last year, that could be obtained, were sown in pots in the hot-house; of these, seventy-two produced healthy plants,—a loss of ten per cent. only.

tained, and in some respects better; for as a bushel of much blighted corn will contain one-third at least more grains in number than a bushel of plump corn, three bushels of such corn will go as far in sowing land, as four bushels of large grain.

The use of the flour of corn in furthering the process of vegetation, is to nourish the minute plant from the time of its developement till its roots are able to attract food from the manured earth; for this purpose one-tenth of the contents of a grain of good wheat is more than sufficient. The quantity of flour in wheat has been increased by culture and management calculated to improve its qualities for the benefit of mankind, in the same proportion as the pulp of apples and pears has been increased, by the same means, above what is found on the wildings and crabs in the hedges.

It is customary to set aside or to purchase for seed corn, the boldest and plumpest samples that can be obtained; that is, those that contain the most flour; but this is unnecessary waste of human subsistence; the smallest grains, such as are sifted out before the wheat is carried to market, and either consumed in the farmer's family, or given to his poultry, will be found by experience to answer the purpose of propagating the sort from whence they sprung, as effectually as the largest.

Every ear of wheat is composed of a number of cups placed alternately on each side of the straw; the lower ones contain, according to circumstances, three or four grains, nearly equal in size; but towards the top of the ear, where the quantity of nutriment is diminished by the more ample supply of those cups that are nearer the root, the third or fourth grain in a cup is frequently defrauded of its proportion, and becomes shrivelled and small. These small grains, which are rejected by the miller, because they do not contain flour enough for his purpose, have nevertheless an ample abundance for all purposes of vegetation, and as fully partake of the sap (or blood, as we should call it in animals) of the kind which produced them, as the fairest and fullest grain that can be obtained from the bottoms of the lower cups by the wasteful process of beating the sheaves.

Explanation of the Drawings.

Fig. 1. (Plate VI.) A piece of the infected wheat straw—natural size: at *a* the leaf-sheath is broken and removed, to show the straw which is not infected under it.

 Fig. 2.

Fig. 2. (Plate V.) A highly magnified representation of the parasitic plant which infects the wheat: *a* in a young state; *b* full grown; *c* are two plants bursting and shedding their seeds when under water in the microscope; *d* two plants burst in a dry state; *e* seems to be abortive; *f* seeds in a dry state; *g* a small part of the bottom of a pore with some of the parasitic fungi growing upon it.

Fig. 3. A part of the straw of fig. 1. magnified.

Fig. 4. Part of fig. 3. at *a b* more magnified.

Fig. 5. Part of a straw similar to fig. 3. but in its green state, and before the parasitic plant is quite ripe.

Fig. 6. A small part of the same, more magnified.

Fig. 7. (Plate VI.) A highly magnified transverse cutting of the straw, corresponding with fig. 4. showing the insertion of the parasite in the bark of the straw.

Fig. 8. A longitudinal cutting of the same; magnified to the same degree.

Fig. 9. A small piece of the epidermis of a straw, showing the large pores which receive the seed of the parasite; the smaller spots observable on the epidermis, are the bases of hairs that grow on the plant of the wheat whilst young, but which fall off when it ripens, magnified to the same degree as the preceding figures.

LVII. *On the Maritime Commerce of Bengal. By the late* Anthony Lambert, *Esq.**

To treat fully of objects so important, and of such magnitude, would require a range of information and accuracy of detail, which can only be expected from great practical experience, aided by the most liberal communications from the public offices of government, in their commercial, revenue, and marine departments. The records of the custom-house are in most countries, except Bengal, open to the inspection of individuals; but this source of information being inaccessible to us, the amount of foreign trade must be assumed from other data.

Although Bengal possesses a considerable extent of sea coast, (from the Subunreecka to the Rajoo river, about 340 miles,) she has but few good harbours; her situation, nevertheless, is well adapted for foreign commerce. Occupying an intermediate station in that vast portion of the

* From the *Asiatic Annual Register* for 1803.

 globe

globe usually denominated the East Indies, her access is rendered easy to the remotest shores of Africa, Asia, and America.

On the west, and contiguous to Bengal, lies the great peninsula of Hindustan. To the numerous ports and settlements on both coasts of this peninsula, particularly the coast of Coromandel, Bengal carries on a constant, extensive, and profitable commerce, which may properly be called her home, or coasting trade. On the east she borders on Assam, and touches the dominions of Ava. The former she supplies exclusively with salt; and from the latter receives all her teak timber for ship building and domestic use. The bay of Bengal, embracing the west end of Sumatra, and washing the coast of Malaya, affords a direct communication through the straits of Malacca to China and the eastern isles, where the opium, saltpetre, and piece goods of Bengal are always in great demand. With the Persian and Arabian gulfs, as well as the eastern coast of Africa, Bengal likewise maintains commercial intercourse, though many obstacles have in late years supervened, to impede her commerce in that quarter.

Calcutta, the political and commercial capital of British India, as well as the emporium of Bengal, is situated on the Houghly river, or western branch of the Ganges, about 100 miles from the sea, and accessible to ships of all sizes at all seasons. From Calcutta, foreign imports are transported with great facility by the Ganges and its subsidiary streams to the northern nations of Hindustan; and the consumption and exports of Calcutta are readily supplied through the numerous rivers which intersect Bengal in every direction, and to which her prosperity has been ascribed, not only as they facilitate communication and conveyance, but likewise as they contribute to the fertility of her soil.

The elegant villas that adorn the banks of the Houghly, and the southern aspect of Calcutta, impress the mind of a stranger, on his approach, with high ideas of the opulence of this great city; but the shipping that crowd the port point out to him the true source of its splendor. Numerous and magnificent houses, erected within a few years, are undoubted proofs of prosperity, and the great population and extent of the place (still rapidly increasing), with the busy and animated operations of the harbour, indicate an active and thriving commerce. I am happy to yield my unqualified assent to this observation; and it is with no small degree of national pride, that I can safely ascribe, in

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a great measure, these beneficial effects to the spirited exertions of British merchants resident in India. Exclusive of the company's exports, it is to their individual efforts that Bengal owes her shipping and her commerce.

In tracing the rise and progress of the maritime trade of Bengal, since it fell under the sway of Great Britain, I cannot, for want of materials, extend my researches further back than the year 1773. The accompanying abstract, compiled from the port list of arrivals and departures, will show the number and the tonnage of vessels which have imported and cleared out from Calcutta, or the river Houghly, for the years 1773, 1783, 1791, 1792, 1793, and 1794, distinguishing the nations to which they belong, or whose colours they assume: and annexed thereto will be found a statement for the years 1783 and 1793, showing the different ports from whence the ships of those years arrived, and those to which they were bound.

My intention in compiling this abstract is to show the rapid increase of the maritime commerce of Bengal since the year 1783; and more especially the increase of the country trade, or that which is carried on to and from ports in India. I shall confine my observations principally to the years 1783 and 1793: the former, the first year of peace after the American war; and the latter, the year when the present war commenced, intelligence of which reached Bengal on the 4th of June.

In 1773, the reader will perceive that only 160 sail of vessels entered the port, whose aggregate burthen was 44,497 tons; and no more than 108 vessels, carrying 33,470 tons, cleared out: of the former, 102 sail, burthen 28,872 tons, were country ships, under English colours; and of the latter 95 sail, burthen 25,080 tons, were of the same description. Ten years afterwards, at the close of the American war, we find the tonnage inward increased to 64,510 tons, on 149 vessels; and the departures were 114 sail, carrying 49,225 tons. But this increase was only apparent; for, the war having detained an unusual number of the company's ships in India, it will be perceived that they constitute a large proportion of the arrivals and departures of that year, many of them being employed in carrying stores to the different presidencies, and in the coasting trade: to these must be added transports and men of war. The country shipping under English colours, which arrived and sailed in 1783, only amounts to 128 sail, carrying 44,865 tons; whereas in 1773 their numbers were 190, and burthen 53,952 tons; which exhibits a decline of this tonnage,

tonnage, in consequence of the war, in the proportion of one-fifth nearly; and we are persuaded that the captures made by the enemy during that unfortunate contest, might be stated at a much larger proportion.

Our fleets in India, in that disastrous period, although numerous, powerful, and well appointed, afforded but little protection to the commerce of the country. Not a single frigate, in my recollection, was ever detached as a convoy to merchant ships in the country trade: nay, I have heard it frequently asserted, that ships of war, sailing from Bengal to join the fleet on the coast of Coromandel, have rejected all applications for protection to merchantmen pursuing the same voyage; notwithstanding they were laden with grain for the supply of our armies in the Carnatic, where famine was then raging with all its horrors. I am not competent to say how far the detention of a frigate a few days, for the purpose of a convoy, might have been injurious to the public service; but the merchants here, in the loss of property, and the famished inhabitants of the coast, in the privation of food, felt severely this inattention to trade, and complained bitterly on the occasion. Nor did they fail to observe, that, for other services, that which did not appear to them of any importance to the public welfare, but undertaken solely for the purpose of acquiring prize money, frigates and sloops of war were readily detached. Smarting under repeated and heavy losses, they could neither perceive the utility nor applaud the zeal which prompted the aid of a frigate and sloop of war to assist this government in the reduction of the defenceless Dutch factory at Chinsurah in 1781, the capture of which afterwards furnished a subject of so much litigation.

The daring activity of M. Suffrein at this juncture made a striking impression. No change of monsoon induced him to quit the bay of Bengal; and during the absence of our fleet, in their annual visit to Bombay for refitment, and to avoid the storms that prevail at the autumnal equinox, he swept the seas, destroyed our trade, and intercepted the supplies from this to the other presidencies. A ship of the line and two frigates, which he stationed off the Sand Heads, or entrance into the Houghly, at one time nearly shut up the port, at another made many valuable captures, carrying back an ample supply of all sorts of provisions and stores, which neither his own resources, nor those of his allies, could have furnished. From the abundance of Bengal both friends and foes drew their supplies; and, however much the loss of what fell into the enemy's hands might have

been

been regretted, it was a fortunate circumstance, that, during the whole of that war, from a succession of favourable crops, the great exports of grain created no enhancement of price; or, at least, not greater than is experienced in the ordinary fluctuations of the market.

We shall pass over the years 1791 and 1792 without further observation, than to remark, that from 1783 to 1791, the general trade of Bengal had increased from 113,735 tons, the total of arrivals and departures in the former year, to 244,035 tons of shipping, which imported and cleared out in the latter; and that the English country shipping, which cleared in and out, had risen from 128 sail, carrying 44,865 tons, to 575 sail, burthen 175,407 tons; by which it appears that the country trade, in the course of only eight years, had multiplied near four-fold. The effect of this astonishing increase of maritime trade on the general prosperity of the country, will be readily perceived and admitted.

I come now to the year 1793, when the present war originated, which soon after the commencement here became ruinous in the extreme to the trade of this country. Intelligence of hostilities reached us in June, when the only English ship of force in India was the Minerva frigate: she left the Indian seas in the month of February 1794, and, until the arrival of commodore Newcombe off the Mauritius in May following, the whole of the British commerce and possessions in this quarter of the globe was without the protection of a single ship belonging to the British navy. Thirteen sail of frigates and privateers, which sailed from the Mauritius, captured, besides two Indiamen, numbers of the most valuable ships in the country trade; and would speedily have annihilated our commerce, and shut up every port in India belonging to us and our allies, had they not been checked by the vigour of the supreme government. Our present governor-general, with a promptitude and decision which does honour to his administration, equipped and dispatched a squadron from Bengal, consisting of three armed Indiamen and a country ship, strengthened by a detachment of artillery and troops from the garrison, which captured two of the enemy's privateers, and repulsed an attack made by their grand armament under M. Renaud; obliging him soon after to return to the Mauritius, without effecting any further mischief than the capture of the Pigot Indiaman. Some notice of these circumstances seemed necessary to explain the sudden decline of trade in 1794: that any commerce was continued,

nued, is due to the exertions of the supreme government for its protection.

In 1793, we find the tonnage inward and outward to consist of 757 vessels, burthens 291,190 tons; and of these 575 were English country ships, carrying 209,279 tons. In 1794, the total of arrivals and departures was reduced to 441 sail, burthen 163,484 tons; of which 286 were English country ships, carrying 96,321 tons; so that the general trade of the port, since the commencement of the present war, has decreased 127,706 tons, and the Indian trade on British ships 112,948 tons, being a declension of more than one-half of the country trade.

The documents from which the foregoing statements have been drawn, are, as we have already mentioned, the port lists of arrivals and departures, which are registered in the master attendant's office, and may be received as accurate, so far as they extend, with respect to number. But we cannot say so much as to tonnage, for there being no tonnage duties paid here, the ships are never measured, and their burthen is of course estimated, or taken from the information of the commander. Nor does this list exhibit such vessels as are piloted by native pilots or by their own commanders, which is the case with the native craft, or vessels belonging to and navigated by natives from the northern circars on the coast of Coromandel.

It is also much the practice with native commanders of other vessels outward bound to save the pilotage charged by the company's pilots, which, on ships drawing much water, falls very heavy, particularly on vessels sailing under foreign colours. To estimate, therefore, the maritime commerce of Bengal from these documents, particularly the exports, would be to undervalue it greatly. We lament the want of better materials; but taking them as an occasional guide, and referring to such other sources of information as we have been able to procure, we shall attempt to form some general idea of its magnitude, and the channels through which it flows.

The exports to Europe and to the United States of America, in importance and extent constitute by far the most considerable portion of the commerce of Bengal. They may be comprised under the general heads of cotton and silk wrought and unwrought, sugar, drugs, and dyes, including indigo and saltpetre. As the medium adopted for the remittance of the surplus revenues of these provinces, the company's investment occupies the greatest share in this trade, being unquestionably the most valuable.

In

In No. 15 of the Appendix to the Report of the Committee of Accounts, published by the court of directors in February 1793, we find an account of the prime cost of all the cargoes purchased by the company in India for five years, from 1786 to 1791 inclusive. We shall only state the last year's investment for Bengal, or that provided for 1790-1, as we believe it has rather been increased since that period; and we shall adopt that as the present amount of the company's exports from Bengal, being 99,11,598 current rupees, or 1,06,00,109 current rupees, including commercial charges at 6,88,511 current rupees. The private trade laden on the company's ships by individuals is estimated by the directors, on an average of three years prior to 1793, at 300 tons, and valued in England at 694l. per ton, making 208,200l., the prime cost of which may be taken, on a conjectural estimate, at 15 lacks of current rupees; to this must be added the value of goods laden on the privileged tonnage of the commanders and officers of the company's ships. Fifty tons are allowed to each ship of 755 tons and upwards; and a further privilege of 30 tons is allowed, provided no goods ordered to be laden on the company account are refused. We will suppose that 50 tons only are occupied; and, estimating the number of ships on an average of 15 per annum, give us 750 tons for the whole privileged tonnage. It is to be remarked, that all the ships which arrive at Bengal generally fill up their privilege at this place, although they may be afterwards destined to Madras, Bencoolen, or other ports in India; and as the company have lately increased their tonnage to this port, we presume the number of tons we have allowed for privilege is less than what is really occupied*. This tonnage we value at 3000 current rupees per ton, making 22½ lack of current rupees, or about 15,000l. for each ship.

Had we estimated the value of privileged tonnage at 20,000l. per ship, we should probably have approached nearer to the truth; for it is the medium by which the captains and officers remit home the proceeds of their outward adventures; and those who have no adventures sell their privilege to others.

* Fourteen company's ships sailed from Bengal in the season 1793-4 fr Madras, Bencoolen, and Europe, and three on a cruise for the protection of trade. In 1794-5 the number dispatched was twenty-three, including those ships that were employed as cruizers, and exclusiv of six small ships not in the regular line of the service, which were set out to be laden with sugar.

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It is curious to observe the various modes by which commerce is pursued, and the expedients which are adopted for mutual advantage. For some years past it has not been the practice with the captains and officers of the company's ships to fill up their own privileged tonnage, or but a portion of it; and yet they convert it into a profitable and safe remittance for the proceeds of their adventures to this country. Little skilled in Indian goods, and of course liable to imposition, they have wisely abandoned the homeward adventure to merchants resident in Bengal, who fill up their privilege, receive their money, and grant bills, at the rate of 2s. 4d. to 2s. 6d. for the current rupee. In the exchange is included freight and insurance, and it depends on the value remitted per ton, whether the freight is dear or cheap. The less the merchant draws for, the cheaper he obtains his freight; for the exchange may at least be reckoned 20 per cent. beyond par, which of course becomes a charge for freight and insurance. The bills are paid from the proceeds of the goods, and if the ship is lost, the obligation of payment is void.

In estimating the value of exports to Europe and America on foreign ships, we shall form our calculation from the tonnage cleared out in the last three years, 1792, 1793, and 1794. It may be objected to this estimate, that two of the years we have selected being a period of war, neutral tonnage under foreign flags would be increased. This, no doubt, has some influence; but the war having involved every nation in Europe, except the Danes and Swedes, although we have had an increase of Danish ships in consequence thereof, other foreign tonnage has declined in a greater proportion. Taking, then, the departures of foreign ships for Europe and America in 1792, we find them to consist of

	Tons Bur.
7 Ships under French colours - -	2,410
1 Dutch ditto - - - -	200
4 Danish ditto - - -	2,300
3 Portuguese ditto - - -	1,400
1 Imperial ditto - - -	730
5 Genoese ditto - - -	2,280
16 American ditto - - -	4,302
	13,622

For

For 1793.	Tons Bur.
3 Ships under French colours - -	2,000
6 Danish ditto - - -	3,150
1 Portuguese ditto - - -	370
5 Genoese ditto - - -	2,900
21 American ditto - - -	6,297
	14,717

For 1794.	
14 Ships under Danish colours - -	7,600
3 Portuguese ditto - - -	1,400
6 American* ditto - - -	1,550
	10,550

The medium of the three years gives 12,963 tons; but as many of the ships under foreign colours from Europe and America, touch at intermediate ports in India, and are therefore recorded as arriving from or sailing to an Indian port, they must be added to the ships which made a direct voyage. In the years before mentioned, these departures were as follows:

In 1792, 27 vessels, carrying -	6,880 tons.
1793, 28 ditto - -	9,555
1794, 11 ditto - -	2,200
	18,635

The medium is 6,211$\frac{2}{3}$ tons per annum.

The proportion of the cargoes of these ships intended for the Europe market, it would be impossible to ascertain: we shall estimate it at one-sixth of the medium for three years, or 1,035$\frac{5}{6}$, which, added to the direct tonnage, gives 13,998$\frac{5}{6}$ tons.

As a considerable portion of tonnage is occupied by gruff goods, we cannot estimate it higher than 1000 current rupees, or 100l. per ton: even at this rate the whole value will amount to current rupees 1,39,98,833,54, to which adding the exports on the company's ships, the total of goods exported to Europe and America amounts by this computation to two crores, eighty-three lacks, forty-eight thousand nine hundred and forty-two current rupees, five

* The American tonnage declined this year, from a very general apprehension that prevailed here, of the United States becoming a party in the present war.

annas,

annas, four pice, or 2,834,894,48l. 4s. 8d. The Dutch company, whose trade from Bengal was formerly so considerable, that, within our recollection, their exports to Europe exceeded forty lacks per annum, have not, to our knowledge, provided any investment for Europe for several years past; we must therefore exclude them for the present from our estimate of Europe exports, and proceed to the country trade.

That branch of it which first claims our attention, is the intercourse with our settlements, and the different ports on the coast of Coromandel in its greatest extent, including the Northern Circars, and reckoning from Point Palmiras to Cape Comorin; which we have already denominated the home trade.

This trade, as will be perceived from the port lists, gives employ to the greatest portion of our home tonnage; and is important, not only for its nature and extent, but for the constant resource which it affords to our shipping, of moderate freights, on grain, when other employments fail, or at intervals when they must otherwise remain idle.

The principal articles of export to Madras and the coast of Coromandel are grain and pulse, sugar, saltpetre, molasses, ginger, long pepper, clarified butter, oil, silk wrought and unwrought, muslins, spirits, provisions, &c.

In the year 1793, 234 ships, burthen 84,045 tons, cleared out for the coast of Coromandel; and of this tonnage we suppose that 1,033½ tons were filled by goods intended for Europe, and 80,000 tons at least were occupied by grain and pulse; which, valued on a medium at two and a half current rupees per bag of two bazar maunds, or 164lb. avoirdupois, when shipped, and 13 bags to the ton, amounts to 26 lacks of rupees. Other exports to this coast on shipping owned by European traders, are estimated at 8 lacks, making in the whole 34 lacks of current rupees. But the advantages of this traffic must not be appreciated by the value of the goods when shipped, but their value when sold; for the freight of grain is nearly equal to the cost; and, if we take the sales, on a medium of five current rupees per bag, or allow for freight and charges two and a half current rupees, we find it to be a trade which pays to the European shipping of India near twenty-seven lacks of current rupees per annum. To this must be added the exports on donies and native craft, or vessels belonging to and wholly navigated by natives of India. Before the prohibition of foreign salt their number was very considerable, particularly from the Northern Circars; but that measure depriving

depriving them of a freight of salt to Bengal, and having nothing to substitute but money for their purchases, it operated for many years as a severe check on this branch of trade. A more liberal policy was adopted by lord Cornwallis, by drawing part of the annual supply of salt from the coast, which, with many other advantages, afforded considerable encouragement both to native and European shipping. Since that period this trade has begun to revive, and we may now rate the tonnage of vessels belonging to and navigated by natives, which annually visit Bengal, from all quarters, including the Maldivian vessels, and those from the coast of Malabar and Muscat, at 10,000 tons. Their exports are principally grain and pulse, with some coarse sugar, long pepper, ginger, and silk and cotton piece goods, which may be estimated at about five lacks of current rupees; and, added to the exports for this coast on ships navigated by or belonging to Europeans, make 39 lacks of current rupees.

After the Coromandel trade, we place that to the eastward, and China; and, were our scale of precedence determined by the capital it employs, exclusive of shipping, or, in other words, by the value of its exports only, it would stand next in rank to that of Europe: but we cannot hold any branch of trade which requires a capital of fifty-five lacks of rupees, and an outlay of twelve months, to give employment to 11,000 tons of shipping, equal to that which employs 84,000 tons on a capital of thirty-four lacks only, and which returns the outlay in eight or ten weeks.

The grand article which supports the eastern trade is opium. This fascinating drug has ever been in great request amongst all eastern nations, but more particularly among the Malays. In its oblivious fume (for they generally smoke it) they find refuge from every care and anxiety; and, when the evils of life press beyond their powers of endurance, taken in another form, it excites the devoted wretch to deeds of horror and destruction.

Amongst this sanguinary people, all ranks and ages, who have the means of procuring it, use opium without restraint; and the Chinese, notwithstanding it is prohibited by their laws under severe penalties, appear to be equally fond of the drug. It was formerly difficult to import opium into China, and the quantity sold there was trifling; but, in defiance of prohibitory laws, the consumption of China cannot now be rated at less than half the quantity exported from Bengal.

By the company's sales for the year 1793-4, it appears that 4,520 chests of Patna opium were delivered to the

Dutch and Danes, and 450 chests were sold, and produced 28,87,780 sicca rupees; besides which 700 chests sent, on the company's account, to Bencoolen and Prince of Wales's Island. These 1,150 chests, valued at the medium rate of the sales of Patna opium, amount to 6,36,668,12 sicca rupees. To this must be added about 500 chests annually imported from Oude, which, estimated at 500 rupees per chest, makes the whole amount to 32,74,448 sicca rupees, or 37,98,359 current rupees. Nearly the whole of this is exported to the eastern islands and China; or, if we deduct two lacks for home consumption (which we know to be principally supplied by smuggled opium), and allow 98,358 10 8 rupees for occasional exports to the coast of Coromandel and Malabar, we shall not over-rate the value of this article exported to the eastward, in stating it at 35 lacks of current rupees. Besides opium, our traders carry to the eastward and China, grain, saltpetre, gunpowder, iron, fire-arms, cotton, wool, silk, and cotton piece goods, &c.; of the latter, including what goes to Manilla and Batavia, the value is considerable; not less, in our opinion, than ten lacks of rupees. If I estimate all other articles at five lacks, the exports amount to fifty-five lacks; and I do not conceive my assumption of the value of eastern exports will be found overcharged.

Next to the eastern trade I place that to Bombay and the ports on the Malabar coast, including Surat, which, in the year 1793, occupied 51 vessels, carrying 28,100 tons. Of this tonnage, I think, no less than 25,000 tons consisted of grain and pulse, which, taken at the former valuation of two and a half current rupees per bag, gives 8,12,500 current rupees. Other articles of export to these marts consist principally of sugar, raw silk, some silk and cotton piece goods, saltpetre, ginger, long pepper, sacking (called gunnies), hempen rope, &c., which do not exceed five or six lacks of rupees; and the whole exports may be reckoned at 14 lacks of current rupees.

To the gulfs of Arabia and Persia, Bengal sends grain, sugar, silk and cotton piece goods, &c. This trade was formerly so considerable, that the annual returns were estimated at thirty lacks of rupees; but, owing to the anarchy which has prevailed in Persia since the death of Kherim Khan, the successor of Nadir Shah, and in Egypt, since the overthrow of Ali Bey, with a variety of other causes, it has greatly declined of late years*; and including the eastern coast of

* It has been confidently asserted that the trade to Suez was shut up by

of Africa, the Maldives, and Mauritius, we cannot estimate the exports at more than eight lacks of rupees.

Notwithstanding the large quantity of teak timber annually imported from Pegue, the balance of trade is much in favour of Bengal. Her exports to the dominions of the king of Ava, including Arracan, consist chiefly of silk and cotton piece goods, fire-arms, iron, nails, naval and military stores, and a variety of European goods; which may be estimated at about six lacks of current rupees.

It remains to be noticed, the supplies to the new settlement on the Andamans, occasional cargoes to the colonies at Port Jackson, in New Holland, and expeditions to the north-west coast of America and Kamschatka: these cannot be rated beyond two lacks per annum.

Combining all the exports by sea under the heads to which we have referred them, they appear as follow:

	Curr. Rupees.
Europe and America - -	2,83,48,942 5 4
Madras and coast of Coromandel - -	39,00,000
Eastern islands, Malay coast, and China -	55,00,000
Bombay, Surat, and other ports on the Malabar coast - - - - -	14,00,000
Gulfs of Persia, to Arabia, eastern coast of Africa, Maldives and Mauritius - -	8,00,000
Pegue and Arracan - - - -	6,00,000
Andamans, Port Jackson, and north-west coast of America - - - -	2,00,000
	4,07,48,942 5 4

To this sum should be added exports by land to the Decan, Thibet, Nepaul, and the various nations that surround Bengal; but of these, although considerable, we can form no computation. We know, however, that in the year 1791 there was exported from Benares alone, to the Decan and Mahratta states, above a lack of maunds of sugar by inland traders, and the quantities of raw and wrought silks, and piece goods, with a variety of European goods, which are annually purchased by inland merchants, amount to a considerable sum; probably not less than an eighth part of the

by the Porte in consequence of representations made by our ambassador to the Ottoman government, at the instance of the court of directors. A measure so injurious to Bengal we cannot attribute to those who are bound to cherish and support her; policy and humanity would prompt a different conduct. We must therefore suppose the prohibition arose from the natural jealousy of the Turkish government.

the exports by sea. Was I, therefore, to rate the whole annual exports of Bengal, by sea and land, at four millions and a half of pounds sterling, I should, in my own opinion, form a moderate estimate of their value.

Imperfect as the materials are from which I have drawn my computation of the export trade of Bengal, I am sorry to confess, that I am without any guide whatsoever to direct me in forming the most distant idea of the amount of imports. Had I even access to the records of the custom-house, they would afford very unsatisfactory grounds from which any conclusions could be drawn.

The company's imports pay no duty. Some of the foreign ships discharge their cargoes at Serampore, which of course pay no duty to the company, and do not appear on the books of the custom-house; and smuggling is a plant which rears its head in every climate. I shall not, therefore, hazard any estimates on this head, for all that I could offer would be only vague conjecture. Since the abolition of government customs, no duties have been levied at Calcutta on exports. Foreign and inland imports pay four per cent. *ad valorem*, with an exception to indigo, and to silk and cotton piece goods of the produce of the country; the former paying no duty, and the latter only two per cent. The duties on liquors are fixed at so much per dozen, or gallon. A new regulation, I am informed, is about to take place, which frees inland imports from all duty, and imposes two and a half per cent. on all imports by sea, and the same on exports. This regulation will increase the port duties, without being unfavourable to the trade of the country, inasmuch as the whole consumption of inland produce in Calcutta is thereby liberated; for we cannot estimate the impost on goods exported, including even the advanced price, or the profits of the intermediate merchant, who buys from the manufacturer or inland trader, and sells to the foreign exporter at a sum equal to the amount of the present duties on inland imports into Calcutta, which comprehend as well the consumption of the place as the exports therefrom.

Provided the different articles of import and export be precisely enumerated at the custom-house, and this source of information is accessible, the regulation will afford to future speculators on this subject some better data than we possess for estimating the amount of the trade of Bengal.

The imports of Bengal may be classed under the same general heads into which we have divided the exports. From Europe she receives metals of all sorts, wrought and unwrought,

wrought, woollens of various kinds, naval and military stores of every description, gold and silver coin and bullion; and almost every article of the produce of Europe, which people in affluent circumstances there consume, is imported for the use of the European inhabitants.

The returns from Madras and the coast of Coromandel consist of salt, red wood, some fine long cloth, izarees, and chintz, and occasional speculations of European goods, or the produce of other countries previously imported there. The balance due to Bengal is either absorbed by drafts or bills on this government, drawn by the Madras presidency, or is remitted in specie.

From the eastern islands and Malay coast are received pepper, tin, wax, dammer, brimstone, gold dust, specie, betel-nut, spices, benzoin, &c.: from China, tutenag, sugar-candy, tea, alum, dammer, porcelain, and lackered ware, and a variety of manufactured goods: and from Manilla, indigo of a very fine quality, (which is re-exported to Europe,) sugar, japan wood, and specie. The balance of this trade, meaning the whole eastern commerce, is generally paid into the company's treasury at Canton for bills on the court of directors, (which are negotiated here, and, whilst the exchange was at 5s. 6d. for the Spanish dollar, formed an advantageous remittance,) or it is absorbed by bills granted by the traders to this government, and payable to the supercargoes in China.

The Malabar coast pays her purchases with sandal wood, coyar rope, pepper, some cardamums, and occasional cargoes of cotton wool: the balance is remitted by bills, or sunk in the annual supplies which Bengal furnishes to the presidency of Bombay.

From Pegue are brought teak timber, tin, wax, elephants' teeth, lac, &c. The gulfs make their returns in coffee, specie, brimstone, dates, and some other articles of inconsiderable value. And the Maldives and eastern coast of Africa supply cowries and coyar.

Abstract of Arrivals and Departures of Ships at and from Calcutta, in the Years 1773, 1783, 1791, 1792, 1793, *and* 1794.

Year.		ENGLISH. Men of War. No.	Tons.	Transports. No.	Tons.	Company's Europe Ships. No.	Tons.	Company's Packets, &c. No.	Tons.	Country Ships. No.	Tons.
1773	Arrivals	2	750			10	8000	1	200	102	28,872
	Depart.	2	750			5	4000			88	25,080
1783	Arrivals	3	2000	4	2250	26	20,800	2	200	71	24,740
	Depart.	3	2000	3	1800	17	13,600	6	1000	54	20,125
1791	Arrivals					19	15,200	1	50	291	78,137
	Depart.					13	10,400	3	250	281	97,270
1792	Arrivals	1	1000			18	14,375	2	320	206	66,165
	Depart.	1	1000			18	14,400	7	1035	208	70,663
1793	Arrivals	2	1080			21	16,605	9	[illegible]	280	99,676
	Depart.	1	1000			20	15,452	6	1120	295	109,603
1794	Arrivals					28	19,328	12	1970	135	44,876
	Depart.					16	11,650	8	1065	151	51,44[illegible]

Year.		FRENCH. From and to Ports in Europe. No.	Tons.	FRENCH. From and to Ports in India. No.	Tons.	DUTCH. From and to Ports in Europe. No.	Tons.	DUTCH. From and to Ports in India. No.	Tons.	DANISH. From and to Ports in Europe. No.	Tons.	DANISH. From and to Ports in India. No.	Tons.	PORTUGUESE. From and to Ports in Europe. No.	Tons.	PORTUGUESE. From and to Ports in India. No.	Tons.
1773	Arrivals	2	800	3	420											3	670
	Depart.	1	500	4	1000							1	250			5	1600
1783	Arrivals	5	2150	3	390					6	2550	7	2400	6	3350	6	1480
	Depart.	2	1100							4	2250	7	1650	3	1700	11	2700
1791	Arrivals	7	3170	21	5001			4	1050	7	3830	7	2420	5	2290	5	1360
	Depart.	3	1900	13	2720			4	1000	5	2870	6	2430	4	1500	2	450
1792	Arrivals	6	2830	20	7620			2	500	3	1800	6	2330	2	850	6	1300
	Depart.	7	2410	14	3290	1	200	3	310	4	2300	2	900	3	1400	3	480
1793	Arrivals			7	1670			3	980	4	1750	12	4710	2	1200	5	950
	Depart.	3	2000	6	3220			2	350	6	3150	12	3840	1	370	3	775
1794	Arrivals							2	780	3	1700	5	2250	3	1000	3	925
	Depart.							1	190	14	7600	2	520	3	1400	6	900

Year.		IMPERIAL, TUSCAN, and FLEMISH. From and to Ports in Europe. No.	Tons.	IMPERIAL, TUSCAN, and FLEMISH. From and to Ports in India. No.	Tons.	GENOESE, SWEDISH, and SARDINIAN. From and to Ports in Europe. No.	Tons.	GENOESE, SWEDISH, and SARDINIAN. From and to Ports in India. No.	Tons.	AMERICAN. From and to Ports in America and Europe. No.	Tons.	AMERICAN. From and to Ports in India. No.	Tons.	INDIAN. No.	Tons.	TOTAL. No.	Tons.	Grand Total of Arrivals and Departures. No.	Tons.
1773	Arrivals													37	4785	160	41,497	268	77,967
	Depart.													2	290	108	33,470		
1783	Arrivals					1	450							6	1750	149	64,510	163	113,735
	Depart.	1	300											3	1000	114	49,225		
1791	Arrivals	2	900	3	1030					7	2567	1	200	8	2350	391	119,555	739	214,035
	Depart.	1	600	4	1650					4	920	2	500	3	1400	348	124,480		
1792	Arrivals	1	700	1	200	3	760	2	1080	4	1280	11	3235	3	1150	297	117,445	592	225,015
	Depart.	1	730	1	700	5	2280			16	4302	4	1200	2	1000	295	108,600		
1793	Arrivals			1	500	1	600	4	2200	6	1537	6	1330	7	2850	370	139,243	757	291,190
	Depart.					5	2900	1	600	21	6297	4	770	1	500	387	151,947		
1794	Arrivals									5	1470	6	2000	15	5375	217	81,674	441	163,481
	Depart.			1	400					6	1550	1	200	15	4900	224	81,810		

Ports

Ports from whence the Ships of 1783 arrived, and those for which they cleared out.

Arrivals.			Departures.		
From Europe - - -	34	22,900	To Europe - - - - -	17	9,200
Madras - - -	79	28,510	Madras - - - -	68	27,455
Bombay - - -	7	4,100	Bombay - - - - -	8	5,700
Eastward and China	13	2,730	Eastward and China	13	3,470
Pegue - - - - -	10	3,790	Pegue - - - - -	1	150
Gulfs - - - - -	1	70	Gulfs - - - - - -	2	700
Maldives - - -	1	200	Isle of France - -	2	550
Isle of France - -	1	160	Men of War - -	3	2,000
Men of War - -	3	2,000			
Total	149	64,510	Total	114	49,225

Ports from whence the Ships of 1793 arrived, and those for which they cleared out.

Arrivals.			Departures.		
From Europe & Amer.	36	20,332	To Europe & Amer.	52	25,367
Madras - - -	248	90,658	Madras - -	234	84,045
Bombay - -	20	9,080	Bombay - -	51	28,100
Eastw. & China	36	10,133	Eastw. & China	33	11,255
Basso. & Muscat	3	1,100	Basso. & Muscat	2	750
Pegue - - -	14	4,500	Pegue - - -	7	990
Andamans - -	10	2,440	Andamans - -	5	820
Isle of France -	2	650	Isle of France -	1	120
Pattah - - -	1	350	Mozambique -	1	350
			Cape of G. Hope	1	150
Total	370	139,243	Total	387	151,947

LVIII. *An*

LVIII. *An Essay on Medical Entomology. By* F. Chaumeton, *Physician to the Army.*

[Continued from p. 242.]

ORDER II.

HEMIPTERA.

Coccus—*Gall Insect.*—The female, says Cuvier, has the form of a buckler firmly attached to the stems and leaves of plants, and lives on the juice, which it extracts by a long beak it inserts into them. It has six short feet, and two short and cylindric antennæ: it has no wings. The male, in the state of larva, has almost the same form as the female; but it is metamorphosed into a very small insect with two long wings, long filiform antennæ, and six smooth eyes, without any apparent beak. When the female has been fecundated, she becomes considerably larger. The eggs which she lays remain under her body, which afterwards becomes dry and serves as a shelter to the eggs, and for some time to the young after they have been hatched. The latter issue from an indentation in the posterior part of the body of their mother, and run about some time on the tree before they become fixed.

Coccus Ilicis—*Kermes.*—This gall insect lives on a kind of green oak which grows in Spain, Portugal, and the south of France (*Quercus coccifera*). The female, which in April is not larger than a grain of millet, acquires by fecundation such a size, that in the month of June she is almost as large as a juniper berry, which she pretty nearly resembles in shape and colour. At this last period, when the female loses life by communicating it, the follicles formed by her body and eggs are torn off by means of the nails. To prevent the latter from being hatched they are besprinkled with good vinegar, and dried in the open air.

With the juice expressed from these follicles is prepared what are called *graines d'écarlate* and syrup of kermes, which is employed as an astringent, stimulant, and aphrodisiac.

It will be sufficient to enumerate the different substances which enter into the preparation of alkermes, to show how little foundation there is for its great reputation. Notwithstanding the successive reforms which this electuary has experienced since the time of Messue, it could not lose the impression of that Arabic polypharmacy with which, during a long series of ages, medicine was infected, and from which it is not yet totally freed.

Pastils of alkermes deserve as little confidence, and must also be rejected.

Kermes furnish to the arts a red of a good colour, but less brilliant than that of cochineal. The latter is an insect of the same genus (*Coccus cacti*), which is produced in America on a kind of *cactus* called nopal (*Cactus coccinelliferus*). The female is oval, and retains traces of the segments of her body. A decoction of these insects, mixed with a nitro-muriatic solution of tin, produces scarlet: alone, they dye crimson.

Stisser, Lister, and Struve, have extolled cochineal in affections of the urinary passages; yet its medicinal qualities are very uncertain, and, in my opinion, it ought to be applied only to dyeing*.

Another kind of *coccus* produces gum lac. This, also, medicine may give up to dyeing, which derives from it a beautiful red colour.

ORDER III.

LEPIDOPTERA.

PHALÆNA—*Moth.*—The phalænæ are distinguished from the butterfly and sphynx by their antennæ decreasing from the base to the summit, and by their flying abroad chiefly in the night.

PHALÆNA (BOMBYX) MORI—The larva of this species is known generally under the improper denomination of silk worm. A great deal has been written on the method of producing and rendering useful the valuable tissue which forms the tomb it constructs for itself: Chaussier has chemically examined the phalæna of the mulberry tree, and has extracted from it, by means of alcohol, an acid (the bombic) pretty well concentrated, with which the materia medica might be enriched. I consider all acids as capable of furnishing powerful succour to medicine; and, in my opinion, none of them ought to be neglected.

Bonnet, Bergman, and Sauvages have found acid properties in the larvæ of several other lepidopteræ. It would be of importance to repeat their experiments, and make an application of them to the art of healing.

ORDER V.

HYMENOPTERA.

CYNIPS—*Cynips.*—The mouth of these insects is furnished with jaws, and unprovided with a trunk. They have

* In general it appears that all insects introduced into the animal economy carry their action chiefly to the urinary organs.

a small

a small head, and long thin antennæ of thirteen or fifteen articulations. The wings large, and almost without ribs. The thorax, as it were gibbous. The abdomen compressed on the sides and sharp below, where it contains, between two scaly laminæ, a sting bent in a spiral form, and which issues only when the insect wishes to deposit its eggs under the epidermis of a plant. Its prick occasions a protuberance called *gall*, which always increases, and in which the larva lives till the time of its metamorphosis*. It then gnaws through its prison, and the place where it issues is marked by a hole with which the *gall* is pierced: sometimes, however, the larva dies before that period, or is not able to form for itself a passage; in that case the *gall* remains without being perforated.

Cynips Quercus—*Gall Fly*.—The oak affords nourishment to several kinds of cynips, which all prick it in certain parts; such as the branches, flowers, leaves, and footstalks. The species which attack the latter part have a black body, whitish legs, and brown thighs. It produces the large round gall full of tubercles, a decoction of which, mixed with a solution of the sulphate of iron, composes ink, and almost all black colours.

The gall (called commonly the gall-nut) was formerly considered as an excellent remedy; and I consider as very blameable the forgetfulness to which it appears to be at present condemned. It has a great analogy indeed to cinchona; and if it cannot, in certain circumstances, supply its place, there are others in which it is superior. Hippocrates employed it externally against affections of the matrix, and Galen cured intermittent fevers by administering it in doses of a gros.

The external and internal use of gall-nuts is indicated in asthenic diseases of the lymphatic and cellular systems, in some mucous fluxes too abundant, such as blennorrhea and leucorrhea. It is a powerful auxiliary for keeping in contiguity parts which have been divided.

The gall nut of the oak, by simple infusion in water, deposits crystals disposed in the form of a sun, of a gray colour, and an acid styptic taste. It is gallic acid, which retains the properties of the substance that furnished it. Boiling alcohol dissolves equal parts of that acid; cold, it dissolves a fourth. The gallic alcohol which results from it ought, in my opinion, to surpass in virtue all the preparations of gall nuts hitherto employed.

* Cuvier *Tab. Elem. de l'Hist. Nat. des Animaux.*

Cynips

Cynips Rosæ.—The cynips of the rose tree is black; its abdomen and feet are red: the excrescence which gives rise to its larva is spongy, reticulated, and formed of yellow and red filaments. It is known under the name of moss of the rose tree, or *bedeguar.* It is astonishing that illustrious physicians have ascribed diuretic, somniferous, and even ante-hydrophobic properties to this substance, which has no odour*.

Chrysis—*Chryside.*—The beautiful colours with which the bodies of all these insects are ornamented, justify the name of *golden wasp* which has been given to them. They have jaws, but no trunk; their tongue is small and oval; their antennæ are filiform, and composed of twelve articulations, the first of which is longer than the rest: their sting is enveloped in a scaly covering, and serves the insect only for depositing its eggs in the small cells which it forms in the mortar of walls exposed to the south.

Cynips ignita—*Blue and red Chryside.* Cuvier.—The head and breast of this species are blue, changing to golden green: the abdomen is red, changing to gold colour, and terminated by four indentations.

It has been proposed to employ this insect, dried and pulverized, or digested in alcohol, in the same manner and the same diseases as cantharides. Beiris recommends it in particular in paralytic affections.

Apis—*The Bee.*—The mouth of bees is furnished with jaws, and a trunk, with which they extract the juice from flowers: their antennæ are filiform. The females and males have their anus armed with a retractile sting, which inflicts a painful wound.

Apis mellifica—*The domestic Bee.* Geoff., called improperly the *Honey Bee.*—While the farmer is employed only in increasing the product of bees, the philosopher observes them in their solitary retreats; and after having studied the manners given them by nature, he collects them into colonies, in order to appreciate the modifications they have experienced from the hand of man. He constructs for them transparent habitations, which permit him to contemplate their admirable labours, and the police which prevails among them. These details, equally calculated to interest and excite curiosity, do not fall within my province; and I must confine myself to distinguish the

* The only quality that can be distinguished in them is the astringency common to them with many other vegetable matters.

domestic

domestic bee from the other species of the same genus. It is well known that a hive contains bees of three kinds:

1st, The queen or mother is smaller and longer than the males: her wings do not extend to the extremity of the body: the latter is of a bright brown colour above, and of a beautiful yellow below. She has neither palettes nor brushes on the legs: her trunk is very short and very delicate.

2d, The males or drones have long wings, a short trunk, no palettes on their legs, and no sting. The only use of them seems to be to fecundate the queen. This important function is scarcely discharged when they are expelled, or massacred without mercy. Yet bees are quoted as a perfect model of good government*.

3d, Bees without sex, which are called working bees, because, indeed, the whole labour of the hive belongs exclusively to them, are distinguished by their smaller size, and their long pointed trunk, moveable in every direction. Their paws resemble brushes; the posterior ones are hollowed out in the spoon form. It is by means of this conformation that they are able to dive into the corolla of flowers, suck the nectar from them, and load themselves with pollen to convert it into honey and wax. The latter forms the basis of the combs, the surface of which exhibits an assemblage of a multitude of cells arranged with wonderful art and astonishing symmetry. A part of these cells or alveolæ is destined to receive the honey, and the mother bee deposits in the rest the hope of a new generation.

Most medicines are distinguished by a dark colour, a nauseous odour, and a detestable taste. The patient shudders at the bare view of the disgusting beverage which he is ordered to swallow to the very dregs; and, if the danger is not urgent, he refuses to purchase health at that price. Manna and senna enter into the composition of the purgatives most generally employed. The odour which exhales from them often produces spasms and other accidents in persons of a nervous constitution. I knew a young man to whom this odour gave frequent stools; and I rarely prepare these medicines myself without experiencing nausea, sometimes followed by vomiting. Hippocrates, two thousand years ago, recommended some remedy less energetic, and more agreeable to the patient, in the room of one more

* It appears much more probable that these drones die naturally after having discharged the function for which they are destined; for it is the common fate of all male insects to die after they have engendered.

efficacious

efficacious which excited his aversion. Honey possesses the double advantage of flattering the taste and producing excellent effects. If it does not occupy one of the first places in the materia medica, it is probably because it has an agreeable savour, and is very common. There are few diseases, indeed, in which honey is counter-indicated. In many it acts as a powerful palliative, and in many others it produces a radical cure. Affections of the urinary passages and those of the organs of respiration are the cases, however, in which the use of it is crowned with the happiest success. Last winter I had several instances of pulmonary catarrh, and honey was always the principal means of cure. I had also to treat a dyspnœa, and three cases of phthisis in the highest degree. One of the patients affected with the latter ascribed his malady to cinchona, of which he had been made to take more than twelve ounces. All of them were indebted, in a great measure, for their cure, to honey. I advised them to eat it with their bread; and I caused them to put it into their common beverage, which was an infusion of the roots of the *polygala amara*. The anti-phthisical properties of this plant have been placed beyond doubt by a physician as estimable for his talents as for his virtues*. I wished to try this treatment on a phthisicky patient in the second degree, who had been imprudently moved about from hospital to hospital for a considerable time. Honey and polygala both failed, and the patient soon sunk under the disease. I also had the misfortune to see fall a sacrifice a captain of the 48th regiment of infantry, attacked with a phthisis laryngea †, the fatal termination of which ought chiefly to be ascribed to different treatments with hyper-oxygenated muriate of mercury. Can Van Swieten be pardoned for having put into the hands of ignorance a terrible poison, to which thousands daily fall victims? Water in which honey is dissolved is called simple hydromel. If this mixture be subjected to vinous fermentation, the result is vinous hydromel. The first is proper in angiotenic fevers and phlegmasiæ; the second is indicated in particular in adynamic diseases.

Honey boiled with half its weight of white wine vinegar constitutes simple oxymel, the utility of which in meningo-gastric fevers, and phlegmasiæ complicated with adynamic symptoms, has been proved by long experience. If vinegar

* Mat. Medic. indigene, par I. F. Coste et P. R. Willemet, couronnée en 1776 par l'Acad. de Lyon.

† *Phthisis Siphillitica*, Sauv. Nos.

of

of squills be substituted for common vinegar, there will be formed oxymel of squills, which ought to be considered as an excellent hydragogue. I cured, in the hospital of Berg-op-Zoom, several persons attacked with anasarca and partial dropsies just beginning, and many œdematous affections, by prescribing for them daily nothing but one or two ounces of oxymel of squills in two pounds of the infusion of absynthium and a chopin of good wine, of which the patient took alternately a glass full every hour. Being persuaded that the best remedies to succeed require to be seconded by a good regimen, I did every thing in my power to prevent the hydropical patients from gratifying their appetite, which is often voracious. Their quantity of bread never exceeded twelve ounces; and the only food I allowed them to add to it was eggs, carrots, rice, turnips, and prunes. I could have wished to allow them a little animal food, such as veal or chicken; but, having at my disposal nothing except beef of an indifferent quality, I was obliged to interdict them from flesh meat altogether.

Honey, whether employed in its natural state or formed into the different preparations before mentioned, must be chosen exceedingly white, firm, and granulated. That of Narbonne possesses all these qualities. The Gatinois furnishes some also, which is very good. The use of yellow liquid honey is confined to lotions and cataplasms.

I have said nothing of electuaries, confections, conserves, opiates, &c., of which honey is often one of the ingredients, and sometimes the base. The bare mention of electuary suggests theriac, orvietan, mithridate, double catholicum, &c.: and one cannot help being vexed to see these whimsical compositions still make so conspicuous a figure in the lists of pharmaceutical remedies.

Though wax seems exclusively devoted to the arts, some celebrated physicians have, in certain circumstances, administered it with success. Jacobi found it very useful in convulsive cough, hematuria, and dysentery. It is above all in the last disease that the efficacy of it, used internally and under the form of injection, has been confirmed by Diemerbroek, Valleriola, and Pringle. Soap serves as a medium for making of it pills or an aqueous solution.

In certain cases the too speedy union of the lips of a wound or the edges of an ulcer must be retarded, because it may be followed by disagreeable consequences: at other times it is necessary to oppose the contraction of the muscles, which continually tend to contract or shut a natural aperture. Sponge prepared with wax would not fulfil these

8 indications

indications but with extreme difficulty and extraordinary slowness, because our humours, both in the sound state and when degenerated into pus, have too weak an action on the wax. This inconvenience has been avoided by a very simple process, which perfectly answers the proposed end. A sponge is dipped in water in such a manner as to be completely soaked: it is then compressed as much as possible in every direction with a piece of packthread. If the latter be taken away at the end of a certain time, it is observed that the sponge retains the form given to it by the compression; but the slightest humidity is sufficient to make it resume its natur l volume; and in this consists the merit of this preparation, which was published as new a few years ago, though long known, and though employed with great success by I. F. Morand, surgeon.

Cerates are indebted for their consistence and name to wax; it is wax which gives to ointments and plasters that apparent homogeneity and smoothness which is sought for. Desault was so fully convinced of the danger which accompanies the application of greasy substances to the surface of the body, that he almost entirely proscribed the use of these topics. I have attended too little the lectures of Desault to be well acquainted with his general method of treating external diseases; but I have had for colleagues in the army several of his pupils, who applied in abundance aqueous solution of acetite of lead (vegeto-mineral water of Goulard) to all wounds, ulcers, and tumours. I congratulate myself that I have not imitated them, and that I followed the wise counsels of my learned Mecænas*, who recommends the substitution of muriate of soda for acetite of lead. This metallic salt, indeed, participates in all the faults so justly ascribed to fat bodies. Like them it forms a stratum impermeable to the excrementitious fluids, and gives besides to the orifice of the exhaling vessels an astriction which may occasion a fatal metastasis, or mortal tetanus.

* Heurteloup.

[To be continued.]

LIX. A

LIX. *A new, easy, and cheap Method of separating Copper from Silver.* *By* M. Goetling*.

Four methods are known for separating copper from silver, in all of which the alloy is dissolved in the nitric acid. As the price of this acid is high, M. Goetling, in place of it, employs sulphuric acid, which is much cheaper. His process, which has fully answered his expectation, is as follows:

The proportion of silver in the alloy is first to be ascertained by the touch, or in any other way. For each part of silver one part of sulphuric acid, and for each part of copper three and three-fifth parts of the same acid, are to be taken. The acid, diluted with half its weight of water, is to be poured into the matrass on the alloy, reduced to small pieces. An addition of one part more of the acid to every sixteen parts of the alloy facilitates the solution. Place the matrass in a sand heat, and bring the contents to a state of ebullition. If care be taken to stir it frequently with a glass rod, the alloy will be broken down and converted into a sulphate in two or three hours. It will become thick, and sometimes hard. While still hot, six or eight times its weight of boiling water is to be added to it, and the heat to be continued for some time. By this means the sulphate will be dissolved, and a great part of the sulphate of silver will be precipitated. When the whole is found to be completely dissolved, a clean plate of copper, or a few pieces of clean copper money tied loosely in a coarse cloth, is suspended in the fluid, and the boiling is continued for some hours, by which means all the sulphate of silver is decomposed, and the metal separated in a metallic form.

To ascertain when the separation is complete, a small quantity of the solution is taken out and tried, by adding a few drops of a solution of muriate of soda. If a curdly precipitate is formed, it is a proof that some of the silver still remains in it; in which case the boiling must be continued.

When a complete separation is effected, the clear solution is to be decanted off with care, and the precipitate washed. To ascertain that all adhering sulphate of copper is removed, drop into the water last poured off from the precipitate a few drops of liquid ammonia. If any of that sulphate be

* From *Tascben Buch fur Skeidekunstler*, &c. 1804.

still

still present, the ammonia will produce a blue colour in the water. The silver, if not wished to be kept as a powder, may be melted with from a fourth to a half of its weight of nitrate of potash.

The liquid sulphate of copper decanted from the precipitate, as also the water employed in washing it, may afterwards be evaporated in a copper bason, and, by crystallization, a quantity of blue vitriol equivalent to the cost of the acid will be obtained.

Should some parts of the alloy, by accident, have remained undissolved, they may be separated by decantation, and reserved for the next repetition of the process.

LX. *Short Account of Travels between the Tropics, by Messrs.* HUMBOLDT *and* BONPLAND, *in* 1799, 1800, 1801, 1802, 1803, *and* 1804. *By* J. C. DELAMETHERIE*.

THE interest which the learned world so justly takes in the travels of Messrs. Humboldt and Bonpland, as well as my friendship for them, impose on me the agreeable obligation of giving an abstract of what I have been able to learn respecting them, either from their public and private correspondence, or from the memoirs read in the Institute. This account will be short, but correct.

After making physical researches for eight years in Germany, Poland, England, France, Swisserland, and Italy, M. Humboldt came to Paris in 1798, where the Museum of Natural History afforded him an opportunity of making a voyage round the world with captain Baudin. When on the point of setting out for Havre, with Alexander-Aimé Goujou Bonpland, a pupil of the School of Medicine and Garden of Plants, the war which recommenced with Austria, and the want of funds, induced the Directory to put off the voyage of Baudin till a more favourable occasion. M. Humboldt, who since 1792 had conceived the design of undertaking, at his own expense, a voyage to the tropics, in order to promote the physical sciences, resolved then to accompany the men of science who were destined for Egypt. The battle of Aboukir having interrupted all direct communication with Alexandria, his plan was to take advantage of a Swedish frigate which was to carry the consul Seziolde-

* From *Journal de Physique*, Thermidor, an 12.

brant to Algiers, to accompany the caravan thence to Mecca, and to proceed to India by Egypt and the Persian Gulph: but the war, which broke out in an unexpected manner in the month of October 1798, between France and the Barbary powers, and the troubles in the East, prevented M. Humboldt from setting out from Marseilles, where he waited to no purpose for two months. Impatient at this new delay, but always firm in the project of joining the expedition in Egypt, he set out for Spain, hoping he should be able to proceed more easily under the Spanish flag from Carthagena to Algiers or Tunis. He took the road to Madrid through Montpellier, Perpignan, Barcelona, and Valentia; but the news from the East became every day more distressing. The war there was carried on with unexampled fury, and he was at length obliged to renounce the design of going through Egypt to Indostan. A happy concurrence of circumstances soon indemnified M. Humboldt for this delay. In the month of March 1799, the court of Madrid granted him full permission to proceed to the Spanish colonies in both the Americas, in order to make such researches as might be useful to the sciences. His catholic majesty even deigned to show particular interest for the success of this expedition; and M. Humboldt, after residing some months at Madrid and Aranjues, set out from Europe in June 1799, accompanied by his friend Bonpland, who unites an extensive knowledge of botany and zoology to that indefatigable zeal and love for the sciences which induce men to submit with indifference to every kind of hardship.

With this friend M. Humboldt travelled for five years, at his own expense, between the tropics, passing over, by sea and land, nearly 9000 leagues. These two travellers, provided with recommendations from the court of Spain, embarked in the Pizarro frigate, at Corunna, for the Canaries. They touched at the island of Graciosa, near Lancerotta, and at Teneriff, where they ascended to the crater of the peak, in order to analyse the atmospheric air, and make geological observations on the basaltes and porphyritic schist of Africa. In the month of July they arrived at the port of Cumana, in the gulph of Cariaco, a part of South America celebrated by the labours and misfortunes of the indefatigable Löfling. In the course of 1799 and 1800 they visited the coast of Paria, the Indian missions of Chaymas, and the province of New Andalusia, one of the hottest, but at the same time healthiest, countries in the world, though convulsed by dreadful and frequent earthquakes. They traversed the provinces of New Barcelona, Venezuela, and

Spanish Guyana. After determining the longitude of Cumana, Caraccas, and several other points by observations of the satellites of Jupiter; after collecting plants on the summits of Caripe and Silla de Avila, crowned by *Befaria*, they set out for the capital of Caraccas in February 1800, and the beautiful valleys of Aragua, where the large lake of Valentia calls to remembrance that of Geneva, but embellished by the majestic vegetation of the tropics.

From Portocabello they proceeded south, penetrating from the coast of the sea of the Antilles as far as the boundaries of Brazil towards the equator. They first traversed the immense plains of Calabozo, Apure, and Lower Orenoko; the Llanos, deserts similar to those of Africa, where by the reverberation of the heat, but under the shade, Reaumur's thermometer rises to 33° or 37°, and where the scorching soil, for more than 2000 leagues, differs in its level only five inches. The sand, similar to the horizon at sea, exhibits every where the most curious phænomena of refraction and elevation. Without any vegetation, in the dry months it affords shelter to the crocodile and the torpid boa.

The want of water, the heat of the sun, and the dust raised by the scorching winds, harass in turns the traveller, who directs himself and mule by the course of the stars, or by some scattered trunks of the *mauritia* and *embothrium* which are discovered every three or four leagues.

At St. Fernando d'Apure, in the province of Varinas, Messrs. Humboldt and Bonpland began a laborious navigation of nearly 500 nautical leagues in canoes, during which they made a chart of the country by the help of timekeepers, the satellites, and lunar distances. They descended the river Apure, which falls into the Orenoko in the latitude of seven degrees. Having escaped from the danger of imminent shipwreck near the island of Panamuma, they ascended the latter river as far as the mouth of the Rio Guaviare, passing the famous cataracts of Atures and Maypure, where the cavern of Ataruipe contains mummies of a nation destroyed by the war of the Caribs and Maravitains. From the mouth of the Rio Guaviare, which descends from the Andes of New Granada, and which father Gumilla erroneously took for the sources of the Orenoko, they quitted the latter and ascended the small rivers Atabapo, Tuamini, and Temi.

From the mission of Javita they proceeded by land to the sources of the Guainia, which the Europeans call the Rio Negro, and which Condamine, who saw it only at its

 mouth

mouth in the river Amazon, calls a fresh water sea. Thirty Indians carried their canoes through bushy trees of *hevea, lecythis,* and the *laurus cinnamomoides,* to Cano Pimichin. By this small stream our travellers proceeded to the Rio Negro, which they descended as far as the small fortress of San Carlos, which has been erroneously believed to be situated under the equator, and as far as the frontiers of the Grand Para, the captainry-general of Brazil. A canal from Temi to Pimichin, which on account of the level nature of the ground is very practicable, would form an interior communication between the province of Caraccas and the capital of Para much shorter than that of Casquiare. By this canal also, such is the astonishing disposition of the rivers in this new continent, one might descend in a canoe from Rio Guallaga, within three days journey of Lima, or the South Sea, by the river Amazon and Rio Negro, as far as the mouths of the Orenoko opposite to Trinidad, a navigation of nearly 2000 leagues. The misunderstanding which prevailed then between the courts of Madrid and Lisbon prevented M. Humboldt from carrying his operations beyond St. Gabriel de las Cochuellas, in the captainry-general of Great Para.

La Condamine and Maldonado having determineda stronomically the mouth of the Rio Negro, this obstacle was less sensible, and it remained to fix a part more unknown, which is the arm of the Orenoko called Casquiare, forming the communication between the Orenoko and the river Amazon, and respecting the existence of which there have been so many disputes for fifty years past. To execute this labour, Messrs. Humboldt and Bonpland ascended from the Spanish fortress of St. Carlos along the Rio Negro and the Casquiare to the Orenoko, and on the latter to the mission of Esmeraldo, near the volcano Duida, or as far as the sources of that river.

The Guaica Indians, a very white, small, and almost pigmy race of men, but exceedingly warlike, who inhabit the country to the east of the Pasimoni; and the Guajaribes, of a dark copper colour, extremely ferocious, and still anthropophagi, render fruitless every attempt to reach the sources of the Orenoko, which the maps of Caulin, though in other respects meritorious, place in a longitude much too far east.

From the mission of Esmeralda, an assemblage of huts situated in the most remote and most solitary corner of this Indian world, our travellers descended, with the assistance of the floods, 340 leagues; that is to say, the whole of the

Orenoko, as far as towards its mouths at St. Thomas de la Nueva Guyana or Angostura, passing a second time the cataracts, to the south of which the two historiographers of these countries, father Gumilla and Caulin, never penetrated.

In the course of this long and painful navigation, the want of food and shelter; the nocturnal rains; living in the woods; the mosquitoes, and a multitude of other stinging and venomous insects; the impossibility of cooling themselves by the bath, on account of the ferocity of the crocodile and of the small carib fish; together with the miasmata of a hot and damp climate, exposed our travellers to continual suffering. They returned from the Orenoko to Barcelona and Cumana by the plains of Cari and the missions of the Carib Indians, a very extraordinary race of men, and, next to the Patagonians, the tallest and most robust perhaps in the world.

After a stay of some months on the coast, they proceeded to the Havannah by the south of St. Domingo and Jamaica. This navigation, performed when the season was far advanced, was both long and dangerous, the vessel having been in great danger of being lost on the bank of Vibora, the position of which M. Humboldt determined by the timekeeper. He staid in the island of Cuba three months, during which time he employed himself on the longitude of the Havannah, and the construction of a new kind of stove in the sugar-houses, which was speedily and generally adopted. When on the point of setting out for La Vera Cruz, intending to proceed by the way of Mexico and Acapulco to the Philippines, and thence, if possible, by Bombay, Bussorah, and Aleppo, to Constantinople, false intelligence respecting the voyage of captain Baudin alarmed him, and induced him to alter his plan. The American papers announced that this navigator would set out from France for Buenos-Ayres, and that after doubling Cape Horn he would proceed along the coasts of Chili and Peru.

M. Humboldt, at the time of his departure from Paris in 1798, had promised to the Museum and to captain Baudin, that in whatever part of the world he might be, he would endeavour to join the French expedition as soon as he should hear of its having been set on foot. He flattered himself that his researches and those of Bonpland would be more useful to the progress of the sciences if they united their labours to those of the men of science who were to accompany captain Baudin. These considerations induced M. Humboldt to send his manuscripts of the years 1799 and 1800 directly to Europe, and to freight a small galliot in the port of Batabano to proceed to Carthagena in the Indies, and thence, as soon as possible, by the isthmus of Panama to the South Sea. He hoped to find captain Baudin at Guyaquil or at Lima, and to visit New Holland and the islands of the Pacific Ocean, so interesting in a moral point of view, and by the richness of their vegetation.

It appeared to him imprudent to expose the manuscripts and collections already formed to the dangers of this long navigation. The manuscripts, respecting the fate of which M. Humboldt remained in painful uncertainty for three years, till his arrival at Philadelphia, were saved; but a third of the collections were lost at sea by shipwreck: fortunately this loss, and that of some insects from the Orenoko and Rio Negro, extended only to duplicates; but this shipwreck proved fatal to a friend to whom M. Humboldt had intrusted his plants and insects, Fray Juan Gonzales, a Franciscan, a young man of great courage and activity, who had penetrated in this unknown world from Spanish Guyana much farther than any other European.

M. Humboldt set out from Batabano in March 1801, coasting along the south side of the island of Cuba, and determining astronomically several points in that group of small isles called the King's Gardens, and the approaches to the port of Trinidad. A navigation which ought to have been only thirteen or fifteen days, was prolonged by currents beyond a month. The galliot was carried by them too far east, beyond the mouths of the Atracto. They touched at Rio Sinu, where no botanist had ever searched for plants; but they found it difficult to land at Carthagena, on account of the violence of the breakers of St. Martha. The galliot had almost gone to pieces near Giant's Point: they were obliged to save themselves towards the shore in order to anchor; and this disappointment gave M. Humboldt an opportunity of observing the eclipse of the moon on the 2d of March 1801. Unfortunately they learned on this coast that the season for navigating the South Sea from Panama to Guyaquil was already too far advanced: it was necessary to give up the design of crossing the isthmus; and the desire of seeing the celebrated Mutis, and examining his immense treasures in natural history, induced M. Humboldt to spend some weeks in the forests of Turbaco, ornamented with *gustavia*, *toluifera*, *anacardium caracoli*, and the *Cavanillesca* of the Peruvian botanists; and to ascend in thirty-five days the beautiful and majestic river of the Magdalen, of which he sketched out a chart, though tormented

tormented by the mosquitoes, while Bonpland studied the vegetation, rich in *heliconia, psychostria, melastoma, myrodia,* and *dychotria emetica,* the root of which is the ipecacuanha of Carthagena.

Having landed at Honda, our travellers proceeded on mules, the only way of travelling in South America, and by frightful roads through forests of oaks, *melastoma* and *cinchona,* to Santa Fé de Bagota, the capital of the kingdom of New Grenada, situated in a beautiful plain 1360 toises above the level of the sea, and, in consequence of a perpetual spring temperature, abounding in the wheat of Europe and the sesamum of Asia. The superb collections of Mutis; the grand and sublime cataract of Tequendama, 98 toises or 588 feet in height; the mines of Mariquita, St. Ana, and Zipaguira; the natural bridge of Icononzo, two detached rocks which by means of an earthquake have been disposed in such a manner as to support a third; occupied the attention of our travellers at Santa Fé till September 1801.

Though the rainy season had now rendered the roads almost impassable, they set out for Quito; they re-descended by Fusagasuga, in the valley of Magdalena, and passed the Andes of Quindiu, where the snowy pyramid of Tolina rises amidst forests of *styrax passiflora* in trees, *bambusa,* and wax palms. For thirteen days they were obliged to drag themselves through horrid mud, and to sleep, as on the Orenoko, under the bare heavens, in woods where they saw no vestiges of man. When they arrived, bare-footed and drenched with continual rain, in the valley of the river Cauca, they stopped at Cathago and Buga, and proceeded along the province of Choco, the country of platina, which is found between rolled fragments of basaltes, filled with olivin and augite, green rock (the *grunstein* of Werner), and fossil wood.

They ascended by Caloto and Quilichao, where gold is washed, to Popayan, visited by Bouguer when he returned to France, and situated at the bottom of the snowy volcanoes of Puracé and Sotara, one of the most picturesque situations and in the most delightful climate of the universe, where Reaumur's thermometer stands constantly between 17 and 19 degrees. When they had reached, with much difficulty, the crater of the volcano of Puracé, filled with boiling water, which from the midst of the snow throws up, with a horrid roaring, vapours of sulphurated hydrogen, our travellers passed from Popayan by the steep cordilleras of Almaguer a Parto, avoiding the contagious air of the valley of Patia.

From Pasto, a town situated at the bottom of a burning volcano, they traversed by Guachucal the high plateau of the province of Pastos, separated from the Pacific Ocean by the Andes of the volcano of Chili and Cumbal, and celebrated by its great fertility in wheat and the *erytroxylon Peruvianum*, called cocoa. At length, after a journey of four months on mules, they arrived at the towns of Ibarra and Quito. This long passage through the cordillera of the high Andes, at a season which rendered the roads impassable, and during which they were exposed to rains which continued seven or eight hours a day, encumbered with a great number of instruments and voluminous collections, would have been almost impossible, without the generous and kind assistance of M. Mendiunetta, viceroy of Santa Fé, and the baron de Carondelet, president of Quito, who, being equally zealous for the progress of science, caused the roads and the most dangerous bridges to be repaired on a route of 450 leagues in length.

Messrs. Humboldt and Bonpland arrived on the 6th of January 1802 at Quito, a capital celebrated in the annals of astronomy by the labours of La Condamine, Bouguer, Godin, and Don Jorge-Juan and Ulloa; justly celebrated also by the great amiableness of its inhabitants and their happy disposition for the arts. Our travellers continued their geological and botanical researches for eight or nine months in the kingdom of Quito; a country rendered perhaps the most interesting in the world by the colossal height of its snowy summits; the activity of its volcanoes, which in turns throw up flames, rocks, mud, and hydrosulphureous water; the frequency of its earthquakes, one of which, on the 7th of February 1797, swallowed up in a few seconds nearly 40,000 inhabitants; its vegetation; the remains of Peruvian architecture; and, above all, the manners of its antient inhabitants.

After two fruitless attempts, they succeeded in twice ascending to the crater of the volcano of Pinchinca, where they made experiments on the analysis of the air; its electric charge, magnetism, hygroscopy, electricity, and the temperature of boiling water. La Condamine saw the same crater, which he very properly compares to the chaos of the poets; but he was there without instruments, and could remain only some minutes.

In his time this immense mouth, hollowed out in basaltic porphyry,

porphyry, was cooled and filled with snow: our travellers found it again on fire; and this intelligence was distressing to the town of Quito, which is distant only about four or five thousand toises. Here M. Humboldt was in danger of losing his life. Being alone with an Indian, who was as little acquainted with the crater as himself, and walking over a fissure concealed by a thin stratum of congealed snow, he had almost fallen into it.

Our travellers, during their stay in the kingdom of Quito, made several excursions to the snowy mountains of Antisana, Cotopaxi, Tunguragua, and Chimborazo, which is the highest summit of our earth, and which the French academicians measured only by approximation. They examined in particular the geognostic part of the cordillera of the Andes, respecting which nothing has yet been published in Europe; mineralogy, as we may say, being newer than the voyage of La Condamine, whose universal genius and incredible activity embraced every thing else that could be interesting to the sciences. The trigonometrical and barometrical measurements of M. Humboldt have proved that some of these volcanoes, and especially that of Tunguragua, have become considerably lower since 1753; a result which accords with what the inhabitants of Pelileo and the plains of Tapia have observed.

M. Humboldt found that all these large masses were the work of crystallization. "Every thing I have seen," says he in a letter to Delametherie, "in these regions, where the highest elevations of the globe are situated, have confirmed me more and more in the grand idea that you threw out in your Theory of the Earth, the most complete work we have on that subject, in regard to the formation of mountains. All the masses of which they consist have united according to their affinities by the laws of attraction, and have formed these elevations, more or less considerable in different parts on the surface of the earth, by the laws of general crystallization. There can remain no doubt in this respect to the traveller who considers without prejudice these large masses. You will see in our relations that there is not one of the objects you treat of which we have not endeavoured to improve by our labours."

In all these excursions, begun in January 1802, our travellers were accompanied by M. Charles Montufar, son of the marquis de Selvalegre, of Quito, an individual zealous for the progress of the sciences, and who caused to be reconstructed, at his own expense, the pyramids of Sarouguier, the boundaries of the celebrated base of the French and Spanish academicians.

demicians. This interesting young man, having accompanied M. Humboldt during the rest of his expedition to Peru and the kingdom of Mexico, proceeded with him to Europe. The efforts of these three travellers were so much favoured by circumstances, that they reached the greatest heights to which man had ever attained in these mountains. On the volcano of Antisana they carried instruments 2200, and on Chimborazo June 23, 1802, 3300 feet higher than Condamine and Bouguer did on Corazon. They ascended to the height of 3036 toises above the level of the Pacific Ocean, where the blood issued from their eyes, lips, and gums, and where they experienced a cold not indicated by the thermometer, but which arose from the little caloric disengaged during the inspiration of air so much rarefied. A fissure eighty toises in depth and of great breadth prevented them from reaching the top of Chimborazo when they were distant from it only about 224 toises.

[To be continued.]

LXI. *On the Formation of Water by Compression; with Reflections on the Nature of the Electric Spark. Read before the National Institute by* M. Biot.

Some time ago, conversing with M. Berthollet on the nature and properties of heat, I told him I was convinced that the combination of hydrogen gas and oxygen gas might be determined without the aid of electricity, merely by the effect of very rapid compression. This result appeared to me to be so immediate a consequence of the observations already made on heat disengaged from air by compression, that I thought it superfluous to assure myself of it. But, having afterwards spoken of it to M. Laplace, he was so much interested in this object as to induce me to verify it. I therefore made the experiment, and it completely succeeded.

I took the barrel of an air-gun the breech of which was closed by a piece of very thick glass, in order that I might observe the light disengaged, as usual, by compression. The barrel was of iron, and was furnished on the side with a cock for introducing the gas, and its lower extremity towards the piston was surrounded by a cylinder of lead, sufficiently heavy to accelerate the fall and render the compression more rapid. This apparatus was first tried by introducing atmospheric air; but though we darkened the apartment no sensible light was perceived, because, in all probability,

probability, the violent motion necessary to compress with rapidity prevented us from seeing into the interior of the tube in a manner sufficiently direct to observe the fugitive light disengaged by the manifest compression, and which in other experiments I had myself seen.

After this trial we introduced into the tube a mixture of hydrogen and oxygen gas; gave a stroke with the piston, and there immediately appeared a bright flash. A strong detonation took place. The glass bottom was driven out; the copper ring by which it was screwed fast was broken; and the person who held the barrel had his hand slightly burnt and bruised by the force of the explosion.

We renewed the experiment, substituting for the glass bottom one of copper, made of one piece, and screwed in. Having then introduced into the barrel a new mixture of the two gases, an explosion similar to the smart crack of a whip was heard on the first stroke of the piston; but a second stroke given to the new gas made it detonate, and broke the barrel, or rather tore it, with a violent explosion.

After these phænomena no doubt could remain in regard to the combination of these two gases, since it is known it is that which produces the detonation by the immense quantity of heat disengaged when they pass to the liquid state: a heat which is sufficient to reduce them immediately into vapour, and to give them in that state an excessive dilatation. We did not then think it necessary to repeat any more this experiment, which is not free from danger.

The theory of these phænomena is exceedingly simple. A rapid compression forces the gas to abandon a very large quantity of heat, which, as it cannot be immediately dissipated, raises their temperature for a moment, and in that state of compression is sufficient to inflame them.

We find therefore in the two gases all the elements necessary for combining them, independently of the electric spark or external fire; and it is not improbable that all the gaseous combinations which require an elevation of temperature might be formed in the same manner without any foreign agent.

This identity of results suggested an idea which I submit to the opinion of philosophers. It is known, and M. Berthollet has shown in his *Statique Chimique*, that electricity in traversing bodies produces in their moleculæ a real compression. This effect is produced with prodigious velocity, as may be proved by a variety of experiments; but, as electricity has a similar velocity, it is impossible that it should not disengage light from the air, since we are able to disengage

engage it by a compression much less rapid. We are thus led to see in the electric spark a result purely mechanical.

If we now compare what takes place in the compressing-pump and Volta's eudiometer, the analogy is complete: only in the first case we are obliged to confine the air, because the velocity which we can give to the piston is limited; whereas in employing electricity the particles are compressed with a velocity so great, that they can never recede with so much speed as to withdraw themselves from its effort. The compression then, and also the disengagement of light, or the spark, which is the consequence of it, may take place as well in the open air. But this effect is local; and if the gases, not being susceptible of combining, should return, after each explosion, to their primitive dimensions, they would immediately resume in that state of dilatation all the heat at first disengaged from them, so that no lasting change could be effected in their constitution: and this serves to explain why no alteration has been observed in pure and unmixed gases when subjected to the action of the electric spark.

This light which electricity disengages from gases by compression would still be disengaged from those most rarefied, and in consequence of its extreme velocity it ought to disengage it even from vapours, if the experiment were made under a receiver or in the Torricellian vacuum; for we can never form a perfect vacuum with our machines, and even in the barometric tube there is always mercury in a state of vapour. This vapour, though highly rarefied, still contains a very large quantity of caloric, which electricity in its passage ought to disengage by compression; but the instantaneous increase of elasticity which thence results cannot become sensible, on account of the little density of the medium; whereas it becomes sensible in denser air, as seen in that instrument called Kinnersley's thermometer.

These considerations seem to me to indicate that the phænomenon called the electric spark arises from the light disengaged from the air by compression during the passage of electricity; so that this phænomenon is merely mechanical, and has nothing in it electric. Such is the idea which I submit to philosophers. If true, it tends to diminish considerably the number of the hypotheses already formed, and which might be formed on the nature of electricity. For this reason I thought it my duty to present it to their reflections; but I beg them to be persuaded that I shall attach no more importance to it than what they themselves shall give to it.

LXII. *No-*

LXII. *Notices respecting New Books.*

It has often been remarked as a singular circumstance, that during the last half century, while the practice of mechanics and the structure and operation of machines have received so many and such valuable improvements in this country, we have only had one treatise (that by Emerson) into which we can look for information both on the theory and the actual construction of machinery. Mr. Gregory, of the Royal Military Academy, Woolwich, has endeavoured to supply the deficiency just adverted to, and has now in the press a General Treatise of Mechanics, which is intended to be comprised in two volumes octavo. The first volume will be devoted chiefly to the theory, and will be divided into five books, under the several heads of Statics, Dynamics, Hydrostatics, Hydrodynamics, and Pneumatics. The second volume will be chiefly appropriated to the description of machinery, and will commence with some practical remarks on the application, improvement, and simplification of mechanical contrivances; on friction, the stiffness of ropes, the energy of different first movers, &c. And these will be followed by accounts, arranged alphabetically, of about one hundred of the most curious, useful, and important machines. In this latter part Mr. Gregory has been promised the assistance of some celebrated civil engineers; and the alphabetical arrangement (the only unfinished part of the work) will be completed in the course of the month of July, when he hopes he shall have received the communications of these gentlemen, or of any others who may favour him with descriptions of new and useful machines. The work is intended to be published before the end of the present year.

LXIII. *Proceedings of Learned Societies.*

ROYAL SOCIETY OF LONDON.

The Transactions of the Society for 1805, Part I., have just appeared. This Part contains:—The Croonian Lecture on muscular Motion. By Anthony Carlisle, Esq. F.R.S.—Experiments for ascertaining how far Telescopes will enable us to determine very small Angles, and to distinguish the real from the spurious Diameters of celestial and terrestrial Objects: with an Application of the Result of of these Experiments to a Series of Observations on the Nature and Magnitude of Mr. Harding's lately discovered Star. By William Herschel, LL.D. F.R.S.—An Essay on the Cohesion of Fluids. By Thomas Young, M.D. For. Sec. R.S.—Concerning the State in which the true Sap of Trees is deposited during Winter. In a Letter from Thomas Andrew Knight, Esq. to the Right Hon. Sir Joseph Banks, Bart, K.B. P.R.S.—On the Action of Platina and Mercury upon each other. By Richard Chenevix, Esq. F.R.S. M.R.I.A. &c.—An Investigation of all the Changes of the variable Star in Sobieski's Shield, from Five Years' Observations, exhibiting its proportional illuminated Parts, and its Irregularities of Rotation; with Conjectures respecting unenlightened heavenly Bodies. By Edward Pigott, Esq. In a Letter to the Right Hon. Sir Joseph Banks, K.B. P.R.S.—An Account of some analytical Experiments on a mineral Production from Devonshire, consisting principally of Alumine and Water. By Humphry Davy, Esq. F.R.S. Professor of Chemistry in the Royal Institution.—Experiments on Wootz. By Mr. David Mushet. Communicated by the Right Hon. Sir Joseph Banks, K.B. P.R.S.—Appendix.—Meteorological Journal kept at the Apartments of the Royal Society, by Order of the President and Council.

ACADEMY OF SCIENCES AT LISBON.

This society proposed the following subjects for prizes on the 18th of January last:

1st, The subjects proposed by the class of natural history are: the natural history and physical description of any province or considerable district of Portugal, or of any part of the Portuguese foreign possessions; also an economical description of the same kind.

In the department of agriculture, a particular prize is offered for a popular introduction, grounded on experience, to the improvement of agriculture in Portugal, written for agriculturists.

Another prize is proposed by a member of the academy, for an account of the physical and moral causes of the neglect of agriculture in Portugal, and of the most effectual means of applying a remedy; also a description of the present state of the breeding of sheep in Alentejo, and the cause of the increase or decrease of these animals since the middle of the 18th century; with an account of the most common diseases among sheep.

In the department of medicine: an account of the sym-

 ptoms

ptoms of the yellow fever; the most effectual remedies hitherto discovered for that disease; and the best preservatives.

2d, The Class of the Mathematical Sciences requires an application of analytical calculation to political economy in short and clear formulæ.

In mechanics: a complete theory of the balance, and its different forms: and for hydraulics, a plan of a canal, in order to employ the water of any river in Portúgal for watering the fields properly; with an exact calculation of the level.

3d, The Class of Literature: a history of the Portuguese export trade from the foundation of the monarchy to the present period.

Also a philosophical grammar of the Portuguese language.

And in poetry: a tragedy and a comedy in verse or in prose.

In national jurisprudence: an account of the nature and political effect of the old Foræ, or laws of commerce.

The common prize, which may be competed for by foreigners in the languages of Europe most generally used, is a gold medal of the value of 50,000 reis. The prize for the philosophical grammar of the Portuguese language is double.

ACADEMY OF SCIENCES AT COPENHAGEN.

On the 1st of March professor Bygge read in this society a letter from lieutenant Von Ohlsen, employed in the astronomical and geographical measurement of Iceland, containing an accurate description of the two remarkable hot springs in Iceland, the Geisser and Stork, the latter of which broke out in the year 1784, and spouted up to the height of 300 feet.

LXIV. *Intelligence and Miscellaneous Articles.*

NATURAL HISTORY.—FOSSIL BONES.

Cuvier has published in the Annals of the Museum of Natural History some curious researches in regard to the *Megalonix* and *Megatherium*, two large fossil animals, of the size of the ox and rhinoceros, no animals analogous to which now exist. M. Cuvier has determined the genus to which they ought to be referred.

He

He has accomplished this by his usual method, attending to the relations which exist between the different parts of the skeleton of each genus of animals; relations which are not eventual, but which, on the contrary, are connected with the whole of the organization; since from them result the animal's mode of life, its strength or its weakness, its agility or slowness; in a word, its whole nature, which is thus entirely impressed on the smallest of its bones.

The fragments of the megalonix hitherto discovered consist of some bones of the thighs or legs, and several phalanges, of which complete toes can be formed. These bones have been found in America, and we are indebted for the first publication of them to Mr. Jefferson, president of the United States, who thought he saw in them an animal of the genus of the lion. Cuvier now proves that these remains belong to an animal of the genus of the sloth.

He first proves it by the first fossil phalangium, which formed the extremity of the toe of a megalonix. This phalangium, examined successively on its six faces, exhibits six faces of the sloth, and excludes all other genera. The other phalanges of the same toe examined in the same manner, each in particular and independently of the rest, were also the phalanges of the sloth. These phalanges, when examined in their articulations, and the relation of their length, exhibit all the modifications by which this genus of animals is characterized.

From the perfect agreement of all these modifications, one may no doubt conclude, with Cuvier, that the toe formed by these phalanges was the toe of a sloth.

The phalanges of the second toe, when examined in like manner, lead to the same consequence. The insertion of these toes in the bone of the foot, the form of the facets where they are applied, and the remaining bones, all equally prove the same truth.

If one attend to this inevitable connexion of all the parts of animals, and their reciprocal dependence, it will not be necessary to see the other bones of the megalonix, to be sensible that the same conclusions ought to be admitted in regard to them. But Cuvier has had the advantage of being able to remove even the smallest scruple, by inspecting a fossil tooth of the megalonix brought from America by M. Palisot-Beauvois. This tooth is a tooth of the sloth; and this proof is equal to all the rest, since the teeth, by their influence on the system of nutrition, furnish the surest characters for the classification of animals.

What

What Cuvier has proved in regard to the megalonix, he before proved in regard to the megatherium. The remains of that animal found in Paraguay, show that it must have been of the size of the rhinoceros. An entire skeleton of it is preserved in the cabinet of Madrid. M. Cuvier, employing the same method and form of reasoning in regard to these bones, as those applied to the bones of the megalonix, establishes, with the same force of argument, that the megatherium ought to be placed also in the genus of the sloth.

These two large species, therefore, which have disappeared from the surface of the earth, were herbivorous, and it is difficult to conjecture by what causes they were annihilated. The neighbouring species, which still exist, are composed of animals much smaller.

The captain-general Ernouf, commandant of Guadaloupe, has written a letter to M. Faujas Saint Fond, dated 21st Messidor last, in which he communicates to him some observations of natural history, and among others the following note:

"Your son must have informed you, on his arrival in France, of the tour I made in the island, and that I visited the famous *Côte du Mole*, where are found bodies of the Caribs, enveloped in masses of petrified madrepore. I encouraged an active and intelligent individual, with a view of procuring some of these remarkable skeletons. The one in the best preservation I destine for the Museum of Natural History. I have given some negroes, who are stone-cutters, to the person who presides over this labour, which is attended with great difficulty in the execution: 1st, because these bones of the Caribs adhere to a bed of madrepores exceedingly hard, and which can be attacked only with the chisel; 2nd, Because the sea at every full tide covers the place where they are. I however hope to accomplish my end.

"These human remains are of a large size; the mass which must be extracted with them is about eight feet in length, and two and a half broad, and will weigh about 3000 pounds, but it can be easily transported by sea.

"Opinions are divided in regard to their origin: some say that a great battle was fought in this place between the natives of the island and those of another; others assert, that a fleet of piroguas perished in this spot, where the sea indeed breaks with great violence when the wind is strong; in the last place, others presume that it was the burying-place of the natives of the country, and that the sea may have encroached upon it; but all these are mere conjectures.

ANTIQUITIES.

M. Kaehler, who is on a tour through the Crimea at the expense of the Emperor of Russia, in a letter dated August 1804, at Sympheropol, says, That he has discovered several curious old inscriptions of the temple of Apollo, at Olbia, without which several antient coins could not have been ascribed to that city. He had found above 200 old and scarce coins of that district, among which was a very beautiful gold one of Olbia, the oldest of all the known coins belonging to this country; also, a beautiful gold figure of a syren, and a gold ear-ring, of excellent workmanship, both of Olbia, &c. This celebrated antiquary was expected to return to Petersburgh about the end of last year.

Some time ago, a peasant of the Veltschanskoi district, in the Ukraine, found, not far from the village of Schikailof, in ploughing a field, a copper vessel, covered with a great deal of rust, and of a form not used by the inhabitants of that district. This vessel contained a great number of antient Roman silver coins, of the size of a silver piece of ten copecs. The weight of the vessel was two pounds and a half, and that of the coins eleven. The latter, when cleaned, exhibited heads of Trajan, Vitellius, Nero, Anthony, and some of the early Roman emperors. The discovery of Roman coins in a district into which the Roman arms never penetrated, must appear as extraordinary as that of French coins of the fifteenth and sixteenth centuries, found the same year in the Ukraine, not far from Pultawa. But this circumstance may be explained, perhaps, by supposing that among the Poles who were expelled from their possessions about the middle of the seventeenth century, by the Cossacs of Lesser Russia, there were rich amateurs of antiquities, who had collected the above coins, and, in consequence of the disturbed state of the country, were obliged to bury them in the earth. The appearance of French coins in the Ukraine may be more easily comprehended, when it is recollected that Henry III. of France was in possession, for a short time, of the throne of Poland, and resided in that turbulent kingdom. It is very probable that a great many French coins were carried to Poland by his numerous followers, and that they were deposited by them in the places where they were found; a conjecture still further strengthened by many of them being

 inscribed

inscribed with the name of that prince, and none of them being older than the short period during which the prince of Anjou sat on the throne of Poland.

VACCINATION.

A letter from Copenhagen, dated April 27th, says, "The King has received with great satisfaction the last report of the commission for the vaccine inoculation, and at the same time resolved, that their labours shall be continued. He has given orders also, that the clergy, at baptisms, and on other proper occasions, shall recommend to parents to have their children inoculated, and that all medical men, when they establish themselves in business, shall enter into an engagement to promote vaccination as much as possible. According to a general estimate made in the report, 480 pieces of glass, with vaccine matter, have in the course of last year been distributed; namely, 230 to different places in Denmark; 117 to Norway; 39 to the Duchies; 30 to Iceland; 30 to Greenland; 4 to China; 8 to the East Indies, and the rest to Sweden. In Copenhagen, during the last year, 1007 persons were inoculated; and in the whole kingdom 7985; making altogether a total of 28966 inoculated in the three last years, since the introduction of this practice.

BOTANY.

In honour of Count Alexis Razumofsky, of Mosco, Professor Sprengel, of Halle, has given the name of *Razumovia* to a genus of plants belonging to the *Syngenesia Polygamia æqualis flosculosa*; and which stands next to the *Eupatorium* and *Piqueria*. Its generic characters are:

Calyx imbricatus, biflorus, squamis cariosis laxis.

Rec. nudum.

Papp. 0.

Sem. teretia, glandulosa.

The species is *Razumovia paniculata*.

M. Sprengel obtained it, by means of a friend, from the herbal of Sir Joseph Banks.

DEATH.

Professor Vahl, who died at Copenhagen on the 10th of December last, was born at Bergen, in Norway, on the 10th of October, 1749. In the year 1766 he left the school of Bergen, and entered at the university of Copenhagen, where he studied a year. From 1767 to 1769 he

 resided

resided in Norway, with the celebrated naturalist Professor Ström, and studied five years at Upsal, under Linnæus, whose friendship he had obtained. On his return to Copenhagen, in 1779, he became lecturer at the botanical garden, and in 1783 undertook, by command of the King, a tour through Holland, France, Spain, Barbary, Italy, Swisserland, and England. When he returned in 1785, he was nominated Professor, and appointed to superintend the publication of the *Flora Danica*. To qualify himself for discharging with more advantage this important task, he explored the coasts and mountains of Norway, as far as Wardoe. In the years 1799 and 1800 he undertook another tour, at the expense of government, to Holland and Paris, where he met with a most favourable reception. The French Directory made him a present of that scarce work *Plantes du Roi*, which had been destined for him by the celebrated Malherbes, in the time of Louis XVI. When he returned from this tour, he was appointed Professor of Botany, and obtained the management of the botanical garden belonging to the university. For some years Madame Buonaparte sent him, in a most flattering manner, the numbers of the *Jardin de Malmaison*, as they were published, and those of Redouté's *Liliacées*. Though Professor Vahl had devoted himself to botany, he did not neglect the other departments of natural history. He had a share in the *Zoologia Danica*, and the *Icones* of Ascanius, director of mines. Cuvier received from him contributions towards his History of the red-blooded animals, and Fabricius towards his History of insects. During his travels he collected a considerable herbal, which, by the abundant contributions of his friends in every part of the world, increased to an uncommon magnitude, and was scarcely equalled by any, on account of the multitude of plants, and their proper arrangement. He had an extensive knowledge of bibliography, and the history of literature, had read much, and with great diligence. His last work, *Enumeratio Plantarum*, was interrupted by his death.

LIST OF PATENTS FOR NEW INVENTIONS.

[Continued from p. 95.]

James Fullarton, surgeon in the navy, for a diving-machine or apparatus, upon an improved construction, applicable to various useful purposes.

Christopher Perkins, of Stockton, in the county of Durham, builder; for a machine for thrashing corn and pulse.

James Ryan, of Doonane, in the Queen's county, Ireland, engineer to the undertakers of the grand canal; for sundry tools, implements, or apparatus for boring the earth for coal, and all kinds of minerals and subterraneous substances, by which the different strata may be cut out in a cheap and expeditious manner, in cores or cylinders, from one inch to twenty inches and upwards in length, and from two inches to twenty inches and upwards in diameter, so as to be taken up entire at any depth that has hitherto been bored; by which, not only the quality of such minerals and substances, but also the declination or dip of the strata, can be ascertained beyond a possibility of mistake; and which tools, implements, or apparatus, are also advantageously applicable to the purpose of sinking for wells, and giving vent to subterraneous water in bogs, and draining mines and grounds, and ventilating pits, and other beneficial purposes.

Charles Coe, of the parish of St. Mary Whitechapel, in the county of Middlesex, baker; for a flue upon an improved construction, applicable to the heating of ovens, or any other thing that requires an uniform heat.

William Martin, of Houghton Pans, in the county of Northumberland, rope maker; for a mode of fastening shoes to the feet of men, women, and children.

George Dodd, of Great Ormond-street, in the county of Middlesex, engineer; for improvements on the Royal York gun-lock, other gun-locks, and the locks of all description of fire-arms.

John Robert Irving, of the city of Edinburgh, advocate, and Isabel Lovi, of the city of Edinburgh aforesaid, worker in glass; for an improved apparatus for determining the specific gravity of fluid bodies, and the relation that their weight bears to a given measure.

John Baptiste Denize, of West-street, Somers Town, in the county of Middlesex, chemist; for a mode of procuring a greater quantity of resinous, bituminous, and oily substances from various articles.

Archibald Blair, of Bayford, in the county of Herts, Esquire; for a method of retaining cotton and other elastic substances when pressed by means of wrappers.

William Bell, of the town of Derby, engineer; for an improved method of manufacturing blanks or moulds for knife, razor, and scissar blades, and various other edged tools, and of forks, files, and nails.

Thomas Jones, of Bilstone, in the county of Stafford, japanner; for compositions for the purpose of making trays, waiters, and various other articles, and new modes or methods of manufacturing the same, that is to say, by presses and stamps.

Richard Brandon, the elder, of Lucas-street, in the parish of St. Mary Rotherhithe, in the county of Surrey; for a composition from British herbs and plants for the cure of the evil, scrophula, scurvy, leprosy, gout, and rheumatism, and which he has denominated and called *Brandon's British Constitutional Pills, and Liquid and Botanic Ointment*, and which in upwards of 3000 cases has been attended with the most unparalleled success in the course of the last nine months.

Jonathan Hornblower, of the borough of Penryn, in the county of Cornwall, engineer; for a steam-wheel or engine for raising water, and for other useful purposes, in arts and manufactures, by means of steam.

Stuart Arnold, of Wakefield, in the county of York, gentleman; for a chimney safe-guard, for the preservation of houses and buildings from fire, robbery, and foul air.

George Alexander Bond, of Hatton Garden in the parish of St. Andrew Holborn, in the county of Middlesex, gentleman; for certain improvements in the construction of clocks and other time-pieces, whereby they are rendered of much greater utility and service both by sea and land than any heretofore made use of.

Job Rider, of Belfast, in the county of Antrim, in that part of the united kingdom called Ireland, clock and watch-maker; for certain improvements on the steam-engine.

Willis Earle, of Liverpool, in the county of Lancaster, merchant; for improvements in the mode of constructing and working steam-engines.

Sir George Wright, of Ray Lodge, in the county of Essex, baronet; for an instrument or machine for cutting out of solid stone, wood, or other materials, pillars and tubes, either cylindrical or conical, with great saving of labour and materials.

METEORO-

METEOROLOGICAL TABLE

By Mr. Carey, of the Strand,

For May 1805.

Days of the Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock, Night.	Height of the Barom. Inches.	Degrees of Dryness by Leslie's Hygrometer.	Weather.
April 26	42°	52°	40°	29·54	29°	Cloudy
27	40	50	45	·67	30	Cloudy
28	35	43	40	·76	19	Cloudy
29	34	40	35	·30	0	Rain and snow
30	38	48	40	·64	47	Fair
May 1	41	50	42	·59	42	Fair
2	40	48	41	·50	31	Fair
3	42	56	42	·58	32	Fair
4	43	59	46	·78	54	Fair
5	47	56	44	·87	43	Fair
6	47	61	50	·97	37	Fair
7	52	59	49	·87	25	Showery
8	50	45	39	·48	0	Rain
9	40	49	45	·70	35	Fair
10	49	58	49	·52	35	Showery
11	49	56	44	·29	40	Stormy
12	45	55	44	·53	37	Showery
13	49	59	46	30·04	60	Fair
14	47	56	43	·10	41	Fair
15	46	53	46	29·79	28	Cloudy
16	49	64	52	·75	39	Fair
17	52	58	51	·89	25	Cloudy
18	52	58	54	·98	29	Cloudy
19	55	61	53	·92	25	Cloudy
20	54	61	51	30·01	26	Cloudy
21	50	60	55	·04	35	Fair
22	56	65	46	29·79	40	Fair
23	46	51	40	·80	52	Fair
24	44	57	51	·95	58	Fair
25	51	63	50	·96	53	Fair
26	49	60	48	·95	39	Fair

N. B. The barometer's height is taken at noon.

INDEX TO VOL. XXI.

Chaumeton

Hand-mill.

Society

END OF THE TWENTY-FIRST VOLUME.

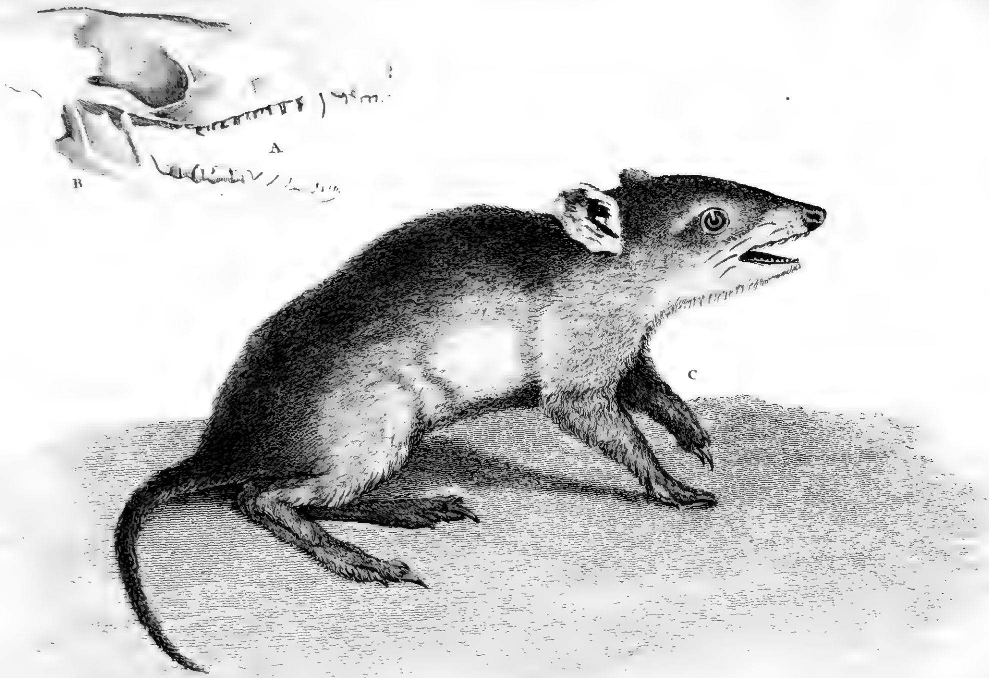
ERRATA.

In our 19th volume, p. 311, the 7th line from the bottom, for *four minutes* read *eight minutes*.

In the present volume, p. 254, to the title of the article on a Safety-valve add,—*By the Chevalier Edelcrantz, of Sweden.*

Printed by R. Taylor and Co., 38, Shoe Lane, Fleet Street.

PERAMELES NASUTA.



PERAMELES OBESULA.

Fig. 1.

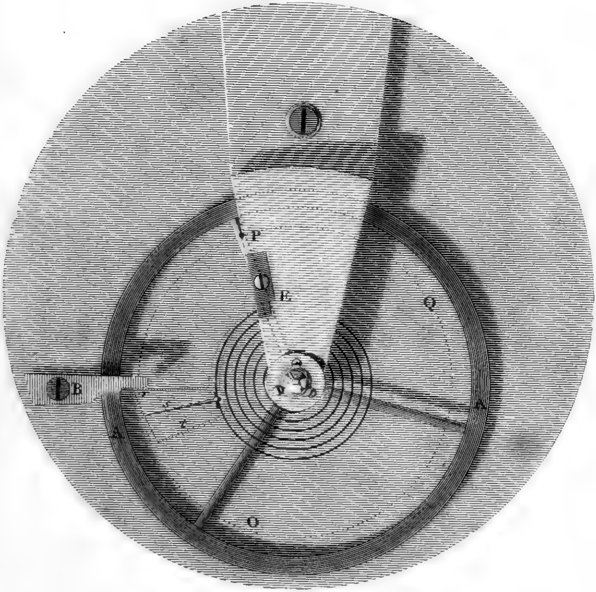
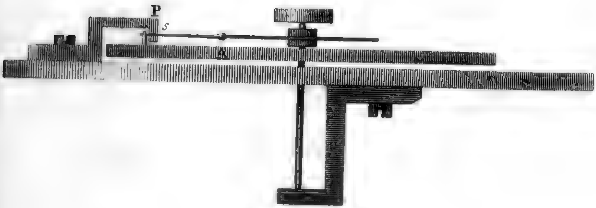
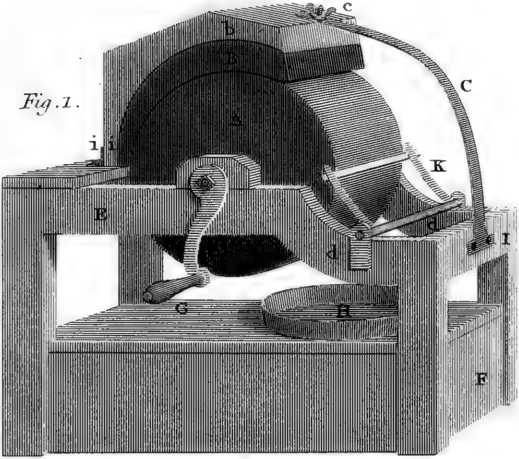


Fig. 2.



Mr. Rawlinsons Colour Mill.

Fig. 1.



Improved Indigo Mill.

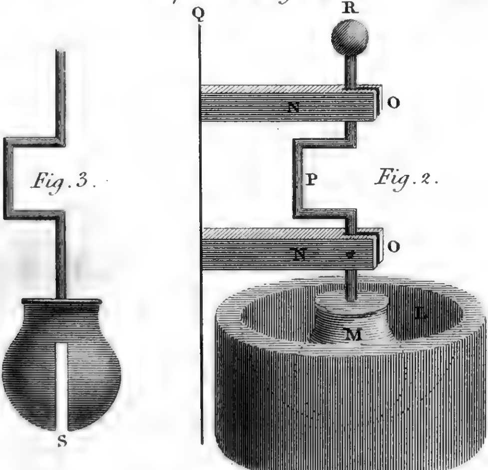
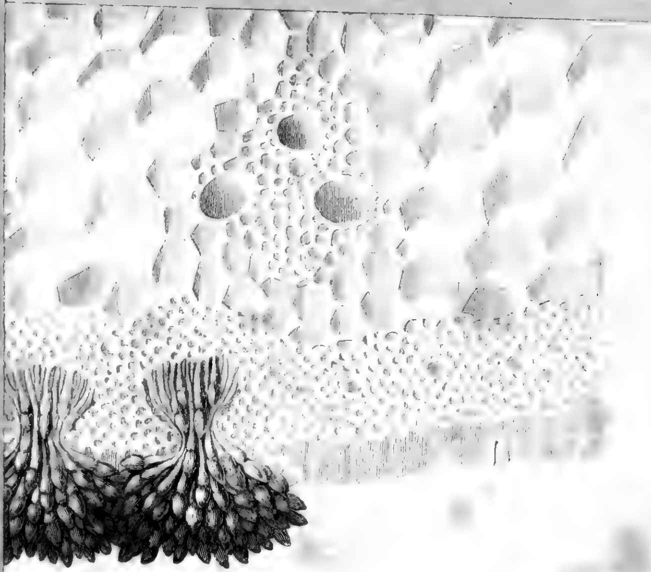


Fig. 3.

Fig. 2.



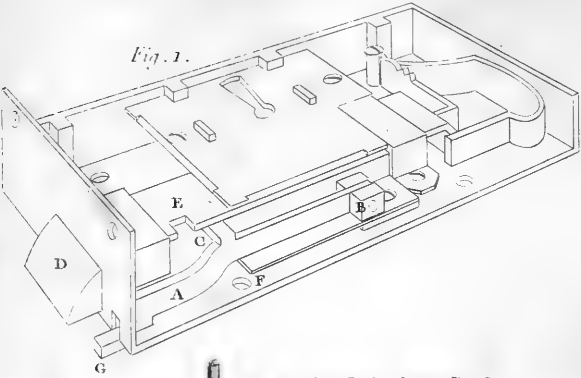
t which causes the Blight in Corn.

Lowry sculp

Representations of the Parasitic Plant which causes the Blight in Corn

Mr. Bullock's Drawback Lock.

Fig. 1.



Mr. Wm. Bowler's Screw Press.

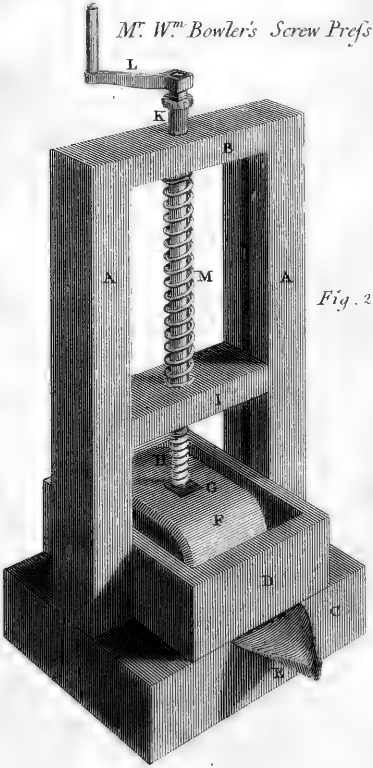
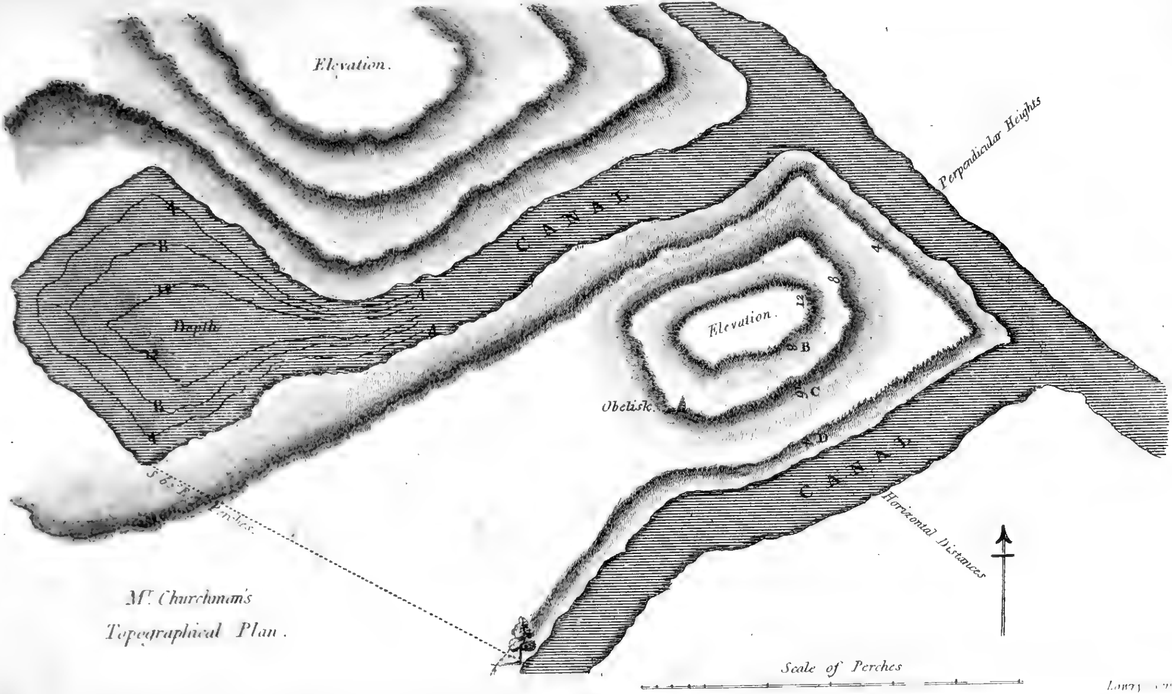


Fig. 2.

Fig. 3.

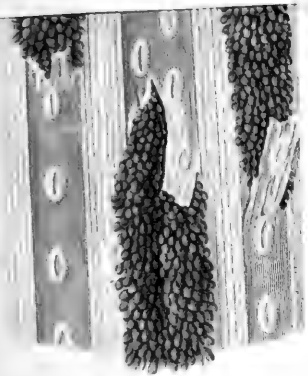
Lowry sculp.

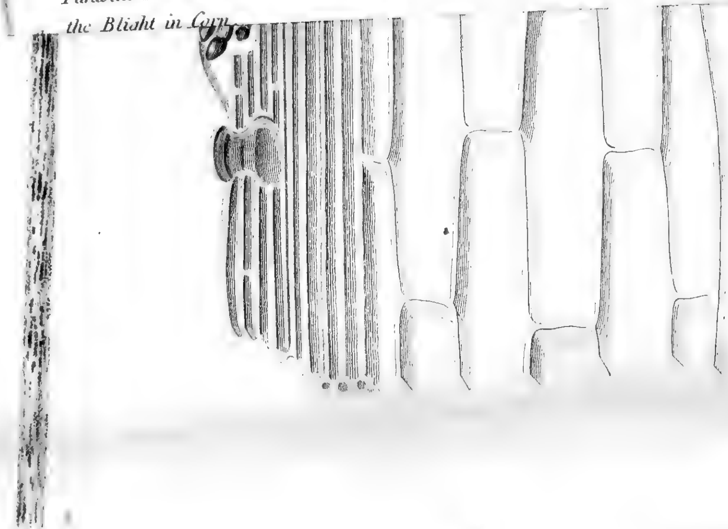


Mr. Churchman's
Topographical Plan.

Lowry sculp.

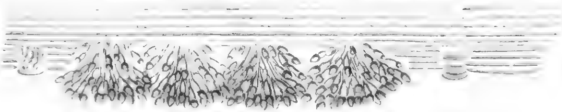
Representations of the Parasitic Plant which causes the Blight in Corn.

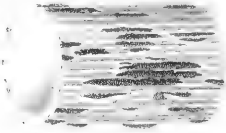


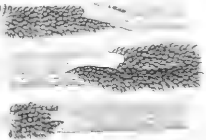


Bauer del.

Lowry sculp.







Chevalier Edelcrantz's Valves for Steam Engines.

Fig. 3.

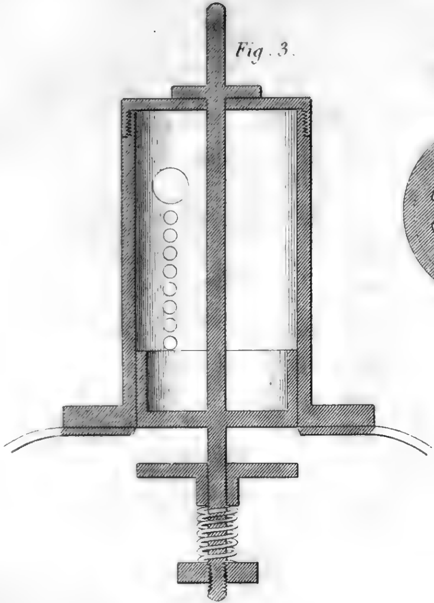


Fig. 2.

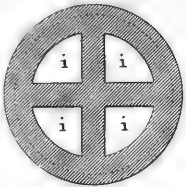
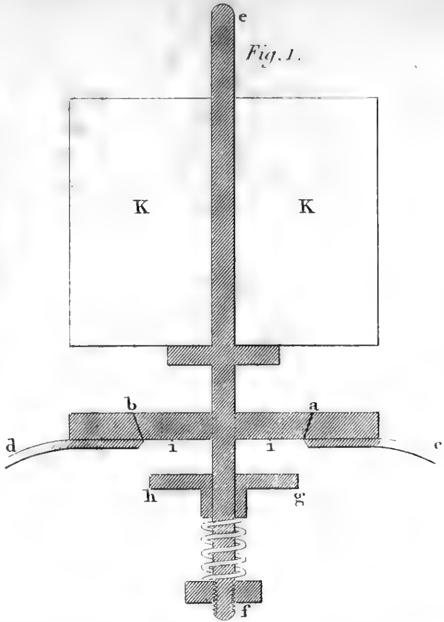


Fig. 1.



Lowry sculp.

*** For the Contents of No. 84, see the middle of the last sheet, from Article LIII. to the end.

THEATRE OF ANATOMY,

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The Summer Course of Lectures on Anatomy, Physiology, and Surgery, will commence on Saturday, the 8th of June, at Two o'Clock in the Afternoon, and will be continued on Monday the 10th, and every subsequent Morning at Seven, Sundays excepted,

By Mr. BROOKES.

IN these Lectures the Structure of the Human Body will be demonstrated on recent Subjects, and further illustrated by Preparations, and the Functions of the different Organs will be explained.

The Surgical Operations are performed, and every Part of Surgery so elucidated, as may best tend to complete the Operating Surgeon.

The Art of Injecting, and of making Anatomical Preparations, will be taught practically.

Gentlemen zealous in the pursuit of Zoology will meet with uncommon opportunities of prosecuting their researches in Comparative Anatomy.

Surgeons in the Army and Navy may be assisted in renewing their Anatomical Knowledge, and every possible attention will be paid to their Accommodation as well as Instruction.

Anatomical Conversaziones will be held Weekly, when the different Subjects treated of will be discussed familiarly, and the Students' views forwarded.. To these none but Pupils can be admitted.

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An extensive Museum, containing Preparations illustrative of every Part of the Human Body, and its Diseases, is attached to the Theatre, to which Students will have occasional admittance. Gentlemen inclined to support this Medical School by contributing preternatural or morbid Parts, Subjects in Natural History, &c. (individually of little value to the possessors,) may have the pleasure of seeing them preserved, arranged, and registered with the names of the Donors.

The inconveniences usually attending Anatomical Investigations, are counteracted by an Antiseptic Process, the result of Experiments made by Mr. Brookes on Human Subjects, at Paris, in the year 1782; the account of which was delivered to the Royal Society, and read on the 17th of June 1784. This method has since been so far improved, that the florid colour of the Muscles is preserved, and even heightened.

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Gentlemen established in Practice, desirous of renewing their Anatomical Knowledge, may be accommodated with an Apartment to Dissect in privately.

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