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INTRODUCTION

TO VOL. THE THIRD.

An Eſſay on thoſe inquiries in Natural Philoſophy, which at preſent are moſt beneficial to the UNITED STATES OF NORTH AMERICA. *By* DR. NICHOLAS COLLIN, *Rector of the Swediſh Churches in Pennſylvania.*

Read before the Society the 3d of April, 1789.

PHILOSOPHERS are citizens of the world; the fruits of their labours are freely diſtributed among all nations; what they ſow is reaped by the antipodes, and blooms through future generations. It is, however, their duty to cultivate with peculiar attention thoſe parts of ſcience, which are moſt beneficial to that country in which Providence has appointed their earthly ſtations. Patriotic affections are in this, as in other inſtances, conducive to the general happineſs of mankind, becauſe we have the beſt means of inveſtigating thoſe objects, which are moſt intereſting to us. In the preſent circumſtances of the United States ſome problems of natural philoſophy are of peculiar importance; a ſurvey of theſe may contribute to the moſt uſeful direction of our own inquiries, and thoſe of our ingenious fellow citizens. I ſubmit, gentlemen, my reflections on this ſubject to your candid indulgence and enlightened judgment.

1. *ARTICLE, Medical Enquiries.*

All countries have ſome peculiar diſeaſes, ariſing from the climate, manner of living, occupations, predominant paſſions, and other cauſes, whoſe ſeparate and combined influence is but imperfectly known. In North America we may count five—nervous diſorders, rheumatiſm, intermitting fevers, loſs of teeth, and colds. It is remarkable that nervous complaints are at preſent more frequent in Europe than they formerly were. They ſpring in a great meaſure from the indulgencies of a civilized life; but in America theſe fiends infeſt with leſs diſcrimination the dwellings of induſtry and temperance. Proteus-like they aſſume every ſhape, and often baffle the beſt phyſicians. Their baneful effect on the mind requires the ſerious attention of legiſlators, divines, and moral philoſophers: I have myſelf often ſeen their amazing influence on religious ſentiments. When extreme, they derange the whole ſyſtem; obſcure the intelects, bewilder the imagination; prevent the natural order and operation of all the paſſions: the ſoul vibrates between apathy and morbid ſenſibility: ſhe hates when ſhe ſhould love; and grieves when ſhe ought to rejoice: ſhe reſembles a diſordered clock, that after a long ſilence chimes till you are tired, and often inſtead of one ſtrikes twelve— Theſe extremes are indeed rare; but the more general degrees are ſtill analogous, and produce a great ſum of evil.

Slight rheumatic pains are almoſt epidemic in ſome ſeaſons of the year. Yet, theſe are ſcarcely worth mentioning in compariſon to the ſevere fits that afflict a great number of perſons, even in the earlier parts of life, growing more frequent and violent with age; not ſeldom attended with lameneſs, and contraction of limbs.

Fever and ague is here, as in other countries, the plague of marſhy and fenny ſituations, but what is ſingular, it alſo viſits the borders of limpid ſtreams. The leſſer degree of it generally called *dumb ague*, is not rare in the moſt ſalubrious places during the months of September and October. Through all the low countries from north to ſouth this diſeaſe rages in a variety of hideous forms; and chiefly doth the fury *quartan* with livid hue, haggard looks, and trembling ſkeleton-limbs, embitter the life of multitudes: I have known many to linger under it for years, and become ſo diſpirited, as not even to ſeek any remedy. It is a foul ſource of many other diſeaſes; often terminating in deadly dropſies and conſumptions.

Premature loſs of teeth is in many reſpects a ſevere misfortune. By impairing maſtication, and conſequently digeſtion, it diſpoſes for many diſorders. It injures the pronunciation; and is a particular diſadvantage in a great republic, where ſo many citizens are public ſpeakers. It expoſes the mouth and throat to cold, and various accidents. It diminiſhes the pleaſure of eating, which is a real though not ſublime, pleaſure of life; and which I have heard ſome perſons very emphatically regret. Finally, it is a mortifying ſtroke to beauty; and as ſuch deeply felt by the fair ſex! Indeed that man muſt be a ſtoic, who can without pity behold a blooming maiden of eighteen afflicted by this infirmity

of

of old age! This consideration is the more important, as the amiable affections of the human soul are not less expressed by the traits and motions of the lips, than by the beaming eye. I have not mentioned the pains of tooth-ach, because they are not more common or violent in this country than in some others, where loss of teeth is rare; many persons here losing their teeth without much pain, as I have myself experienced.

The complaint of *catching cold* is heard almost every day, and in every company. This extraordinary disorder, little known in some countries, is also very common in England. An eminent physician of that country said that "colds kill more people than the plague". Indeed many severe disorders originate from it among us: it is probably often the source of the before mentioned chronic diseases. When it does not produce such funest effects, it is nevertheless a serious evil; being attended with loss of appetite, hoarseness, sore eyes, head-ach, pains and swellings in the face, tooth and ear-ach, rheums, listless langour and *lowness of spirits*: wherefore *Shenstone* had some reason to call this uneasiness *a checked perspiration*. Great numbers in the United States experience more or less these symptoms, and are in some degree valetudinarians for one third of the year.

Eminent medical authors have indeed treated of these distempers; and some American physicians deserve applause for their theoretical and practical exertions. Still, it is devoutly to be wished that these national evils may draw a more pointed attention. The limits of my design permit only a few additional remarks.

These distempers frequently co-exist in the most unhealthy parts of the country; and not seldom afflict individuals with united force. Compassion for suffering fellow citizens ought in this case to animate our investigation of those general and complicated local causes. The extreme variableness of the weather is universally deemed a principal and general cause of colds, and of the disorders by them produced; the fall and rise of the thermometer by 20 a 30 degrees within less than four and twenty hours, disturbing the strongest constitutions, and ruining the weak. A most important desideratum is therefore the art of hardening the bodily system against these violent impressions; or, in other words, accommodating it to the climate. The general stamina of strength support it under the excesses of both cold and heat. The latter is, however, the most oppressive as we can less elude it by artificial conveniencies. We suffer

especially

eſpecially during the ſummer four, til 6 a 8, critical extremes, when the thermometer after 86 a 92 degrees, falls ſuddenly to 60. Could means be found to blunt theſe attacks on the human conſtitution, they would ſave multitudes from death and lingering diſeaſes. Sometimes this criſis happens as late as medium September, and is in a few days ſucceeded by the autumnal froſts: in ſuch caſe weak perſons receive a ſhock, from which they cannot recover during the autumn, and which will aggravate the maladies of the winter, eſpecially when it is early and rigorous.

Searching for general cauſes of the mentioned diſtempers in the popular diet, we ſhould examine the following circumſtances—exceſſive uſe of animal food, eſpecially pork: the common drink of inferior ſpiritous liquors both foreign and home made; not to mention a too frequent intemperance even in the beſt kinds: the conſtant uſe of tea among the fair ſex, drank generally very hot and ſtrong; and often by the poorer claſſes, of a bad quality.

In the general modes of dreſs we plainly diſcern theſe defects:—the tight-bodied clothes, worn by both ſexes, encreaſe the heat of a ſultry ſummer; the cloſe lacing and cumberſome head-dreſſes of the ladies are eſpecially injurious to health. The winter-cloathing is too thin for the climate of the northern and middle ſtates, which is for ſeveral months at times equally cold with the North of Europe. Few perſons preſerve their feet from the baneful dampneſs of the ſluſh occaſioned by the frequent viciſſitudes of hard froſts and heavy rains during the winter: women generally wear ſtuff-ſhoes: the American leather, though otherwiſe good, is very ſpungy; a defect owing to the precipitate proceſs of tanning. Nor does either ſex guard the head againſt the piercing north-weſt wind which is ſo general for five or ſix months: on journeys eſpecially, the men ſhould exchange their hats for caps that cover the ears and cheeks.

In the modes of lodging theſe improprieties are obſervable:—the poorer, or more indolent people, eſpecially in the leſs improved parts of the country, frequently dwell in houſes that are open to the driving ſnow, and chilling blaſt: good houſes often want cloſe doors; a chaſm of ſix or eight inches near the floor admits a ſtrong current of cold air, which ſenſibly affects the legs. Such houſes cannot be ſufficiently warmed by the common fire-places; hence the frequent complaint, that the fore part of the body is almoſt roaſted, while the back is freezing: a ſituation very unnatural, productive of rheumatiſm and other diſtempers. The

larger

larger towns of North-America have, with their ſpacious ſtreets, a number of narrow alleys; which are peculiarly detrimental in a ſultry climate, and in co-operation with the ſlovenly habits of their poorer inmates, are nurſeries of diſeaſe.

Among the general cuſtoms which may influence health, the moſt ſtriking is an exceſſive, and in ſome caſes ill-judged cleanlineſs: the continual waſhing of houſes, eſpecially in the cold ſeaſon, has, I am confident, coſt the lives of many eſtimable women, and entailed painful diſeaſes on their families.

In the buſineſs of life we often remark a very irregular application; indolence ſucceeded by hurry and intenſe fatigue. This muſt particularly injure our huſbandmen, as the neglect of a day may damage a precious crop, if it is not compenſated by exertions, which in the ſultry heat of ſummer are very trying to the ſtrongeſt conſtitution.

As to nervous diſorders, philanthropy compells me to remark, that, beſides their general connexion with a ſickly conſtitution, they have in a great meaſure originated from two ſingular cauſes. One is the convulſion of public affairs for a conſiderable time paſt, which occaſioned many and great domeſtic diſtreſſes: the natural events of the late war are univerſally known: numbers of virtuous citizens have alſo felt the dire effects of the ſucceeding anarchy; eſpecially in the loſs of property.* The operations of this cauſe are, however, continually leſſened by time that cures our griefs, or buries them in the grave; and ſuch evils will under Providence be for ever prevented by the new confederation of the United-States— The other cauſe is that gloomy ſuperſtition diſſeminated by ignorant illiberal preachers; the bane of ſocial joy, of real virtue, and of a manly ſpirit. This phantom of darkneſs will be diſpelled by the rays of ſcience, and the bright charms of riſing civilization.†

2. *ARTICLE, Inquiries relative to rural œconomy.*

The United States poſſeſs a vaſt territory fertile in many valuable productions. They will therefore, if truly wise, make agriculture the principal ſource of proſperity and wealth: to prefer other objects, however uſeful in a ſecondary view, would be perverting the order of nature, nay,

* Not by violence, but the well known diſorders of paper money in various forms.

† It is pleaſing to ſee how fanaticiſm declines with agricultural improvement in many new ſettlements; and how refinement of public manners keeps pace with a preference of enlightened teachers.

ny, oppoſing the will of nature's God. Agriculture has made a wonderful progreſs in ſeveral countries, ſince it became the buſineſs and favourite amuſement of philoſophers and men of taſte. We may reap great advantage from the many excellent writings on this ſubject in the Engliſh, French, German, and Swediſh languages; but much improvement is yet wanting in every part of this noble ſcience. Beſides, our local circumſtances require in ſome caſes peculiar methods. The United States extend through ſeveral climates; and the general irregularity of the ſeaſons mingles the diverſity of climate in every ſtate: Pennſylvania f. e. has often within two or three months the climates of Sweden, England, and Italy. This points out the propriety of adopting ſome practices from different countries, and eſtabliſhing others as our own.

On our tillage the following remarks appear to me very intereſting.—The ſucceſſion of ſevere froſts and deep thaws during winter in all the northern and middle ſtates makes a variety of drains neceſſary in moſt ſoils and ſituations; yet an almoſt general neglect of this deſtroys a great part of the ſeed: a judicious treatiſe on the forms and courſes of ſuch drains would be very uſeful. A large portion of the arable lands in this and ſome other ſtates being hilly, is detrimentally waſhed by heavy rains in every ſeaſon of the year: eſpecially is the manure thereby totally loſt. This would be much prevented by tranſverſe ploughing in a proper degree of horizontal inclination, which may be traced by computing the force and quantity of the water..

The Indian corn * is an eſſential article among American grains; and peculiarly ſuitable to an extenſive country. It might be raiſed at ſo moderate a price as to bear exportation to Europe; in the northern parts of which it would be very valuable as nouriſhment for domeſtic animals during the long winter. The mode of planting this grain by four or five ſeeds together in hills at the diſtance of ſeveral feet, appears leſs reaſonable from the conſideration, that one part of the ground is left vacant, while the other is over charged; that the contiguous ſtalks muſt impede each other; that their ſpindling height, and cloſe poſition ſubjects them more to the high winds, which not unfrequently ſweep down whole fields. I am informed by natives of Italy, that in that country the corn is planted ſo as to cover the ground equally, with convenient intervals for weeding.

The culture of meadows has gained a conſiderable perfection in the middle ſtates; but ſtill is capable of much improvement. We muſt diſcover

* Maize or zea.

cover a mode of banking effectual againſt the floods that often ruin the beſt marſh-meadows: in open ſituations a cloſe row of ſome aquatic trees beyond the bank is indiſpenſible for breaking the force of a ſtormy tide. We want graſſes that will flouriſh in dry and ſandy ſoils: ſuch f. é. as were lately introduced in Spain, and are ſaid to have proved ſo beneficial to that dry and warm country.

The heat of our ſummers is unfavourable to graſs, where the ground, though fertile, has not a degree of moiſture; it is therefore adviſeable to try, whether barley, rye, or wheat, if cut young, would make good hay; and whether a ſecond crop or the ſucceeding paſture, may help to make a full compenſation for an eventual harveſt? I remember to have heard this method much recommended by ſome cultivators in a European country. The diviſion of paſture grounds by encloſures is generally neglected. Clean feeding is an advantage of admitting cattle, horſes, and ſheep in rotation, that deſerves attention.

The value of land, and cloſe neighbourhood, makes good fences very neceſſary in old ſettlements. Worm-fencing and ſimilar expedients of infant cultivation, ſhould never be ſeen; they occaſion loſſes, vexation and contention. The regular frames of rails and boards would be much improved by hardening againſt heat and moiſture: to render the lower part of the poſt more durable, burning, encruſting with mortar, and ſoaking in ſalt water, are expedients partly uſed, and worthy of trial. Live hedges are in general preferable to any, but yet very rare; though the country preſents many ſhrubs of promiſing qualities.

The vaſt domains of the United States can vie with any country in the variety, utility, and beauty of trees and ſhrubs. Our ſtately foreſts are a national treaſure, deſerving the ſolicitous care of the patriotic philoſopher and politician. Hitherto they have been too much abandoned to the axes of rude and thoughtleſs wood-choppers. What perſon of ſenſe and feeling can without indignation behold millions of young oaks and hickories deſtroyed, to make bonfires in open ſmoaky houſes, or trucked in the cities for foreign toys! ſome parts of Europe were thus laid waſte in former centuries; and the preſent generations muſt with great labour and expenſe repair the ravages of their forefathers. In many parts of this country a preſervation and encreaſe of the timber for fuel and other domeſtic uſes renders theſe queries important.—What trees are of the quickeſt growth? at what age do they encreaſe moſt? what is the proper diſtance between them? what is the beſt mode of pruning, for promoting the growth, and taking off all ſuperfluous branches? what kinds are ſuitable to different ſoils? what ſpecies thrive beſt together? a judicious lopping of the branches, thinning cloſe the clumps of trees, and clearing the ground of underwood, will make many woodlands good pastures, and form them into beautiful parks. This management would alſo improve the quality of timber by procuring the benefit of ſun and air: the want of this may be regarded as one principal cauſe of the ſpungineſs of our timber, which defect ſo inimical to durability, ſtrength, and preſervation of a given form, is further encreaſed by a too common ignorance or neglect of the proper ſeaſon for ſelling the materials of building, furniture, ſtaves and various utenſils. Some valuable trees and ſhrubs are yet obſcurely known: among theſe the ſo called *coffee-tree* * in the weſtern country, that bears a hard nut, the kernel of which is generally uſed by the inhabitants as a ſubſtitute for coffee; the native plumb trees on the Miſſiſſippi, ſaid to be far ſuperior to thoſe in the middle ſtates; the newly diſcovered and much extolled grape of Scioto.† Many of thoſe which have long been familiar to us, ſtill poſſeſs uſeful qualities little explored. Oil might be extracted from acorns, and eſpecially from the large and greaſy ſpecies of the cheſnut-oak; as lately, though but in few places, is done from the various kinds of walnuts. Spirits may be diſtilled from the berries of the red cedar, which ſo much reſſemble thoſe of the European Juniper. Wine far better, than what is generally done, can be made from the late grapes, as I know by my own experiments. From all kinds of grapes, the Perſimon fruit, the berries of the ſour-gum, ‡ and white-thorn,§ the crab-apple, the wild-pears, plumbs, and cherries, with ſimilar fruits, ſpirituous liquor, and vinegar may be obtained. This white-thorn will, if it can be kept cloſe and low, make an impenetrable and beautiful hedge, by its long ſharp and ſolid ſpears, and by its cluſtering bloſſoms and large red berries. The new experiment of grafting foreign kinds on our native grape-wines, ſaid to be very promiſing, may prove a good preſervative againſt the rigour of winter. In all probability many ſpecies of leaves would make good fodder for cattle, if gathered in the proper ſeaſon, and well cured: this expedient practiſed in the north of Europe* is of great importance to one half of the American ſtates, which have according to ſituation no paſture

for

* Guilandia.

† A branch of the Ohio.

‡ Nyſſa

§ Crus gally.

* Aſpin leaves f. e. are a pleaſing and ſalutary food for horſes.

for five a feven months. Finally we may fincerely wifh that the owners of venerable woodlands might regard them as principal ornaments of their country; and while they clear a part for the purpofes of agriculture, leave thefe hills crowned with towering pines, and manly oaks; fuffering likewife the groves of tulip-trees and magnolias to wave among yellow harvefts and blooming meadows. In fome of the old countries many gentlemen would purchafe fuch rural charms at any expenfe, but muft wait till the evening of life for the fhade of their plantations; is it not then deplorable, that fo many American farmers daily deftroy what their offspring of better tafte will deeply regret! this evil might in a great meafure be leffened by a *treatife on ornamental planting* adapted to the prefent circumftances of this country.

Half a century ago, philofophers thought it beneath them to inveftigate the œconomy of domeftic animals. By this ridiculous pride European countries have fuffered much. The Swedifh naturalifts were roufed near thirty years ago, to a ferious attention, by a peftilence among horfes and horned cattle, which deftroyed many thoufands in fome provinces. In America, this important fcience has been much neglected. Not to enlarge upon a fubject which efpecially concerns agricultural focieties, I fhall only mention two or three particulars—This country is not unfavourable to horfes; yet thofe of good quality are not very common, becaufe the natural hiftory of thefe noble animals is but little cultivated. They are often difabled by want of proper care; and perifh by various diforders; efpecially by fwelling in the throat, cholic, and the botts.* Sheep thrive well in fome parts, but in others I have feen them die by dozens, without the owners knowing or inquiring into the caufe.

Horned cattle fuffer much when expofed to the winter's cold, which deftroys their hoofs even under the 39 degree. Both they and horfes are affected by excefs of heat in fummer: which not feldom caufes a fever, difcernible by their want of appetite, dullnefs, and a yellow tinge of the mouth and eyes. The beft European treatifes on domeftic animals will more or lefs apply to diverfe parts of this country: a book written on fheep, in Swedifh, by Haftfer, has great merit, and is applicable to the colder ftates.

Goats would be very valuable in the rocky woodlands of America, as they are in thofe of Europe. They are very hardy: their maintenance is cheap, as they browfe fummer and winter on moft kinds of trees and

 fhrubs;

* A kind of worms that devours their maw.

ſhrubs: they yield a great quantity of rich milk: and their ſkins are very uſeful.* The Angora goat, whoſe fine gloſſy hair is a material of the mohair, may alſo thrive as well here as in Sweden, where he was introduced by the patriotic Ahſtrömer.

Good orchards eminently unite the uſeful and pleaſing; gratifying through the greater part of the year, the taſte, ſcent, and ſight. Horticulture was an early object in America, and has made conſiderable progreſs. At preſent our firſt care ſhould be, to prevent diſtempers of the fruit-trees, of late become very alarming—Peach-trees, have till within 20 or 30 years been very flouriſhing: ſome Engliſh writers relate with amazement that the Americans fatten their hogs on this fruit, which is ſo coſtly in the North of Europe; and it is true, that many common farms abounded ſo far in a promiſcous collection of better and worſe. But at preſent the peach-trees are few, and generally in a ſickly condition, through the greater part of the country. Of this one principal cauſe is a fly, that depoſits her eggs within the ſtem near the ground, which produce a great number of worms, who quickly conſume all the lower bark. Moſt kinds of plum-trees are liable to decay, and the fruit is deſtroyed by a ſpecies of fly; but the ravages of this inſect have been for a long time. Pear-trees have never indeed flouriſhed well, but of late far leſs: ſome aſcribe the blights of them to lightning, and hang pieces of iron in the branches, to anſwer the purpoſe of electric rods. In ſome places lately cherry and apple-trees have been attacked by various diſtempers, which cauſe the fruit to rot, and the limbs to decay in rapid ſucceſſion till the tree dies. This grangrene in fruit trees bears a ſtrong reſemblance to the mortification of members in the human body; the corruption ſpreads quickly over a large limb, and amputation is the only preſervative of the tree yet known. The loſs of peach-orchards is a conſiderable diſadvantage, as their early bloom is the principal beauty of ſpring; and the fruit is not only very pleaſing both green and preſerved, but alſo yields by diſtilling an agreeable and wholeſome liquor, well known by the name of *peach-brandy*. The apple-orchards claim a ſolicitous care merely as great ornaments of the country; much more as they ſupply a great article of diet and a ſalutary beverage equal to ſeveral ſpecies of wine. We want an American *treatiſe on fruit-trees*, which would ſhow how far the beſt Engliſh authors are applicable to diverſe parts of the United States; give a full account of all the beſt fruits here culti-

vated,

* Their miſchievous agility in climbing is impaired by cutting the ſinews of the hindfeet.

vated, with their variation from local caufes ; collect all the various names of the fame fruit, and fix one as national, to prevent a confufion that often fruftrates information both foreign and domeftic.

Fifh-ponds are ufeful decorations in places diftant from lakes and rivers. I have often wondered why this advantage is not derived from ponds and ftreams which are fo common : a ufelefs and unwholefome fwamp may thus be changed into an elegant improvement. A German author has wrote a valuable treatife on the fifh-ponds of Bohemia. The fubject has alfo been well treated by feveral œconomical writers of Sweden : in which country fifh-ponds of all kinds are very common.

ARTICLE. Phyfico Mathemacical enquiries.

Machines for abridging human labour are efpecially defired in America, as there can be no competition between them and the arms of induftrious labour, while thefe have full employ on her extenfive lands ; which muft be the cafe for ages. Agriculture has the firft claim to the exertions of mechanical genius, as the principal fource of national profperity. Extent of territory, improved by artificial induftry, muft yield a great quantity of products at fo cheap a rate, as to bear exportation to very diftant markets. It is moreover a weighty confideration to the humane philofopher, that agricultural mechanifm would in the Southern ftates fupply the labour of flaves. Among important defiderata we may place thefe——A machine for fowing broad-caft, fo as to fpread the grain even and in proper quantity : another for cutting drains, and making banks on our extenfive marfh-meadows : an apparatus for clearing new lands ; which ought to be a compound of coulters, faws, axes, and fcrews ; fo that the trees may be pulled out of the ground, cut in convenient pieces, and heaped : a better inftrument for reaping than the common fickle, fuch f. e. as the cradling fcythe of Northern Europe : temporary fheds of eafy and light conftruction for the prefervation of the reaped grain in wet feafons.

The many fhipwrecks that happen on the extenfive, and often ftormy coaft of this country render diving bells very neceffary ; thefe machines are yet but little known.

A plenty of naval ftores, and numerous ports render fhip-building an important branch of national induftry. This noble art, which has long been cultivated with fuccefs, would ftill be much improved by more expeditious modes of hauling timber, and of preparing the main pieces for the finifhing workmanfhip.

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An extenſive inland navigation by locks and canals, is now become a great object of legiſlative care in ſeveral ſtates; it is to be hoped, that ſuch perſons may be entruſted with theſe important works; as have a perfect theory of hydraulics, and a practical knowledge of local circumſtances, among which the force of ice in winter, and of rainy torrents in ſummer, are to be duly eſtimated.

As many new towns and villages will gradually riſe with the encreaſing population of the country, their ſituation and form ſhould be choſen with a view to permanent circumſtances. A ſure ſupply of water is one great object. If the advantage of ports is deſired, enquiry ſhould be made whether the preſent water-courſes are likely to continue; as in the old countries, ſeveral towns have been immerſed, and others left far within land, by the encreaſe or diminution of the water, or by the change of the channels. Health and conveniency require ſeveral open ſquares, wide ſtreets, and a direction of them calculated for ſhelter in the winter, and for ſhade and ventilation in the fervent ſummer months.

Our architecture claims the following remarks—The poſition of houſes ought to ſecure the fanning ſummer breeze, and exclude the wintry blaſt. Another object ſhould be to exclude from ſummer-rooms, the burning ſun, during the hotter part of the day. Entries throughout the houſe are very common, but not generally in directions that beſt anſwer theſe purpoſes. The length, and by frequent intervals, ſeverity of winter in the northern and middle ſtates, makes warm rooms not only agreeable, but in a degree neceſſary. For this purpoſe the moſt improved chimneys and iron-ſtoves are inadequate expedients: eſpecially as the open kind of theſe, though the more pleaſant, yet conſume a great quantity of wood. The ſtoves, which have long been in uſe through Sweden, and a part of the neighbouring countries, are unqueſtionably the beſt ever yet deviſed: they warm the room uniformly, with a quarter of the wood required for theſe laſt mentioned; are free from any diſagreeable ſteams; and have the appearance of elegant furniture*. Larger farms require ſeveral buildings; eſpecially in cold countries, where ſtore-houſes, and warm dwellings for domeſtic animals are neceſſary. If all theſe ſtructures are formed on regular plans calculated for the values of eſtates, and reſpective local circumſtances, the uſeful and agreeable may be united

* They are conſtructed by an iron grate-work, and panes of a fine clay fitted therein, which are varniſhed according to taſte and ability. At Bethlehem, in Pennſylvania, an inferior kind of theſe are already in uſe.

united in a very high degree: a well-written treatife on this fubject, would be very valuable.

To form with fpeed and conveniency a tolerably accurate map of the United States, aftronomical obfervations ought to determine the latitude and longitude of thofe places, which are moft effential to the figure of the whole country, or to the fituation of certain parts in a political, and œconomical view.

Exact furveys of private eftates are indifpenfible for the fecurity of landed property: from a defect of fuch many law-fuits have originated and will enfue for years. I omit what is the province of government in this matter; and only fuggeft a wifh, that a fmall treatife on the furvey of woodlands might be compofed; as the beft Englifh guides, being calculated for an open country, do not particularly attend to this branch.

4. *ARTICLE, Inquiries in Natural Hiftory.*

Natural hiftory, like a faithful guide, leads us through the myfterious mazes of nature, and opens to our enraptured eye her fublime and beautiful wonders. How many precious plants are as defpicable weeds trod under foot in every part of the world! How many new qualities are from time to time difcovered in productions, which have been known for centuries in countries long ago perluftrated with this facred lamp! what treafures may we not then expect in this new and vaft divifion of the globe! in the forefts of a thoufand miles hitherto traverfed only by favage tribes, and mercenary traders; in our lakes, fome of which are inland-feas; and rivers that wander through feveral ftates before they meet the ocean! * neglect of natural hiftory under circumftances fo alluring would indicate a want of rational tafte. I often heard the great *Linnæus* wifh that he could have explored the continent of North America; may this wifh animate American philofophers.

The vegetable realm claims our firft attention. Let us begin with a refearch of the ftores it offers for the prefervation and recovery of health. The frequent appearance of trees, fhrubs, and plants, whofe tafte and fcent, or analogy with well known pharmaceutics, is very promifing, would lead us to expect a very confiderable ftock of native Materia-Medica. But, although above an hundred of thefe fpecies are, or have been, more or lefs in ufe among the inhabitants, † very few of them are

* The United States extend from the Atlantic to Miffiffippi, and from Florida to Canada: taking in half of the great lakes, and of all the rivers, by the boundary-line.

† Indefinite calculation from written and verbal accounts, with perfonal obfervation.

are well known as to the extent and peculiarity of their qualities, and a very ſmall number is adopted either by the apothecaries, or regular phyſicians. On this view the following expedients merit attention—to ſubſtitute indigenous medicines of equal value for thoſe imported, which by quantity or price cauſe a great national expenſe; and that are liable to adulteration, or depreciation by age: to point out the beſt native plants in local diſtricts, with fixed names, clear deſcriptions, and accurate medical inſtructions, for ſafe convenient and general uſe: to appreciate the merit of thoſe drugs, which are eſteemed ſpecifics in the worſt epidemic or particular diſtempers. Collecting all the botano-medical information at preſent attainable, we may judge what plants are moſt intereſting, in what degree they are known, and how this knowledge may probably be moſt improved*—the Indians have ſeveral remedies againſt the diſeaſes and accidents ariſing from the climate, and their ſavage mode of life; as fevers, rheumatiſm, wounds, bruiſes, ſcalding, chillblains, bite of venomous ſerpents; beſides emetics, cathartics, ſudorifics, and dietics. Theſe have the ſanction of time and ſimplicity. It is alſo generally believed, that they poſſeſs very important ſecrets, of which only a few extraordinary ſpecimens are related with plauſible authenticity——In domeſtic practice, particularly of the country people, we obſerve medical plants of general ſalubrity, uſed as detergents, tonics, ſudorifics, and laxatives; and others of particular virtue in rheumatiſm, fevers, pectoral ailments, viſceral obſtructions, ulcers, external hurts, poiſons, female complaints, and diſeaſes of children. Among the great number of theſe popular drugs, particular attention is due to thoſe that are recommended by their ſalutary effects, atteſted by the patients or other perſons of credit; and more ſo, when the teſtimonial is attended with a preciſe ſtatement of facts. In caſe of defective information, we may expect valuable qualities in thoſe which are in vogue over large diſtricts; becauſe this general eſteem cannot be owing to imitation in a country, where intercourſe between diſtant places has till of late been very limited, and where botanical curioſity is yet very rare.—The medical plants we have in common with other countries, poſſeſs the ſame virtue, under variations from climate and local circumſtances; the too common opinion of their inferiority

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* See materia medica Americana potiſſimum regni vegetabilis, by David Schoeph, printed in Germany 1787. The author has great merit in collecting the accounts of preceding writers, whoſe authority he cites, with addition of popular information received, and perſonal remarks made during his reſidence and travels in this country.

ority will often be changed by a fair trial. Different ſpecies alſo promiſe a reward of examination from the generic ſimilarity: when theſe are actually in uſe among the people of this country, the probability of their value is the greater.

An application of theſe principles will bring the following plants to our particular notice—Agrimony, Potentilla-quinquefolium, Polygonum-biſtorta, Gentiana, Fumaria, Angelica, Cochlearia, Eryſimum officinale, Arum, Symphitum, Jnula campana, Aſarum, all grow in the northern and middle ſtates; and are the ſame with, or near a-kin to thoſe claſſed among the beſt ſimples by Dr. Cullen in his Materia Medica*. The gentiana growing in the *glades* of Pennſylvania, is by Dr. Sch. eſteemed the beſt of our ſeveral ſpecies. The Arum of North America is generally called Indian turnep, from its ancient value among the Indians; and often uſed with other ingredients by the country people, in that general debility, conſequent on tedious fevers.—The beſt recommended remedies againſt intermittent fevers, are Cornus *florida*, Dogwood; Quercus *phellos*, Live-oak; Perſimon; Lonicera *ſymphoricarpos;* by their barks: Pyrola *maculata*, with the Indian name *pipſiſſeva:* Sambucus *canadenſis:* Laurus *æſtivalis*, Spicewood, Benjamin-tree, Benzoin. The firſt is more generally known: a decoction of the bark has in many caſes been effectual; it is by ſome deemed equal, when freſh, to the Peruvian:† The ſecond is much valued in the ſouth, its native place: that of Perſimon in North Carolina; and of Lonicera *ſymphoricarpos* in Virginia.‡ An infuſion of the plant Pyrola *maculata* has been frequently uſed for ſome years in Pennſylvania, under the name of *pipſiſeva.*§ The Sambucus *canadenſis*, Red berry elder, is by the Indians called the *fever-buſh;* a decoction of its wood and buds being of ancient renown among them.¶ The laurus *æſtivalis*, Spicewood, Benjamin-tree, is alſo diſtinguiſhed with that name by the people in the northern parts, for the ſalutary decoction of its wood and leaves.‖ The bark of the Liriodendron, *Tulip-tree*, is alſo very generally eſteemed a good ſubſtitute for the peruvian: eſpecially that of the root. We may obſerve on theſe and other febrifuges,

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* Confer this book with Dr. Schoeph's, and John Bartram's notes to Short's Medicina Britannica, reprinted in Philadelphia, 1751.

† Kalm ſays that in Weſt-Jerſey many were cured by the bark of the root, who had in vain tried the peruvian: in that ſickly country, I have myſelf made uſe of it, and think it worthy of a full trial.

‡ Called St. Peter's wort, Indian currants; a ſpecies of honey ſuckle; ſee Arbuſt. Amer. of Marſhal.

§ See ditto: a ſpecies of winter green.

¶ Geſchichte der Miſſion der Evangeliſchen Brüder unter den Jndianern in Nord America, by *Loſkiel*, publiſhed 1787.

‖ Memoirs of the American Academy etc. printed in Boſton, 1785.

is called *poor Robins plantain;* and ſaid to fruſtrate the bite both of the rattle ſnake, and of his ſuppoſed precurſor the *pilote-ſnake.* Erigeron, likewiſe called Roberts plantain in Pennſylvania, is deſcribed by Dr. Schoef thus (radix repens; folia radicalia ovata, baſi attenuata, dentata dentibus paucis a medio ad apicem glanduliferis, obtuſa, piloſa, venis paucis. Scapus biuncialis, pedalis, ſtriatus, villoſus, uniflorus etc. etc.) Dr. Otto, a reſpectable practitioner, informed him that the herb ought to be given in a plentiful decoction, and alſo applied with the root to the wound. The herb of Solidago *virga aurea,* Golden rod, is uſed in the ſame manner. * The root of Aletris *farinoſa* is taken in powder, or bruiſed and ſteeped in liquor: this root is called *ſtar-root, blazing ſtar, devil's bit;* and greatly eſteemed, both by the Indians and the people of ſeveral ſtates, for many qualities. † The Polygala *Senega* is well known. The *plantain* of Negro Cæſar I juſt mention with a wiſh, than an authentic account could be obtained of the experiments for which he obtained a public reward. Many credible teſtimonies agree in the fact that Indians have extraordinary ſkill in curing the bites of ſerpents; but whether any ſpecific antidote is known, appears doubtful: the plants in uſe act however as powerful ſudorifics and abſorbents: a narrative of my own obſervations on this matter would here be too prolix.

Of late years madneſs of dogs has been more frequent: the Swertia *difformis* recommended by Clayton, ſhould be tried.*

In the ſearch of new medicines, ſpicy trees and balmy ever-greens are particularly inviting. The ſwamps of the low country abound in plants of aromatic ſcent: the magnolia glauca ſo frequent in them ſeems to hold out her fragrant lillies and crimſon-berries to the ſkeleton-prey of Stygian vapours; probably her lovely ſiſters are alſo compaſſionate.‡

Indigenous eſculents claim attention in ſeveral views. Thoſe roots, herbs, grains, and barks, that in caſe of need can ſupport life, may be uſeful to travellers in the wilderneſs and to troops that carry on an Indian war: the ſavages make this uſe of the inner bark of the elm, and the roots of Aralia *nudicaulis.* The ſallads of many kinds, gathered in diverſe parts of the country during ſpring, ſhould be generally known. Several wild fruits might be improved by culture; as walnuts, crab-apples,

* Schoef deſcribes it as *hirſuta, radice amara:* Bartram as "having ſlender purple ſtalks, riſing a foot high, with a ſpike of fine yellow flowers, for near one third part of the length of the plant." ſays it is much extolled.

† Bartram ſpeaks of it principally as a "remedy in grievous pains of the bowels;" and ſays it has a ſtalk eighteen inches long with a fine ſpike of white flowers ſix inches, blooming in June, growing plentifully in the back parts of the country. * See Gron. Virginia.

‡ Serpent. Virg. Sarſaparilla, etc. want no mention; ſeveral cannot here find room.

ples, papaws, *(annona)* plumbs, grapes, perſimons, honeylocuſt *(Gleditſia Triacanthos)*; ſome perſons have planted orchards of this and made plenty of metheglin from the ſweet pods. While the Sugar-maple is of late juſtly valued, its kindred alſo merit more attention: I am credibly informed that in Canada, equally good ſugar is made from the weaker juice of the Red maple; a tree that abounds through all the ſtates. The Cheſnut oak is ſaid by Schoef, to yield in ſpring a copious agreeable drink: other trees may have ſimilar ſaps. Aromatic plants deſerve notice: the barks of young Saſſafras, and of *Calycanthus Floridus* * much reſemble cinnamon: the *Acorus calamus* is under name of Spice-wort, uſed in Maſſachuſetts. The plants uſed as tea in diverſe parts deſerve examination: the *Caſſine,* called South ſea-tea-tree, is obſcurely known by us, but has long been famous among the Indians. †

Many vegetable dies are already in uſe, both among the Indians, and the inhabitants: ſome of them are alſo recorded by writers: but a collection of ſcattered practice, and a ſelection of the beſt in every kind, are yet wanted. In this branch, the practice of other countries may alſo be adopted: thus the *Rhus-toxicodendron-vernix,* Varniſh-tree, Poiſon-aſh, is probably the ſame with the valuable ſpecies of Japan.‡

Saps, roots, leaves, flowers, barks, may be uſeful in a variety of modes; for example——The roots of Aeſculus Pavia, *ſcarlet horſe cheſnut,* and of Jucca filamentoſa, *ſilk-graſs,* are uſed for ſoap:§ cheſnuts can be prepared for the ſame uſe. The two kinds of *Myrica,* Candle berry myrtle, are known: the Melia *azedarach* grows in the South, under the name of *bead tree*; but its berries are not yet in uſe for tallow, as in Japan*. The Aſclepias, called *ſilkweed,* has a fine white down in its pods, which in Maſſachuſetts, is carded and ſpun into very good wick-yarn. While oaks abound, an extract of their barks might, as an article in tanning, be a valuable export.

Vegetable medicines for cattle are very intereſting: a critical compariſon of European treatiſes, with what is written and practiſed here will point out the beſt.

The

* Called Carolina allſpice.

† They call it *Yaupan*, and drink an infuſion of the leaves in copious draughts, both as a diætic and inebriating. It grows near the ſea in the ſouthern ſtates, ten or twelve feet high.

‡ By the travels of Prof. Thunberg (in Swediſh, I find great analogy between Japan and N. America: thus the Perſimon grows there: the cones of the Alder are in common uſe for black dye.

§ They grow in the ſouthern ſtates.

* An oil is preſſed which becomes equally ſolid with tallow. *Thunberg.*

The beauties of our Flora are yet difplayed only to thofe admirers, who have fought them, in fields and woods, from fpring to autumn, in northern and fouthern climes, in the grand Magniflora and the humble lilly of the valles. Many of the wild flowers would adorn gardens, and embellifh groves and meadows: but a great part of thefe are known only in their native places, and fome have not even obtained a vernacular name. Flowery fhrubs are gradually coming into more notice; and fome of the fineft will endure the winter of Pennfylvania: the Chionanthus *(Snow drop, Fringe tree,)* Calycanthus floridus, Bignonia *radicans* (*Trumpet* flower) and the beautiful *Franklinia*, all grow well near Philadelphia. * Several of the trees moft agreeable by foliage, bloom or lofty growth, have a fpontaneous wide range; and others will under a fkillful hand pafs their natural limits.†

My remarks on the Animal domains fhall begin with the fmall tribes, becaufe fome of thefe do us remarkable mifchief. The *Heffian fly* has for feveral years made great havock in the wheat fields through all the middle-ftates. ‡ The canker worms, caterpillers, and other vermine lay wafte our orchards: fome remedies will hopefully refult from the enquiries of late begun in feveral places. Hofts of locufts fome years infeft the woods, and caufe confiderable damage by devouring the leaves of trees over large diftricts, many of which decay when thus expofed to the burning fun: they lie in the ground for a period of years, not yet afcertained; appear in the latter part of the fpring, when the oaks are in perfect foliage; and in a few weeks difappear.§

Venomous infects are rare, and obfcurely known, as they feem confined to the woods. A fpecies of thefe, called *mountain fpider*, that haunts the inner parts of the fouthern ftates, is faid to be large; ftrong enough to take fmall birds in his net; and by his fting to produce violent pains at the heart, inflammations with alternate cold fweats, tremors, frenzy, and death, if proper cure is not obtained. In the middle ftates there is a black fpider, whofe bite caufes great pains and a tranfient blindnefs, but is not mortal. A large ant with a long fting, common in Maryland and further fouth, is alfo very noxious.

Among

* The laft is in Mr. Bartram's garden fifteen a twenty feet high; and has not been affected with the five fevere winters within twelve years, though its native place is Georgia. The flowers are large and fragrant, with lilly-like petala, and a tuft of gold-coloured ftamina.

† Bignonia Catalpa flourifhes in and beyond Pennfylvania.

‡ Neftling in the joints of the ftalk, they bite it off before the grain is ripe.

§ They feem to extend far, as many hundred acres upon the Ohio are faid to be fpoliated by them; yet is their depredation local and varying, fo that different parts have their turn: they were in Pennfylvania eighty years ago, and with the fame qualities, as I find by the old Swedifh records, which alfo add that the Indians fed upon them.

Among our handſome inſects the *fire-fly* is the firſt: thouſands of theſe illumine our ſummer nights, and by their gambols in the air, preſent a ſky full of falling ſtars;* but we know not where theſe lamps are hid in the long winter-nights.

A ſtriking mechaniſm is remarked in the *horn-beetles* of various kinds; and eſpecially the *wood ſawer*, who with two curve inwardly dentated prongs, can cut off ſmall twigs of trees. I venture to add a *zoophyton* in the Ohio country, which alternately is vegetable and animal.† But without ſuch extraordinary phænomena, the œconomy of the numerous little animals is wonderful enough to awaken our attention, eſpecially in this country, where it is yet unexplored.

Thirty a forty ſpecies of ſnakes are counted; but ſeveral are very imperfectly known; eſpecially thoſe who are rare or local. The *horn-ſnake* is now ſeldom ſeen; but many accounts agree, that the ſpur of his tail is ſo venemous, as to kill young trees, if by accident it ſtrikes them; which has with minute facts been told me by ſome ancient Swedes. The *king-ſnake* of the South, is not ſeen (I believe) far North. The *double-headed* ſnake may be a monſtrous production; but two ſpecimens of it are found in New-England, and two more are now in Mr. Peale's Muſe-um. That ſome kinds of ſerpents charm birds and ſquirrels is a fact; but in what manner we know not. Fortunately the ſmaller number is venomous; but which ſpecies ſhould be avoided is an intereſting queſti-on: though the *green ſnake*, unperceptible in the graſs, is harmleſs; ſome that occaſionally come near houſes, are not ſo.

On quadrupeds in general, two inquiries are intereſting: what is the ſpecific difference from thoſe of the ſame genus in the Eaſtern world? and how doth the ſame ſpecies vary here under different latitudes? in the firſt our *tygers* and *panthers* require particular notice: in the ſecond the bear, who frequents the interior country from North to South; and this panther, who has alſo a wide range. Among thoſe peculiar to North America the *Moſe-deer* is yet undeſcribed, and known to few perſons

* Thunberg deſcribes thoſe of Japan in the ſame manner, under name of *Lampyris Japonica*.

† This was communicated to me by a reſpectable Miſſionary, who had long been among the Indians, and had ſeen this animal; but would not have his name mentioned, as the matter may appear incredible: it is 3 a 4 inches high, and after having crawled about the woods, is fixed in the ground, becoming a plant with a ſtem through its mouth etc. It is analogous to the vegetable fly of Dominica, that buries itſelf in the ground, dies, and ſprings up like a young coffee-plant; for which it is often miſtaken, untill the root upon examination is found to be the head, feet, and body of the animal: ſee the Natural hiſtory of Dominica by Th. Atwood, publiſhed 1791.

persons below the South of Canada*. The *Opossum* common among us, and long known for singularities, is yet unexplored in the greatest of all—to wit that the female breeds her young at her teats within the false belly: many persons in distant quarters assert that they have seen them adhering to the teats when small as a pea. The vast Mahmot, is perhaps yet stalking through the western wilderness; but if he is no more, let us carefully gather his remains, and even try to find a whole skeleton of this giant, to whom the elephant was but a calf†.

The great herds or buffaloes in the Western country, are a valuable national possession; a wanton destruction of them should be checked; and trial of domestication would perhaps be both practicable and useful.

The greater number of birds in the old settlements have been described; but many equivocally: and our knowledge of their habits is in general very small. We should not indiscreetly destroy those deemed of no value; who knows what part is assigned to them in the œconomy of nature? perhaps our numerous tribes of woodpeckers save many trees from destructive worms? as to the useful and ornamental birds, they demand our protection against licentious and greedy tyranny: the beautiful and melodious birds diminish fast; and the Turkeys once so abundant, have long ago been drove into the remote woods.

General knowledge of our fishes is very limited and confused: of those in the western waters we have here only reports; I never had even from eye witnesses a tolerable account of the *cat-fish* that weighs 70 a 100 pounds. Those proper in fish ponds cannot be selected without knowing what kind of water, food, &c. they require.

Natural history demands more esteem from our seminaries of learning: the principal among them should immediately form botanical gardens, on a plan so liberal as gradually to receive all the trees, shrubs, and plants most valuable in every respect. Museums are also very important, for exhibition of both native and foreign productions‡. Finally, it is necessary to fix general names for every vegetable and animal of public utility, that great numbers may receive and impart information.

5th

* Some years ago one was exhibited in Philadelphia: it is a large animal with very high forelegs, a short neck, &c. On the American Elk see Jefferson's Notes on Virginia.

† Great quantity of his bones are found on the Ohio: see Jefferson's Notes.

‡ That of Mr. Peale in Philadelphia, commenced a few years ago, is by his laudable care coming into reputation both at home and abroad, and merits the public patronage.

5th ARTICLE, *Meteorological Enquiries.*

Changes in the atmofphere have fuch important confequences on the affairs of human life; that the art of prognofticating them is very beneficial. It has of late years been cultivated with great affiduity in various parts of Europe; and the feries of obfervations will gradually form a fyftem, that may at leaft, unite probable conjectures with much certain knowledge. Several circumftances of the United States point out corresponding inquiries—We are fubject to fudden gufts of wind, and fome tornados that rapidly pafs over a fpace of one a two hundred miles: from the beginning of Spring till the fetting in of Winter, thefe occafion many unhappy accidents on our extenfive coafts, and ample navigable rivers. Their tranfient ftrokes are, however, not comparable to thofe fevere ftorms that generally vifit us two or three times in that feafon: after thefe the gazettes anounce numerous deplorable fhipwrecks, and other difafters: coming from the Eaft with heavy rains, they generally caufe inundations, which overflow a vaft extent of meadow grounds, on the lengthy rivers and winding creeks, and fometimes damage wharves and ftores of commercial towns. A forefight of all thefe would enable us to elude their fury: veffels might ftay in port, or feek a fhelter: merchandize might be fecured: the hay might be removed, and the cattle, which fometimes perifhes by the fudden rife of the water. In fummer the fudden gufts happen generally towards evening, after a fultry calm for fome hours: when attended with thunder and rain, warning is given by the rifing clouds: thofe with a clear fky are lefs frequent, and preceded only by light eddies in the air for fome minutes*. The tornados are probably announced by fome remarkable fymptons, though their happily rare occurrence has prevented attention: the air is (I believe) very fultry for two or three preceding days, and on the laft, fomewhat hazy with tremulous light breezes from the Weft. The eafterly ftorms are ufhered in by the gradual thickening of the clouds, and encreafe of the wind for many hours: †

The irregularity of our feafons, is a great impediment in the bufinefs of focial life—The fallacious appearance of an early fpring often invites the hufbandman and gardener to planting and fowing, which will be injured by fevere frofts and cold rains. The beginning of winter varies alfo by feveral weeks: after the firft of December, mild weather is often changed into a cold, that within two or three days fills the rivers of the

* Thefe are generally called whirlwinds from their verfatile direction.

† When they continue for two a three days, they are not at their hight before twelve hours.

northern and middle ſtates with ice; by which veſſels outward bound are detained, and thoſe coming on the coaſt ſuffer ſeverely. A greater diſadvantage of this variation, is uncertainty of the ſeeding-time, on which much depends the future crop: if it is too early, the luxuriance of autumnal vegetation exhauſts the root; if too late, it cannot acquire ſufficient firmneſs to bear the froſt. We have two prognoſtics of winter which are founded in nature: the migration of wildgeeſe ſhows that the northern waters are freezing, and that we may expect ſevere north weſterly winds: abundance of rain, by cooling the air, and wetting the earth, prepares both for the impreſſion of the froſts: encreaſing number of partridges, pheaſants, and other ground birds in the populous parts, with the appearance of bears, doth alſo indicate that the weſtern woods are already covered with ſnow. Mild winters are always ſucceeded by cold ſprings*. Early thunder is a ſure token of immediate cold weather for a week or two. The progreſs of the vernal ſeaſon would moſt probably appear from an accurate *Calendarium-Floræ*: the bloom and foliation of ſome trees being unfolded not by an occaſional warmth of the air, but by a gradual penetration of the heat to their deep roots, proves at leaſt an aſcendancy of the vernal temperature not eaſily overcome by the northerly gales.

A continuance of wet weather in time of hay-making, is not very common, but, when it happens, very deſtructive by the heat of the ſeaſon. It is to be apprehended after a long drought; and is generally foreboded by a moiſture in the air, viſible on glaſs, walls, wooden furniture, ſalt, and other attractive bodies, for two days. As graſs may be cut ſomewhat ſooner or later, its preſervation may be obtained by this foreſight. The harveſt of grain can bear no delay, eſpecially in a hot climate; but diſpatch is neceſſary in a critical time.

The ſudden alterations of cold and heat throughout the year, would often be leſs injurious to health, by foreſeeing them: general rules are theſe—exceſſive warmth for the ſeaſon ſeldom continues above a few days, and quickly changes into the oppoſite extreme: fine days in winter, ſpring, and latter part of autumn are immediately ſucceeded by cold and wet, rain or ſnow, according to ſeaſon and latitude; wherefore they are called *weather-breeders*.

The

*Long experience has given riſe to the adage, *winter never rots in the ſky*, and to the *Indian* rule ſtill generally ſo called, that *winter muſt come when the ponds are full*.

The limits of an eſſay exclude a detail of obſervations made by myſelf, or collected from judicious perſons, and of their more general, or local and temporary application: I wiſh that curioſity rouſed by facts may be further animated by this reflection——In the works of Almighty power and infinite wiſdom there can be *no chance*; the ſeaſons revolve on the ſame fixed principles as the planets; and the apparent diſorders leſſen with our encreaſing knowledge. The bountiful Creator diſcovers his marvels in proportion to our wants; if man has by a ſublime ſagacity traced the intricate path of the moon, why may he not explore the ſource of the tempeſt? every country has native remedies againſt its natural defects; is it not then probable that as the *Polygala Senega* was given us againſt the rattle-ſnakes, ſo may we have faithful prognoſtics of the dangerous caprices of our climate? Let us therefore ſtudy nature, and nature's Ruler ſhall reward our labour.

LIST OF THE OFFICERS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY,

Held at PHILADELPHIA for promoting Useful Knowledge.

For the Year 1793.

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Adam

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Dr. Enoch Edwards.

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Joſhua Humphrys.
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John Hoge.

I

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K

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L

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Peter Legaux.
George Logan, M. D.

M

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John Morris, M. B.
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George Monro, M. D. of Delaware.
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N

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R

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T

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B

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———Gaſtilleir, M. D. of Montarges.

M. Grivel, of Paris.

Hubert de Garbier, M. D. of Paris.

M. M. de Grauchain, Major General of the French Navy.

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H

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Baron de Heinitz, of Berlin, Miniſter of the Mineral Department.

Baron de Hupſch, of Cologne.

I

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K

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L

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M

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N

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O

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S

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T

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Rodolph

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W

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Thomas White, of Manchester England.
Caleb Whitford, of London.
John Walker, D. D. and M. D. Prof. Nat. History in the University of Edinburgh.

CONTENTS

OF

VOLUME III.

IX. *An*

XIX.

XL. *Description*

ERRATA.

Page 86 line 1 for 600° *read* 60°.
88 at bottom for appendix N°. iv. *read* N°. v.
89 line 1 dele *for*.
Page 194. after the Title of the piece N°. 23. *read* To David Rittenhouse, L. L. D. President of the American Philosophical Society.
247, line 16 for spot, *read* pot. Page 251, line 4, for the, *read* they.

TRANS-

TRANSACTIONS

OF THE

American PHILOSOPHICAL SOCIETY, &c.

N°. I.

Conjectures concerning the formation of the Earth, &c. in a letter from Dr. B. Franklin, to the Abbé Soulavie.

Passy, September 22, 1782.

SIR,

Read Nov. 21, 1788. I RETURN the papers with some corrections. I did not find coal mines under the Calcareous rock in Derby Shire. I only remarked that at the lowest part of that rocky mountain which was in sight, there were oyster shells mixed in the stone; and part of the high county of Derby being probably as much above the level of the sea, as the coal mines of Whitehaven were below it, seemed a proof that there had been a great bouleversement in the surface of that Island, some part of it having been depressed under the sea, and other parts which had been under it being raised above it. Such changes in the superficial parts of the globe seemed to me unlikely to happen if the earth were solid to the centre. I therefore imagined that the internal part might be a fluid more dense, and of greater specific gravity than any of the solids we are acquainted

quainted with; which therefore might ſwim in or upon that fluid. Thus the ſurface of the globe would be a ſhell, capable of being broken and diſordered by any violent movements of the fluid on which it reſted. And as air has been compreſſed by art ſo as to be twice as denſe as water, in which caſe if ſuch air and water could be contained in a ſtrong glaſs veſſel, the air would be ſeen to take the loweſt place, and the water to float above and upon it; and as we know not yet the degree of denſity to which air may be compreſſed; and M. Amontons calculated, that its denſity increaſing as it approached the centre in the ſame proportion as above the ſurface, it would at the depth of——leagues be heavier than gold, poſſibly the denſe fluid occupying the internal parts of the globe might be air compreſſed. And as the force of expanſion in denſe air when heated is in proportion to its denſity; this central air might afford another agent to move the ſurface, as well as be of uſe in keeping alive the ſubterraneous fires: Though as you obſerve, the ſudden rarefaction of water coming into contact with thoſe fires, may alſo be an agent ſufficiently ſtrong for that purpoſe, when acting between the incumbent earth and the fluid on which it reſts.

If one might indulge imagination in ſuppoſing how ſuch a globe was formed, I ſhould conceive, that all the elements in ſeparate particles being originally mixed in confuſion and occupying a great ſpace, they would as ſoon as the almighty fiat ordained gravity or the mutual attraction of certain parts, and the mutual repulſion of other parts to exiſt, all move towards their common centre: That the air being a fluid whoſe parts repel each other, though drawn to the common centre by their gravity, would be denſeſt towards the centre, and rarer as more remote; conſequently all matters lighter than the central part of that air and immerſed in it, would recede from the centre

centre and riſe till they arrived at that region of the air which was of the ſame ſpecific gravity with themſelves, where they would reſt; while other matter, mixed with the lighter air would deſcend, and the two meeting would form the ſhell of the firſt earth, leaving the upper atmoſphere nearly clear. The original movement of the parts towards their common centre, would naturally form a whirl there; which would continue in the turning of the new formed globe upon its axis, and the greateſt diameter of the ſhell would be in its equator. If by any accident afterwards the axis ſhould be changed, the denſe internal fluid by altering its form muſt burſt the ſhell and throw all its ſubſtance into the confuſion in which we find it.

I will not trouble you at preſent with my fancies concerning the manner of forming the reſt of our ſyſtem. Superior beings ſmile at our theories, and at our preſumption in making them. I will juſt mention that your obſervation of the ferruginous nature of the lava which is thrown out from the depths of our valcanos, gave me great pleaſure. It has long been a ſuppoſition of mine that the iron contained in the ſubſtance of this globe, has made it capable of becoming as it is a great magnet. That the fluid of magnetiſm exiſts perhaps in all ſpace; ſo that there is a magnetical North and South of the univerſe as well as of this globe, and that if it were poſſible for a man to fly from ſtar to ſtar, he might govern his courſe by the compaſs. That it was by the power of this general magnetiſm this globe became a particular magnet. In ſoft or hot iron the fluid of magnetiſm is naturally diffuſed equally; when within the influence of a magnet, it is drawn to one end of the iron, made denſer there, and rarer at the other, while the iron continues ſoft or hot, it is only a temporary magnet: If it cools or grows hard in that ſituation, it becomes a permanent one, the magnetic fluid not eaſily reſuming its equilibrium. Perhaps it may be owing to the permanent magnetiſm of this globe, which it had not at firſt, that its axis is at preſent kept parallel to itſelf, and not liable to the changes it formerly ſuffered, which occaſioned the rupture of its ſhell, the ſubmerſions and emerſions of its lands and the confuſion of its ſeaſons. The preſent polar and equatorial diameters differing from each other near ten leagues; it is eaſy to conceive in caſe ſome power ſhould ſhift the axis gradually, and place it in the preſent equator, and make the new equator paſs through the preſent poles, what a ſinking of the water would happen in the preſent equatorial regions, and what a riſing in the preſent polar regions; ſo that vaſt tracts would be diſcovered that now are under water, and others covered that now are dry, the water riſing and ſinking in the different extremes near five leagues.—Such an operation as this, poſſibly, occaſioned much of Europe, and among the reſt, this mountain of Paſſy, on which I live, and which is compoſed of lime ſtone, rock and ſea ſhells, to be abandoned by the ſea, and to change its ancient climate, which ſeems to have been a hot one. The globe being now become a permanent magnet, we are perhaps ſafe from any future change of its axis. But we are ſtill ſubject to the accidents on the ſurface which are occaſioned by a wave in the internal ponderous fluid; and ſuch a wave is producible by the ſudden violent exploſion you mention, happening from the junction of water and fire under the earth, which not only lifts the incumbent earth that is over the exploſion, but impreſſing with the ſame force the fluid under it, creates a wave that may run a thouſand leagues lifting and thereby ſhaking ſucceſſively all the countries under which it paſſes. I know not whether I have expreſſed myſelf ſo clearly, as not to get out of your ſight in theſe reveries. If they occaſion any new enquiries and produce a better hypotheſis, they will not be quite uſeleſs. You ſee I have given a looſe to imagination; but I approve much more your

your method of philofophizing, which proceeds upon actual obfervation, makes a collection of facts, and concludes no farther than thofe facts will warrant. In my prefent circumftances, that mode of ftudying the nature of this globe is out of my power, and therefore I have permitted myfelf to wander a little in the wilds of fancy. With greate fteem I have the honour to be, &c.

P. S. I have heard that chemifts can by their art decompofe ftone and wood, extracting a confiderable quantity of water from the one, and air from the other. It feems natural to conclude from this, that water and air were ingredients in their original compofition. For men cannot make new matter of any kind. In the fame manner may we not fuppofe, that when we confume combuftibles of all kinds, and produce heat or light, we do not create that heat or light; but only decompofe a fubftance which received it originally as a part of its compofition? Heat may thus be confidered as originally in a fluid ftate, but, attracted by organized bodies in their growth, becomes a part of the folid. Befides this, I can conceive that in the firft affemblage of the particles of which this earth is compofed each brought its portion of the loofe heat that had been connected with it, and the whole when preffed together produced the internal fire which ftill fubfifts.

N°. II.

A new and curious Theory of Light and Heat; in a letter from Dr. B. Franklin to David Rittenhoufe, Efq.

Read June 20, 1788.

UNIVERSAL fpace, as far as we know of it, feems to be filled with a fubtil fluid, whofe motion, or vibration, is called light. This

This fluid may possibly be the same with that which being attracted by and entering into other more solid matter, dilates the substance, by separating the constituent particles and so rendering some solids fluid, and maintaining the fluidity of others; of which fluid when our bodies are totally deprived, they are said to be frozen; when they have a proper quantity, they are in health, and fit to perform all their functions; it is then called natural heat; when too much, it is called fever; and when forced into the body in too great a quantity from without, it gives pain by separating and destroying the flesh, and is then called burning; and the fluid so entering and acting is called fire.

While organized bodies, animal or vegetable, are augmenting in growth, or are supplying their continual waste, is not this done by attracting and consolidating this fluid, called fire, so as to form of it a part of their substance; and is it not a separation of the parts of such substance, which dissolving its solid state, sets that subtil fluid at liberty, when it again makes its appearance as fire?

For the power of man relative to matter, seems limited to the separating or mixing the various kinds of it, or changing its form and appearance by different compositions of it; but does not extend to the making or creating of new matter, or annihilating the old: thus if fire be an original element or kind of matter, its quantity is fixed and permanent in the universe. We cannot destroy any part of it, or make addition to it. We can only separate it from that which confines it, and so set it at liberty, as when we put wood in a situation to be burnt; or transfer it from one solid to another, as when we make lime by burning stone, a part of the fire dislodged from the fuel being left in the stone. May not this fluid when at liberty be capable of penetrating and entering into all bodies, organized or not: quitting easily in totality those not organized, and quitting

quitting eaſily in part thoſe which are; the part aſſumed and fixed remaining till the body is diſſolved?

Is it not this fluid which keeps aſunder the particles of air, permitting them to approach, or ſeparating them more in proportion as its quantity is diminiſhed or augmented?

Is it not the greater gravity of the particles of air, which forces the particles of this fluid to mount with the matters to which it is attached as ſmoke or vapour?

Does it not ſeem to have a great affinity with water, ſince it will quit a ſolid to unite with that fluid, and go off with it in vapour; leaving the ſolid cold to the touch, and the degree meaſurable by the thermometer?

The vapour riſes attached to this fluid, but at a certain height they ſeparate, and the vapour deſcends in rain retaining but little of it, in ſnow or hail leſs. What becomes of that fluid? Does it riſe above our atmoſphere, and mix with the univerſal maſs of the ſame kind?

Or does a ſpherical ſhell or ſtratum of it, denſer, as leſs mixed with air, attracted by this globe, and repelled or puſhed up only to a certain height from its ſurface by the greater weight of air, remain there ſurrounding the globe and proceeding with it round the ſun?

In ſuch caſe, as there may be a continuity or communication of this fluid through the air quite down to the earth, is it not by the vibrations given to it by the ſun that light appears to us; and may it not be, that every one of the infinitely ſmall vibrations, ſtriking common matter with a certain force, enters its ſubſtance, is held there by attraction, and augmented by ſucceeding vibrations, till the matter has received as much as their force can drive into it?

Is it not thus that the ſurface of this globe is continually heated by ſuch repeated vibrations in the day, and cooled by the eſcape of the heat when thoſe vibrations are diſcontinued in the night, or intercepted and reflected by clouds?

Is

Is it not thus that fire is amaſſed and makes the greateſt part of the ſubſtance of combuſtible bodies?

Perhaps when this globe was firſt formed and its original particles took their place at certain diſtances from the centre in proportion to their greater or leſs gravity, the fluid fire attracted towards that centre might in great part be obliged, as lighteſt, to take place above the reſt, and thus form the ſphere of fire above ſuppoſed; which would afterwards be continually diminiſhing by the ſubſtance it afforded to organized bodies, and the quantity reſtored to it again by the burning or other ſeparating of the parts of thoſe bodies?

Is not the natural heat of animals thus produced by ſeparating in digeſtion the parts of food, and ſetting their fire at liberty?

Is it not this ſphere of fire which kindles the wandering globes that ſometimes paſs through it in our courſe round the ſun, have their ſurface kindled by it, and burſt when their included air is greatly rarefied by the heat on their burning ſurface?

May it not have been from ſuch conſiderations that the ancient philoſophers ſuppoſed a ſphere of fire to exiſt above the air of our atmoſphere?

N°. III.

Deſcription of the proceſs to be obſerved in making large ſheets of paper in the Chineſe manner, with one ſmooth ſurface. Communicated by Dr. B. FRANKLIN.

Read June 20, 1788.

IN Europe to have a large ſurface of paper connected together and ſmooth on one ſide, the following operations are performed.

1. A number of ſmall ſheets are to be made ſeparately.

2. Theſe

2. Theſe are to be couched, one by one, between blankets.

3. When a heap is formed it muſt be put under a ſtrong preſs, to force out the water.

4. Then the blankets are to be taken away, one by one, and the ſheets hung up to dry.

5. When dry they are to be again preſſed, or if to be ſized, they muſt be dipped into ſize made of warm water, in which glue and allum are diſſolved.

6. They muſt then be preſſed again to force out the ſuperfluous ſize.

7. They muſt then be hung up a ſecond time to dry, which if the air happens to be damp requires ſome days.

8. They muſt then be taken down, laid together, and again preſſed.

9. They muſt be paſted together at their edges.

10. The whole muſt be glazed by labour, with a flint.

In China, if they would make ſheets, ſuppoſe of four and an half ells long and one and an half ell wide, they have two large vats, each five ells long and two ells wide, made of brick, lined with a plaſter that holds water. In theſe the ſtuff is mixed ready to work.

Between theſe vats is built a kiln or ſtove, with two inclining ſides; each ſide ſomething larger than the ſheet of paper; they are covered with a fine ſtucco that takes a poliſh, and are ſo contrived as to be well heated by a ſmall fire circulating in the walls.

The mould is made with thin but deep ſides, that it may be both light and ſtiff: It is ſuſpended at each end with cords that paſs over pullies faſtened to the ceiling, their ends connected with a counterpoiſe nearly equal the weight of the mould.

Two men one at each end of the mould, lifting it out of the water by the help of the counterpoiſe, turn it and apply it with the ſtuff for the ſheet, to the ſmooth ſurface of the ſtove, againſt which they preſs it, to force out great part of the water through the wires. The heat of the wall ſoon evaporates the reſt, and a boy takes off the dried ſheet by rolling it up. The ſide next the ſtove receives the even poliſh of the ſtucco, and is thereby better fitted to receive the impreſſion of fine prints. If a degree of ſizing is required, a decoction of rice is mixed with the ſtuff in the vat.

Thus the great ſheet is obtained, ſmooth and ſized, and a number of the European operations ſaved.

As the ſtove has two poliſhed ſides, and there are two vats, the ſame operation is at the ſame time performed by two other men at the other vat; and one fire ſerves.

N°. IV.

QUERIES *and* CONJECTURES *relating to Magnetiſm, and the Theory of the Earth, in a Letter from* Dr. B. FRANKLIN, *to* Mr. BODOIN,

DEAR SIR,

Read Jan. 15, 1790.

I RECEIVED your favours by Meſſrs. Gore, Hilliard and Lee, with whoſe converſation I was much pleaſed, and wiſhed for more of it; but their ſtay with us was too ſhort. Whenever you recommend any of your friends to me, you oblige me.

I want to know whether your Philoſophical Society received the ſecond volume of our Tranſactions. I ſent it, but never heard of its arriving. If it miſcarried, I will ſend another. Has your Society among its books the French Work *ſur les Arts & les Metiers?* It is voluminous, well executed, and may be uſeful in our country. I have bequeathed it them in my will; but if they have it already, I will ſubſtitute ſomething elſe.

Our

Our ancient correſpondence uſed to have ſomething philoſophical in it. As you are now more free from public cares, and I expect to be ſo in a few months, why may we not reſume that kind of correſpondence? Our much regretted friend Winthrop once made me the compliment, that I was good at ſtarting game for philoſophers, let me try if I can ſtart a little for you.

Has the queſtion, how came the earth by its magnetiſm, ever been conſidered?

Is it likely that *iron ore* immediately exiſted when this globe was firſt formed; or may it not rather be ſuppoſed a gradual production of time?

If the earth is at preſent magnetical, in virtue of the maſſes of iron ore contained in it, might not ſome ages paſs before it had magnetic polarity?

Since iron ore may exiſt without that polarity, and by being placed in certain circumſtances may obtain it, from an external cauſe, is it not poſſible that the earth received its magnetiſm from ſome ſuch cauſe?

In ſhort, may not a magnetic power exiſt throughout our ſyſtem, perhaps through all ſyſtems, ſo that if men could make a voyage in the ſtarry regions, a compaſs might be of uſe? And may not ſuch univerſal magnetiſm, with its uniform direction, be ſerviceable in keeping the diurnal revolution of a planet more ſteady to the ſame axis?

Laſtly, as the poles of magnets may be changed by the preſence of ſtronger magnets, might not, in ancient times, the near paſſing of ſome large comet of greater magnetic power than this globe of ours have been a means of changing its poles, and thereby wracking and deranging its ſurface, placing in different regions the effect of centrifugal force, ſo as to raiſe the waters of the ſea in ſome, while they were depreſſed in others?

Let me add another queſtion or two, not relating indeed to magnetiſm, but, however, to the theory of the earth.

Is not the finding of great quantities of ſhells and bones of animals, (natural to hot climates) in the cold ones of our preſent world, ſome proof that its poles have been changed? Is not the ſuppoſition that the poles have been changed, the eaſieſt way of accounting for the deluge, by getting rid of the old difficulty how to diſpoſe of its waters after it was over? Since if the poles were again to be changed, and placed in the preſent equator, the ſea would fall there about 15 miles in height, and riſe as much in the preſent polar regions; and the effect would be proportionable if the new poles were placed any where between the preſent and the equator.

Does not the apparent wrack of the ſurface of this globe, thrown up into long ridges of mountains, with ſtrata in various poſitions, make it probable, that its internal maſs is a fluid; but a fluid ſo denſe as to float the heavieſt of our ſubſtances? Do we know the limit of condenſation air is capable of? Suppoſing it to grow denſer *within* the ſurface, in the ſame proportion nearly as we find it does *without*, at what depth may it be equal in denſity with gold?

Can we eaſily conceive how the ſtrata of the earth could have been ſo deranged, if it had not been a mere ſhell ſupported by a heavier fluid? Would not ſuch a ſuppoſed internal fluid globe be immediately ſenſible of a change in the ſituation of the earth's axis, alter its form, and thereby burſt the ſhell, and throw up parts of it above the reſt? As if we would alter the poſition of the fluid contained in the ſhell of an egg, and place its longeſt diameter where the ſhorteſt now is, the ſhell muſt break; but would be much harder to break if the whole internal ſubſtance were as ſolid and hard as the ſhell.

Might not a wave by any means raiſed in this ſuppoſed internal ocean of extremely denſe fluid, raiſe in ſome degree

gree as it paſſes the preſent ſhell of incumbent earth, and break it in ſome places, as in earthquakes? And may not the progreſs of ſuch wave, and the diſorders it occaſions among the ſolids of the ſhell, account for the rumbling ſound being firſt heard at a diſtance, augmenting as it approaches, and gradually dying away as it proceeds? A circumſtance obſerved by the inhabitants of South-America in their laſt great earthquake, that noiſe coming from a place, ſome degrees north of Lima, and being traced by enquiry quite down to Buenos Ayres, proceeding regularly from North to South at the rate of—Leagues per minute, as I was informed by a very ingenious Peruvian whom I met with at Paris.

N°. V.

Explanation of a ſingular phenomenon, firſt obſerved by Dr. FRANKLIN, *and not hitherto ſatisfactorily accounted for. In a Letter from* Mr. R. PATTERSON, *to* Dr. B. RUSH.

SIR

Read Oct. 5, 1787.

I REMEMBER, ſeveral years ago to have read, in one of Dr. Franklin's philoſophical tracts, an account of a ſingular phenomenon, obſerved when a veſſel, containing oil and water, is put in motion—Thus if a glaſs tumbler, for inſtance, about two thirds filled, with equal parts of water and oil, be moved gently backwards and forwards in the hand; or, ſuſpended by a cord, be made to ſwing like the pendulum of a clock, the ſurface of the water in contact with the oil, which floats upon it, will be thrown into a violent wave-like commotion, while the upper ſurface of the oil will be comparatively placid and even.

The Doctor obſerves, that having ſhewn this experiment to a number of ingenious perſons, " thoſe who are

but

but ſlightly acquainted with the principles of hydroſtatics &c. are apt to fancy immediately, that they underſtand it, and readily attempt to explain it: but their explanations have been deſficient, and, to me, not very intelligible. Others more deeply ſkilled in thoſe principles, ſeem to wonder at it, and promiſe to conſider it. And I think, adds the Doctor, it is worth conſidering. For a new appearance, if it cannot be explained by our old principles, may afford us new ones, of uſe, perhaps, in explaining ſome other obſcure parts of natural knowledge."

When I read this account I formed in my own mind a ſolution of the phenomenon which (perhaps from the cauſe mentioned above) ſatisfied myſelf, and have not ſince conſidered the ſubject, nor ſeen any thing written upon it, till the other day, when looking over the 2d Vol. of the *Mancheſter Society's Memoirs*, I found the matter mentioned there, and two different ſolutions attempted; one by Dr. Thomas Percival, of Mancheſter, and the other by Dr. Wall of Oxford. Dr. Percival ſuppoſes "that the fact in queſtion may ariſe from a repulſive power, ſubſiſting between the particles of oil and water, and depending poſſibly upon the vibrations of that ſubtile ether, which Sir Iſaac Newton ſuppoſes to pervade all bodies. For when this ether is excited into motion, by percuſſion or agitation, its elaſtic force is augmented, becauſe it becomes denſer in the pulſes of its vibrations, than in a quieſcent ſtate."

Dr. Wall thinks "that the commotion, which the water undergoes while the oil remains tranquil, depends upon the different ſpecific gravity of the two fluids (whereby they receive the force of the impulſe in unequal proportions) and upon the diſpoſition of the oil, from its ſuperior levity, to preſerve its place, upon the top of the water, whatever agitation the water beneath may be ſubjected to." That is, as I underſtand it, the water, being ſpecifically heavier than the oil, will, from the action of a given en impulſe, acquire a greater motion than the oil, and that therefore the waves excited on the ſurface of the one, will be greater than thoſe on the ſurface of the other—Upon this principle, then, if quickſilver be ſubſtituted in place of the water, the commotion excited in it would be ſtill greater than that in the water; as it would " receive the force of the impulſe, form its ſuperior ſpecific gravity, in a much greater proportion." But *in fact* the direct contrary will be found to be the caſe. Moreover, if two fluids, of unequal ſpecific gravities, be put ſeparately into two different glaſſes, and moved with equal velocities, the commotion excited in the *heavier* fluid will be apparently *leſs* than that in the lighter; the former, from its greater ſpecific gravity, preſerving its level ſurface with more obſtinacy than the latter; which is contrary to what ought to take place upon the above principles.

But without entering further into a refutation of the above ſolution, I ſhall ſubmit to your conſideration one, which to *me*, at leaſt appears better to account for this ſingular phenomenon.

1. When the tendency of a body *upwards* is *juſt* equal to its tendency *downwards*, it will then, upon the *leaſt* impulſive force, move indifferently in either direction.

This is the caſe of a body immerſed in a fluid of the ſame ſpecific gravity; where the buoyancy of the fluid, to raiſe the body upwards, is juſt equal to the power of gravity, to draw it downwards.

2. When the tendency of a body *upwards* is *nearly* equal to its tendency *downwards*, then, a *ſmall* impulſive force upwards, will move it in that direction.

This is the caſe of a body immerſed in a fluid of *nearly* equal ſpecific gravity; for then the relative gravity, or tendency of the body downwards, will be only the exceſs of its ſpecific gravity above that of the fluid in which it is immerſed.—But water immerſed in common oil is juſt in the circumſtances laſt mentioned; and therefore a ſmall impulſive force, ſuch as that communicated by ſwinging the veſſel backwards and forwards, will be ſufficient to raiſe the water into waves, and produce that commotion which is deſcribed by Dr. Franklin in the experiment alluded to.

If this reaſoning be juſt, then, the leſs difference there is between the ſpecific gravities of the two fluids, the greater will the agitation excited in the lower fluid be, and *vice verſa;* and accordingly you will conſtantly find this to be the caſe. For if quickſilver be one of the fluids, the waves excited in it will be but very ſmall, if water and oil be uſed, the waves on the water will be much greater; but if ſpirits and oil, of nearly equal ſpecific gravities, be made uſe of, the commotion excited in the lower fluid will be very conſiderable indeed.

Hence we ſee the reaſon why the motion given to a mug of cyder or beer, after having ſtood before the fire to warm, by ſwinging it backwards and forwards in the hand, as the common cuſtom is in the winter, before one drinks, will ſo effectually mix the cold and warm parts of the liquor together, which before occupied different places in the mug.

The placid appearance of the upper ſurface of the oil, in the above experiment, is no doubt to be attributed, *in part*, to the tenacity, or glutinous conſiſtance of that fluid; but the chief cauſe undoubtedly is the great difference between its ſpecific gravity and that of the air—the fluid in which it is immerſed. For if oil be made the lower fluid, by uſing with it any other fluid of leſs ſpecific gravity, it will, notwithſtanding the tenacity of its particles, while any conſiderable degree of fluidity remains, be affected in the ſame manner as any other fluid in like circumſtances.

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N°. VI.

An Account of an Earthy Substance found near the Falls of Niagara and vulgarly called the Spray of the Falls: together with some remarks on the Falls. *By* ROBERT M'CAUSLIN, M. D. *Communicated by* BENJAMIN SMITH BARTON, M. D.

Read Oct. 16, 1789. THIS substance is found, in great plenty, every where about the bottom of the Falls; sometimes lying loose amongst the stones on the beach, and sometimes adhering to the rocks, or appearing between the layers upon breaking them. The masses are of various sizes and shapes, but seldom exceed the bulk of a man's hand. Sometimes they are of a soft consistence and crumble like damp sugar; whilst other pieces are found quite hard, and of a shining foliated appearance; or else opaque and resembling a piece of burnt allum. It often happens that both these forms are found in the same mass. Pieces which are taken up whilst soft soon become hard by keeping; and they are never known to continue long in a soft state, as far as I have been able to learn. In order to determine the nature of this substance, I made the following experiments.

Exp. 1st. I put an opaque piece, weighing 14 grains, into the vitriolic acid diluted with three times its quantity of water; And let it remain there twenty-four hours, shaking it now and then. Not the least effervescence ensued, and on taking out the piece it weighed near one grain more than when it was put in, although care was taken to absorb the moisture which was upon its surface. This experiment was repeated with a shining piece, and with exactly the same result.

Exp. 2d. When put into vinegar it did not produce the least effervescence. The vinegar having stood upon it some-

 time

time was then poured off and ſpirit of vitriol dropped into it, yet not the leaſt precipitation enſued.

That I might not be led into error by the vinegar not being good of its kind, I repeated theſe experiments with chalk; and as both effervеſcence and precipitation took place it was evident that there was no defect in the vinegar.

Exp. 3d. A ſmall piece was expoſed to the heat of a blackſmith's forge during fifteen hours. Upon taking it out and pouring water upon it, no ebullition enſued: nevertheleſs it taſted like weak lime water; being then divided into two portions, a ſolution of mild fixed alkali was dropped into the firſt, and immediately a precipitation enſued. The ſecond portion being expoſed to the air in a tea-cup ſoon contracted a changeable coloured film, which next morning was become very thick, reſembling in every reſpect that of lime water.

Exp. 4th. Hot water being poured on ſome of this ſubſtance reduced to powder and the whole ſuffered to ſettle, the clear liquor had not the taſte of lime water as in the 3d experiment; nevertheleſs a ſolution of mild fixed alkali being dropped into it as copious a precipitation enſued as when the earth had undergone calcination.

As I had neither the nitrous nor muriatic acids, nor even cauſtic fixed alkali, I had it not in my power to make any trials with them.

From theſe experiments we may, perhaps, be authorized to draw the following concluſions.

1ſt. That this concrete is not an alkaline earth, as it is not affected either by the vitriolic or vegetable acids.

2dly. We may, with more probability, ſay that it is a combination of an acid with a calcareous earth, and that it might with propriety be ranked amongſt the ſelenites. This ſuppoſition is founded on the following reaſons: 1ſt, It appears from the 4th experiment that it is partially ſoluble

luble in water, and that its earth can be precipitated by a mild fixed alkali: 2dly, the 3d experiment ſhews evidently that its earth is of the calcareous kind, as appears by the ſtyptic taſte and changeable coloured film, agreeing exactly with common lime water. It ſeems probable that the vehemence of the fire had in part expelled the acid, leaving a portion of the maſs in the ſtate of quicklime.——It is well known that moſt waters are more or leſs impregnated with a ſelenitic matter. It is ſaid that agitation diſpoſes water to depoſite a part of its earth.

It is alſo agreed that water becomes more pure by being freed from its earthy parts.

Theſe three conſiderations, together with the reſult of the above experiment, inclined me much to favour an opinion which univerſally prevails in this part of the world, viz. That the water is purified by coming down the Falls. They alſo ſuggeſted a thought to me, that this purification might depend upon the latter depoſiting part of its earth in conſequence of the violent agitation it had received in paſſing over rapids upwards of a mile in length, and then tumbling down the falls. Such a ſuppoſition received great ſupport from the ſubſtance called the Spray being only found at the bottom of the Falls, which ſeemed to ſhow that a depoſition did actually take place. This theory was very plauſible, and gave me, at firſt, much pleaſure in contemplating it: nevertheleſs ſucceeding obſervations and more ſtrict enquiries have led me to entertain many doubts upon the ſubject.——That the water is much better at Niagara, which is about thirteen or fourteen miles below the Falls, than it is at Fort-Schloſſer, which is about a mile and a half above them is an unqueſtionable fact: nevertheleſs, I do not think that this can with ſtrict juſtice be alone attributed to the depoſition of the earthy parts. There are ſeveral low marſhy grounds, which empty themſelves by ſmall creeks into the river immediately above the

 Falls;

Falls; and it is reaſonable to ſuppoſe that ſuch an impregnation will be more ſenſibly perceived at its ſource than afterwards, when it is mixed and diluted with the water of the river. To this may be added that at Fort-Erie, about twenty miles above the Falls, the water is thought not to be inferior to that of Niagara. In the ſecond place, it occurred to me that if any *conſiderable* depoſition of earth took place, as I had ſuppoſed, the ſpecific gravity of the water below the Falls muſt be leſs than that of the water above.——To determine this point, I weighed a quantity of water at Niagara with all the care and exactneſs I was maſter of; and the very ſame day made a journey up to Fort-Schloſſer, and weighed the water immediately above the Falls. The ſpecific gravity was found to be exactly the ſame. As I conducted this experiment with all poſſible caution, meaſuring the temperature of the water and alſo that of the room, in which it was weighed, each time by Farenheit's thermometer, I think I can depend upon its being pretty accurate.——In enquiring into the formation of this ſubſtance called the ſpray, it muſt be obſerved 1ſt. That the rocks near the Falls are kept conſtantly wet by the vapour which riſes in form of a thick miſt; and even thoſe at the diſtance of a quarter of a mile, or more, are affected by it, when the wind blows down the river. 2dly. That theſe rocks, either from the nature of their ſtructure, or from the circumſtance of their being kept conſtantly wet; or perhaps from the ſpray accumulating between their layers, and acting as a wedge, are very apt to crack and ſplit; and hence are almoſt conſtantly tumbling down in larger or ſmaller pieces.

3dly. That upon ſeparating the layers of theſe rocks there is generally more or leſs of this ſubſtance called ſpray found between them and almoſt univerſally in a ſoft ſtate. From the beſt enquiries I have been able to make, during a reſidence of many years, this ſubſtance is never found above

bove the Falls, perhaps never at a much greater diſtance than one mile below them. Cloſe to the Falls it is found between the layers of moſt of the rocks, the quantity leſſening in proportion to the diſtance from the Falls. Upon comparing all theſe circumſtances together, it ſeems probable that this ſubſtance is formed by the moiſture ariſing from the Falls conſtantly and ſlowly filtering between the layers of the rocks; and it ſeems very poſſible that the violent agitation which the water has undergone may diſpoſe it to part with its earth more eaſily than it otherwiſe would do.—The circumſtance of this ſpray not being found above the Falls ſeems to ſuggeſt an opinion that that part of the vapour which hangs upon the ſurrounding rocks is the heavieſt as being moſt loaded with earthy particles, whilſt the remainder which mounts up is the pureſt and contains little or no earth. The want of proper rocks to filter through and to attract the earthy particles may likewiſe be a reaſon why the ſpray is not found above the Falls, and the ſpecific gravity of the water which runs down the channel of the river below the Falls being equal to that of the water above them (which ſeems to argue that from want of ſome attracting body it had parted with little or none of its earth) favours ſuch a ſuppoſition.

The reaſon why ſo little progreſs has hitherto been made in inveſtigating the natural formation of this concrete ſeems to be, that travellers who have only an opportunity of ſeeing the Falls once or twice, have ſo many more intereſting objects within their view, that they have little leiſure, and leſs inclination, to ſearch for it amongſt the rocks; and generally content themſelves with the pieces which they find amongſt the ſtones on the beach. To thoſe who find it in this ſituation, and who do not attempt to diſcover how it came there, its formation muſt appear utterly incomprehenſible. To explain this matter clearly we have only to recollect what has been ſaid of the frequent fall of

parts

parts of the neighbouring rocks: when theſe are daſhed in pieces it is evident that the ſpray which they contain between their layers muſt be broke off and ſcattered about. To this may be added that travellers who collect pieces of this ſpray as they go along generally throw away what they have gathered when they meet with other fragments which are larger or pleaſe them better: hence we often ſee this ſubſtance at ſome diſtance from the rocks, and in places where otherwiſe it would be difficult to account for its being found in.

Several attempts have been made to aſcertain the height of theſe Falls at different times and by different perſons; but their accounts have varied from 138 feet to 174.

Upon an attentive view it evidently appears that the ſtrata of the rock over which the river is projected are inclined to the plane of the horizon: this is diſtinctly ſeen in the Iſland which divides the Fall into two parts. It is likewiſe very certain that a much larger body of water comes down the South-Weſt channel than down the North-Eaſt one.

From theſe conſiderations I began to ſuſpect, that the height of the South-Weſt ſide was leſs than that of the North-Eaſt; and ſuppoſing this to be the caſe it accounted eaſily for the variety in the different meaſurements. To aſcertain this point, I, in the year 1781, undertook to meaſure both ſides, in company with the acting engineer.

The firſt attempt which we made was by trigonometry, but in the execution of this we found many difficulties from the great inequality and ruggedneſs of the rocks. I even ſuſpected that the rays of light paſſing through the medium of a thick miſt, might ſuffer more or leſs refraction, and occaſion a deception in the angle taken. As we had previouſly determined to meaſure them in every poſſible manner, we next proceeded to let a cord down with a ſmall weight hung to it. From the inequality of the rocks at the bottom, it was impoſſible to let the cord quite down.

We,

We, therefore, took the level from the water's edge below, to the weight. By this method it appeared that the South-West ſide was actually twenty feet lower than the North-Eaſt one, the former being 143 feet, and the latter 163. It may, perhaps, be alledged that the ſtretching of the cord muſt occaſion ſome error. Suppoſe it to have ſtretched ſix inches, or even twice that length, the difference is very trifling; and although it might occaſion the Falls to appear 8 or 10 inches lower than they actually were, yet it could not, in any manner, affect the comparative meaſurement of the two ſides. The breadth of the cataract, including all the windings and alſo the Iſland in the middle, is unqueſtionably upwards of a mile: it may not appear to be ſo much; but it is well known that high banks always ſeem to be much nearer each other than they actually are. In the preſent caſe I have not formed my opinion from my eye alone, but chiefly from obſervations on the oppoſite bank. The line which the Fall forms upon a horizontal plane has ſome reſemblance to a reaping hook.

I have never had ſufficient leiſure to take the level of the rapids immediately above the Falls; but I am much inclined to think that they amount to about half the height of the Falls themſelves.—If the level of all the different currents, rapids and falls which are found between Lake-Superior and the mouth of the river St. Laurence could be aſcertained, I apprehend that the ſurface of the water in the former would be found to be at leaſt one thouſand feet higher than that of the latter.

At the diſtance of ſix or ſeven miles below the Falls, the face of the country deſcends by a very conſiderable and ſudden declivity.—This ridge runs many miles and divides the high land in the vicinity of the Falls from the low land upon which the Fort of Niagara ſtands.

It is univerſally believed that the cataract was originally at this ridge, and that it has by degrees worn away and broke

broke down the rock for the ſpace of theſe ſix or ſeven miles. Some have ſuppoſed that from theſe appearances, conjectures might be formed of the age of this part of the world.—To enter upon ſuch a calculation, it would previouſly be neceſſary to aſcertain how much the fall had retired in a hundred years, or any other certain period—Suppoſe that we were even in poſſeſſion of ſuch a fact, ſtill the concluſions drawn from it would be liable to the greateſt uncertainty, as it is evident that the ſpace of rock broke down and worn away in a certain number of years would not always be the ſame.—The more or leſs hardneſs and brittleneſs of the rock in different parts; the greater or leſs ſeverity of the froſts in different years; and the quantities of water that flowed at different periods in the cataract of the river, would all occaſion conſiderable variations. This retroceſſion of the Falls does not by any means go on ſo quickly as ſome have imagined. During nine years that I have remained at Niagara, very few pieces of the rock have fallen down which were large enough to make any ſenſible alteration in the brink; and in the ſpace of two years I could not perceive, by a pretty accurate meaſurement, that the North-Eaſt brink had in the leaſt receded. If we adopt the opinion of the Falls having retired ſix miles, and if we ſuppoſe the world to be 5700 years old, this will give above ſixty-ſix inches and an half for a year, or ſixteen yards and two thirds for nine years, which I can venture to ſay has not been the caſe ſince 1774. But if we accede to the opinion of ſome modern philoſophers, and ſuppoſe that America has emerged much later than the other parts of the world, it will neceſſarily follow that this retrograde motion of the Falls muſt have been quicker, which is a ſuppoſition ſtill leſs conſonant to the obſervations of late years.

Obſervations

N°. VII.

Obſervations on the probabilities of the Duration of Human Life, and the progreſs of Population, in the United States of America; in a Letter from WILLIAM BARTON, ESQ. *to* DAVID RITTENHOUSE, L. L. D. *Preſident*, A. P. S.

DEAR SIR,

Read Mar. 18, 1791. I BEG leave to communicate to our Philoſophical ſociety, the following obſervations, *on the probabilities of the duration of human life, in this country*;—and, likewiſe, *on the progreſs of its population*; together with the cauſes which accelerate that progreſſion, in a degree unparalleled elſewhere. By comparing the reſults, with ſimilar eſtimates made for ſome European countries—the advantages on the ſide of the United States, in theſe reſpects, will be readily diſcerned.

There is not, perhaps, any political axiom better eſtabliſhed, than this,—That a high degree of* population contributes greatly to the riches and ſtrength of a ſtate. In fact, the progreſſive increaſe of numbers, in the people of any civilized country, is reciprocally the cauſe and effect of its real wealth: and, therefore, there cannot be a ſurer criterion by which we may judge, whether a nation be, in reality, on the riſe or on the decline, than by obſerving, whether the number of its inhabitants increaſe or diminiſh.

If, then, numbers of people conſtitute (or, at leaſt, contribute to) the ſtrength and riches of a ſtate; that country, whoſe population is rapidly advancing, may fairly be ſaid to be increaſing in both theſe concomitants of national proſperity, with proportionable celerity. For, if a country exhibits ſo unequivocal a teſt of ſtrength and riches,

* "The encouragement of population ought to be one of the firſt objects of policy, in every State." Dr. Price.

riches, as that circumſtance indicates,---a good ſyſtem of government, well adminiſtered, muſt inſure its proſperity (ſo far as human efforts can produce the end;) notwithſtanding the tranſitory effect of ſuch incidents, as have no neceſſary connection with, or permanent influence upon, the fundamental ſources of a nation's welfare: Theſe could only occaſion a temporary derangement in the political œconomy of the ſtate, whereby the operation of the national reſources might, for a time, be ſuſpended; during which interval there might be an appearance (or even an actual exiſtence, in ſome degree,) of public debility and diſtreſs.

If theſe obſervations be applied to the United States of America, it will appear, that this country poſſeſſes, in a ſuperior degree, an inherent, radical and laſting ſource of national vigor and greatneſs:—For, it will be found, that, in no other part of the world, (at leaſt, in none of thoſe parts with which we are beſt acquainted) is the progreſs of population ſo rapid, as in theſe ſtates.—And this increaſe ariſes from the ſalubrity of the climate; the great fruitfulneſs and reſources of the country; the conſequent facility of acquiring the means of a comfortable ſubſiſtence, which, aided by the benign influence of our government, produces* early marriages;—and, laſtly, from the† virtuous and ſimple manners of the great body of our inhabitants. Theſe are either the proximate or remote cauſes which accelerate the population of this favoured land; independently of acceſſions to our numbers, occaſioned by migrations from foreign countries. As

* In a letter written in the year 1768, by our venerable Franklin, to John Alleyne; Eſq. (in anſwer to one wherein Mr. Alleyne had requeſted to know the Doctor's impartial thoughts, on the ſubject of an early marriage,) there is this paſſage.—"With us in America, marriages are generally in the morning of life,---our children are therefore educated, and ſettled in the world, by noon; we have an afternoon and evening of chearful leizure to ourſelves,---ſuch as your friend at preſent enjoys. By theſe early marriages, we are bleſt with more children; and, from the mode among us---founded in nature---of every mother ſuckling and nurſing her own child, more of them are raiſed. Thence the ſwift progreſs of population, among us,---unparalleled in Europe!"

† "A nation ſhall be more populous, in proportion as good morals and a ſimplicity of taſte and manners prevail; or, as the people are more frugal and virtuous."---Wallace's Diſſertation on the numbers of mankind, in ancient and modern times.

As a plenitude of inhabitants is of ſo much importance to the intereſts of a nation, numerous eſtimates have been made, of the ſtate and progreſs of population in divers countries; and the circumſtances are deſignated which occaſion its growth or declenſion, in different places and at particular ſeaſons. The reſults of ‡ eſtimates, on this ſubject, furniſh uſeful reflections to a contemplative mind: they are not only inſtructive to the moraliſt and pleaſing to the mere ſpeculative philoſopher; but they are peculiarly intereſting to the ſtateſman and the medical enquirer.

In order to ſhew the difference between the progreſs of population in this country, and that in ſome parts of the old world, as well as in the probabilities of the duration of life in each, reſpectively,—I ſhall offer ſome remarks from ſuch *data*, as, I preſume, will be ſatisfactory on the occaſion. Although the kind of documents, on which calculations of this nature are uſually founded, could not, in relation to this country, be obtained in ſo perfect a ſtate, as to warrant very accurate inferences from them, in *every* particular,—the deductions, in general, are nevertheleſs not far from the truth.—It is greatly to be wiſhed, that the ſeveral religious denominations of chriſtians, throughout the United States,—at leaſt, in our conſiderable towns and well ſettled parts of the country,—would be at the pains of obtaining and publiſhing, every year, liſts of the births and deaths in their reſpective pariſhes or congregations; together with the proportion of the ſexes in each liſt, the ages of the deceaſed, their diſeaſes, and the numbers dying in each month. The number of marriages ſhould alſo be added: and it would, moreover, be uſeful

‡ "La population eſt un des plus ſûrs moyens de juger de la proſpérité d'un empire; et les variations q'elle éprouve, comparées aux évènemens qui les precèdent, ſont la plus juſte meſure de l'influence des cauſes phyſiques et morales, ſur le bonheur on ſur le malheur de l'eſpèce humaine."---See a paper on the births, marriages and deaths, at Paris, &c. by M. de la Place, Hiſt. Royal read ſciences, for 1783.

"La connoiſſance des probabilities de la durée de la vie, eſt une des choſes les plus intereſſantes dans l'hiſtoire naturelle de l'homme."---See M. de Buffon's eſſay on the probabilities of the duration of life---in the ſupplement to the Nat. Hiſtory.

to notice in what inſtances thoſe dying after eighty years of age were foreigners. But a laudable ſpirit of enquiry is gaining ground among us, ſo faſt, that there is reaſon to expect the introduction of great regularity and preciſion in ſuch arrangements, in the ſeveral departments of our public œconomy, as may lead to further attainments in uſeful knowledge, and particularly to improvements in this branch of ſcience.

In purſuing this ſubject, it becomes neceſſary to ſtate thoſe facts, from which, as *data*, deductions are uſually made, for the purpoſe of aſcertaining the condition of any given country, with reſpect to its population. And, after ſhewing the reſult of ſimilar ſtatements, here, and comparing them with ſuch as have been made the ground-work, in eſtimates relating to European countries, the balance in favor of this country will be evident.

Marriage is the ſource of population. Therefore, the greater is the proportion of marriages in any country, the greater will be its proportion of births.—It appeared, by a collection of the yearly bills of mortality, publiſhed in London, in 1759, by Mr. Corbyn Morris,—that, in *England*, each marriage produces four children. Dr. Short, in his comparative hiſtory of the increaſe of mankind, ſays, that, in order to be fully ſatisfied reſpecting the numbers of perſons to be allowed to a family, he obtained the true number of families and individuals in fourteen market-towns, ſome of them conſiderable in trade and populouſneſs; and that they contained 20,371 families, and 97,611 individuals;—or, but little more than $4\frac{3}{4}$ to a family. He adds, that, in order to find the difference in this reſpect, between towns and country-pariſhes, he procured, from divers parts of the kingdom, the exact number of families and individuals, in ſixty-five country-pariſhes. The number of families was 17,208,—individuals, 76,284; or, not quite $4\frac{1}{2}$ to a family. Dr.

Davenant,

Davenant, from the obſervations of Mr. King, gives $4\frac{1}{13}$ as the number of perſons to a family, *for the whole kingdom.*——By the ſtate of births, marriages and deaths, in the city and Fauxbourgs of Paris, from 1771 to 1784 (both incluſive,) each marriage produced the proportion of $3\frac{93}{100}$ births. The marriages and births at Paris, for 22 years (viz. from 1745 to 1766, both incluſive) as ſtated by the Count de Buffon, give the proportion of $4\frac{36}{100}$ births to a marriage. But M. Buffon ſuppoſes, that about one half the foundlings (les enfans trouvès) ought to be included in the liſt of births for that city; inſtead of their whole number, which averaged, during thoſe twenty-two years, 4,509 per annum: deducting, therefore, one half of the foundlings from the total number of births, and each marriage gives the proportion of $3\frac{84}{100}$ births. The Abbè D'Expilly has given a ſtatement of the births, deaths and marriages for the whole kingdom of France, including Lorraine and Bar, from 1754 to 1763, comprehending a term of nine years; and likewiſe one for France, excluſive of thoſe provinces, during the ſame term. By *both* theſe ſtatements it appears, that each marriage gives the proportion of $4\frac{1}{2}$ births, for that kingdom.——In the Pais de Vaud, in Switzerland, on a medium of ten years, the proportion of marriages to births, was—as 1 to $3\frac{9}{10}$. According to Dr. Price, the proportions of marriages to births are, at Berlin, 1 to $3\frac{93}{100}$—at Copenhagen, 1 to $3\frac{5}{100}$—and at Amſterdam, 1 to $1\frac{92}{100}$.—In the Iſland of Corſica, indeed, during the years 1781 and 1782, there were five births to a marriage, according to the tables of births, deaths and marriages, within the French Dominions in Europe——(publiſhed by M. de la Place, in the memoirs of the Royal Academy of Sciences for 1783.) But this is a ſolitary inſtance of ſo large a proportion of births to marriages: and, being for a ſmall iſland, ſcarcely containing 129,000 inhabitants, it is not proper to take it into an eſtimate, on this occaſion. From

From the foregoing ſtatements it may be preſumed, that four and an half perſons to a houſe, and the ſame proportion of births to a marriage, are an allowance quite high enough for ſome of the healthieſt parts of Europe, comprehending a large extent of territory.—There is but one inſtance, in which I have been enabled to obtain the actual proportion of marriages to births, in this country—At the firſt pariſh in Hingham, in the ſtate of Maſſachuſetts, during the courſe of fifty-four years, there were two thouſand two hundred ſeven and forty births, one thouſand one hundred and thirteen deaths, and five hundred and twenty one marriages; which gives the proportion of ſix and a quarter births to a marriage. If the number of inhabitants in this pariſh had remained ſtationary, during the whole term of fifty-four years,—and if one out of forty-five had died there, annually; it would have contained nine hundred and twenty-ſeven ſouls—Therefore, the proportion of births to marriages, in that pariſh, being taken out of ſo conſiderable a number of perſons, and for ſo long a time, inclines me to think it may ſerve as a pretty juſt ſtandard for the country parts of the northern, and, perhaps, of the middle ſtates.—But, not being poſſeſſed of documents of this kind, for other parts of the Union, I ſhall aſſume the proportion of perſons to a houſe, or to a family, as the next beſt means for aſcertaining the proportion of births to marriages.—When we find a large proportion of perſons to a family, taking a country *en gros*, it may be reaſonably preſumed that the births are numerous in the ſame ratio: And the moſt obvious cauſes, which produce this effect, have already been noticed. It has been obſerved, that, in ſome of the healthieſt and moſt conſiderable portions of Europe, four and an half perſons to a houſe is a large allowance for thoſe countries. The late cenſus of the inhabitants in the ſtate of Maſſachuſetts ſhews, that there are in that ſtate, upwards of five and

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two thirds ſouls to a *family*, in that ſtate---excluſive of Indians and Negroes—The proportion to a *houſe* is $6\frac{5}{100}$: For, the *families* are to the *houſes*, in that ſtate, as ſix to five. In Boſton, there are to a *family*, $5\frac{39}{100}$ ſouls: and in the three next largeſt towns, placed in the order of their magnitude, the proportions of perſons to a family, are as follow, viz. Salem, $5\frac{30}{100}$, Marblehead, $5\frac{12}{100}$ Newbury-Port, $4\frac{84}{100}$: At Ipſwich, containing four thouſand five hundred and ſixty two inhabitants (and which will be mentioned hereafter,) the proportion is, $5\frac{6}{100}$. In this eſtimate for Maſſachuſetts, the diſtrict of Maine is not included: but the ſtate contains 373,324 inhabitants, excluſive of that diſtrict.—When the cenſus in completed, for the ſeveral ſtates in the Union, the reſult it will furniſh, on this ſubject, will prove highly intereſting—It appears, however, by the cenſus for the large and populous ſtate of Maſſachuſetts, that the proportion of births to marriages, there, greatly exceeds that which obtains in ſome of the principal countries of Europe: And, it is probable, the reſult will be found nearly the ſame, in this particular, with relation to the major part of the Union.

There is, however, another means, by which the ſuperior number of births in proportion to the whole number living, in this country,---compared with the proportion which obtains, in this reſpect, in proſperous European countries,—may be aſcertained.—In an eſſay for aſcertaining the population of France, by Meſſrs. Du Sejour, the Marquis De Condorcet and De La Place, (in the memoirs of the Royal Academy of ſciences for 1783,) it is aſſumed as an hypotheſis---that multiplying the medium of annual births in the whole kingdom, by $25\frac{1}{2}$, will give the number of inhabitants; and that, for the cities of Paris and Verſailes, thirty muſt be the multiplier. The Count De Buffon ſuppoſes, that the number of thoſe who die in France, annually, is $\frac{1}{35}$ of all the living; and, conſe-

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quently, if the medium of annual deaths in the kingdom be multiplied by thirty five, the product will be the number of inhabitants it contains---Accordingly, by the firſt hypotheſis, France ſhould contain 24,812,877 inhabitants (taking the medium of births in that kingdom, excluſive of Corſica, in 1781 and 1782,---as ſtated in the memoirs of the Royal Academy of Sciences, for 1783):—And by the ſecond hypotheſis, the number would amount to 25,916,170, (taking the medium of deaths in nine years, viz. from 1754 to 1763,---as ſtated by the Abbè D'Expilly.) The variance in the reſult of theſe two hypotheſes ſhews, that both cannot be juſt.—I am induced to believe that the ſecond proportion approaches neareſt the truth, for the following reaſon---Each marriage gives four and an half births, during the nine years eſtimated by the Abbè D'Expilly; whereas the ſame gives only the proportion of $4\frac{23}{100}$ births, for the years 1781, and 1782,—as ſtated by M. de la Place: and it may be preſumed, that the longeſt term gives the trueſt proportion. If, therefore, the proportion of births to marriages from 1754 to 1763 (the laſt, included,) compared with the proportion of births to marriages, in 1781 and 1782, be admitted as a *Datum*, from which any probable eſtimate of the number of inhabitants in France may be deduced, for the latter period,—that number would be 26,396,667; which exceeds the higheſt number above ſtated. But $4\frac{4}{10}$ births to a marriage—an intermediate ratio—will give the number of inhabitants the ſame, as thirty five of the whole number, living in a given term, to each death during the ſame time; and this accords with M. de Buffon's hypotheſis.---Aſſuming, then, the truth of this poſition---there are in France $26\frac{63}{100}$ perſons living, in proportion to each birth—Hence the number of annual births in that kingdom, multiplied by $26\frac{63}{100}$, will yield the number of its inhabitants.---It appears, alſo, by an enumeration of the inhabitants of the

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kingdom of Naples, taken in the year 1769,---that by multiplying, by twenty-five and an half, the births of a common year, in that kingdom, the product gave the real number of the inhabitants: and, further, that, on comparing the number of births and that of the inhabitants, in the city of Turin, in the years 1767 and 1768,---the proportion of the former was to the latter, as one to twenty-seven.---Considering these several circumstances, I would infer---that the proportion of about twenty-six and an half existing persons to each birth, is nearly right with reference to France. In this estimate for France, the Island of Corsica, subject to that crown, is not comprehended.---If there be one birth to every twenty-six and an half inhabitants, in that Island,---the latter must amount to 136,077; and, if this number be divided by the medium of annual deaths,---these will be to the whole number of the living, as one to $32\frac{71}{100}$. But, taking the medium of marriages and births, respectively, for Corsica, there were five births for one marriage. For this reason, a greater number ought not to be assumed, for ascertaining the actual population of that Island, than twenty-five persons to each birth. This reduces the total number of inhabitants to 128,375; and makes the number of those who die annually, compared with the whole number living, as one to $30\frac{86}{100}$: a degree of mortality, which indicates the unhealthiness of the climate; notwithstanding the high proportion of births to marriages, in that country, makes the number of deaths appear low, in comparison with the births.——

With respect to England—although Sir William Petty and other English writers agree in saying, that, in the *country* in that kingdom, there dies one in thirty-two,--- M. Buffon estimates the proportion to be one in thirty-three. And Petty supposes that five are born, to four that die, in that country.---This ratio gives one birth to nearly twenty-ſix and an half inhabitants.---Dr. Price preſumes, that 591,580, is nearly the true number of inhabitants, in London; but, that 651,580, though ſhort of the number ſuppoſed in that city, is very probably greater, and cannot be leſs, than the true number.—In the firſt caſe, the number of inhabitants in London, divided by the annual number of deaths (including therein an addition of 6,000, for omiſſions,) gives $21\frac{62}{100}$, as the proportion out of which one dies annually:—and, in the ſecond caſe, that proportion will be one out of $23\frac{80}{100}$. There are, notwithſtanding, ſome circumſtances, which diſpoſe me to conclude, that London contains 711,516 ſouls---Firſt; we find, by taking the medium of two eſtimates (one by Meſſrs. du Sejour, Condorcet and de la Place, and the other by M. Buffon,) that Paris contains about 626,285 ſouls, and that there are nearly thirty-two and an half living in that city, to each annual death.—We alſo find, that the mortality of London exceeds that of Paris, about one fourth part,—as eſtimated from the births and deaths for each city, reſpectively: conſequently, the number of perſons living, to each annual death, in London, will be twenty-ſix; agreeably to my hypotheſis---Secondly; although Graunt, Petty, Morris, Smart, and other Engliſh authors, have adopted the number of thirty of the living, to each death, for London; yet the Count de Buffon ſuppoſes---that thirty-one to one, is near the truth: and Dr. Price ſtates the proportion to be twenty-one to one:---The medium, therefore, of M. Buffon's and Dr. Price's eſtimates is twenty-ſix to one. Now, if we aſſume the proportion of one birth to twenty-ſix inhabitants, annually, for France, which is leſs favorable, with reſpect to the ratio of births to inhabitants in that kingdom, than the eſtimate of M. du Sejour, &c.---and, if it be aſſumed as a fact, that one in twenty-ſix dies, annually, in London; the proportions of the births in a year, for the ſeveral places herein mention-

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ed, are, to the number of souls in those places, respectively, as follow, viz.

In France	1 birth	to 26	inhabitants
England	1 do.	to $26\frac{1}{2}$	do.
Paris	1 do.	to 30	do.
London	1 do.	to $32\frac{1}{2}$	do.

Yet, even in the city of Philadelphia, the annual births amount to one in twenty-two and an half, of all the inhabitants. A bare inspection of the several proportions, in this particular, will enable one to form a judgment of the increase of population in this country, beyond that of the two most considerable in Europe.

Another circumstance, from which the extraordinary progress of population, in this country, may be inferred, is the high proportion of those under the age of 16 years, to those above that age, out of the whole number of the living.—Dr. Halley computes the number of the living, under 16, to be but a *third* of all the living at all ages. But it appears from the census of the inhabitants of New-Jersey, taken by order of the government at two periods, viz. 1738 and 1745, that, in the year 1738, the number of those *under* 16, was to the whole amount, as $47\frac{63}{100}$ to 100; and, in 1745, the proportion was, as $49\frac{55}{100}$ to 100. The proportion of free white males, to the whole number of persons of that description, in Massachusetts, taken from the recent census of inhabitants in that state, is as $48\frac{2}{100}$ to 100.—Hence we find nearly* *one-half*, instead of one-third, is the proportion, here, of those under 16, out of the total number of our inhabitants.—The proportion for the city and suburbs of† Philadelphia, is,

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* Mr. Jefferson observes—in his notes on Virginia—that, to find the number of free inhabitants in that state, it is to be noted---that those above and those below 16 years of age, are nearly equal.

† The celebrated founder of Pennsylvania, in a letter to his friends in London (dated at Philadelphia, the 16th of August, 1783)---acquaints them, that the planted parts of the province were then erected into six counties, containing about four thousand souls; and that the *capital* had advanced, within less than a year, to about four score houses and cottages, such as they were.—Philadelphia *now* contains about 44,000 inhabitants!

by the cenſus,* $41\frac{38}{100}$ to 100: but this inferiority of the proportion of perſons under 16 to thoſe above that age, in Philadelphia, may be attributed to a greater proportion of children dying in large cities, than in country places. The next circumſtance, from which I ſhall infer that the progreſs of population is much more rapid in this country, than elſewhere, is, that the births exceed the deaths, in number, in a ſuperior degree, among us.—The Abbè D'Expilly, in his eſtimate before mentioned, gives the births to the deaths, in France, as 100 births to $76\frac{94}{100}$ deaths. In the Pais de Vaud, on an average of ten years, the proportion was, to 100 births, $79\frac{37}{100}$ deaths.——In great cities, the degree of mortality is much higher. By the tables of births and deaths in Paris, for twenty-two years (viz. from 1745 to 1766,) the births and deaths give the proportion of 100 of the former, to $99\frac{1}{3}$. The medium of four other ſtatements (two by M. de la Place, one by Dr. Price, and the other taken from Anderſon's hiſtorical and chronological deduction of the origin of commerce,) gives, for Paris, 100 births to $100\frac{99}{100}$ deaths: and the Count de Buffon ſays, that, in fifty-eight years, the deaths in Paris exceeded the births only about $\frac{1}{75}$ part. This is a fa orable proportion for ſo great a city.—Mr. Anderſon has given the numbers of annual births and deaths in London, during a term of twenty-ſix years; from which it is found, that the deaths exceed the births, in that city, at the rate of five to four, very nearly. This ſtatement, which gives the proportion of births, in London, rather higher than others, ſhews, that the mortality of that city is about one-fourth greater, than that of Paris. At Amſterdam and Berlin, according to Dr. Price, the degree of mortality is ſtill higher than in London; there being, in the former, to 100 births $169\frac{56}{100}$ deaths, and in the latter, to 100 births 131 deaths. In the city of Norwich, Great-Britain, on a medium of thirty years, there

* Since the cenſus has been *compleated*, the proportion appears to be 42 5-100 to 100.

there were, to 100 births, $114\frac{4}{100}$ deaths—That city is ſuppoſed to contain about 33,000 inhabitants. And at Breſlaw, which contains about as many inhabitants as Philadelphia, the births are to the deaths (taking the medium of two ſtatements) as 100 births to $119\frac{1}{2}$ deaths. The proportions of births to deaths vary, in different countries; and, in large towns, the proportion of the latter is always higher than in country places, *cæteris paribus*. But, taking the principal countries of Europe, *en gros*, the births do not exceed the deaths in any great degree—I have ſubjoined a ſcale of theſe proportions, for ſeveral cities and countries, not enumerated in the foregoing ſtatements.

The births (eſtimated from the *chriſtenings*) in Philadelphia, in the year 1788, were 1583; and the burials, excluſive of negroes, amounted to 872. The number of negro births for this city, as appears by the bills for the years 1789 and 1790, average 144 *per annum*. Suppoſing one-third of this number to be included in the *chriſtenings*, forty-eight muſt be deducted from the liſt of births. This will give 1536 births, to 872 deaths, for the year 1788:—and, taking the average proportion of births to deaths, for four years, it gives to 100 births, $56\frac{1}{2}$ deaths. The average number of deaths, among *all* the *white* inhabitants of this city, for the three laſt years, is 924 *per annum*. The proportion of births to deaths, in the German Lutheran congregation of this city, which comprehends about one-fifth of all the white inhabitants, is, on an average of* ſixteen years, as one hundred births to forty-five deaths: and therefore, taking the medium of this proportion and that above ſtated, it gives to 100 births, $50\frac{3}{4}$ deaths. The bills, for the white inhabitants in this city, for 1789 and 1790, give the proportion as only 100 births to $49\frac{94}{100}$ deaths; and, as theſe bills are the moſt full:

* The Rev. Dr. Helmuth, rector of the German Lutheran church, in Philadelphia, was ſo obliging as to furniſh me with theſe liſts.

full and ſatisfactory of any I have yet ſeen, for Philadelphia, I think the births may be fairly ſtated as being double to the number of deaths.—At Salem in Maſſachuſetts, on a medium of the years 1782 and 1783, the births were to the deaths, as 100 births to 49 deaths, including the ſtill-born in the number of deaths.—Dr. Holyoke ſays (in the memoirs of the American Academy of Arts and Sciences, Boſton,) that both 1782 and 1783 were ſickly at Salem;—particularly the latter years, in which, during the months of May and June, the meaſles were epidemic. The births and deaths at Hingham, in the ſame ſtate, during 54 years, gives to 100 births 49½ deaths.——Hence it may be inferred, that, ſo far as deductions from theſe documents may be relied on, there are two births to one death, in this country.

The peculiar circumſtances of this new country will not permit me to aſcertain, from the *data* uſually employed for ſuch purpoſes, the comparative longevity of our inhabitants.—Agreeably to Dr. Halley's table for Breſlaw,* 34 perſons, out of 1000, ſurvive 80 years of age. In the paper on the longevity of the inhabitants of Ipſwich and Hingham, in Maſſachuſetts (communicated to the Boſton Academy, by the Rev. profeſſor Wiggleſworth,) the writer obſerves, that, out of 164 perſons who died at Ipſwich Hamlet, in ten years, twenty-one perſons ſurvived eighty years complete; being one in about eight: whereas, at Breſlaw, the proportion is one in about thirty—He alſo ſtates, that, out of 1,113 deaths in 54 years, at Hingham, 84 perſons ſurvived 80 years complete; being one in 13¼. It is obſerved by Mr. Morſe, in his American Geography, that the ſtate of Connecticut, though ſubject to the extremes of heat and cold, in their ſeaſons, and to frequent, ſudden changes, is very healthful. He ſays, that as many as one in

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* This does not, however, by any means, correſpond with M. Buffon's eſtimate; as he makes the proportion to be only 27 63-100 out of 1000.—

46 of the inhabitants of Connecticut, who were living in 1774, were *upwards* of ſeventy years old: and that it is found, from actual calculations, that about one in eight live to the age of ſeventy years; one in thirteen, to the age of eighty; and one in about thirty, to the age of ninety years.—"From the 1ſt January 1771, to the 1ſt January 1777,---239 perſons died at Milford, (Connecticut;) of which thirty-three, or about one ſeventh part, were upwards of ſeventy years old---and eighty four. From Jan. 1ſt 1771, to June 3d 1782, died at Milford, 417 perſons; of which, thirty-one (or about one thirteenth part of the whole number) were eighty years old, and upwards. Other calculations of a ſimilar kind, continues Mr. Morſe, made in different parts of the ſame ſtate, from the bills of mortality, confirm the juſtneſs of the above proportion."--The number dying in Philadelphia, aged upwards of eighty years, during the year 1789, is in the proportion of about twenty-four and an half out of 1000 perſons. Thoſe dying after that age, and upwards to the age of 101 incluſive, muſt have been born between 1688 and the end of 1709. During this term of twenty-one years (commencing about ſix years after the firſt ſettlement of Europeans, on this ſpot,) it is not probable that more than 1000 children were *born* here; and, even admitting that *all* of theſe died here, the proportion of *ſuch* could not, agreeably to Dr. Halley's eſtimate, exceed thirty-four, during the year 1789. But it is probable, that many of thoſe who were born here, during the above mentioned term of twenty-one years, had removed from the city, prior to the year 1789; and it is alſo probable, that *ſome* of thoſe who died at Philadelphia in that year, aged upwards of eighty, were not natives of this city—It may, therefore, be preſumed, that the *chances* of an addition to the number of thoſe dying after eighty, which have been loſt by the removal of natives before that age, may be *balanced* by the

the ſame number of non-natives, who died here after eighty, in the courſe of that year. In this caſe, the number of thoſe who die at Philadelphia, after completing the 80th year of their age, compared with the total number of deaths in the year 1789, will ſtand in the proportion of $24\frac{1}{2}$ of the former, to 1000 of the latter. It muſt be obvious, to any perſon conſidering this ſubject, that every calculation of the probabilities of the duration of life, at the *later* periods of life, and of the proportions, which the numbers of thoſe dying at very advanced periods of its exiſtence, bear to the numbers of ſuch as die, at its early and middle ages,--muſt neceſſarily give a more unſatisfactory reſult, than ſimilar eſtimates for the anterior periods of life.—This is the caſe, in ſome degree, when applied to any country; under whatever circumſtances the application may be made: the obſervation is true, in a greater degree, when applied to towns, whether great or ſmall:—and it is ſtill more juſt, with reſpect to *American* towns; by reaſon of the infant ſtate of our country,—the continual fluctuation in the migrations of the inhabitants,—and the rapid increaſe of population, as well in our capitals as in the country generally.—The reaſon of my not having gone higher than the age of 101 years complete, is, that M. Buffon, in his general table of the probabilities, &c. makes no calculation for any age beyond that period of life: out of 23,994 deaths, he eſtimates only two to be living after the completion of the 101ſt year, and *none* at 102.

A further *datum* for aſcertaining the ſuperiority of this country, in the progreſs of its population, is founded on the proportion which the annual deaths bear to the whole number of the living, in different countries.—In Dr. Price's eſſay on the expectation of lives, ſtate of London, population, &c. it is laid down, as the reſult of various calculations, that in London and Edinburgh, there die annually about one in twenty-one; in Dublin, one in twen-

ty

ty-two; in Rome, one in twenty-three; in Amſterdam, one in twenty-four, &c. M. Suſmilch makes the proportion of thoſe who die, annually, in *great* towns, to be from $\frac{1}{24}$ to $\frac{1}{28}$; in *moderate* towns, from $\frac{1}{28}$ to $\frac{1}{31}$; and, in the *country*, from $\frac{1}{40}$ to $\frac{1}{50}$. But Dr. Price ſuppoſes the following proportions more juſt, viz. Great towns, from $\frac{1}{19}$ or $\frac{1}{20}$, to $\frac{1}{23}$ or $\frac{1}{24}$; moderate towns, from $\frac{1}{23}$ to $\frac{1}{28}$; and the country, from $\frac{1}{30}$ or $\frac{1}{35}$, to $\frac{1}{50}$ or $\frac{1}{60}$: and he is of opinion, with M. Suſmilch "that, taking a whole country in groſs, including all cities and villages, mankind enjoy among them about thirty-two or thirty-three years, each, of exiſtence; or,—which amounts to the ſame thing,--that one out of thirty-two or thirty-three dies annually.—Sir William Petty, in his eſſays on political arithmetic, ſays—that in the *country*, in England, one dies out of thirty-two; and, that five are born to four that die. "This laſt fact, 'ſays M. Buffon,' agrees pretty well with what happens in France: but if the firſt fact be true, it follows, that the ſalubrity of the air in France is much greater than in England,—in the proportion of thirty-five to thirty-two;—for, it is certain, that, in the *country* in France, no more than one dies out of thirty-five."—M. Suſmilch makes the proportion, as deduced from 1098 country pariſhes in Germany, to be one out of forty-three. He likewiſe gives the proportion of one to forty-five for a country pariſh in Brandenburgh: and M. Muret eſtabliſhes the ſame, for the Pais de Vaud,--(See Dr. Price's obſervations, &c.) The two laſt are the higheſt proportions I find for any part of Europe. In Madeira,——(an African Iſland) Dr. Heberden ſtates the proportion to be one in fifty—the climate of that Iſland, it is true, is remarkably ſalubrious: but Dr. Price thinks the eſtimate of Dr. Heberden is exceptionable. Large towns give the proportions dying out of the whole number, much higher,—even at Breſlaw—which has, in this kind of calculations, been ſtiled *the*

Britiſh ſtandard of life,—the proportion is ſtated as being one to twenty-eight.—It appears, however, by the number of inhabitants in Philadelphia and Salem, that in the former—a town about as populous as Breſlaw—the proportion is one to forty-five; and in Salem, one to forty-ſeven.

There is no circumſtance that affords a more ſtriking proof of the rapid progreſſion of population in this country, than the prodigious increaſe in the numbers of our people, ſince the original ſettlements of Europeans on theſe ſhores. The firſt ſettlement made by Europeans, within the preſent limits of the United States, was in Virginia, by a colony conſiſting of about one hundred Engliſh, in the year 1607. The honorable Mr. Jefferſon (in his notes on Virginia) remarks, that, about the year 1654, the progreſſion in the population of that ſtate became pretty uniform; importations having in a great meaſure ceaſed, and the inhabitants become too numerous to be ſenſibly affected by Indian wars. Beginning, at that period, therefore, ſays this gentleman, we find,—"that from thence to the year 1772, our tythes had increaſed from 7,029, to 153,000."—The whole term being of 118 years, yields a duplication once in every 27¼ years. The intermediate enumerations, taken in 1700, 1748 and 1759, furniſh proofs of the uniformity of this progreſſion."—A very inconſiderable colony of Engliſh formed a ſettlement at Plymouth, in New-England, in 1620. In 1643, 21,200 perſons, alſo emigrants from Britain, ſettled in New-England: and, ſince that period, it is ſuppoſed more have emigrated from thence, than the numbers who had gone thither would amount to.* In the year 1760, they were increaſed half a million.——Therefore, as Dr. Price obſerves, they have all along doubled their own number, in twenty-five years. Two years ſince, Mr. Morſe eſtimated the number of people in New-England, at 823,000.

Our

* See a diſcourſe on Chriſtian union, by Dr. Stiles—Boſton, 1761.

Our late Prefident, the illuftrious Franklin, was of opinion, that the people of thefe ftates double their number in twenty years.* Dr. Price feems to think---that, " in the back fettlements, where the inhabitants apply themfelves entirely to agriculture, and luxury is not known, they double their own numbers in fifteen years; and all through the Northern colonies, in twenty-five years;---- which, continues Dr. Price, is an inftance of increafe fo rapid, as to have fcarcely any parallel."---Even in Madeira---where, according to Dr. Heberden, only $\frac{1}{50}$ part of all the inhabitants die annually,---it is faid they do not double their number in lefs than eighty-four years.

To affift us in forming a fatisfactory judgment, refpecting the probabilities of the duration of life, in this country---a confideration intimately connected, in the prefent enquiry, with the caufes of the quick progrefs of its population,---it becomes neceffary to examine into the ‡ longevity of the inhabitants.---Having noticed, in the preceding part of thefe obfervations, that nearly one half of the people, in the Northern and middle ftates of the union, are under fixteen years of age—although Dr. Halley ftates, that, in Europe, the proportion of fuch is only one-third----the inference, neceffarily refulting from thefe facts, is---either, that the probability of the continuance of life is greater here than in Europe, between the birth and fixteen years of age, out of equal numbers born; or, if the probabilities are equal, prior to that period of life, in the two countries refpectively—that the proportion of births to the number of inhabitants, here, exceeds that in Europe;---or, on the other hand, that the probabilities of life are lower in this country, fubfequent to that period.

 From

* Obfervations concerning the increafe of mankind, peopling of countries, &c.

‡ " Thofe inhabitants of Pennfylvania, who have acquired the arts of conforming to the changes of our weather, in drefs, diet, and manners, efcape moft of thofe acute difeafes, which are occafioned by the fenfible qualities of the air: and faithful enquiries and obfervations have proved, that they attain to as great ages, as the fame number of people in any part of the world."----Dr. Rufh's account of the climate of Pennfylvania, &c.

From circumſtances which have been already ſtated, it is evident the proportion of births, to the exiſting number of the whole people, is greater here than in Europe: but it is not probable that this exceſs is greater than in the proportion of one-half to one-third---I preſume it is rather leſs.---If, however, this exceſs be in the ratio of three to two, the chances of life from the birth to ſixteen will, in this caſe, be the ſame in both countries. On this ſuppoſition, then, the probabilities in favor of the continuance of life *after* ſixteen, through all the ſubſequent ſtages of its poſſible exiſtence, muſt be higher here than in Europe: becauſe, as I have ſhewn, only one in forty-five die annually, even in the city of Philadelphia; whereas, in France, the proportion is one in thirty-five, and in England, one in thirty-three.

In addition to what has been ſaid, reſpecting the longevity of the inhabitants of Connecticut, and of Hingham and Ipſwich-Hamlet in Maſſachuſetts, I ſhall mention a few remarkable inſtances of longevity, which have occurred in other parts of the union--They are not adduced as being, of themſelves, proofs of American longevity; but rather to evidence its reality, in ſuch caſes as ſerve to corroborate the truth of the poſition, that the people of this country are long-lived.---The inſtances are the following.---In the year 1765, a Mr. Temple died in the county of Worceſter, Maſſachuſetts, aged eighty-ſix years--He left eight children, four ſons and four daughters, all of whom were living in September 1788; and their ages were as follow, viz. 89, 85, 83, 81, 79, 77, 75, and 73. John Sydenham (commonly called Sidman) was living near Mount Holly, in the ſtate of New-Jerſey, on the 5th of November 1788: he was then 106 years and three months old—This man was born near Exeter, in England; but was brought to America, when only eighteen months of age.—Edward Drinker was born in Philadelphia, December 24th, 1680, and

and died November 17th, 1782.—Mr. Hooton, a native of the city of New-York, was living laſt ſummer (and I believe is ſtill alive,) in the diſtrict of Southwark; aged, at that time, upwards of 107 years.—In the bill of mortality for Chriſt church and St. Peter's, in this city, in the year 1775, I obſerve the death of one perſon, aged 120 years. The Pennſylvania Mercury of the 1ſt of March, 1788, has, republiſhed from a Wilmington paper under the date of February 27th, the names of fifty perſons then living, in Anameſſex and Pocomoke Hundreds, Somerſet county, in the ſtate of Maryland,--all of great ages: of theſe, twenty-three were upwards of ninety years of age; ſixteen, upwards of eighty-ſeven; and eleven, aged eighty-five.——In the year 1775, Mrs. Lear died at Portſmouth, New-Hampſhire, at the age of 103 years. In the ſame year, Mrs. Abigail Mayo died at Cambridge, Maſſachuſſetts, aged 106 years. And Mr. William Ward, a native of Fairfield, in Connecticut, died in the ſtate of New-York, alſo in the year 1775, aged 105 years, four months and twenty days.

On the 20th of Sept. 1788, died at his ſeat in Albemarle country, Virg. Daniel Maupin, who was born on the 25th of March, 1700. At the time of his death, there were living, of his offspring, upwards of 200 perſons, including ſome of the fifth generation. His wife was then alive and in good health; and it was not known that any female of her generation, after attaining to the years of a woman, died under the age of eighty-five years.---About three years ſince, Arthur Bibbington died at Wyndham in Connecticut, aged 107 years:---And, about the ſame time Mrs. Jane Braſher died in the city of New-York, at the age of a 102 years.---Timothy Matlack, Eſq. clerk of the Senate of Pennſylvania, has favored me with a communication of the following facts, tranſcribed from a note made by him, about twenty-four years ſince—Upon reading a

paragraph

paragraph in a Philadelphia paper, republiſhed from an *Engliſh* paper, mentioning that five brothers, the ſons of one mother, had met, whoſe ages, added together, amounted to 311 years,—his mother (a widow) obſerved, that ſhe had five brothers and ſiſters, then living—the children of one man and one woman, whoſe ages, added to her own amounted to upwards of 400 years—He alſo mentions, that there were then living, of the brothers and ſiſters of his father, ſix perſons—the children of one man and one woman,—whoſe ages added together amounted to 426 years; all of whom were born in weſt New-Jerſey---At the ſame time, his wife obſerved, that her father had ſix brothers and ſiſters---the children of one man and one woman,---all born in Pennſylvania and then living,--whoſe ages added together, including his own, amounts to 470. To theſe circumſtances, his mother added, that ſhe and her two ſiſters had borne thirty-ſeven children; of whom thirty were then living,---and the youngeſt of them, ſeventeen years old. Hence it appears, that the mean age of theſe *nineteen perſons*---who may be conſidered as of *one family*---exceeded ſixty-eight years. Mr. Matlack adds, that he is not certain whether any of his father's brothers be now living; although ſome of them were alive, within a few years paſt: But, that the laſt of his mother's ſiſters died four years ſince, and the laſt of his wife's uncles died within a few months paſt.*

But

Additional Inſtances of Longevity, in America.

* On the 4th of February, 1787, died in Pennſylvania, in the 103d year of his age, Jacob Wiſmer, a native of Germany. In Queen Anne's reign, he emigrated to N. Carolina, where he lived ten years; after which he ſettled in Bucks county in Pennſylvania, where he married his third wife, with whom he had 170 children, grand-children and great grand-children; and left his widow, about 84 years old.—He muſt have reſided in America, *at leaſt* 72 years.

Zachariah, regent of the Mohegan tribe of Indians, died in his Wigwam, in Pomſchang near Norwich, in Connecticut, in the 100 year of his age—in the year 1787.

Mrs. Hannah Flagg, died at Boſton, at the age of 102 years—in the year 1787.

Dr. Bernard Vanlear died in Delaware county, Pennſylvania, in the 104th year of his age—in the year 1790.

At Exeter in New-Hampſhire, in 1790, Mr. Thomas Hayley,—aged 101 years.

At Southborough in Maſſachuſetts, in 1790, Mrs. Newton,—aged 106 years—Her mother lived 113 years, and her ſiſter 102 years.

At

But numerous and remarkable inſtances of American longevity are, by no means, confined to the Northern and middle ſtates. On the authority of two gentlemen of reſpectability and obſervation one from Virginia—and the ‡ other from North-Carolina,---I am warranted in ſaying, ſuch inſtances occur in thoſe ſtates, as induce a belief, that their climates are favorable to a long duration of human

At Thomſon in Connecticut, in 1790, Mr. Henry Elthorp—aged 105 years.

At Albany, in the ſtate of New-York, in 1790, Mr. Abraham Vanverts,—aged 124 years.

At Eaſt-Haddon, in Maſſachuſetts, in 1790, Mr. Weeks Williams,—aged 100 years.

At Windham in Connecticut, in 1788, Mr. Arthur Ribbins—aged 110 years and ten months.

At Cheſterfield in Virginia, in 1788, Daniel Nunally—aged 105 years.

At Wilmington in the ſtate of Delaware, in 1789, Mr. Chriſtopher Hendrickſon,—aged upwards of 100 years---He was one of the firſt Swediſh ſettlers on the Delaware.

At Northampton in Maſſachuſetts, in 1788, Mr. Joſiah Clark--aged 92 years. He was the youngeſt of 11 children (ſix ſons and five daughters,) three of whom lived to be above 90, four above 80, and three above 70 years of age. From the ſix *ſons*, only, have deſcended 1158 children, grand-children and great-grand children; 925 whom are now living.

At Dover in New-Hampſhire, Mrs. Margant Wight, in 1787---aged 102 years.

In Berks county, Pennſylvania, in 1789, Joſeph Mountz,---aged 100 years.

At New-London, Connecticut, in 1789, Mrs. Dowſett,---aged 102 years.

In the city of New-York, in 1789, Mrs. Elizabeth Lynch,---aged 104 years.

At Great Barrington, in Maſſachuſetts, in 1789, Mrs. Chapman,---aged 101 years.

In South-Carolina, not long ſince, Mrs. Dedcot,---aged upwards of 100 years; Mrs. Maſſey, aged 102; and Mrs. Maſſey's nurſe, aged 115 years.

I am indebted to Jonathan Williams, jun. Eſq. one of the Secretaries of the A. P. S. for the following inſtances of American Longevity, which he was ſo obliging as to tranſmit to me, from Richmond in Virginia, in June laſt ——viz.

Abraham Eades, now living in Albemarle county Virginia, is 110 years old.---His wife died at 100, and they were married 80 years.

A man of the name of Lee, Monongalia county Virginia, is now living---106 years old.

A Mr. Crafton, King and Queen county Virginia, is 104 years old, now living.

John Dance, of Cheſterfield county Virginia died at 125 years old. He began to cut teeth before his death.

‡ *Dr. Williamſon. This Gentleman has given me permiſſion to make uſe of the following letter, on this occaſion.*

SIR,

It is not poſſible to give a general rule which ſhall apply to the ſeveral parts of North-Carolina, in anſwer to your queſtions concerning the duration of human life in that ſtate. In the eaſtern part of the ſtate, within fifty or ſixty miles of the ſea, where the country is flat and there are many marſhes, the inhabitants are much afflicted during the ſummer and autumn by intermitting and other bilious fevers. During the winter, as the cold is ſeldom intenſe and by no means conſtant or certain, the inhabitants in general are not ſufficiently careful to defend themſelves againſt the cold: hence many, in the vigor of life, men eſpecially, are cut off in a few days by pleuritic or other inflammatory fevers. Such is the ſtate of the fluids in thoſe who have been reduced by intermittents during the autumn, that they ſeldom reſiſt inflammatory fevers. Time and obſervation will doubtleſs teach the inhabitants, by keeping themſelves dry and warm, to prevent what they cannot readily cure. There are inſtances neverthleſs of a conſiderable degree of old age, in that very climate. In the weſtern parts of North-Carolina, towards the mountain, the inhabitants enjoy a great degree of health. Many of them have very numerous families and attain to old age. As that country was long the reſidence of a maternal anceſtor, I have probably been more attentive to the progreſs of population there.

We

man life. The ſame may be obſerved, with reſpect to † South-Carolina and Georgia, in which ſtates the climate is ſalubrious; although low, flat parts of the country, and ſuch as lie in the vicinity of the rice and indigo ſwamps, as well as the bad quality of the water in ſuch ſituations, render ſome parts of thoſe countries unhealthy.—Even in Eaſt-Florida (if Captain Bernard Romans is to be credited), the climate is very healthful—St. Auguſtine, the capital

We have ſome reaſon for believing, that on the weſt ſide of the Apellachian mountain, in the territory ceded by North-Carolina, the period of human life may be extended to what would be called a great length in any part of the world.

In that country, there are few marſhes or ponds of ſtagnant water. The ſoil is dry, and lime ſtone abounds every where: the water is conſequently very good.

In or near the latitude of 36 degrees, we are neither to expect the extremes of heat nor cold; but we have noted cauſes in this very latitude, which are very injurious to health: theſe cauſes however do not exiſt in the country of which I am ſpeaking. The Apellachian mountain effectually protects the inhabitants from the moiſt and cold eaſterly winds with which we are afflicted in the Atlantic ſtates; and the North-Weſt wind, in ſuch a latitude, at ſuch a diſtance from the ocean and on the weſt ſide of thoſe great mountains, has little of that piercing quality by which it is diſtinguiſhed in this part of the world. From the circumſtances mentioned you would infer, and experience ſupports the inference, that the inhabitants of that country are neither afflicted with intermitting fevers, inflammatory fevers, conſumptions, nor other diſeaſes, which are uſually induced by heat and moiſture or by a ſudden check to the perſpiration. As no part of that country has been ſettled much more than twenty years, we are not to expect many inſtances of extreme old age, among the inhabitants; but appearances are in favour of long life. In the year 1789, Jonathan Tipton died, in Waſhington County near Halſton River, aged 105 years: he had lived there 20 years. Benjamin Cobb, Val. Sevier, and others, have been mentioned to me, as perſons now living in that country, above 90 years old, who enjoy perfect health; and ride about, as uſual, in purſuit of buſineſs or amuſement.

I am Sir,

With the utmoſt reſpect

Your obedient Servant,

Philadelphia, 17th March, 1791. HU. WILLIAMSON,

† The author of a work, entitled—"An hiſtorical account of the riſe and progreſs of the Colonies of South-Carolina and Georgia" (printed in London, in 1779,) obſerves, that in South-Carolina, in the months of July, Auguſt and September, the heat in the ſhaded air, from noon to three o'clock, is often between 90° and 100°: but, that ſuch extreme heat is of ſhort duration. He ſays, he has ſeen the mercury, in Fahrenheit's Theremometer, riſe in the ſhade to 96° in the hotteſt, and fall to 16° in the cooleſt ſeaſon of the year; and that others have obſerved it as high as 100° and as low as 10°--He obſerves that the mean diurnal heat of the different ſeaſons, in South-Carolina, has been, upon the moſt careful obſervation, fixed at 64° in ſpring, 79° in ſummer, 72° in autumn, and 52° in winter; and the mean nocturnal heat, in thoſe ſeaſons, at 56° in ſpring, 75° in ſummer, 68° in autumn, and 46° in winter: The mean temperature of the air is, therefore, in South-Carolina, (at leaſt, in the level and maritime parts of the ſtate) 64°, which is 11°½ leſs than what Dr. Ruſh mentions to be the ſtandard temperature of the air, in the city of Philadelphia, viz. 52°½—"It has been obſerved (ſays the author of the hiſtory of Carolina, &c.) that, in proportion as the lands have been cleared and improved, and ſcope given for a more free circulation of air, the climate has likewiſe become more

capital of that province, is, in his opinion, as healthy a ſpot as any on the continent. He aſſerts, that the Spaniſh inhabitants lived here to a great age; and that the people of the Havanna conſidered it as their Montpelier, frequenting it for the ſake of health.---According to Captain Romans, the climate of Weſt-Florida agrees, in every reſpect, with that in the Northern diviſion of Eaſt-Florida; excepting that the winters are ſomewhat more ſevere, in the former---He ſays there were ſuch inſtances of longevity in Weſt-Florida, as were not to be outdone in any part of America. Yet circumſtances, ſimilar to thoſe which render particular *ſituations*, in ſome of our Southern ſtates, unfavorable to health,---produce ſimilar effects in ſome parts of theſe two provinces; though in a greater degree. Clavigero (in his hiſtory of Mexico) aſſerts that Calmecahua, one of the Tlaſcalan captains who aſſiſted

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more ſalubrious and pleaſant. This change was more remarkable in the heart of the country, than in the *maritime* parts, where the beſt plantations of rice are, and *where water is carefully preſerved to overflow the fields*: yet even in *thoſe* places, cultivation has been attended with ſalutary effects---time and experience had now taught the planters, that, during the autumnal months, their living among the low rice plantations ſubjected them to many diſorders, from which the inhabitants of the *capital* were *entirely exempt*:——This induced the richer part to retreat to *Town*, during this unhealthy ſeaſon. Governor Ellis has mentioned that, on the 7th of July, while he was writing in his piazza, in Savanna, the Mercury ſtood at 102° in the ſhade; that it had twice riſen to that height, during the ſummer, ſeveral times to 100° and, for many days together, to 98°; and in the night, it did not ſink below 89°. He had the ſame thermometer with him, in the equatorial parts of Africa, in Jamaica, and in the Leward iſlands: yet it appears, that he never found it ſo high in thoſe places;---its general ſtation was between 79° and 86°. He acknowledges, however, that he felt thoſe degrees of heat, in a *moiſt* air, *more diſagreeable than at Savanna*, when the themometer ſtood at 84° in his cellar, at 102° in the ſtory above it, and in the upper ſtory of his houſe, at 105°.—And he aſſerts, that few people died at Savanna, out of the ordinary courſe; though many were working in the open air, expoſed to the ſun during this extreme heat, (See notes to the tables, N°. 11.) The town of Savanna being ſituated on a ſandy eminence, greatly increaſes the heat of that ſpot: But the climate of Georgia, in general, like that of South-Carolina, is more mild and temperate in the inland, than in the maritime parts. And the late Dr. Moultrie,—who reſided, and practiſed phyſic with great reputation, in South-Carolina, fifty years—was of opinion, that Charleſton is as healthy a ſpot, as any upon earth.—A writer, in a late Charleſton paper—who ſubſcribes the ſignature H. L. and dates from St. Johns, Berkeley, (ſuppoſed to be Henry Laurens, Eſq.) ſays he has frequently heard Dr. Moultrie declare that opinion: and this writer gives the names of fifteen perſons, who had died in South-Carolina, within a ſhort time paſt, whoſe ages average $83\frac{1}{2}$ each:—three of the fifteen averaged $105\frac{2}{3}$ years, each. He mentions, alſo, that a great number of other inſtances might be adduced, of perſons who within his own memory, lived to the like great ages;—ſeveral, upwards of 100 years.

On the whole, it is evident—that, in South-Carolina and Georgia, the flat, marſhy parts of the country, and the artificial ſwamps which the culture of Rice and Indigo render neceſſary,—are, only, unhealthful: but that high, airy and dry ſituations, in thoſe ſtates, experience no ſuch effect, from the *heat* of the climate.

the Spaniards, in the conqueſt of Mexico, lived 130 years. He alſo makes mention of a Jeſuit, who died in that country at the age of 132; and of a Franciſcan, who died in Somberete, aged 117, making preachings to the people, until the laſt month of his life. "We could (ſays this author) make a long catalogue of thoſe, who, in the two centuries paſt, have exceeded one hundred years of life, in theſe countries:---*particularly among the Indians*, there are not a few, who reach 90 and 100 years; preſerving, to old age, their hair black, their teeth firm, and their countenance freſh."—Don Ulloa (in his Noticias Americanas) ſays, that, in general, the American Indians live to a great age.---This longevity, attended in general with uninterrupted health, is thought, by ſome writers, to be the conſequence in part of their vacancy from ſerious thought and employment, joined alſo with the robuſt texture and conformation of their bodily organs. If, continues this writer, the Indians did not deſtroy one another, in their almoſt perpetual wars-- and if their habits of intoxication were not ſo univerſal and incurable, they would be, of all the races of men who inhabit the globe, the moſt likely to extend, not only the bounds, but the enjoyments of animal life, to their utmoſt duration.

In the courſe of theſe obſervations, I have endeavoured to ſhew---and, I flatter myſelf, not altogether without ſucceſs,---that the probabilities of life, *in all its ſtages*, from its commencement to the utmoſt poſſible verge of its duration, are higher in theſe United States, than in ſuch European countries, as are eſteemed the moſt favorable to life. And, if this poſition be well founded, it follows---that the bodily conſtitutions of the American people are proportionably *healthful.* For, although it may be deemed problematical by ſome, whether an extraordinary degree of vigor, in the ſyſtem of the human body, affords a greater probability of attaining to extreme old age, than, *cæteris*

paribus

paribus, is annexed to a more delicate frame;---yet it will not admit of a doubt, that a great portion of vital energy and ſtrength muſt neceſſarily exiſt, where the probabilities of life are high throughout all its periods---from the birth, until the uſual term of its duration be compleated.

The climate of much the greater portion of the United States furniſhes great degrees of* heat and cold, in their reſpective ſeaſons; but neither of the extremes is of long continuance. Our climate is alſo very † variable, the temperature of the atmoſphere being liable to great and ſudden viciſſitudes. Nevertheleſs, taking the whole rontine of the ſeaſons, we enjoy a large proportion of fine and moderate weather; with more days of ‡ ſun-ſhine and ſerene ſky, than, perhaps, any part of Europe exhibits. A very conſiderable part of* France experiences greater

 extremes

* Dr. Ruſh has noticed—in his account of the climate of Pennſylvania---that "the greateſt degree of heat upon record, in *Philadelphia*, is 95°:" but the obſervations made at Spring-mill (13 miles from Philadelphia, in lat. 40°. 9',) ſhew---that the Mercury roſe to 96°, at *that place*, on the 3d of July, 1787; yet the mean degree of heat, during that day, was only 85° 8-10.----See Columbian Mag. for Auguſt 1787.

† Dr. Ruſh---in his account of the climate of Pennſylvania---has cited the authority of Dr. Huxam, to ſhew---that the healthieſt ſeaſons in Great-Britain have often been accompanied by the moſt variable weather. And Dr. T. Bond---in his oration before the Philoſophical ſociety, in 1782---remarks, that "we live in a healthy, though the moſt variable and active climate, in the univerſe"---"Hiſtory (he obſerves, further) and the firſt ſettlers of this country agree, that the native Indians of North-America were found, by the Europeans, to be a ſtout, hardy, brave, virtuous, healthy, and remarkably long-lived people." After other obſervations on this ſubject, the Doctor continues thus---"I am ſenſible this opinion, of the advantages reſulting from a changeable atmoſphere, is counter to the common notions of mankind:---it is nevertheleſs true, and adopted by the beſt writers;---and not only confirmed by meteorological and morbid regiſters, and the general laws of creation; but will further ſtand the teſt of hiſtorical enquiry."

‡ "The month of May, 1786, will long be remembered, for having furniſhed a very uncommon inſtance of the abſence of the ſun for fourteen days, and of conſtant damp or rainy weather."---Dr. Ruſh's account of, &c.

* Mr. Jefferſon (in his notes on Virginia) makes mention, that, "at Williamſburg, in Auguſt 1766, the mercury in Fahrenheit's thermometer was at 98° correſponding with 29⅕ of Reaumur---At the ſame place, in January 1780, it was at 6° correſponding with 11½ below 0, of Reaumur. At Paris, in 1753, the mercury in Reaumur's thermometer was at 30½ above 0; and, in 1776, it was at 16 below 0:---the extremities of heat and cold, therefore, at Paris, are greater than at Williamſburg, which is the hotteſt part of Virginia."---Captain Romans ſays---that, in Eaſt-Florida, on ſome ſultry-hot days in July and Auguſt, he has known the mercury riſe to 94° of Fahrenheit's ſcale: but that, during the ſummer, the general height of the mercury was between 84°, and 88°, when the thermometer was placed in the ſhade, acceſſible to a free circulation of the air.---At the Norriton obſervatory (in lat. 40°. 9'. 31", and about twenty miles Weſtward from Philadelphia,) the mercury in Fahrenheit's thermometer---not expoſed to the ſun ſhine, but open to the air---was at 94½, on the 5th of July, 1769; which was the greateſt height it had ever been obſerved to riſe to, at that place. (from

extremes of heat and cold, than the United States in general: yet we find that country to be more favorable to fecundity and life, than England, where the ſummers and winters are † leſs intemperate. And in the Swiſs Cantons and Sweden, where the frequent and ſudden changes, in the temperature of the atmoſphere, are very ſimilar to the viciſſitudes which prevail in our own climate,—the natives are a hardy, vigorous and healthful people. According to M.Catteau, in his general view of Sweden, the winters in that country are long, dry and extremely cold; the ſummers ſhort, and exceedingly hot; and the inhabitants experience a rapid change from the former of theſe ſeaſons to the latter, ſpring and autumn being almoſt unknown to them. The pure and ſharp air which the Swedes breathe (this writer further obſerves,) renders them vigorous, and preſerves them from epidemical diſeaſes: and he refers to a memoir publiſhed by M. Wargentin, to ſhew, that there are numerous inſtances of their attaining to a very great age. The

(From a letter dated July 26, 1769, from Mr. Rittenhouſe, to the late Rev. Mr. Barton--*penes* W. Barton.)—Dr. Ruſh, in his account of the climate of Pennſylvania, obſerves—that the mercury in Fahrenheit's thermometer ſtood at 95°. on the 15th of Auguſt 1779, at Philadelphia, (which is the higheſt degree to which it has ever been known to riſe in this city;) and that it fluctuated between 93°. and 80°. for many weeks. The Doctor ſays it ſtood, for ſeveral hours, at 5°. below 0, in January 1780, at Philadelphia; and, during the whole of that month, excepting one day, it never roſe to the freezing point, in the city.---It appears by Mr. Wiggleſworth's thermometrical obſervations --(publiſhed in the memoirs of the Boſton Academy, for the year 1783,) that, at Cambridge in Maſſachuſſetts, in Auguſt, 1780, the mercury was at 92°. of Fahrenheit's ſcale.

† I have ſaid "*leſs intemperate*"---The climate of England is, by no means, a temperate one. That country not only experiences great extremes of heat and cold; but the weather is remarkably variable and inconſtant, with very frequent rains: The tranſitions from heat to cold, and from moiſture to dryneſs---and *vice verſâ*---are ſudden, and conſiderable in their degree. On the 18th of June 1788, the mercury, by Fahrenheit's ſcale, was at 88°. in London; and, on the 30th and 31ſt days of December, in the ſame year, it fell to 4½ at the city of Canterbury---On the 5th of January following, the mercury was at 5½ at the latter place. The weather was very ſevere, in England, from the 21ſt of December 1788, to the 11th of January 1789; during which term, the mercury roſe twice to 44°. and once to 45°. Even at Sienna in Italy---in lat. 43°. 10′---during the ſame interval of time, the mercury fell, on the 31ſt of December 1788, to 10°; and, on the 11th of January following, it roſe to 53°.----The obſervations at Canterbury and Vienna, were taken from two Sixian thermometers. (See Gent. Mag. for February and May, 1789.)---I alſo find, that, on the 21ſt and 22d days of laſt June, the mercury was at 86°. in London, by Fahrenheit's thermometer: and an Engliſh gentleman aſſures me, he has known a froſt happen, in England, in the laſt week in July---Dr. Ruſh, in his account of the climate of Pennſylvania, mentions Mr. Rittenhouſe's having informed him, that he had never paſſed a ſummer, during his reſidence in the country, without diſcovering froſt in every month of the year, *excepting July*.

The winters, in our own country,‡ brace and invigorate the bodies of the people: and the genial warmth of our ſummers increaſes the* generative principle of animal nature:—the cold is accompanied with a pure and† elaſtic atmoſphere; and, during the continuance of the greateſt heats, the air is frequently‡ corrected by thunder-guſts and plentiful ſhowers of refreſhing rain.—The face of the country, too, is of ſuch a nature, as muſt contribute to the ſalubrity of the climate—The United States are, in general, diverſified with hills and vallies, mountains and plains: and Ariſtotle obſerves, that people do not feel the effects of age ſo ſoon, in hilly, as in flat countries.

What has been premiſed, concerning the longevity of the inhabitants of theſe ſtates, will, I preſume, be an ample refutation of thoſe writers, who, influenced by European prejudices, or conſidering the ſubject in a ſuperficial manner, have aſſerted, that the Americans are not ſo long-lived as the Europeans.

On the whole I truſt, that the points, which it was my principal deſign to aſcertain, have been ſatisfactorily eſtabliſhed. With a view, however, to a further illuſtration of this intereſting ſubject, I have formed the tables (which are annexed hereto,) ſhewing the numbers dying annually out

‡ Zimmerman, treating of the effects of a cold climate, ſays---"Frigoris igitur perennitas, et artus, et integra corpora, comprimendo corroborat, efficitque ut naturam longé firmiorem, valentioremque induant."---Zool. Geograph.

* From a table of the baptiſms, marriages and deaths, at Paris, from 1745 to 1766 (both incluſive,) the Count de Buffon has ſhewn,---that the months in which the greateſt number of children were born, are March, January and February; and that thoſe in which the feweſt were born, are June, December and November: from which circumſtance, he infers---that, in the climate of France, the heat of Summer contributes to the ſucceſs of generation.---(Supplement to his nat hiſt.)

† "The air in Pennſylvania, when dry, has a peculiar elaſticity, which renders the heat and cold leſs inſupportable than the ſame degrees of both are, in moiſter climates. It is only in thoſe caſes when ſummer-ſhowers are not ſucceeded by North-Weſt winds, that the heat of the air becomes oppreſſive and diſtreſſing, from being combined with moiſture." Dr. Ruſh's account of, &c.

‡ "The heat of Summer ſeldom continues more than two or three days, without being ſucceeded by ſhowers of rain, accompanied ſometimes with thunder and lightning, and afterwards with a North-Weſt wind,---which produces a coolneſs in the air that is highly invigorating and agreeable"———"There are ſeldom more than three or four nights, in a ſummer, in which the heat of the air is nearly the ſame as in the preceding day. After the warmeſt days, the evenings are generally agreeable, and often delightful."---Dr. Ruſh's account of the climate of Pennſylvania.

out of 1000 perſons, in the city of Philadelphia, and the town of Salem in Maſſachuſetts, at eleven different periods of life. The table for Philadelphia, (No. 1.) is conſtructed from the bills of mortality for the congregations of Chriſt-church and St. Peter's in this city, for† twenty-two years; viz. from Chriſtmas 1754, to Chriſtmas 1790, excluſive of fourteen years during that term. And the table (No. 2.) is formed from the bills for the ſame congregations, for the years 1782, 1788, 1789 and 1790: from which it will appear, that, although one-eighth of the whole number, in the bill for 1782, are ſtated to have died of the ſmall-pox, the mortality has been leſs, taking the medium of theſe four late years, that the medium of eighteen preceding years gives it.—The table for Salem, in Maſſachuſſetts, is formed from the bills of mortality, for that town, for the years 1782, 1783, 1788 and 1790: But I have before obſerved, that the years 1782 and 1783 were unuſually ſickly; and this circumſtance has, no doubt, exhibited the probabilities of life too low, for that town; eſpecially, as I find the bill for 1788 makes the probabilities conſiderably higher, than the average of thoſe four years. I have alſo given a general table of the probabilities of life, at the ſame periods of its duration,—formed from the eſtimates of the Count de Buffon;—one for the city of Paris, alſo from the eſtimates of that celebrated author;---and, likewiſe, tables for ſundry other cities and places; which I have taken from thoſe ſubjoined to Dr. Price's eſſay on the expectations of lives, and adapted to the ſame ſcale and the ſame periods of life, as the others.—Beſides theſe, I have ſtated the proportions dying, annually, out of the whole number of the living, in a variety of places;—and the

† I was favored with theſe bills by Michael Hillegas, Eſq.---The earlieſt is from Chriſtmas 1754 to Chriſtmas 1755; and the lateſt is for the laſt year, ending at Chriſtmas. Mr. Hillegas furniſhed me with two others, viz. for the years 1756 and 1759; making, in the whole, twenty-four years: but, as there appears to have been a *very extraordinary* degree of mortality, among children under three years of age, during thoſe years,---I left them out of my calculations. The bills for twelve other years, between 1755 and 1790, could not be obtained.

the proportions of those who die, after compleating the 80th year of their age, out of 1000 annual deaths,---for various cities, towns and countries.---A comparison of the results of these several tables, furnishes very interesting conclusions, in regard to the subject of the foregoing observations.

Although, in treating this subject, I have protracted my observations to a greater length than I had designed,—I cannot conclude without remarking, that the result of this investigation has afforded me great pleasure.—Must not the mind of every American citizen be impressed with gratitude, and glow with emotions of a virtuous pride, when he reflects on the blessings his country enjoys? Let him contemplate the present condition of the United States,—enjoying every advantage which nature can bestow—inhabited by more than three millions of the freeest people on earth—and possessing an extent of territory amply sufficient to maintain, for ages to come, many additional millions of freemen, which the progression of its population is supplying, with wonderful celerity;—let him, also, contrast this situation of his country, with the condition in which it was found by our ancestors, scarcely two centuries ago;—and it will be impossible for him not to experience, in an exalted degree, those sensations, which patriotism and benevolence ever inspire!——

I am, Dear Sir,

With great Respect,

Your affectionate Nephew,

W. BARTON.

Philadelphia, March 17th, 1791.

TABLES,

TABLES, ſhewing the Probabilities of the Duration of Human Life, from the Birth up to ninety years of age---for divers intermediate Periods of Life;---at the City of Philadelphia, and at the Town of Salem in Maſſachuſetts; and alſo in ſeveral parts of Europe.———

GENERAL Table of the Probabilities of Life, from the Calculations of *M. Buffon.*

Periods of Life.	Perſons living.	Decreaſe of Life.
	1,000	
Between the Birth and 3	591	409
3 and 5	540	51
5 and 10	490	50
10 and 20	450	40
20 and 30	392	58
30 and 40	323	69
40 and 50	252	71
50 and 60	180	72
60 and 70	101	79
70 and 80	27.63	73.37
80 and 90	3.54	24.09

N°. 1. PHILADELPHIA, for twenty-two Years.

Periods of Life.	Perſons living.	Decreaſe of Life.
	1,000	
Between the Birth and 3	612	388
3 and 5	555	57
5 and 10	511	44
10 and 20	465	46
20 and 30	368	97
30 and 40	270	98
40 and 50	178	92
50 and 60	114	64
60 and 70	52	62
70 and 80	20	32
80 and 90	5.61	14.39

N°. 2. *(a)* PHILADELPHIA, for 1782, 1788, 1789 and 1790.

Periods of Life.	Perſons living.	Decreaſe of Life.
	1,000	
Between the Birth and 3	611	389
3 and 5	569	42
5 and 10	546	23
10 and 20	497	49
20 and 30	400	97
30 and 40	296	104
40 and 50	195	101
50 and 60	140	55
60 and 70	62	78
70 and 80	25	37
80 and 90	6	19

SALEM *(in Maſſachuſetts)* for 1782, *(b)* 1783, 1789 and 1790.

Periods of Life.	Perſons living.	Decreaſe of Life.
	1,000	
Between the Birth and 3	----	----
3 and 5	555	445
5 and 10	505	50
10 and 20	470	35
20 and 30	342	128
30 and 40	252	90
40 and 50	169	83
50 and 60	129	40
60 and 70	94	35
70 and 80	26	68
80 and 90	*(c)*	

SALEM *(in Maſſachuſetts,) for* 1790. *(d)*

Periods of Life.	Perſons living.	Decreaſe of Life.
	1,000	
Between the Birth and 3	----	----
3 and 5	550	450
5 and 10	503	47
10 and 20	487	16
20 and 30	356	131
30 and 40	293	63
40 and 50	220	73
50 and 60	178	42
60 and 70	126	52
70 and 80	42	84
80 and 90	15.71	26.29

PARIS, From the Calculations of M. Buffon. *(e)*

Periods of Life.	Perſons living.	Decreaſe of Life.
	1,000	
Between the Birth and 3	----	----
3 and 5	580	420
5 and 10	524	56
10 and 20	485	39
20 and 30	433	52
30 and 40	366	67
40 and 50	293	73
50 and 60	212	81
60 and 70	116	96
70 and 80	32	84
80 and 90	4.50	27.50

LONDON,

London; from the calculations of M. Buffon, (e)		
Periods of Life.	Perfons living.	Decreafe of Life.
	1,000	
Between the Birth and 3	---	-----
3 and 5	587	413
5 and 10	553	34
10 and 20	522	31
20 and 30	436	86
30 and 40	332	104
40 and 50	222	110
50 and 60	138	84
60 and 70	72	66
70 and 80	25	47
80 and 90	3.20	21.80

London; from the calculations of Dr. Price.		
Periods of Life.	Perfons living.	Decreafe of Life.
	1,000	
Between the Birth and 3	492	508
3 and 5	426	66
5 and 10	374	52
10 and 20	325	49
20 and 30	272	53
30 and 40	219	53
40 and 50	148	71
50 and 60	97	51
60 and 70	50	47
70 and 80	16	34
80 and 90	2	14

Vienna.		
Periods of Life.	Perfons living.	Decreafe of Life.
	1,000	
Between the Birth and 3	431	569
3 and 5	379	52
5 and 10	327	52
10 and 20	288	39
20 and 30	247	41
30 and 40	199	48
40 and 50	147	52
50 and 60	96	51
60 and 70	47	49
70 and 80	15	32
80 and 90	2	13

Breslaw in Silesia, from the Calculations of Dr. Halley.		
Periods of Life.	Perfons living.	Decreafe of Life.
	1,000	
Between the Birth and 3	760	240
3 and 5	710	50
5 and 10	653	57
10 and 20	592	61
20 and 30	523	69
30 and 40	436	87
40 and 50	335	101
50 and 60	232	103
60 and 70	131	101
70 and 80	34	97
80 and 90	1	33

Norwich, G. Britain.		
Periods of Life.	Perfons living.	Decreafe of Life.
	1,000	
Between the Birth and 3	544	456
3 and 5	498	46
5 and 10	440	58
10 and 20	394	46
20 and 30	341	53
30 and 40	290	51
40 and 50	233	57
50 and 60	168	65
60 and 70	94	74
70 and 80	31	63
80 and 90	4.22	26.78

Northampton, G. Britain.		
Periods of Life.	Perfons living.	Decreafe of Life.
	1,000	
Between the Birth and 3	585	415
3 and 5	544	41
5 and 10	496	48
10 and 20	448	48
20 and 30	379	69
30 and 40	318	61
40 and 50	247	71
50 and 60	177	70
60 and 70	107	70
70 and 80	40	67
80 and 90	3.48	36.52

Parish of Holy-Crofs, Great-Britain.			Pais de Vaud, in Switzerland.			A Country parifh in the Electorate of Brandenburgh.		
Periods of Life.	Perfons living.	Decreafe of Life	Periods of Life.	Perfons living.	Decreafe of Life.	Periods of Life.	Perfons living.	Decreafe of Life.
	1,000	——		1,000	------		1,000	-------
Between the Birth and 3	717	283	Between the Birth and 3	735	265	Between the Birth and 3	687	313
3 and 5	659	58	3 and 5	701	34	3 and 5	642	45
5 and 10	589	70	5 and 10	653	48	5 and 10	577	65
10 and 20	545	44	10 and 20	610	43	10 and 20	527	50
20 and 30	486	59	20 and 30	563	47	20 and 30	486	41
30 and 40	426	60	30 and 40	506	57	30 and 40	432	54
40 and 50	353	73	40 and 50	431	75	40 and 50	374	58
50 and 60	273	80	50 and 60	314	117	50 and 60	282	92
60 and 70	171	102	60 and 70	168	146	60 and 70	166	116
70 and 80	90	81	70 and 80	46	122	70 and 80	44	122
80 and 90	7	83	80 and 90	5	41	80 and 90	3	41

Number of the Deaths out of 1,000, under the ages of 3 and 5 years, refpectively,--- for Ipfwich Hamlet, in Maffachufetts, Hingham, in the fame ftate, and for the city of Berlin.---

		Deaths,
Ipswich Hamlet, on a medium of 10 years	under 3 years,	-----
	under 5 do.	181
Hingham, on a medium of 54 years,	under 3 do.	-----
	under 5 do.	363
Berlin, from the bills given by M. Sufmilch,	under 3 do.	516
	under 5 do.	598

The numbers of those who die, after compleating their 80th year of age---proportioned to the whole numbers of Annual Deaths;---at the following places, respectively; viz.

Names of the Places.	Proportions, out of 1000 deaths.
1. Ipswich-hamlet, Massachusetts 10 years,	128 *survive* 80 *years.*
2. Parish of Holy-Cross, Great Britain,	90. 91
3. Hingham, Massachusetts—54 years,	75. 47
4. Connecticut—the whole state,	74.
5. Milford, Connecticut--12 years,	74.
6. Europe, *averaged*, according to Mr. Kersseboom,	71.
7. The Pais de Vaud, in Switzerland,	46. 50
8. A country parish in Brandenburg,	44. 44
9. Northampton, Great Britain,	40.
10. Breslaw, according to Dr. Halley,	34.
11. Paris, deducting children sent to the country; M. Buffon,	31. 84
12. Norwich, Great Britain,	31.
13. According to M. Buffon's *general* table,	27. 63
14. Berlin,	27.
15. Salem, Massachusetts—1788, 1790,	26.
16. Philadelphia---1782, 1788, 1789, 1790,	25.
17. { London---according to M. Buffon, See note *(j)*	{ 24. 56
Do. according to Dr. Price,	16. 46
18. Edinburgh, do.	24.
19. Vienna,	15.

The proportions which the numbers of annual deaths bear to the whole numbers of the living---at the following places, respectively; viz.

1. The Island of Madeira---	1	to	50
2. Salem, in Massachusetts--- *(f)*	1	to	47
3. Philadelphia---The city and suburbs,	1	to	45
4. A country parish in Brandenburgh,	1	to	45
5. The Pais de Vaud,	1	to	45
6. 1098 Country parishes in Germany,	1	to	43
7. The kingdom of Sweden,	1	to	38. 60
8. Montbard, in Burgundy--- *(g)*	1	to	36
9. France,	1	to	35
10. England,	1	to	33
11. The parish of Holy-Cross, near Shrewsbury, Great Britain,	1	to	33
12. Paris.	1	to	32. 50
13 The Dukedom of Wurtemberg,	1	to	32
14. Savanna, in Georgia---*(h)*	1	to	31. 70
15. Breslaw,	1	to	28
16. Berlin, *(i)*	1	to	26. 50
17. Northampton, Great Britain,	1	to	26. 50
18. { London, *(j)*	{ 1	to	26
do. according to Dr. Price,	1	to	20. 75
19. { Edinburgh---*(k)*	{ 1	to	26
do. according to Dr. Price,	1	to	20. 80
do. according to Mr. Maitland,	1	to	28
20. Amsterdam,	1	to	24
21. Rome,	1	to	23
22. Dublin,	1	to	22
23. Leeds, in Yorkshire, Great Britain, *(l)*	1	to	21. 60

The proportionate numbers of Annual Deaths, to 100 Annual Births; at the following places, respectively;—viz.

Names of the Places.	To 100 Births	N°. of Deaths.
1. Salem, in Massachusetts, for 1782 and 1783—including the still-born in the number of deaths,	To 100 Births.	49. 00
2. Hingham, in Massachusetts, for 54 years,	do.	49. 50
3. Philadelphia---City and suburbs,	do.	50. 00
4. The kingdom of Prussia, for 4 years, ending in 1718,	do.	57. 43
5. The Island of Madeira,	do.	58. 75
6. All the king of Prussia's dominions in Germany, &c. exclusive of Prussia; 4 years, as above,	do.	71. 00
7. The kingdom of Prussia, in 1766,	do.	72. 50
8. Sweden, for 1774, 1775, 1776 and 1777,	do.	72. 86
9. France, from 1754 to 1763,	do.	76. 94
10. England,	do.	80. 00
11. City of Brunswick, in Germany---1764 and 1767,	do.	80. 97
12. The Island of Corsica,	do.	81. 00
13. Manchester, in Great Britain---1764, 1766, 1768, 1771, and 1777,	do.	82. 57
14. Dantzic---1717, 1718, 1720 and 1721,	do.	85. 77
15. Koningsberg---1766, 1768,	do.	87. 49
16. Duchies of Holstein and Sleswic---1765, 1767,	do.	88. 23
17. Whitby, in Yorkshire, Great Britain---1767, 1768, 1772 and 1777,	do.	88. 45
18. Norwich, Great Britain---1768, 1774 and 1777,	do.	92. 96
19. Denmark and Norway, in 1764 and 1765; and do. including the Danish dominions in Germany, in 1766,	do.	93. 17
20. Paris---14 years, viz. from 1771 to 1784.---M. de la Place,	do.	97. 65
21. Do.---22 years, viz. from 1745 to 1766.--M. de Buffon,	do.	99. 34
22. City of York and suburbs, Great Britain---1768, 1770,	do.	100. 75
23. Paris, 1781, and 1782, M. de la Place,	do.	101. 24
24. Do. according to M. de Buffon,	do.	101. 36
25. Do. according to Dr. Price's statement of the numbers of births and deaths, there,	do.	101. 57
26. Copenhagen---1765, 1766, 1767, 1771, and 1772,	do.	101. 81
27. City of Freyberg, in Saxony---for a whole century, ending in 1717,	do.	102. 92
28. Paris---from 1764 to 1773, both inclusive, and 1775, 1778, according to Mr. Anderson,	do.	103. 49
29. Chester, Great Britain---4 years,	do.	107. 42
30. Liverpool, Great Britain---5 years,	do.	112. 70
31. Norwich, Great Britain---30 years,	do.	114. 09
32. Breslaw, in Silesia,	do.	119. 50
33. Vienna,	do.	121. 43
34. Copenhagen,	do.	122. 22
35. Northampton, Great Britain,	do.	123. 23
36. London---26 years.---From the bills of births and deaths, during that term,	do.	124. 92
37. Berlin---5 years, ending in 1759,	do.	131. 00
38. Rome,	do.	138. 43
39. Amsterdam,	do.	169. 56
40. do. from 1764 to 1768, both inclusive, and 1771, 1772,	do.	171. 95

No.

(a) Out of 198 deaths, in the congregations of Christ-church and St. Peter's, from Christmas 1781 to Christmas 1782,---24 died of the small pox, 21 of purging and vomiting, and 27 of fits and convulsions. The average number of deaths, in the same congregations---during the years 1788, 1789 and 1790---is only 145; and not quite 145. 7-8, during the 22 years, from which the table for Philadelphia N°. 1 is formed--The deaths, therefore, in 1782, exceeded the average number of those for the 22 years, in the proportion of 136 to 100: and, consequently, the year 1782 was unusally sickly in Philadelphia, as well as at Salem in Massachusetts. In the year 1789, also (viz. from Christmas 1788 to Christmas 1789,) out of 164 persons, who died in the congregations of Christ-church and St. Peter's, 20 died of the measles. From these circumstances, it is reasonable to suppose---that even the *second* table for Philadelphia gives the probabilities of life too low, for this city; because, out of the *four* years above mentioned, one was more sickly than common; and, during another, near one eighth of the deaths from which that table is formed, were occasioned by a disorder not annually epidemic.----In the year 1782, there died between the age of 80 and 90 years, out of 198,---3 persons; in 1788, out of 126,---1; in 1789, out of 164,----3; and in 1790, out of 145,---5; being, in the whole, 12 out of 633: and this gives the proportion of 6 persons, out of 1000, attaining to 90 years of age.

(b) The measles having been very mortal at Salem, in 1783,---that year has been omitted, in calculating the proportion of deaths, for the first twenty years of the ages.

(c) The number of deaths at Salem, exclusive of the still-born, during the years 1782, 1783, 1789---averaged 167½ per annum; and the number of those who died between 80 and 90 years of age, during the same term, averaged 4 per annum---This gives the proportion of those dying, between the 80th and 90th year of life, in that town, as 23. 88 out of 1000 deaths. The bills for 1782 and 1783 do not notice any deaths, *after* 90 years of age, and this is also the case, with the bill for 1789: but, in the two former, the lists of ages comprehend 36 deaths of "*ages unknown*," and, in the year 1790, three survived 90 years of age.——See the table for Salem, for the year 1790.

(d) Out of 191 deaths, from which this table is found, two were between the age of 90 and 100 years, and 1 at 103 years.

(e) According to M. Buffon, the proportion of deaths, at Paris, in the two first years of life, is 313, 21 out of 1000; and, at London, 334. 59, out of 1000. The number of deaths, he observes, is greater at Paris than in London, from two years of age to five; less at Paris than at London, between 5 and 50 years; pretty nearly equal, in both cities, between 50 and 60; and much greater at Paris than at London, from the 60th year of age to the end of life --This shews, continues M. Buffon, that *old age* is, in general, much less in London than in Paris; for, out of 1000 persons, 212 died after compleating their 60th year, at Paris; whereas, only 138, out of 1000, died after that age, at London.--The continual supply of people, mostly from about twenty years of age and upwards, which great cities draw from the *country*, gives the proportion of those who die at *old age*, in such cities, much higher than the number of those *born* in them would give. Hence the favorable appearance, with respect to longevity, which many great cities exhibit, is extremely fallacious: and this observation is particularly applicable to London, where the continual diminution of the number of its inhabitants, occasioned by the great excess of deaths beyond the births, renders such supplies necessary, to support its population.

(f) The still born are included, in the number of deaths.

(g) This town contains, according to M. de Buffon, 2337 inhabitants.

(h) From the 1st of July, 1790, to the 1st of July, 1791, the number of deaths at Savanna, was in the proportion of one out of every 31 7-10 of the total number of *white* inhabitants (exclusive of Mariners and Sojourners) in that city. It appears by the census, that, in January 1791, Savanna contained 1712 white inhabitants.---

(i) Berlin contains, according to Dr. Price, 134,000 inhabitants.

(j) Dr. Price supposes the proportion of annual deaths to the whole number of the living in Edinburgh, to be nearly the same as in London---I have therefore given the proportion of one to twenty-six, for both cities; and my reasons for assuming *this* proportion---which differs considerably from that stated by Dr. Price---will appear, in the course of the foregoing observations.---

(k) By the London Bill of Mortality, made up from the 16th of Dec. 1788, to the 15th Dec. 1789, it appears---that, in the 123 parishes in London and Westminster, and the 23 *Out-parishes* in Middlesex and Surry, 20,749 persons were buried within the year. Of this number, those who died after compleating the several periods of age, after mentioned, give the following proportions, viz.

(l) This town contained, in the year 1770,---16,380 inhabitants,

Out

Out of 1,000 deaths, there died—upwards of 100 years of age.		0. 48
Do.	90	3. 66
Do.	80	23. 66
Do.	70	76. 34
Do.	60	146. 46
Do.	50	227. 72
Do.	40	318. 95

These proportions correspond so nearly with those given by M. Buffon, in his estimate of the probabilities of life, for London, as to induce a belief, that the calculations of that celebrated Philosopher may be depended upon, in this instance.

N°. VIII.

Extract of a Letter from Andrew Ellicott, to DAVID RITTENHOUSE, *Esq. dated at Pittsburg, November 5th* 1787, *containing observations made at Lake-Erie.*

Read Nov. 21, 1788

ON the thirteenth of last month, while we lay on the banks of Lake-Erie, we had an opportunity of viewing that singular phenomenon, by Seamen termed looming. It was preceded by a fine Aurora-borealis, on the evening of the 12th——the 13th was cloudy; but without rain: about ten o'clock in the morning, as I was walking on the beach, I discovered something that had the appearance of land, in the direction of Presque-Isle; about noon it became more conspicuous and; when viewest by a good Achromatic-Telescope, the branches of the trees could be plainly discovered——From 3 o'clock in the afternoon, till dark, the whole Peninsula was considerably elevated above the horizon, and viewed by all our company with admiration.——There was a singular appearance attending this Phenomenon, which I do not remember to have seen taken notice of by any writer—The Peninsula was frequently seen double, or rather two similar Peninsula's, one above the other, with an appearance of water between:—the separation, and coincidence was very frequent, and not unlike that observed in shifting the index of an adjusted Godfrey's quadrant.——As singular

lar as this may appear, it is not more ſo than the double refraction produced by the Ice-Land cryſtal.—The next morning Preſque-Iſle was again inviſible, and remained ſo during our ſtay at that poſition. Preſque-Iſle was about twenty-five miles diſtant, its ſituation very low.

The ſame evening the wind began to blow briſkly from about two points weſt of North, and continued to increaſe till the evening of the 14th, when it was more violent than any thing of the kind I had ever been witneſs to before, and continued till the evening of the 16th without the leaſt intermiſſion—Our tents were all blown down, and we were under the neceſſity of fortifying our camp, by driving poſts near to each other, firmly into the ground on the windward ſide, and filling up the vacuities with buſhes in form of an hedge.---During the continuance of this wind, we frequently obſerved ſmall black clouds hanging over the lake;---they had but little velocity, and were ſometimes exhauſted, and diſappeared without reaching the ſhore.

From the large bodies of timber blown down about the lakes, it appears that hurricanes are not uncommon;——Coxe obſerves in his travels through Ruſſia, that the lakes in that country are ſubject to terrible ſtorms.

No. IX.

N°. IX.

An account of the Sugar Maple-tree of the United States, and of the methods of obtaining Sugar from it, together with observations upon the advantages both public and private of this Sugar. In a letter to THOMAS JEFFERSON, *Esq. Secretary of the United States, and one of the Vice Presidents of the American Philosophical Society by* BENJAMIN RUSH, M. D. *Professor of the Institutes and of Clinical Medicine in the University of Pennsylvania.*

DEAR SIR,

Read Aug. 19, 1791

IN obedience to your request, I have set down to communicate to our Society through the medium of a letter to you, a short account of the *Sugar Maple-tree* of the United States, together with such facts and remarks as I have been able to collect, upon the methods of obtaining Sugar from it, and upon the advantages both public and private, of this Sugar.

The *Acer Sacharinum* of Linnæus or the Sugar Maple-tree grows in great quantities in the western countries of all the middle states of the American Union. Those which grow in New-York, and Pennsylvania yield the Sugar in a greater quantity than those which grow on the waters of the Ohio.—These trees are generally found mixed with the Beach, (a) Hemlock, (b) white and water ash, (c) the Cucumber tree, (d) Linden, (e) Aspen (f) Butter nut, (g) and wild cherry trees. (h) They sometimes appear in groves covering five or six acres in a body, but they are more commonly interspersed with some or all of the forest trees which have been mentioned. From 30 to 50 trees are generally

(a) Fagus Ferruginea. (b) Pinus abies. (c) Fraxinus Americana. (d) Magnolia acuminata. (e) Tilia Americana. (f) Populus tremula. (g) Juglans alba (oblonga.) (h) Prunus Virginiana, of Linnæus.

generally found upon an acre of ground. They grow chiefly in the richeſt ſoils, and frequently in ſtony ground. Springs of the pureſt water abound in their neighbourhood. They are when fully grown as tall as the white and black oaks, and from two to three feet in diameter, * They put forth a beautiful white bloſſom in the ſpring before they ſhow a ſingle leaf. The colour of the bloſſom diſtinguiſhes them from the acer rubrum, or the common maple which affords a bloſſom of a red colour. The wood of the Sugar Maple-tree is of an inflammable nature, and is preferred upon that account by hunters and ſurveyors for fire wood. Its ſmall branches are ſo much impregnated with ſugar as to afford ſupport to the cattle--horſes, and ſheep of the firſt ſettlers during the winter, before they are able to cultivate forage for that purpoſe. Its aſhes afford a great quantity of pot aſh exceeded by few or perhaps by none of the trees that grow in the woods of the United States.

The tree is ſuppoſed to arrive at its full growth in the woods in twenty years.

It is not injured by tapping; on the contrary, the oftener it is tapped, the more ſyrup is obtained from it. In this reſpect it follows the law of animal ſecretion. A ſingle tree has not only ſurvived, but flouriſhed after *forty-two* tappings in the ſame number of years. The effects of a yearly diſcharge of ſap from the tree in improving and increaſing the ſap is demonſtrated from the ſuperior excellence of thoſe trees which have been perforated in an hundred places, by a ſmall wood-pecker which feeds upon the ſap. The trees after having been wounded in this way diſtil the remains of their juice on the ground, and afterward acquire a black colour. The ſap of theſe trees is much ſweeter to the taſte than that which is obtained from trees

* Baron LaHontan, in his voyage to North America gives the following account of the Maple tree in Canada. After deſcribing the black Cherry tree ſome of which he ſays are as tall as the loftieſt oaks and as big as a hogſhead, he adds " The Maple tree is much of the ſame height and bulk. It bears no reſemblance to that ſort we have in Europe."

which have not been previously wounded, and it affords more sugar.

From twenty three gallons and one quart of sap procured in twenty hours from only two of these dark coloured trees, Arthur Noble, Esq. of the state of New-York obtained four pounds and thirteen ounces of good grained sugar.

A tree of an ordinary size yields in a good season from twenty to thirty gallons of sap, from which are made from five to six pounds of sugar. To this, there are sometimes remarkable exceptions. Samuel Low, Esq. a Justice of Peace in Montgomery County, in the state of New-York informed Arthur Noble, Esq. that he had made twenty pounds, and one ounce of sugar between the 14th and 23d of April in the year 1789. from a single tree that had been tapped for several successive years before.

From the influence which culture has upon forest and other trees, it has been supposed, that by transplanting the Sugar Maple tree into a garden, or by destroying such other trees as shelter it from the rays of the sun, the quantity of the sap might be increased and its quality much improved. I have heard of one fact which favours this opinion. A farmer in Northampton County in the state of Pennsylvania, planted a number of these trees above twenty years ago in his meadow, from *three* gallons of the sap of which he obtains every year a pound of sugar. It was observed formerly that it required five or six gallons of the sap of the trees which grow in the woods to produce the same quantity of sugar.

The sap distils from the *wood* of the tree. Trees which have been cut down in the winter for the support of the domestic animals of the new settlers, yield a considerable quantity of sap as soon as their trunks and limbs feel the rays of the sun in the spring of the year.

It is in consequence of the sap of these trees being equally diffused through every part of them, that they live three years after they are *girdled*, that is, after a circular incision is made through the bark into the substance of the tree for the purpose of destroying it.

It is remarkable that grass thrives better under this tree in a meadow, than in situations exposed to the constant action of the sun.

The season for tapping the trees is in February, March and April according to the weather which occurs in these months.

Warm days *and frosty* nights are most favorable to a plentiful discharge of sap. *The quantity obtained in a day from a tree, is from five gallons to a pint, according to the greater or less heat of the air. Mr. Low, informed Arthur Noble, Esq. that he obtained near three and twenty gallons of sap in one day (April 14, 1789,) from the single tree which was before mentioned. Such instances of a profusion of sap in single trees are however not very common.

There is always a suspension of the discharge of sap in the night if a frost succeed a warm day. The perforation in the tree is made with an ax or an auger. The latter is preferred from experience of its advantages. The auger is introduced about $\frac{3}{4}$ of an inch, and in an ascending direction (that the sap may not be frozen in a slow current in the mornings or evenings) and is afterwards deepened gradually to the extent of two inches. A spout is introduced about half an inch into the hole, made by this auger and projects from three to twelve inches from the tree.

* The influence of the weather in increasing and lessening the discharge of the sap from trees is very remarkable.

Dr. Tonge supposed long ago (Philosophical Transactions No. 68) that changes in the weather of *every kind* might be better ascertained by the discharge of sap from trees than by weather glasses. I have seen a journal of the effects of heat, cold, moisture, drought and thunder upon the discharges from the sugar trees, which disposes me to admit Dr. Tonge's opinion.

The ſpout is generally made of the *Shumach or †Elder, which generally grow in the neighbourhood of the ſugar trees. The tree is firſt tapped on the *South* ſide; when the diſcharge of its ſap begins to leſſen, an opening is made on its *North* ſide, from which an increaſed diſcharge takes place. The ſap flows from four to ſix weeks, according to the temperature of the weather. Troughs large enough to contain three or four gallons made of white pine, or white-aſh, or of dryed water-aſh, aſpen, linden, ‡poplar or common maple, are placed under the ſpout, to receive the ſap, which is carried every day to a large receiver, made of either of the trees before mentioned. From this receiver it is conveyed, after being ſtrained, to the boiler.

To preſerve the ſap from rain and impurities of all kinds, it is a good practice to cover the troughs with a concave board, with a hole in the middle of it.

It remains yet to be determined whether ſome artificial heat may not be applied ſo as to increaſe the quantity and improve the quality of the ſap. Mr. Noble informed me, that he ſaw a tree, under which a farmer had accidentally burnt ſome bruſh, which dropped a thick heavy ſyrup reſembling Melaſſes. This fact may probably lead to ſomething uſeful hereafter.

During the remaining part of the ſpring months, as alſo in the ſummer, and in the beginning of autumn, the maple tree yields a thin ſap, but not fit for the manufactory of ſugar. It affords a pleaſant drink in harveſt, and has been uſed inſtead of rum, in ſome inſtances by thoſe farmers in Connecticut, whoſe anceſtors have left to them here, and there, a ſugar maple tree, (probably to ſhade their cattle,) in all their fields. Mr. Bruce deſcribes a drink of the ſame kind, prepared by the inhabitants of Egypt, by infuſing the ſugar cane in water, which he declares to be "the moſt refreſhing drink in the world."* There

* Rhus. † Sambucus canadenſis. ‡ Liriodendrum Tulipifera.

* Baron La Hontan, gives the following account of the ſap of the ſugar maple tree, when uſed

There are three methods of reducing the ſap to ſugar. 1. By *freezing it.* This method has been tried for many years, by Mr. Obediah Scott, a farmer in Luzerne county, in this ſtate, with great ſucceſs. He ſays that one half of a given quantity of ſap reduced in this way, is better than one third of the ſame quantity, reduced by boiling. If the froſt ſhould not be intenſe enough, to reduce the ſap to the graining point, it may afterwards be expoſed to the action of the fire for that purpoſe.

2. By *ſpontaneous evaporation.* The hollow ſtump of a maple-ſugar tree, which had been cut down in the ſpring, and which was found ſometime afterwards filled with ſugar, firſt ſuggeſted this method of obtaining ſugar to our farmers. So many circumſtances of cold and dry weather, large and flat veſſels, and above all ſo much time are neceſſary to obtain ſugar, by either of the above methods, that the moſt general method among our farmers is to obtain it. 3. by *boiling.* For this purpoſe the following facts which have been aſcertained by many experiments, deſerve attention.

1. The ſooner the ſap is boiled, after it is collected from the tree, the better. It ſhould never be kept longer than twenty-four hours before it is put over the fire.

2. The larger the veſſel in which the ſap is boiled, the more ſugar is obtained from it.

3. A copper veſſel affords a ſugar of a fairer colour than an iron veſſel.

The

uſed as a drink, and of the manner of obtaining it. "The tree yields a ſap which has a much pleaſanter taſte than the beſt lemonade or cherry water, and makes the wholeſomeſt drink in the world. This liquor is drawn by cutting the tree two inches deep in the wood, the cut being made ſloping to the length of ten or twelve inches, at the lower end of this gaſh a knife is thruſt into the tree ſlopingly, ſo that the water runs along the cut or gaſh, as through a gutter and falls upon the knife, which has ſome veſſels placed underneath to receive it. Some trees will yield five or ſix bottles of this water in a day, and ſome inhabitants of Canada, might draw twenty hogſheads of it in one day, if they would thus cut and notch all the maple trees of their reſpective plantations. The gaſh does no *harm to the tree.* Of this ſap they make ſugar and ſyrup, which is ſo valuable that there can be no better remedy for fortifying the ſtomach, 'tis but few of the inhabitants that have the patience to make them, for as common things are ſlighted, ſo there are ſcarce any body but children that give themſelves the trouble of gaſhing theſe trees."

The ſap flows into wooden troughs from which it is carried and poured into ſtore troughs or large ciſterns in the ſhape of a canoe or large manger made of white aſh, linden, baſs wood, or white pine, from which it is conveyed to the kettle in which it is to be boiled. Theſe ciſterns as well as the kettle are generally covered by a ſhed to defend the ſap from the rain. The ſugar is improved by ſtraining the ſap through a blanket or cloth, either before or after it is half boiled. Butter, hogs lard or tallow are added to the ſap in the kettle to prevent its boiling over, and lime, eggs or new-milk are mixed with it in order to clarify it. I have ſeen clear ſugar made without the addition of either of them. A ſpoonfull of ſlacked lime, the white of one egg and a pint of new-milk are the uſual proportions of theſe articles which are mixed with fifteen gallons of ſap. In ſome ſamples which I have lately ſeen of maple-ſugar clarified with each of the above articles, that in which milk alone was uſed, had an evident ſuperiority in point of colour.

The ſugar after being ſufficiently boiled, is *grained* and *clayed* and afterwards *refined*, or converted into loaf ſugar. The methods of conducting each of theſe proceſſes is ſo nearly the ſame with thoſe which are uſed in the manufactory of Weſt-India ſugar, and are ſo generally known, that I need not ſpend any time in deſcribing them.

It has been a ſubject of inquiry whither the maple ſugar might not be improved in its quality and encreaſed in its quantity by the eſtabliſhment of boiling houſes in the ſugar maple country to be conducted by aſſociated labor. From the ſcattered ſituation of the trees, the difficulty of carrying the ſap to a great diſtance, and from the many expenſes which muſt accrue from ſupporting labourers and horſes in the woods in a ſeaſon of the year in which nature affords no ſuſtenance to man or beaſt, I am diſpoſed to believe that the moſt productive method both in quantity and profit of obtaining this ſugar will be by the labor of private

families

families. For a great number of years many hundred private families in New-York and Pennſylvania have ſupplied themſelves plentifully with this ſugar during the whole year. I have heard of many families who have made from two to four hundred pounds in a year; and of one man who ſold ſix hundred pounds all made by his own hands in one ſeaſon.*

Not more knowledge is neceſſary for making this ſugar than ſoap, cyder, beer, ſour trout, &c. and yet one or all of theſe are made in moſt of the farm houſes of the United States. The kettles and other utenſils of a farmer's kitchen, will ſerve moſt of the purpoſes of making ſugar, and the time required for the labor, (if it deſerves that name) is at a ſeaſon when it is impoſſible for the farmer to employ himſelf in any ſpecies of agriculture. His wife and all his children above ten years of age, moreover may aſſiſt him in this buſineſs, for the profit of the weakeſt of them is nearly equal to that of a man when hired for that purpoſe.

A comparative view of this ſugar has been frequently made with the ſugar which is obtained from the Weſt-India ſugar cane, with reſpect to its *quality price*, and the poſſible or probable *quantity* that can be made of it in the United States, each of which I ſhall conſider in order.

1. The *quality* of this ſugar is neceſſarily better than that which is made in the Weſt-Indies. It is prepared in a ſeaſon when not a ſingle inſect exiſts to feed upon it, or to mix its excrements with it, and before a particle of duſt or of the pollen of plants can float in the air. The ſame obſervation cannot be applied to the Weſt-India ſugar. The

inſects

* *The following receipt publiſhed by William Cooper, Eſq. in the Albany Gazette fully eſtabliſhes this fact.*

"Received Cooper's Town April 30th 1790, of William Cooper, ſixteen pounds, for ſix hundred, and forty pounds of ſugar made with *my own hands*, without any aſſiſtance in leſs than four weeks beſides attending to the other buſineſs of my farm, as providing fire wood, taking care of the cattle, &c. John Nicholls. witneſs R. Smith.

A ſingle family conſiſting of a man and his two ſons on the maple ſugar lands between the Delaware and Suſquehannah made 1800lb of maple ſugar in one ſeaſon.

insects and worms which prey upon it, and of course mix with it, compose a page in a nomenclature of natural history. I shall say nothing of the hands which are employed in making sugar in the West-Indies but, that men who work for the exclusive benefit of others, are not under the same obligations to keep their persons clean while they are employed in this work, that men women and children are, who work exclusively for the benefit of *themselves*, and who have been educated in the habits of cleanliness. The superior purity of the maple sugar is farther proved by its leaving a less sediment when dissolved in water than the West-India sugar.

It has been supposed that the maple sugar is inferior to the West-India sugar in *strength*. The experiments which led to this opinion, I suspect have been inaccurate, or have been made with maple sugar, prepared in a slovenly manner. I have examined equal quantities by weight of both the grained and the loaf sugar, in hyson tea, and in coffee, made in every respect equal by the minutest circumstances that could affect the quality or taste of each of them, and could perceive no inferiority in the strength of the maple sugar. The liquors which decided this question were examined at the same time, by Alexander Hamilton, Esq. Secretary of the treasury of the United States, Mr. Henry Drinker, and several Ladies, who all concurred in the above opinion.

2. Whoever considers that the gift of the sugar maple trees is from a benevolent Providence, that we have many millions of acres in our country covered with them, that the tree is improved by repeated tappings, and that the sugar is obtained by the frugal labor of a farmer's family, and at the same time considers the labor of cultivating the sugar cane, the capitals sunk in sugar works, the first cost of slaves and cattle, the expenses of provisions for both of them, and in some instances the additional expense of

of conveying the ſugar to a market, in all the Weſt-India Iſlands, will not heſitate in believing that the maple ſugar may be manufactured much cheaper, and ſold at a *leſs price* than that which is made in the Weſt-Indies.

3. The reſources for making a ſufficient *quantity* of this ſugar not only for the conſumption of the United States, but for exportation, will appear from the following facts. There are in the ſtates of New-York, and Pennſylvania alone at leaſt ten millions of acres of land which produce the ſugar maple-tree, in the proportion of thirty trees to one acre. Now ſuppoſing all the perſons capable of labor in a family to conſiſt of three, and each perſon to attend 150 trees and each tree to yield 5lb of ſugar in a ſeaſon, the product of the labor of 60,000 families would be 135,000,000 pounds of ſugar, and allowing the inhabitants of the United States to compoſe 600,000 families each of which conſumed 200 pounds of ſugar in a year, the whole conſumption would be 120,000,000 pounds in a year, which would leave a balance of 15,000,000 pounds for exportation. Valuing the ſugar at $\frac{6}{90}$ of a dollar per pound the ſum ſaved to the United States would be 8,000,000 dollars by home conſumption and the ſum gained by exportation would be 1,000,000 dollars. The only part of this calculation that will appear improbable is, the number of families ſuppoſed to be employed in the manufactory of the ſugar, but the difficulty of admitting this ſuppoſition will vaniſh when we conſider, that double that number of families are employed every year in making cyder, the trouble, riſks and expences of which are a l much greater than thoſe of making maple ſugar.

But the profit of the Maple tree is not confined to its ſugar. It affords an agreeable Molaſſes, and an excellent Vinegar. The ſap which is ſuitable for theſe purpoſes is obtained after the ſap which affords the ſugar has ceaſed to flow, ſo that the manufactories of theſe different products of the maple tree, by *ſucceeding*, do not interfere with each other. The Molaſſes may be made to compoſe the baſis of a pleaſant ſummer beer. The ſap of the Maple is moreover capable of affording a ſpirit, but we hope this precious juice will never be proſtituted by our citizens to this ignoble purpoſe. Should the uſe of ſugar in diet become more general in our country, it may tend to leſſen the inclination or ſuppoſed neceſſity for ſpirits, for I have obſerved a reliſh for ſugar in diet to be ſeldom accompanied by a love for ſtrong drink. It is the ſugar which is mixed with tea which makes it ſo generally diſſagreeable to drunkards. But a diet conſiſting of a plentiful mixture of ſugar has other advantages to recommend it which I ſhall briefly enumerate.

1. Sugar affords the greateſt quantity of nouriſhment in a given quantity of matter of any ſubſtance in nature; of courſe it may be preſerved in leſs room in our houſes, and may be conſumed in leſs time, than more bulky and leſs nouriſhing aliment. It has this peculiar advantage over moſt kinds of aliment, that it is not liable to have its nutritious qualities affected by time or the weather; hence it is preferred by the Indians in their excurſions from home. They mix a certain quantity of maple ſugar, with an equal quantity of Indian corn, dried and powdered, in its milky ſtate. This mixture is packed in little baſkets, which are frequently wetted in travelling, without injuring the ſugar. A few ſpoonfulls of it mixed with half a pint of ſpring water, afford them a pleaſant and ſtrengthening meal. From the degrees of ſtrength and nouriſhment, which are conveyed into animal bodies by a ſmall bulk of ſugar, I conceive it might be given to horſes with great advantage, when they are uſed in places or under circumſtances which make it difficult or expenſive to ſupport them, with more bulky or weighty aliment. A pound of ſugar with graſs or hay, I have been told, has ſupported the ſtrength and ſpirits of an horſe, during a whole day's la-

bor in one of the Weſt-India Iſlands. A larger quantity given alone, has fattened horſes and cattle, during the war before laſt in Hiſpaniola, for a period of ſeveral months, in which the exportation of ſugar, and the importation of grain, were prevented by the want of ſhips.

2. The plentiful uſe of ſugar in diet, is one of the beſt preventatives that has ever been diſcovered of the diſeaſes which are produced by worms. Nature ſeems to have implanted a love for this aliment in all children, as if it were on purpoſe to defend them from thoſe diſeaſes. I know a gentleman in Philadelphia, who early adopted this opinion, and who by indulging a large family of children, in the uſe of ſugar, has preſerved them all from the diſeaſes uſually occaſioned by worms.

3. Sir John Pringle, has remarked that the plague has never been known in any country where ſugar compoſes a material part of the diet of the inhabitants. I think it probable that the frequency of malignant fevers of all kinds has been leſſened by this diet, and that its more general uſe would defend that claſs of people, who are moſt ſubject to malignant fevers from being ſo often affected by them.

4. In the numerous and frequent diſorders of the breaſt, which occur in all countries, where the body is expoſed to a variable temperature of weather, ſugar affords the baſis of many agreeable remedies. It is uſeful in weakneſſes, and acrid defluxions upon other parts of the body. Many facts might be adduced in favor of this aſſertion. I ſhall mention only one, which from the venerable name of the perſon, whoſe caſe furniſhed it, cannot fail of commanding attention and credit. Upon my inquiring of Dr. Franklin, at the requeſt of a friend, about a year before he died, whether he had found any relief from the pain of the ſtone, from the Blackberry Jam, of which he took large quantities, he told me that he had, but that he believed the medicinal part of the jam, reſided wholly in the ſu-

gar, and as a reaſon for thinking ſo, he added, that he often found the ſame relief, by taking about half a pint of a ſyrup, prepared by boiling a little brown ſugar in water, juſt before he went to bed, that he did from a doſe of opium. It has been ſuppoſed by ſome of the early phyſicians of our country, that the ſugar obtained from the maple tree, is more medicinal, than that obtained from the Weſt-India ſugar cane, but this opinion I believe is without foundation. It is preferable in its qualities to the Weſt-India ſugar only from its ſuperior *cleanlineſs*.

Caſes may occur in which ſugar may be required in medicine, or in diet, by perſons who refuſe to be benefited, even indirectly by the labor of ſlaves. In ſuch caſes, the innocent maple ſugar will always be preferred.*

It has been ſaid, that ſugar injures the teeth, but this opinion now has ſo few advocates, that it does not deſerve a ſerious refutation.

To tranſmit to future generations, all the advantages which have been enumerated from the maple tree, it will be neceſſary to protect it by law, or by a bounty upon the maple ſugar, from being deſtroyed by the ſettlers in the maple country, or to tranſplant it from the woods, and cultivate it in the old and improved parts of the United States. An orchard conſiſting of 200 trees, planted upon a common farm, would yield more, than the ſame number of apple trees, at a diſtance from a market town. A full grown tree in the woods yields five pounds of ſugar a year. If a greater expoſure of a tree to the action of the ſun, has the ſame effects upon the maple, that it has upon other trees, a larger quantity of ſugar might reaſonably be expected from each tree planted in an orchard. Allowing it

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* Dr. Knowles, a phyſician of worthy character in London, had occaſion to recommend a diet to a patient, of which ſugar compoſed a material part. His patient refuſed to ſubmit to his preſcription, and gave as a reaſon for it, that he had witneſſed ſo much of the oppreſſion and cruelty which were exerciſed upon the ſlaves, who made the ſugar, that he had made a vow never to taſte the product of their miſery as long as he lived.

to be only ſeven pounds, then 200 trees will yield 1400 pounds of ſugar, and deducting 200 from the quantity for the conſumption of the family, there will remain for ſale 1200 pounds, which at $\frac{6}{90}$ of a dol. per pound will yield an annual profit to the farmer of 80 dollars. But if it ſhould be found that the ſhade of the maple does not check the growth of grain any more than it does of graſs, double or treble that number of maple trees may be planted on every farm, and a profit proportioned to the above calculation be derived from them. Should this mode of tranſplanting the means of obtaining ſugar be ſucceſsful, it will not be a new one. The ſugar cane of the Weſt-Indies, was brought originally from the Eaſt-Indies, by the Portugueſe, and cultivated at Madeira, from whence it was tranſplanted directly or indirectly, to all the ſugar iſlands of the Weſt-Indies.

It were to be wiſhed, that the ſettlers upon the ſugar maple lands, would ſpare the ſugar tree in clearing their lands. On a farm of 200 acres of land, according to our former calculation, there are uſually 6,000 maple trees. If only 2,000 of thoſe original and ancient inhabitants of the woods were ſuffered to remain, and each tree were to afford only five pounds of ſugar, the annual profit of ſuch a farm in ſugar alone, at the price formerly mentioned, would amount to 666 dollars, 150 dollars of which would probably more than defray all the expences of making it, and allow a plentiful deduction for family uſe.

According to the uſual annual profit of a ſugar maple tree, each tree is worth to a farmer, two dollars and $\frac{2}{3}$ of a dollar, excluſive therefore of the value of his farm, the 2000 ſugar maple trees alone confer a value upon it of 5333 dollars and $\frac{30}{90}$ of a dollar.

It is ſaid that the ſugar trees when deprived of the ſhelter and ſupport they derive from other foreſt trees are liable to be blown down, occaſioned by their growing in a rich, and of courſe a looſe ſoil. To obviate this, it will only

only be neceſſary to cut off ſome of their branches ſo as to alter its center of gravity, and to allow the high winds to have an eaſy paſſage through them. Orchards of ſugar maple trees, which grow with an original expoſure of all their parts to the action of the ſun will not be liable to this inconvenience.

In contemplating the preſent opening proſpects in human affairs, I am led to expect that a material part of the general happineſs which Heaven ſeems to have prepared for mankind will be derived from the manufactory and general uſe of maple ſugar, for the benefits which I flatter myſelf are to reſult from it will not be confined to our own country. They will I hope extend themſelves to the intereſts of humanity in the Weſt-Indies. With this view of the ſubject of this letter, I cannot help contemplating a ſugar maple tree with a ſpecies of affection and even veneration, for I have perſuaded myſelf to behold in it the happy means of rendering the commerce and ſlavery of our African brethren in the ſugar Iſlands as unneſſary, as it has always been inhuman and unjuſt.*

I ſhall conclude this letter by wiſhing that the patronage which you have afforded to the maple ſugar as well as the maple tree, by your example † may produce an influence in our country as extenſive as your reputation for uſeful ſcience and genuine patriotiſm.

From Dear Sir your

Sincere Friend and Obedient Servant,

BENJAMIN RUSH.

* This letter was written before the account of the war which has lately taken place in Hiſpaniola, between the white people and their ſlaves, had reached the city of Philadelphia.

† Mr. Jefferſon uſes no other ſugar in his family than that which is obtained from the ſugar Maple tree. He has lately planted an orchard of maple trees on his farm in Virginia.

P. S.

P. S. Since writing the above letter, I have procured through the friendſhip of M. Henry Drinker a copy of Mr. Botham's account of the method of manufacturing ſugar in the Eaſt-Indies. It is extracted from the report of the committe of the Britiſh privy Council for trade on the ſubject of the Slave trade. I ſhall inſert in this poſtcript only ſuch parts of it as will throw light upon the method of manufacturing the maple ſugar which has been mentioned and to ſhow how much it is to be preferred in point of œconomy to that which is uſed in the Weſt-Indies.

Extract from the report of the Committee of Privy Council for trade on the ſubject of the African Slave trade, &c. To the King, Part 3. No. 3. Mr. Botham on the mode of cultivating a ſugar plantation in the Eaſt-Indies, &c.

"HAVING been for two years in the Engliſh and French Weſt-Indian Iſlands, and ſince conducted ſugar eſtates in the Eaſt-Indies; before the abolition of the ſlave trade was agitated in parliament, it may be deſirable to know that ſugar of a ſuperior quality and inferior price, to that in our Iſlands, is produced in the Eaſt-Indies; that the culture of the cane, the manufacture of the ſugar and arrack, is with theſe material advantages, carried on by free people. China, Bengal, the coaſt of Malabar, all produce quantities of ſugar and ſpirits; but as the moſt conſiderable growth of the cane is carried on near Batavia, I ſhall explain the improved manner in which ſugar eſtates are there conducted. The proprietor of the eſtate is generally a wealthy Dutchman, who has erected on it ſubſtantial mills, bailing and curing houſes. He rents this eſtate to a Chineſe, who reſides on it as a ſuperintendant; and this renter (ſuppoſing the eſtate to conſiſt of 300 or more

more acres) re-lets it to freemen in parcels of 50 or 60 on these conditions.

That they ſhall plant it in canes, and receive ſo much per pecul of 133½ lbs. for every pecul of ſugar that the canes ſhall produce.

When crop time comes on, the ſuperindant collects a ſufficient number of perſons from the adjacent towns or villages, and takes off his crop as follows.

To any ſet of tradeſmen who bring their carts and buffaloes he agrees to give ſuch a price per pecul to cut all his crop of canes, carry them to the mill and grind them.

A ſecond to boil them per pecul.

A third to clay them and baſket them for market per pecul.

So that by this method of conducting a ſugar eſtate the renter knows to a certainty what the produce of it will coſt him per pecul. He has not any permanent or unneceſſary expence; for when the crop is taken off, the taſkmen return to their ſeveral purſuits in the towns and villages they came from; and there only remains the cane planters who are preparing the next year's crop. This like all other complex arts by being divided into ſeveral branches, renders the labour cheaper and the work more perfectly done. Only clayed ſugars are made at Batavia: theſe are in quality equal to the beſt ſort from the Weſt-Indies, and are ſold ſo low from the ſugar eſtates as eighteen ſhillings ſterling per pecul of 133½ lbs. This is not the ſelling price to the trader at Batavia, as the government there is arbitrary, and ſugar ſubject to duties impoſed at will. The Shabander exacts a dollar per pecul on all ſugar exported. The price of common labor is from 9d to 10 pence per day. By the method of carrying on the ſugar eſtates, the taſkmen gain conſiderably more than this not only from working extraordinary hours, but from being conſidered artiſts in their ſeveral branches. They do not make ſpirits on the

ſugar

ſugar eſtates. The Melaſſes is ſent for ſale to Batavia where one diſtillery may purchaſe the produce of an hundred eſtates. Here is a vaſt ſaving and reduction of the price of ſpirits; not as in the Weſt-Indies, a diſtillery, for each eſtate; many center in one; and arrack is ſold at Batavia from 21 to 25 Rix dollars per Leaguer of 160 gallons; ſay 8d per gallon.

The improvement in making the cane into ſugar at Batavia keeps pace with that in its culture. Evaporation being in proportion to the ſurface, their boilers are ſet with as much of it as poſſible; the cane juice with temper ſufficient to throw up its impurities is boiled down to the conſiſtence of a ſyrup; it is then thrown up into vats calculated to hold one boiling, then ſprinkled with two buckets of water to ſubſide its foul parts; after ſtanding ſix hours, it is let off by three pegs of different heights into a ſingle copper with one fire. It is there tempered again boiled up and reduced to ſugar, by a gentle fire. It granulates, and the ſugar boiler dipping a wand into the copper ſtrikes it on the ſide, then drops the ſugar remaining on it into a cup of water, ſcrapes it up with his thumb nail, and is by this means able to judge to the utmoſt neceſſity of the ſugar having its proper degree of boiling: the vats or receivers I mentioned are placed at the left hand of a ſet of coppers; after running off for boiling all that is clear, the remainder is paſſed through a ſtrainer, on the outſide of the boiling houſe; what is fine is put into the copper for ſugar; the lees are reſerved for diſtilling."

N°. X.

MEMOIR *of* JONATHAN WILLIAMS, *on the uſe of the Thermometer in diſcovering Banks, Soundings, &c.*

Read Nov. 19, 1790.

I HAVE hitherto delayed making a public communication of my ſea journals, from an apprehenſion of being thought too forward in calling the attention of the Philoſophical Society to the ſubject of them; but being impreſſed with a belief, that by noticing the changes in the heat of the ſea water, a navigator might always know when he is in ſoundings, and thereby be able to eſcape the dangers ariſing from unexpected currents, and erroneous reckoning, I cannot think myſelf juſtifiable in longer heſitating to ſubmit my remarks to their learned and judicious examination.

This ſenſe of duty is ſtrengthened by the recollection of many melancholy inſtances where mariners, in full confidence of being at a diſtance from land, have, with crouded ſails, ruſhed on to deſtruction; and I was once within half an hour's time of being ſhipwrecked on the rocks of Scilly, when the return of day preſented to our view the dreadful fate we had ſo narrowly eſcaped.

If it ſhould be found that the uſe of the thermometer would be an improvement in the art of navigation, I ſhall be abundantly rewarded by the reflection of having contributed to the ſervice of humanity, which is the common cauſe of all men. If it ſhould, on the contrary, appear that I am miſtaken, either in the facts or the concluſions deduced, I truſt that the deſire of doing good, the only motive that actuates me, will meet with indulgence from every candid mind.

In the months of Auguſt and September, 1785. I was a fellow paſſenger with the late Doctor Franklin from Europe to America, and made, under his direction, the experiments

periments mentioned in his description of the course of the gulph stream, an account of which was annexed to his maritime observations, and published in the Philosophical Transactions Vol. II. page 328, I then determined to repeat these experiments in my future voyages. Accordingly on a passage from Boston to Virginia in October 1789, I kept a journal of the heat of the air and water at sunrise, noon and sunset; I then noticed that the sea water out of soundings was about ten degrees warmer than that on the coast, and it very naturally occurred to me that the thermometer might become an useful nautical instrument to indicate an approach to the shore. I thought it prudent, however, to keep this idea to myself till after I had made a course of fair and repeated experiments, which I accordingly did during four passages, 1st, the one from Boston to Virginia abovementioned, 2d from Virginia to England, 3d, from England to Hallifax, and 4th, from Hallifax to New-York. By consulting these journals and the observations made at the dates written, together with the tracks of the ship's way marked on the chart annexed, it will not only appear that Doctor Franklin's account of the warmth of the gulph stream has been amply confirmed, but also that banks, coasts, islands of ice, and rocks under water, may be discovered when not visible, and when the weather is too boisterous to sound, with no other trouble than dipping the thermometer into the sea water. It is well known to sailors, that the water on the banks of Newfoundland is cold, but as they only try this, with the hand, their remarks are contradictory owing to the varied temperature of the hand, and I never heard of any further application of what they think merely a matter of curiosity. Doct. Franklin's observations had the knowledge of currents for their object, and this extension of his discovery did not occur; but as I am indebted to his instructive conversation and example, for my inducement to pursue

 philosophical

philoſophical reſearches when in my power to do ſo, he may be conſidered as the original author of what is now preſented for examination.

It will be proper to ſuſpend any concluſions till the journals have been attentively conſidered, but as a guide to the object of them, it may not be amiſs to ſtate ſuch facts as it is preſumed the experiments have a tendency to eſtabliſh.

1. The water over banks is much colder than the water of the main ocean, and it is more cold in proportion as it is leſs deep.

2. The water over ſmall banks is leſs cold than that over large ones.

3. The water over banks that are near the coaſt is warmer than that over banks far diſtant, but it is colder than the adjacent ſea.

4. The water over banks of the coaſt, *i. e.* thoſe immediately connected with the land above water, is warmer than that over thoſe which admit deep water between them and the coaſt; but ſtill it is colder than the adjacent ſea.

5. The water within capes and rivers does not follow the above rules; it being leſs agitated, and more expoſed to the heat of the ſun, and to receive the heat from the circumjacent land, muſt be colder or warmer than that in ſoundings without, according to the ſeaſons, and temperature of the atmoſphere.

6. The paſſage, therefore, from deep to ſhoal water may be diſcovered by a regular uſe of the thermometer, before a navigator can ſee the land; but as the temperature is relative, no particular degree can be aſcertained as a rule, and the judgement can only be guided by the difference. Thus in Auguſt I found the water off Cape Cod to be 58° by Fahrenheit, and at ſea it was 69°; in October the water off Cape Cod was 48°, and at ſea it was 59°. This difference was equally a guide in both caſes, though the heat was different at different ſeaſons.

To face page 84

I do not presume to say what is the cause of this difference of heat between the sea and bank water, but if a navigator were to observe it when near an Island of ice, he would very naturally say that the ice conducted the heat from the circumjacent water, and left it colder than that at a distance. And as it is well known that stones and sand are great conductors of heat, it seems probable that banks also conduct the heat from the adjacent water, though not so rapidly as the ice. The heat of the water may indeed be supposed to seek its equilibrium, but as long as the Islands of ice and banks continue to conduct, there must be some difference, and this it is, which, by attention, may be made a faithful sentinel to give an alarm when danger is near.

I have thought it my duty to present my journals as they were written at sea, to avoid the suspicion of having added any thing from the suggestions of the imagination. While this will be received as a circumstance favourable to the truth of them, I hope it will also operate as an apology for their many imperfections.

The journal A. from Boston to Virginia, shows that the water on the coast of Massachusetts, was at 48°; at sea between that coast and the stream, 59°; in the gulph stream at its edge, 67°; between that, and the coast of Virginia farther southward 64°; and in soundings on that coast, 56°. At that season (in October, just after the warm weather) the water grew warmer as we approached the land.

The journal B. from Virginia to England, shows that in December, the water in the coast of Virginia, was at 47°; between the coast and the stream, 60°; and in the stream, 70°. This current being in our favour, we did not avoid it, and the water continued with little variation, till we came near the banks of Newfoundland, when the thermometer fell from 66 to 54; passing these, it rose again

to

to 600°, and then continued a very gradual deſcent as we went to the Northward, 'till we ſtruck ſoundings, when it was at 48°.

It may be here obſerved, that the decreaſe in the heat of the water was ſo gradual as to give but one degree in a days run, while in going to, or coming from the coaſt of America, the thermometer will alter 8 or 10 degrees in a few hours run. It is well known, by ſounding, that the Engliſh coaſt extends with a very gradual deſcent to a great diſtance. It is alſo known that the American coaſt does not extend very far, and the water is ſuddenly deep. Let theſe facts be compared with the changes in the thermometer, on the two coaſts, and they will agree with what has been ſaid about the uſefulneſs of that inſtrument.

It may be obſerved in Doctor Franklin's journal on board of the Repriſal, that in November 1776, when near the banks of Newfoundland, his thermometer fell ten degrees, though conſiderably to the Southward of them, and after paſſing them, it roſe nearly to its former ſtate: the Doctor did not make any obſervation on this circumſtance; but it agrees with my journal, in nearly the ſame, place made nine years afterwards.

The journal C. from England to Hallifax, ſhows the changes in the heat of the water as we ſailed over banks and deep water alternately, with an accuracy that I confeſs, exceeded my expectation, the land appearing as the thermometer indicated our approach to it.

The journal D from Hallifax to New-York not only ſhows the variety of depths we paſſed over, but indicates the inner edge of the gulph ſtream. As by the thermometer and ſoundings it appeared to me that the ſhip was a head of the reckoning, I made allowances for the eddy current of that ſtream in our favour, and comparing theſe with the chart, I noted in the journal, the longitude I thought we were in, under that calculated by the ſhip's officers:

officers: what encouraged this opinion, was the disagreement between the soundings by the lead, and those marked on the chart in the places where, by the common reckoning, the ship was supposed to be; while upon the other supposition they both agreed. When we made the land this latter reckoning turned out accurate, and I won a small bett of the Captain who candidly acknowledged the usefulness of the thermometer, and declared that he would in future always have one on board.

Finding the coast of America to grow suddenly deep as it approaches the gulph stream, and finding continued soundings from Cape Sable to New-York, I am induced to believe that it has its shape according to the course of that current, and that it is connected in a sweep from the banks of Newfoundland to Florida, the various banks between being only eminences of the coast. If my apprehension of the accuracy of thermometrical observation is well founded, it would be an easy thing to make a general survey of the coast under water, more particularly than has hitherto been, or could be done by sounding.

On the chart annexed the tracks of my several passages are marked with the daily heat of the water in degrees according to Fahrenheit, by which the variations on the approach to land may be seen at one view. The edge of the gulph stream is also traced according to the experiments as far as the banks of Newfoundland: how far it runs to the eastward I do not pretend to say; but having found a current in the natural direction of its sweep among the western islands, I am inclined to think it extends so far, before it turns off to the southward. It may be observed, however, that as this stream, like all other currents, must be affected by tempests on either side; it may, as these prevail, run somewhat nearer or somewhat farther distant from the coast.

In

In confirmation of what has been ſaid about the eddy current of the gulph ſtream, I have extracted from the journal of an officer belonging to the Britiſh ſhip of war Liverpool, ſome obſervations which deſcribe this eddy on both ſides of the ſtream * two other extracts from the ſame journal † deſcribe a current among the weſtern Iſles, which is perhaps the gulph ſtream then turning to the ſouthward. This journal was communicated to me by Capt. Schuyler of the Britiſh packet, on board of which I made my laſt experiments and obſervations.

‡ In addition to my journals I have ſubjoined an account of ſome experiments on fiſh which ſhow that their animal heat was 16° degrees colder than the water at the ſurface; from which it may be ſuppoſed that the water at bottom is in proportion colder than that above. It may be naturally ſuggeſted, that trying the heat of the water at the ſurface, (the only way in one's power when ſailing rapidly through it,) is too inaccurate to be depended on, ſince the ſurface muſt be heated by the atmoſphere. To this it may not be amiſs to anſwer.—1. That by repeated experiments at the depth of 30, 40, and 60 fathom I have found the water below, out of ſoundings, to be no more then ſix degrees colder than that above; and at four or five fathoms depth, when the ſea was agitated, there was no difference worthy notice. 2. When the ſea is not agitated and the ſurface, by being expoſed to a hot ſun, is warmer, the weather being calm, it is eaſy to have water from a conſiderable depth; this I have found to make a difference of one or two degrees only, and it is eaſy to make the allowance. 3. The difference of heat which marks an approach to land is ſufficiently ſenſible at the ſurface for the purpoſe of giving notice of danger, I have generally found it to be 6° in three hours run, and long before we were

* Appendix N°. I.
† Appendix N°. II and III.
‡ Appendix, N°. IV.

were near enough for to be in danger. Upon the whole, as it is fact, and not argument which ſhould inſpire belief, I wiſh every doubting navigator to endeavour to confute me by making other experiments, and thereby, if he can, detect the fallacy of mine.

JONATHAN WILLIAMS, JUN.

Theſe Journals, as they were preſented to the ſociety, contained the experiments in detail; but it was thought expedient in the publication of them, to ſuppreſs all thoſe, which, by having nearly ſimilar reſults, may be conſidered as repetitions of the preceding, or gradual approaches towards the ſucceeding ones. The reader may depend, however, that nothing is altered, and that the heat of the water was taken at leaſt three times every day during all the voyages, and when paſſing over banks, or approaching the coaſt, almoſt every hour, as well by night as by day. N. B. The Thermometer uſed was on Fahrenheit's Scale.

A. A Thermometrical Journal of the temperature of the Atmoſphere and the Sea on a Paſſage from Boſton towards Virginia; on board of the Schooner America, Capt. Brace, by JONATHAN WILLIAMS. Jun.

Dates. 1789.	Time.	Places at Noon.		Temperature of	
		Lat. N.	Long. W.	Air.	Water.
Oct. 11,	Sun ſet.	42° 5′	69° 40′.	58.	48.
12,	Sun riſe.			50.	54.
	Noon.	40 23.	68 46.	50.	52.
	Sun ſet.			52.	59.
13,	Sun riſe.			57.	65.
	Noon.	38 40.	70 35.	60.	67.
	Sun ſet.			64.	66.
14,	Sun riſe.			65.	62.
	Noon.	38 46.	71 58.	69.	61.
	Sun ſet.			66.	64.
15,	Sun riſe.			70.	65.
	Noon.	38 25.	73 10.	67.	64.
	Sun ſet.				
16,	Sun riſe.			59.	63.
	Noon.	37 45.	73 40.	60.	64.
	Sun ſet.			61.	64.
17,	Sun riſe.			62.	64.
	Noon.	37 36.	74 1.	66.	64.
	Sun ſet.			63.	64.
18,	Sun riſe.			60.	57.
	Noon.	37 34.	74 45.	60.	56.
	Sun ſet.			50.	57.
19,	Sun riſe.			56.	60.
	Noon.	37 4.	76 4.	58.	58.

NOTES.

October 11, ſun ſet. Sailed at 8 A. M. from Boſton, and at ſun ſet, we were off Cape Cod, which is in lat. 42. 5. N. and long. 69. 40. W. from London. See John Hamilton Moore's practical navigator.

October 12, noon. No ſympton of the gulph ſtream in this longitude.
ſun ſet. We now probably approach the gulph ſtream, the water being 7°. warmer than at noon.

October 13, ſun riſe. At midnight we had made nearly S. W. courſe diſtant 80 miles; the water then was at 60.

October 13, noon. We are now probably within the ſtream, the water being 15°. warmer than yeſterday at this time.

October 13, ſun ſet. We had a good obſervation at noon; we are probably ſtill in the ſtream, the water continuing warm.

October 14, ſun riſe. We have made about a weſt courſe during the night, diſtant about 52 miles.

October 14. noon. It appears by obſervation that we are 18 miles north of our reckoning; hitherto our reckoning has appeared accurate.

October 14, ſunſet. The water yeſterday noon was 6° warmer than at the ſame time to day, yet the air was 9° warmer to day than at the ſame time yeſterday. By this difference of temperature, and by the loſs of 18 miles diſtance, it is probable that we were within the ſtream yeſterday and carried to the Northward by its current; thus it appears that in the lat. 38°. 43 N. the weſtern edge of the ſtream extends as far as long. 71. 15 W. which is the mean between yeſterday, and to days reckoning.

October 16, noon. I ſent a well corked bottle 30 fathoms deep, and drew it up empty. I ſent it again 60 fathoms deep, and drew it up full, this water was then taken at a depth ſomewhere between 30 and 60 fathoms and it was by the thermometer at 58°. ſix degrees colder than at the ſurface 64°.

October 17, noon. Obſerve how regular the temperature of the water has been during 4 days, *i. e.* ſince leaving the ſtream.

October 18, ſun riſe. By the ſudden change in the heat of the water, I ſuſpect we are drawing near ſoundings.
Noon. Sounded, but no bottom, with 60 fathoms of line. No obſervation for the firſt time ſince we have been out.
At 8 P. M. got bottom 33 fathoms heat of water 56°; at midnight 21 fathoms.

October 19. At 2 A. M. 18 fathoms at 4 A. M. 14 fathoms at 8 A. M. made Cape Charles W. N. W. at 9 Cape Henry, W. by S.W. off Willoughby's point in the mouth of James River. Cape Charles by John Hamilton Moore's practical navigator is in lat. 37°. 9 N. lon. 75°. 50 W. We are now about 16 miles within the Cape, thus the reckoning proves to be very accurate.

N. B. The water appears ſomewhat warmer in ſhoal, than in deep ſoundings.

B. A thermometrical Journal of the temperature of the atmosphere, and the sea, on a passage from Virginia to England, on board of the Brig Mercury, Captain Thompson, by J. W.

1789. Dates.	Time	Places in at Noon. Lat. N.	Lon. W.	Temperature of Air.	Water.	Notes.
Nov. 30	noon	37° 0′	75° 43′	42°	47°	Nov. 30. Sailed this morning from Hampton Road; at noon Cape Henry bore West dist. 2 leagues.
	sun set			42	50	
Dec. 1.	sun rise			42	54	Dec. 1. Entered the Gulph Stream, at 10 P. M.
	noon	36 30	71 2	44	60	
	10 P. M.			50	70	
2.	sun set	36 30	68 47	58	67	
3.	noon	36 30	65 39	60	70	
	sun set			63	71	
4.	sun rise			59	69	
	noon	37 5	62 13	60	68	
	sun set			59	67	
5.	8 A. M.			56	66	
7.	sun set	38 7	54 4	66	68	
8.	noon	38 43	52 12	68	66	
9.	sun rise	39 56	48 52	66	62	
10.	sun rise			46	54	I suppose this coldness to be owing to the Banks of Newfoundland, which are in this Longitude.
	noon	40 10	46 12	54	60	
	sun set			52	62	
11.	noon	40 44	43 39	56	60	
13.	noon	42 22	39 35	62	59	
14.	sun rise	43 54	36 04	61	58	
15.	sun rise			58	57	Dec. 22. Since the 16th there has been little or no alteratio 'till to-day.
	noon	44 58	32 27	60	55	
16.	noon	45 58	29 00	56	53	
22.	sun rise	48 22	21 02	48	50	Dec. 25. At 8 P. M. sounded in 75 fathoms.
24.	midnight	49 48	13 54	46	49	
25.	noon	49 40	10 14	48	48	Dec. 27. At noon sounded in 40 fathoms.
27.	noon	49 56	3 32	58	49	
28.	noon	50 24	2 22	50	49	Dec. 28. At noon saw Portland

C. A thermometrical Journal of the temperature of the atmosphere and the sea, on a passage from Falmouth in England, to Halifax in Nova-Scotia, on board of the British Packet Chesterfield, Captain Schuyler, by J. W.

Dates. 1790.	Time	Places in at Noon. Lat. N.	Long. W.	Temp. of Air	Wat.	Notes.
June 12	Noon.	49° 57′	5° 14′	61°	55°	
	6 P. M.			57	57	
14	Noon.	48 11	12 18	61	58	
15	8 P. M.	47 25	16 16	60	59	
21	Noon.	48 7	25 16	62	57	
22	8 A. M.	47 19	26 11	59	58	
23	Noon.	46 38	27 55	62	60	
24	6 P. M.	45 13	28 29	64	62	
25	Noon.	44 46	30 32	67	63	
26	7 P. M.	44 53	32 15	66	62	
27	Noon.	44 51	33 29	63	61	
30	Noon.	44 56	36 21	64	60	
July 1	Noon.	44 0	37 2	66	64	July 1. In the evening, I strained a bucket of water through a towel, and the luminous appearances so common in the sea, remained upon the cloth.
2	8 P. M.	44 31	38 25	65	61	
3	8 P. M.	44 52	39 56	62	60	
4	Noon.	44 23	40 53	66	62	
5	6 P. M.	44 20	43 25	66	63	
6	6 A. M.			66	62	
	Noon.	44 43	46 7	62	57	
	1 P. M.			62	55	
	4 P. M.			58	53	
	5 P. M.			55	51	I suppose we are on Jacquet's Bank.
	6 P. M.			60	56	
	7 P. M.			59	57	I suppose we are between Jacquet's and the Grand Bank of Newfoundland
	Midnight			59	55	
7	4 A. M.			58	54	These irregular degrees of heat indicate eminences in the valley between Jacquet's and the Grand Bank.
	6 A. M.			56	50	
	7 A. M.			56	49	
	10 A. M.			56	51	
	11 A. M.			55	53	
	Noon.	45 00	47 57	55	51	
	6 P. M.			55	49	
8	6 P. M.	45 14	49 13	53	47	
9	8 A. M.	45 10	51 9	53	47	Sounded in 40 fathoms.
10	8 A. M.	44 54	53 39	57	51	Do. in 45 do.
11	8 A. M.	44 52	54 57	58	53	Do. in 56 do.
	6 P. M.			60	54	Do. in 75 do.
12	8 P. M.	44 49	56 16	55	55	do. no bot. in 110 F. over the G. Bank.
13	8 A. M.	44 30	58 28	55	53	Do. in 42 perhaps on the whale bank
	8 P. M.			56	54	Do. 40 fathoms.
	10 do.			56	53	Do. 35 do.
14	8 A. M.			60	56	Do. 38 do.
	Noon	44 33	59 54	60	61	Do. 60 do. calm and bright Sun.
	Midnight			57	57	
15	2 P. M.	44 50	61 20	60	57	Saw land.
	5 P. M.			60	53	Tack'd, stood off land, soun. 13 fath.
	8 P. M.			60	56	Land out of sight.
16	Noon	44 34	62 17	61	57	Standing in for the land.
	8 P. M.			60	53	Tack'd and off the land.
17	6 A. M.			59	52	On Jeddore Bank.
	Noon			62	57	Off the Bank.
18	4. A. M.	At the mo. of Hal. H.		54	52	

Observations

Obſervations on a paſſage from Falmouth to Halifax by Jonathan Williams.

June 17, 1790, The very gradual increaſe in the heat of the water as we leave England indicates a ſmall deſcent of the coaſt, which, as far as ſoundings go, is known to be the caſe.

July 6, lat. 44. 43. N. lon. 46. 07. W. Here we find a ſudden change of 7 degrees in the heat of the water, which indicates our approach to the Banks of Newfoundland, though not in ſuch ſoundings as we could obtain. We tried with 160 fathoms but the lead was only about 12 pounds, and the line was a very thick one: perhaps the line floated the lead. At 5 P. M. the water was ſtill colder 4 degrees; but at 8 A. M. it grew warmer again 6 degrees, this ſeems to indicate a paſſage, over a bank, into water as deep as when we diſcovered the firſt change.

July 7, lat. 45. 00. N. lon. 47. 57 W. We are now in cold water again (49) 13 degrees colder than the ocean water had regularly been during 12 days previous to the firſt change, except only the ſmall variations of a more northern or more ſouthern courſe, theſe changes ſeem to indicate our entrance on another bank. There is a bank laid down in the charts, by ſome called Jaquet's bank, but by the older charts called falſe bank, over which we have probably paſſed. In this longitude, but farther ſouth, both by Dr. Franklin's and my own obſervations, the water grew ſuddenly cool. This ſeems to confirm the ſuppoſition of this outer bank, the ſouthermoſt point of which I ſuppoſe to extend as far as lat. 40. 00. N. We hove too in order to try the ſoundings but the force of the back ſail carried away the main top maſt head, and brought the top gallant ſail, maſt and rigging down, this confuſion interrupted the ſounding; and we had only 80 fathom of line out, when it was hauled in.

July 8, At 6 P. M. the water was only 2 degrees colder (47°) than when we were interrupted in ſounding, and we got bottom in 40 fathoms.

July 12, lat. 44. 49. N. lon. 56. 16. W. From the laſt ſound to this time the thermometer has varied, regularly as the ſoundings varied, the water being warmer when deeper, and cooler when ſhoaler. It is now at 55, which is 8 degrees warmer than when we had 40 fathoms. We now ſounded and could not reach bottom with 110 fathoms of line. This indicates that we are off the grand bank, and within it. By taking our diſtance from the time the thermometer firſt fell to 54, to the laſt time it ſtood at that degree, we may give an account of the width of the ſoundings on this grand bank, though it probably extends much farther, but in deeper water. This is noted on the chart. The variations in the thermometer between laſt night and this morning, indicate our paſſage over an eminence of the bank, called the Whale Bank, ſituated on its inner edge.

July 13, lat. 44. 30. N. lon. 58. 28. W. Thermometer at 8 A. M. was at 53. two degrees colder than when we could not reach bottom with 110 fathoms of line: and we ſounded in 42 fathoms. This indicates our entrance on another bank, which is called in the charts Banquereau. It is obſervable that the water of ſmall banks is not ſo cold as that of large banks, and this ſeems natural, if it is ſuppoſed that the conducting power of the land, taking away part of the heat of the water, is the cauſe of the changes in the thermometer; for that power muſt have leſs effect, as the quantity of the ground under water is leſs: and this muſt be ſtill more remarkable when the bank is immediately connected with land above water, for ſuch land conducting heat away from the atmoſphere, and receiving much from the ſun, muſt require leſs from the water. This remark has been uniformly confirmed in all my experiments within capes, where the water is much warmer than in ſoundings without them. And it is further obſervable, that the water on the coaſt of America on the edge of ſoundings, is not above 6 or 8 degrees colder than deep water; but on the banks of Newfoundland it is from 12 to 15 degrees colder.

July 14, lat. 44. 33. N. lon. 59. 54. W. Here we have the water 57, which is 2° warmer than when we could not get bottom between the banks, yet we have 65 fathoms, at noon it was up to 61, and we had the ſame ſoundings; but as it was calm weather, and as we had a hot ſun, allowance muſt be made for its influence, and therefore no certain concluſion can be drawn. The depth of the water however indicates our going off Banquereau, and the white ſand of the bottom indicates that we are on the edge of the bank which is connected with the Iſle of Sable. This alſo accounts, from the above mentioned principle, for the unexpected warmth of the water.

July 15, lat. 44. 50. N. lon. 61. 20. W. We ſaw the land at 2 P. M. and now we are in 13 fathoms of water thermometer 53. This land agrees with the deſcription of that about St. Mary's river, and tracing our courſe back, ſhews us to have been laſt night, and the preceding days, in the very places indicated by our reckoning, thermometer, and ſoundings. We tacked and ſtood off.

July 18, off Halifax Harbour. The thermometer, when we ſtood off the land, roſe up to 57. and when we came on and made the high lands of Jeddore it indicated Jeddore banks by falling to 52. when being becalmed we caught fiſh, leaving the bank it roſe to 57, and now we are in ſight of our port it ſtands at 52.

D. A thermometrical Journal of the temperature of the atmoſphere at ſea on a paſſage from Halifax to New-York, on board of the Britiſh Packet Cheſterfield, Captain Schuyler.

Dates. 1790.	Time	Places in at Noon. Lat. N.	Lon. W.	Temp. of Air.	Wat.	Notes.
July 21,	9 A. M.	Halifax Harbour		56	53	Sailed at 8 A. M.
	11 A. M.	without the harbour.		55	52	
	4 P. M.			64	56	Land out of ſight.
22,	6 A. M.			56	50	I ſuppoſe we are on Roſeway bank.
	Noon.	43 12	64 6	56	53	I ſuppoſe we are between Roſeway and Brown's bank.
	4 P. M.			56	50	
	7 P. M.			56	54	July 22, 4 P. M. I ſuppoſe we are on Brown's bank.
24,	8 A. M.			56	50	
	10 A. M.			58	53	July 22, 7 P. M. I ſuppoſe we are off do.
	Noon.	41 57	65 1	68	58	
	6 P. M.			62	57	Tried current and found it NE. 1 knot no bottom in 80 fathoms.
	Midnight.			62	56	
25,	Noon.	41 53	65 33	64	58	Much Gulph weed, a whale 2 ſharks and many porpoiſes.
	4 P. M.			64	55	
	6 P. M.			62	53	Bottom in 42 fathoms, no gulph weed.
	Midnight.			62	60	Bottom in 32 fathoms, ſtood N.
26,	3 A. M.			62	53	Bottom in do. fathoms, ſtood Southward.
	6 A. M.			60	57	
	Noon.	41 8	66 56	64	60	
	4 P. M.			64	62	Bottom in 50 fathoms, ſtood N.
27,	3 A. M.			60	54	Bottom 35 fathom, ſtood Southward.
	7 A. M.			62	60	Stood Weſt.
	Noon.	40 44	67 32	64	56	* N. B. by the ſoundings and the
	4 P. M.	*	68 30	64	54	Bottom 28 fathoms { thermometer, I
	8 P. M.			65	59	Bottom 40 do. { ſuppoſe the true
	10 P. M.			64	55	Bottom 30 do. { long. to be as
28,	1 A. M.			64	56	do. 32 do. ſtood SE. { marked under
	6 A. M.			67	61	Do. 43 do. ſtood S. W. the reckoning.
	Noon.	40 44	68 06	68	60	Do. 36 do. ſtood E. S. E.
	8 P. M.	*	69 40	69	64	Do. 65 do. wore ſhip, almoſt calm.
	10 P. M.			69	64	No bottom, I ſuppoſe we are within the influence of the gulph ſtream; in its eddy perhaps.
29,	4 A. M.			68	63	
	Noon.	40 25	68 20	68	63	
	10 P. M.	*	70 30	65	64	July 29, 4 A. M. bottom in 37 fathoms ſtood W.
30,	Noon.	40 23	69 14	67	66	
	4 P. M.	*	71 10	69	67	July 29, 10 P. M. bottom 45 do. the water being warmer than in the ſame depth when I thought we were near the ſhoals, I am induced to believe that this bottom is that of the Coaſt.
	8 P. M.			69	68	
	Midnight.			70	69	
31,	3 A. M.	40 29	70 51	70	68	
Aug. 1,	4 A. M.	*	72 30	70	68	
	9 A. M.			66	66	
	4 P. M.	40 29	*73 40	68	66	July 30, 8 P. M. bottom 56 do. mud

July 31, 3 A.M. bottom 63 fathoms mud. The muddy bottom ſhows that we are within the ſhoals and banks of the Coaſt.

Auguſt 1, 9 A. M. Saw the land off Long-Iſland, bearing N.

Auguſt 1, 4 P. M. New-York Light Houſe in ſight, bearing Weſt. N. B. ſince 2 A. M. we have been going from 5 to 7 knots *i. e.* about 50 miles Weſt, which makes the longitude by thermometrical reckoning and ſoundings 73, 40 W. at noon, which turns out accurate, the land being in 74. 00 W.

Obſervations

Observations on a voyage from Halifax towards New-York.

1790. July 21. Sailed this morning from Halifax. The water at the harbour's mouth and just within Chebucta head, was at 53. but without it was at 52.—In landlocked places I have generally found the water warmer than in even greater depths, on the borders of the ocean.

22. When we lost sight of land the water was at about 56 but at 6 this morning it having cooled to 50 I suppose we are passing over Roseway bank.

At noon the heat of water had risen to 53 which makes me suppose we are over the ground between Roseway and the other bank called in some charts Brown's bank, and at 4 the water cooling again to 50 I suppose we are on this last mentioned bank.

24. Lat. 41. 57. Long. 65. 01. The water at noon yesterday growing as warm as 56 I suppose we are on the S. E. edge of Brown's bank. As we afterwards hauled up more to the westward, and as the water at 8 this morning cooled to 50 again, I supposed we had returned more on the bank. But at noon the thermometer rose to 58. As it was calm, and the sun hot, I made some allowance for that cause, but supposed we had got off soundings, and as at 6 (the air being 6° cooler than at noon) it was at 57 I was confirmed in this.—It being still calm, and there appearing some gulph weed, we hoisted out the boat to try the current which we found to set N. E. nearly 1 knot. This puzzled me, I could not conceive ourselves to be in the gulph stream, because the water was not hot enough for that supposition, and as the iron pot by which we anchored the boat, was not at bottom though 80 fathoms of line were out, I thought the heat 57 fully accounted for by the depth of water; but about 7 when we had made a little way through the water, it became again calm, and we then saw and heard the ripple of a current as evidently as we could have expected over a shoal. I could not account for this any otherways than by supposing it to be the gulph stream, yet it appeared impossible that it should come so near the bank. Our Captain resolved to try again if there was a current here at a distance from this ripple and in a calm. He accordingly hoisted out the boat again and the current was found to set S. E. by S. about ¾ knot. The evidence of this various current in so short a space, the heat of the water not being raised to the heat of the stream, and our situation to the Northward made me conclude this to be the whirlpools of the eddy of the gulph stream just on the northern edge of it.

July 25, Noon. Lat. 41. 53. Long. 65. 33. The water still continuing till noon nearly at the same temperature, and our course being to the West Southerly I concluded that our situation with respect to the stream was nearly the same as last remarked; this was confirmed by the passage of immense quantities of gulph weed, a deal of scum and mucus with a Whale two or three Sharks and a school of Porpoises in the course of the morning; but in the afternoon we fell off further to the Northward, and at 6 P. M. the water was from 55 to 53. no gulph weed to be seen, and in soundings of 42 fathoms. We tacked and stood south at 8 P. M. and I was astonished to find at midnight that the water was heated to 60, though the soundings were only 32 fathoms. Here again I could account for this only by the influence of the gulph stream, which the Capt. seemed to think probable, and tacked to the

26th. Northward, the wind being still at about W. and by 3 A. M the thermometer fell to 53 with the same soundings, when we again tacked and stood to the southward. I then tried the heat of the water by the thermometer, regularly every hour, and by 5 P. M. it was up to 62. The

27th. soundings then were 46 fathoms:—we tacked and stood North, and at midnight it was again down to 55, at 3 A. M. to 54 the soundings then about 35 fathoms we then stood south when it returned to 60. Thus upon three successive tacks each way we cooled or warmed the water as we were standing either Northward or Southward from 6 to 9 degrees.——I could only account for this (the soundings varying but very little) by supposing that when we stood southward we got into the warm influence of the gulph stream, and as we stood Northward we got

July 27. out of it. I do not think we got into the stream itself, because I should in that case have expected the water to have been much warmer, but probably we have been very near, perhaps upon the edge of it: and perhaps we have had a benefit instead of a disadvantage, by an eddy westerly current: that we have been near it, seems pretty clear, for when we warmed the water we saw plenty of gulph weed, and the weather was clear, when we cooled the water we saw no gulph weed and the weather was foggy.

Perhaps we may be farther to the westward than we think: time and a good look out will discover,

July 30. Lat. 40. 25. Long. 70. 30. Since the last observation relative to the stream and soundings I have kept the thermometer going almost every hour except when we were standing off the shore, and by examining the soundings according to those marked in Mr. Des Barres chart, I have regularly traced them and if we were to suppose that a current was setting us about 1 knot per hour to the westward, the soundings would agree very well. When in about lat. 40. 25. we were standing off shore, we

warmed

warmed the water to 64, and got 45 fathoms this heat I account for by the influence of the ſtream, it being greater than the proportion as to ſoundings, for in 40 fathoms farther toward the ſhore it was only 60. In looking over my journal from Boſton to Virginia in Capt. Brace, I found that in nearly the ſame latitude the heat increaſed in about the ſame time from 52 to 59 but in a ſomewhat longer run. It was then October, it is now July, and the difference in the number of the degrees is eaſily accounted for by the ſeaſon. By going more ſouth and weſt in Captain Brace the water was raiſed to 67 when we found ourſelves within the ſtream, it would at this ſeaſon probably be upwards of 70. I therefore conclude that we are within the influence of the heat, but not the current of the ſtream, and I am in hopes to find that we have had that eddy current in our favour.

Aug. 1, 9 A. M. Having the land in ſight we are confirmed in the ſuppoſition that a favourable current has carried the Ship faſter than the Captain reckoned.

APPENDIX.

NOTES TO THE MARITIME OBSERVATIONS.

N°. I.

Extract from the Journal of an Officer on board the Britiſh Ship of War, Liverpool, in November and December, 1775, on the Coaſt of Carolina and Virginia.

WHEN Cape Henry bore N. W. 160 leagues found a current ſetting to the Southward at the rate of 10 or 12 miles per day, which continued ſo till Cape Henry bore W. N. W. 89 or 90 leagues, then found a current ſetting to the N. E. at the rate of 32 or 34 miles per day, this current continued till within 33 or 30 leagues of the land on the above coaſts, then it ſets to the Southward and Weſtward, at the rate of 10 or 15 miles per day, till within 12 or 15 leagues of the land. This current which is only the eddy of the gulph ſtream, ſets moſtly S. W. or as the land lies.

In lat. 37. 50 ſounded, and had 65 fathoms, fine ſand, being 25 leagues from the land. In the ſame latitude and only 26 leagues from the land, had no bottom, with 180 fathoms.

From

From lat. 35. 30. to lat. 37. 00. there are no ſoundings 20 leagues from the land, but at 19 leagues diſtance there are ſoundings in 60 fathoms, at 18 there are only 35 fathoms, and from thence gradual ſoundings to the ſhore.

From Cape Hatteras to Cape Henry, the ground is fine ſand, and to the Northward of Cape Henry, coarſe ſand with ſome ſhells among it.

N°. II.

Extract from the Journal of an Officer on board the British Ship of War Liverpool, between 26th Sept. and 9th October, 1775.

IN lat. 45. 43. N. long. 21. 20 W. from Greenwich, found a current ſetting to the Southward 12 to 15 miles per day, which continued till we made the Iſland of Corvo, the North part of which is in lat. 39. 56. N. and long. 31. 8. W. from Greenwich by celeſtial obſervation, which agreed within 12 miles of the longitude per account, that being 30. 56. The variation of the compaſs off this Iſland is 18°. 19. W. and in ſailing to the Southward and Weſtward, it gradually diminiſhed, till we arrived in lat. 29. 00. N. long. 66. 40. W. where we had no variation.

N°. III.

Extract from the Journal of an Officer on board the British Ship of War, Liverpool.

ON the 18 of October, 1775, in lat. 42. 4. N. long. 10°. 8. W. from the Iſland of Corvo, it bearing S. 75 E. diſtant 156 leagues, the ſea being then very ſmooth it was ſuddenly agitated into a ſhort irregular ſea (without any ſhift or increaſe of wind) ſuch as is generally occaſioned by currents, and the next day we found we were 30 miles to the Southward of the reckoning. This current continued till the 22d of October, having then arrived in lat. 37. long. 13. 30. W. It ſet S. by W. ½ W. 1½ miles per hour.

Having a fair wind, and a good obſervation every day, and alſo good aſtronomical obſervations for determining the longitude, we had the greateſt reaſon to depend on the authenticity of the above.

No. IV.

Extract from the Journal of an Officer on board the Britiſh Ship of War, Liverpool. July, Auguſt and September, 1775.

THE bank from Cape Cod extends almoſt as far as Cape Sable, where it joins the banks of Nova Scotia deepening gradually from 20 to 50 or 55 fathoms, which depth there is in lat. 43. In croſſing the bank between lat. 41. 41. and lat. 43. the bottom is very remarkable; on the outſide it is fine ſand, ſhoaling gradually for ſeveral leagues on the middle of the bank, it is coarſe ſand or ſhingle with pebble ſtones, on the inſide it is muddy with pieces of ſhells, and deepens ſuddenly from 45 or 48 to 150 or 160 fathoms.

No. V.

In lat. 44. 54. N. long. 53. 19. W. on board the Britiſh Packet Cheſterfield, Capt. Schuyler. July 10, 1790.

THE Captain caught a codfiſh, and in a few minutes after it was opened and gutted, I put the thermometer into its belly, the inſtrument marked 39 when in air it it was 57, and in water on the ſurface 52. Depth 46 fathoms.

In lat. 44. 52. *N. long.* 54. 57. *W.* *July* 11, 1790.

THE people caught ſeveral codfiſh and hallabot, the thermometer was put into three codfiſh and one hallabot ſucceſſively, the inſtant they were hauled up, and the inſtrument marked 37 in every caſe. The air was at 57, and the water at the ſurface was 53. The firſt experiment was repeated after the fiſh was gutted, and it then marked one degree warmer. I thence conclude that the difference between the two experiments was owing to the time the fiſh was in the air before the trial, and that in all the inſtances the animal heat of the fiſh was about 16° colder than the water at the ſurface; and as it ſeems natural, from analogy, to ſuppoſe that animal heat is at leaſt as warm as the fluid in which the animal lives, I conclude that the water at the bottom was as cold as 37 *i. e.* 16° colder than at the ſurface. In a former voyage it was found by deciſive experiment, that near the coaſt in very hot weather the water at the bottom in 18 fathoms was 12 degrees colder * than at the ſurface.

Another reaſon to ſuppoſe that the water was colder at bottom than the animal heat, was the great diſtenſion of the cods ſounds when they were opened, although they had ſent out innumerable bubbles of air in the paſſage up; the air, therefore, within the ſound, muſt have been much more compreſſed, (either by cold or the power of the animal) below, than above, where it was at 37. Several fiſh that had been hauled up to the ſurface of the water, and then droppedfrom the hook, ſwam light on the ſurface

* See Philoſophical Tranſactions, Vol. II. page 329.

till they recovered their vivacity, although they loſt much air in coming, up the ſpecific gravity was therefore much leſs than at bottom, and this was probably owing to the diſtenſion of the ſound. That fiſh riſe and ſink in the water, by this power of increaſing and diminiſhing their bulk, and conſequently their ſpecific gravity, is well known to naturaliſts, but I was pleaſed to ſee the truth of that fact confirmed by theſe experiments.

JONA. WILLIAMS, JUN.

Nº. XI.

An account of the moſt effectual means of preventing the deleterious conſequences of the bite of the CROTALUS HORRIDUS*, *or* RATTLE-SNAKE. *By* BENJAMIN SMITH BARTON, M. D.

Read Aug. 19, 1791.

DURING my paſſage through ſeveral of the weſtern ſettlements of Pennſylvania, and the adjoining States, in the year 1785, I made it an object of attention to acquire every poſſible information reſpecting the effects of the poiſon of the RATTLE-SNAKE, and the methods of prevention, or of cure, which are commonly employed in thoſe parts of our country. A very conſiderable number of vegetables were either mentioned, or ſhown, to me, all of which, I was aſſured, *were good for the bites of Snakes*. Without being much of the ſkeptick

* I think it proper to confine my remarks to this ſpecies of RATTLE-SNAKE, becauſe it is that with which I am beſt acquainted; becauſe it is the moſt common ſpecies in thoſe parts of our country which are beſt known to me, and becauſe I believe it is the moſt deleterious ſpecies that has yet been diſcovered within the limits of the United-States. I have little doubt, however, that the plan which I have recommended, and the remarks which I have made, will equally apply to the Crotalus *miliarius*, the Crotalus *Duriſſus* and the other ſpecies of this formidable family of ſerpents which are deſcribed by Linnæus, and by other writers.

tick in medical matters, I might have doubted either the veracity of my informers, or the accuracy with which their experiments and obſervations were made. It, certainly, did not require a very extenſive acquaintance with botanical or with medical ſcience to diſcover, that theſe reputed ſpecificks were frequently poſſeſſed of proporties the moſt oppoſite; and, conſequently, that the effects of the poiſon of our venemous ſerpents, which are ſo uniform in their appearance, were capable of being obviated or removed, by a number of vegetables, perhaps no leſs different in their influence on animal bodies than they are in family, and in ſpecies. I might have doubted, for a moment, whether the activity of theſe poiſons was ſo great, and the effects of their operation ſo dangerous and ſo fatal, as has been generally imagined. I was not ignorant that in the ſeaſons of ſupervening languor and torpidity the RATTLE-SNAKE, in particular, bites with ſeeming reluctance, and without any, or with but little, ill conſequence ariſing from the wound. I, likewiſe, well knew, that even in thoſe ſeaſons when the ſun powerfully exerts its influence, at which times theſe animals are beſt qualified to ſtrike and to injure, individuals of the ſpecies muſt often be found, the cavities of whoſe venemous fangs are entirely, or nearly, deſtitute of their active poiſon, from the introduction of which into the body, thoſe alarming ſymptoms, which characteriſe the ſucceſsful bite of this animal ariſe†. I could imagine that, in ſome inſtances, the poiſon

† Several years ſince, a gentlemen made the following experiments in Philadelphia. He had a large RATTLE-SNAKE brought to him alive, which he ſo managed by a ſtring that he could eaſily lead it into, or out of, a cloſe cage. On the firſt day, he ſuffered this Snake to bite a chicken, which had been allured to the mouth of the cage by crumbs of bread. In a few hours, the bird "mortified" and died. On the ſecond day, another chicken was bitten in the ſame manner, and ſurvived the injury much longer than the firſt. On the third day, the experiment was made upon a third chicken, which ſwelled much, but, nevertheleſs, recovered. On the fourth day, ſeveral chickens were ſuffered to be bitten, without receiving any injury. After this, it is ſaid, the Snake grew larger and fatter. *M. S. by my father, penes me.* The truth of theſe experiments ſeems to be confirmed by the original and very well-written account of the ſecond volume of the Count de la Cepede's *Hiſtoire naturelle des Serpens, &c.* publiſhed

poiſon might be thrown into ligamentous or tendinous matter, from which there would be little probability of an abſorption into the maſs of blood. Theſe laſt mentioned circumſtances enabled me to underſtand how, in ſome inſtances at leaſt, the internal uſe of the various vegetables which were employed, might have led my informers to ſuppoſe that thoſe vegetables had accompliſhed a cure.

Upon examining the ſubject more minutely, I found that although the principal dependance ſeemed to be placed on the internal uſe of vegetables, yet the employment of external means was evidently the moſt important part, both of the prevention and of the cure. In general, the firſt thing that was attended to, after a perſon had been bitten by the RATTLE-SNAKE, was to throw a tight ligature above the part into which the poiſon had been introduced: at leaſt, this was the practice whenever the ſituation of the wounded part admitted of ſuch an application The wound was next ſcarified, and a mixture of ſalt and gunpowder, ſometimes either of theſe articles ſeparately, was laid upon the part. Over the whole was applied a piece of the bark of the *White-Walnut**. At the ſame time, ſome one, frequently more than one, of the vegetables which were mentioned to me, were given internally, either in decoction, or infuſion, along with large quantities of milk.

Such is the rude and ſimple practice of our weſtern ſettlers for preventing, or for curing, the dangerous effects of the bite of the RATTLE-SNAKE. They likewiſe extend this practice to the bites of ſeveral other kinds of ſerpents, the hiſtory of which will form the ſubject of a memoir,

liſhed in the *Appendix to the ſecond volume of the monthly review enlarged*: ſee page 511. The ſimple experiments which I have juſt related deſerve to be attended to. They enable us to aſſign a reaſon why perſons who have actually been bitten by the RATTLE-SNAKE have ſometimes experienced very inconſiderable, or no bad, conſequences from the wound: they enable us to diſcover in what manner many vegetables have acquired a reputation for curing the bites of ſerpents, without our recurring to the very diſagreeable neceſſity of arraigning the veracity of thoſe from whom our information is derived: and, laſtly, they teach us a phyſiological fact, that the poiſon of the RATTLE-SNAKE is ſecreted very ſlowly.

* The Juglans *alba* of Linnæus.

moir, which I hope to lay before the Society, ſome time in the courſe of the enſuing year. At preſent, I ſhall only remark that there is reaſon to believe, the practice which I have deſcribed has often been employed for the bites of ſerpents which do not belong to our *venemous* tribes. This I know to be the caſe with reſpect to our *Wampum-Snake*, the *Coluber faſciatus* of Linnæus: for, a careful examination of this ſerpent and a curious inquiry into its hiſtory, have convinced me that its bite, like that of many other ſpecies of the extenſive genus of *Coluber*, is really harmleſs. It would be uncandid not to obſerve that Mr. Cateſby, who has given a deſcription and a good figure of the *Wampum-Snake*, in his *Natural Hiſtory of Carolina*, &c.* was of the ſame opinion long before me. I may alſo remark that Linnæus, in his *Syſtema Naturæ*†, has not annexed to the *Coluber faſciatus* that mark by which he deſignates the ſerpents which he ſuppoſed to be venemous. But the Swediſh naturaliſt does not ſeem to have been certain that his *Coluber* is that deſcribed and figured by Cateſby, under the name of the *Wampum-Snake*. From comparing, however, the animal itſelf with the deſcriptions of Cateſby and Linnæus, I am confident that the *Wampum-Snake* of Pennſylvania, Carolina, &c. is no other than the *Coluber faſciatus* of the *Syſtem of Nature*.

But to return from what is rather a digreſſion. In the ſimple practice which I have deſcribed, I am diſpoſed to repoſe great confidence. Nor can I have any doubt that the beneficial effects which have been experienced under the employment of the multifarious means I have mentioned, are to be attributed principally to the uſe of the ligature, to the ſcarification of the wounded part, the application of the ſalt, the gunpowder and the bliſter. I ſhall not deny that ſome of the vegetables which were exhibit-

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* See Volume 2d, p. 58 and t. 58.
† See Volume 1ſt, p. 378. Vienna edition of 1767.

ed internally may be of uſe. Such, perhaps, are the various decoctions which are made of the more ſtimulating vegetables, the infuſions and expreſſed juices of vegetables, accompanied with the uſe of large draughts of warm water, the ſteam-bath, &c. Theſe, by exciting a moſt profuſe perſpiration, may contribute to the diſcharge of the poiſon from the maſs of blood. Some of them act powerfully as diuretics, and in this way may alſo be of ſervice. The Indians in the State of Jerſey, I have been informed, formerly made uſe of the expreſſed juice of the leaves of the common *Garden-Rue* * as a remedy for the bite of the RATTLE-SNAKE. It is well known that this vegetable poſſeſſes very active powers, and in the large doſes in which the Indians preſcribed it, it excited a moſt violent ſweat. They gave to an adult, about two table-ſpoons full of the juice every two hours, until this effect was produced. I think, there can be little doubt, that it has been of conſiderable ſervice.

It deſerves, however, to be mentioned, in this place, that during the uſe of the *Rue*, and even before this vegetable was adminiſtered, external means were employed, the principal of which was the application of the ligature.

We ſee, therefore, that without a knowledge of the name, much leſs of the ſtructure and office, of the abſorbent-ſyſtem, the rude ſavages of our continent, from whom it is probable the white inhabitants derived their experience on the ſubject, had learned the propriety of applying a ligature, in order to prevent the farther introduction of the poiſon into the body. From the nature of the ſavage life, man in this ſtate of his political exiſtence is more liable to be injured by the bites of ſerpents than in the more poliſhed ſtages of his improvement. It is fortunate, therefore, that even among ſome of the rudeſt nations of men, the mode of treating the bites of theſe animals is ſo rational.

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* Ruta *graveolens*, Lin.

If, along with the ligature and the application of different ſtimulants to the wounded part, they make uſe of various internal means, many of which are probably impotent, and ſome of them, perhaps, pernicious, let us remember that even among the moſt poliſhed nations, where medicine is cultivated as a ſcience, phyſicians are accuſtomed to adminiſter many articles whoſe effect on the ſyſtem are known to be inconſiderable or uſeleſs.

The ſalt and gunpowder applied to the ſcarified part act powerfully by exciting a diſcharge of blood, and particularly of the ſerous part, from the wound; whilſt the bark of the *White-Walnut*, already mentioned, which poſſeſſes the evacuant power of cantharides, in no inconſiderable degree, contributes to the farther diſcharge of this ſerum, and along with it the poiſon thrown in by the animal.

I do not know that any vegetable ſubſtance beſides the bark of the *White-Walnut* is ever employed in theſe caſes as a bliſter. I know, indeed, that both the Indians and the white inhabitants of this country are acquainted with the bliſtering property of other indigenous vegetables: ſuch are the *Common-Wintergreen* (*Pyrola rotundifolia*, Lin.), ſome ſpecies of the genus *Ranunculus*, or *Crow-foot*, &c. In ſome parts of Pennſylvania, the roots of the firſt of theſe plants are pounded, and then applied to parts where it is required to raiſe a bliſter. The roots of this *Pyrola* are, however, principally uſed in rheumatick affections, and I have never heard of their being employed in caſes of the bites of venemous ſerpents. I have heard of one inſtance in which a bliſter of cantharides was applied to the wound occaſioned by a RATTLE-SNAKE, and was attended with the beſt effect*.

If the method of treating the bite of the RATTLE-SNAKE which I have deſcribed, is ever of ſervice, it

* Since I wrote the above, I have read, with no ſmall degree of pleaſure, that the bark of the *Daphne Mezereum* of Linnæus (the *Common-Mezereon*, or *Spurge-Olive*) has been applied to the wound

is obvious that no time ſhould be loſt in the employment of the means that have been mentioned, or of ſome means of a ſimilar nature. In thoſe caſes where the poiſon is applied near to the orifice of an abſorbing-veſſel we have reaſon to ſuppoſe that it will be conveyed into the maſs of blood with great celerity. The mildeſt fluids paſs along the lymphatick-veſſels with rapidity, but when theſe veſſels are expoſed to the influence of cold, or when they are ſtimulated by poiſons of any kind, their propelling action is greatly encreaſed. Even, however, after we are convinced that a portion of the poiſon has been abſorbed, we ought not, I think, to omit the uſe of the ligature, and of ſome of the other means which have been mentioned.

As poiſons of various kinds in their paſſage through the lymphatick-veſſels are liable to be detained, for ſome time, in the glandular appendages of this ſyſtem, it would, perhaps, be of uſe to ſcarify theſe parts, and to apply a bliſter to them, in order to promote the diſcharge of the poiſon. Let us ſuppoſe, for inſtance, that the poiſon of the RATTLE-SNAKE is thrown into the ſole, or end, of the foot cloſe to the mouths of a number of lymphatick-veſſels. In moſt caſes, the ſtimulant effects of this ſingular fluid are obſerved to take place in a few minutes. The lymphaticks partake of the inflammation which is excited: the poiſon is quickly propelled along them, but its paſſage into the blood-veſſels is ſomewhat retarded by the conglobate-

wound occaſioned by the bite of a poiſonous ſerpent, and that the application was attended with the happieſt effects. See the *Flora Suecica* of Linnæus, p. 128. It has alſo been lately recommended, and its beneficial effects have been experienced, in the ſame caſe, and in the bite of the mad-dog. See what Acrel has ſaid on the ſubject in the *Vet. Acad. Handl.* for the year 1778, p. 104. All the ſpecies of the genus *Daphne*, with which the botaniſts are acquainted, are indued with the ſame property. The bark when chewed ſtrongly ſtimulates the mouth and fauces, exciting a conſiderable degree of heat: when applied externally to the ſkin, it produces a bliſter and a conſiderable diſcharge of ſerous matter. Its good effects in the inſtances juſt mentioned, are, therefore, I preſume, to be referred to this ſtimulating property. The bark of the *White-Walnut*, as I have already obſerved, acts in the ſame way, though not ſo readily, or ſo powerfully. The *Mezereon* or the cantharides, perhaps more eſpecially the *Daphne Gnidium*, would, I imagine, be very properly ſubſtituted for it.

glands, which form an eſſential part of the abſorbent-ſyſtem in man. In a ſhort time, however, if the ligature has not been very early and very carefully applied, the glands of the groin are obſerved to ſwell, and inflame. In this ſtate of the complaint, I would adviſe an extenſive ſcarification of theſe glands, and the application of ſome powerful bliſter, the effects of which, at the ſame time, are very ſuddenly exerted. I know of no article of the materia medica ſo likely to anſwer both theſe intentions as the *Ecorce de Garou* of the French, the bark of the *Daphne Gnidium*, which I have already mentioned.

It often happens that the poiſon of the RATTLE-SNAKE, like that of the mad-dog, being merely thrown into muſcular, tendinous, ligamentous or cellular parts, is depoſited there ſome time without being abſorbed into the maſs of blood. In theſe caſes the ſucceſs of the plan which I have deſcribed will, probably, be very great. Whatever preference may be given to the uſe of the knife, or of the cauſtick over that of ſcarification, the application of the bliſter, &c. I think, there can be very little doubt of the propriety of employing the ligature. I am convinced, indeed, that on the uſe of this ſimple application, the ſucceſs of our cure, or to ſpeak more properly of our prevention will, in a great meaſure, depend.

Hitherto, I have proceeded on the ſuppoſition, that the poiſon of the RATTLE-SNAKE is conveyed into the blood-veſſels through the medium of the abſorbent-lymphaticks. But, unfortunately, caſes ſometimes occur in which this active matter is thrown immediately into a vein or artery. When this happens, the effects of the poiſon will be the more readily propagated to the remoteſt parts of the ſyſtem; and the powers of medicine will then be found to be leſs conſiderable. I have received an account of the caſe of a perſon who, whilſt he was repoſing himſelf under a tree in a wood, was bit in the neck by a RAT-

TLE-SNAKE: remedies were immediately applied; but to no purpofe, for the unhappy fufferer expired in a few minutes. This very fudden operation of the poifon will not excite much wonder, when we confider the proximity of the wound in this cafe to the fource of circulation. For although experiments are wanted to demonftrate the *precife* action of the poifon of the RATTLE-SNAKE on the human and other animal fyftems, we are already in poffeffion of facts which warrant us to conclude, that it exerts its principal effects on the fanguiferous fyftem, and, as I believe, immediately on the blood itfelf. In what manner it affects this important fluid I am unable to decide with certainty. That it induces a preternatural tenuity of it cannot, I think, be doubted.

But whatever may be the particular operation of the poifon of which I am fpeaking, we are certain that the introduction of the fmalleft portion of it into a blood-veffel is generally attended with the moft ferious confequences. Mr. Catefby fays that, "where a Rattle-Snake "with full force penetrates with his deadly fangs, and "pricks a vein or artery, inevitable death enfues; and "that, as I have often feen, in lefs than two minutes. "The *Indians*," he continues, "know theirdeftiny the "minute they are bit; and, when they perceive it mortal, "apply no remedy, concluding all efforts in vain*." Mr. Catefby is frequently very accurate in relating facts, and in making obfervations. What he has here faid refpecting the fatal confequences of the *immediate* introduction of the poifon into the blood-veffels perfectly correfponds with the information which I have received from a variety of fources. I am unwilling, however, to believe that, in every cafe, fuch an introduction is neceffarily mortal. I cannot but fuppofe that of the many cafes of the bites of the

* The Natural Hiftory of Carolina, &c. vol. 2, p. 41.

the RATTLE-SNAKE which ſo frequently occur in the leſs inhabited parts of our country, the number of thoſe in which the poiſon has been immediately applied to a blood-veſſel cannot be inconſiderable. And yet, at preſent, how ſeldom does the bite of this animal prove mortal! Whatever may be the event of this opinion, I think we ought not to neglect the application of the ligature, &c. even after we are confident the poiſon has been thrown into a blood-veſſel. Perhaps, in this caſe, the *Rue*, or ſome other powerful ſudorifick, may be of ſervice. How far the uſe of milk, &c. will tend to the recovery of our patient, I cannot decide with confidence. I confeſs, however, I ſhould be unwilling to place much hopes in the adminiſtration of this fluid, although the practice is very generally adopted in moſt of our new ſettlements.

I have now deſcribed the modes of peventing the dangerous conſequences of the bite of the RATTLE-SNAKE, as they are practiſed in various parts of our country. At the ſame time, I have ventured to throw out ſome conjectures of my own, which I thought would not be improper, nor altogether unacceptable. As my object in preſenting this paper to the Philoſophical Society is more utility than curioſity, I have avoided mentioning ſeveral other means which are daily employed for the ſame purpoſe, both in the countries to the Eaſt and in thoſe to the Weſt of our mountains. I cannot, however, help obſerving that ſucking of the wounded part, is very generally practiſed by the Creeks, and ſome other native tribes in the ſouthern parts of our States, &c. as I have been informed by my ingenious and worthy friend Mr. William Bartram, who received his information from the traders among theſe people. It appears from Mr. Cateſby's elegant work, which I have already quoted, that ſome of theſe tribes have learned the importance of cutting out the wound-

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ed part, when, from the ſituation of the bite, this can be done*.

When the poiſon of the RATTLE-SNAKE has actually been introduced into the general maſs of blood, it begins to exert its moſt alarming and characteriſtick effects. A conſiderable degree of nauſea is a very early ſymptom †. We now diſcover an evident alteration in the pulſe: it becomes full, ſtrong, and greatly agitated. The whole body begins to ſwell: the eyes become ſo entirely ſuffuſed, that it is difficult to diſcover the ſmalleſt portion of the adnata that is not painted with blood. In many inſtances, there is an hemorrhagy of blood from the eyes, and likewiſe from the noſe and ears: and ſo great is the change induced in the maſs of blood, that large quantities of it are ſometimes thrown out on the ſurface of the body, in the form of ſweat. The teeth vacillate in their ſockets, whilſt the pains and groans of the unhappy ſufferer too plainly inform us that the extinction of life is near at hand.

In this ſtage of its action, and even before it has induced the moſt alarming of the ſymptoms which I have mentioned, the powers of medicines can do little to check the rapid and violent progreſs of this poiſon. The employment of the ligature, the uſe of the bliſter, and of the other modes of treatment which I recommended in the local ſtage, it is obvious to remark, will be of very little, if any, benefit here. When there is no hemorrhagy, however,

* See vol. 2, p. 41. Mr. Cateſby alſo makes mention of the practice of ſucking the wound, which, he ſays, "in a ſlight bite, has ſometimes a good effect; tho' the recovered perſon "never fails of having annual pains at the time they were bit.". Vol. 2. p. 41. The Abbé Clavigero ſays, the moſt effectual remedy for the bite of the RATTLE-SNAKE, "is thought to be "the holding of the wounded part ſometime in the earth." *The Hiſtory of Mexico*, &c. vol. 1ſt, p. 59, Engliſh Tranſlation.

† It is remarkable that a nauſea, and ſometimes a vomiting, is induced in many caſes in a few minutes after the poiſon has been thrown into a muſcular part, and long before it can poſſibly have entered the blood-veſſels, through the medium of the abſorbent-lymphaticks; or, admitting that it has been introduced directly into a blood-veſſel, before this active poiſon can have effected in the general maſs any change whatever. Does not this very ſudden appearance of the nauſea and vomiting ſeem to render it probable that the poiſon of the RATTLE-SNAKE exerts conſiderable effects on the nervous matter of animals?

ever, and when the ſymptoms of a violent action of the heart and arteries take place, mercy may, perhaps, dictate to us the uſe of the lancet, with the view to moderate this action. I ſay nothing of the employment of the other parts of what is called by phyſicians the antiphlogiſtick treatment, as the condition of the unhappy ſufferer will, in moſt caſes, preclude the poſſibility of it.

I ſhould have been glad to have annexed to this imperfect paper, a more accurate account of the effects of the poiſon of the RATTLE-SNAKE, on the ſyſtem of man and other animals, and, likewiſe, an analyſis of this ſingular fluid. The ſubject is, certainly, a curious one, and one the minute inveſtigation of which would, probably, throw ſome lights on the phyſiology of animals, whilſt it would, no doubt, ultimately tend to the eſtabliſhment of a more certain mode of treating the bite of one of the moſt formidable ſerpents that has hitherto been diſcovered in North-America. But ſuch an inveſtigation would require much time and patience, and, perhaps, I may add, a portion of fortitude. Fully impreſſed with a ſenſe of the richneſs of the field, I mean to undertake the inquiry. Meanwhile, I ſhall juſt obſerve that the poiſon of the RATTLE-SNAKE is generally of a yellowiſh, ſomewhat greeniſh, colour, and that it changes to a darker hue with the heat of our ſeaſons. During the period of the animal's amours, the poiſon is obſerved to be of a much darker green than at any other time, and it is certain that it is now alſo of a much more active and deleterious nature. Whether this increaſe of activity depends on the procreative paſſion of the animal, or whether it is not merely a conſequence of the heat of the ſeaſon, I ſhall not decide, at preſent.

From the facts and obſervations which I have ſubmitted to the Society, it appears that, in many caſes, the prevention of the deleterious effects of the poiſon of the RATTLE-SNAKE, may be accompliſhed by means which

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are ſimple, and within the reach of almoſt every perſon. To this ſubject I anxiouſly wiſh to turn the attention of phyſicians and of phyſiologiſts; becauſe the analogies which ſubſiſt between the effects of this poiſon and thoſe of ſome other animals, both of the ſame and of different families, are numerous and ſtriking. It is highly probable, therefore, that our reſearches into this ſubject, would conduct us to the knowledge of means whereby we might ſometimes, perhaps not unfrequently, be enabled to prevent the conſequences of the bite of the mad-dog, &c. Our ſucceſs in one caſe ought, at leaſt, to ſtimulate us to make the experiment in another. Let us not, any longer, look for *abſolute ſpecificks*. Let us be content that, in the fulneſs of her benevolence, nature, ever attentive to our welfare, has enriched her ſeries of animals, of vegetables, and of minerals, with beings, with objects, and with means, which man, in every ſtage of his improvement, is inſtructed to employ for preventing, for alleviating, or for curing at leaſt ſome of thoſe infirmities the whole of which conſtitute, as it were, a part of his eſſence, or nature. The rage for ſpecificks is, indeed, nearly at an end. I exceedingly regret, however, that it is ſtill, in ſome meaſure, ſupported by the botaniſts, who cultivate an uſeful and an amiable branch of natural knowledge. Thus, the *Flora* of almoſt every country, and even of a narrow diſtrict, or of the ſuburbs of a city, is too frequently crowded with the moſt unqualified recommendations of certain vegetables in different diſeaſes. But the partiality of the botaniſts for remedies for the bites of poiſonous ſerpents appears to be peculiarly ſtriking. Perhaps, this partiality may be placed among thoſe errors which diſgrace even the *primordia* of medicine. It is certain, that we very eaſily trace it to a ſtate of ſociety of which credulity, ſuperſtition, and ignorance are the moſt prominent and diſtinctive features.

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Of the many travellers who have visited the countries of North-America, there are very few, indeed, who have not recorded in their journals at least one or two specificks against the bites of serpents. M. le Page du Pratz, who, in some respects, is a judicious writer, seriously informs us that the RATTLE-SNAKE "shuns the habitations of "men, and by a singular providence, wherever it retires "to, there the herb which cures its bite, is likewise to be "found*." Had this gentleman observed that wherever the animal, of which we are speaking, retires, we find vegetables which the full credulity of the Americans has led them to imagine are antidotes to its bite, he would not have exposed himself to the imputation of credulity with those who are more intimately acquainted with the works of nature, or with the powers of medicines. But the truth is, that there is no branch of natural history in the investigation of which even men of science have more prominently discovered their ignorance and weakness than in that of the serpents. Here, even a Linnæus, forgetting the cautious dignity which became the character of him who was destined to reform the science of nature, seriously relates those tales which ought to have been confined to the *wigwaum* of the savage, or to the cabin of the most uninformed hunter.

To this account of what I deem to be the *most effectual means of preventing the deleterious consequences of the bite of the* CROTALUS HORRIDUS, *or* RATTLE-SNAKE, I shall subjoin a catalogue of a number of vegetables which have been recommended for the same purpose, either by the Indians, or by the white inhabitants of our continent. In enumerating these vegetables, I have thought it proper to give both the Linnæan, or classical, and the English, or vulgar, names. Some of these reputed specificks are used *internally*, others are employed *externally*, whilst others, again,

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* The History of Louisiana, &c. p. 269. English Translation.

are uſed both *internally* and *externally*. To ſuch as are uſed *internally* I have prefixed this mark †: to ſuch as are applied *externally*, I have prefixed the mark*: thoſe which are employed both *internally* and *externally* are deſignated by both theſe marks, whilſt to thoſe of which I have not learned, with certainty, the particular exhibition, I have prefixed no mark whatever.

Sanguinaria *canadenſis* (**Puccoon*, *Blood-root*, *Turmerick*), Hypoxis *erecta* (†*Erect-Hypoxis*, *Star of Bethlehem*), Laurus *Saſſafras* (* Saſſafras), Polygala *Senega* (†* *Seneca Snake-root*), Prenanthes *alba* (†*White Ivy-leaf*, *Dr. Witt's Snake-root*), Hieracium *venoſum* († *Veiny-Hawk-weed*), Cunila *mariana* († *Dittany*, *Wild-Baſil*), Collinſonia *canadenſis* († *Horſe-weed*, *Knot-root*), Hydrophyllum *canadenſe* († Scaly-root), Ribes *nigrum* († Black-Currant), Eryngium *foetidum* († *Fetid-Eryngo*), Arctium *Lappa* (* Burdock), Uvularia *perfoliata* (* *Perfoliate-Uvularia*), Aletris *farinoſa* (*Star-graſs*, *Star-root*), Aſarum—*virginicum*? (*Heart Snake-roots*), Marrubium *vulgare* († *White-Horehound*), Scorzonera *hiſpanica* (*Garden Vipers-graſs*), Solidago (* † *Golden-rod.* Different ſpecies are uſed.), Ariſtolochia *Serpentaria* († *Virginian Snake-root*), Iuglans *oblonga* (* *White-Walnut*, *Butter-nut*), Cynogloſſum *virginicum* († *Virginian Hounds-tongue*), Convolvulus——*arvenſis*? (* *Leaſt-Bindweed*) Actæa *racemoſa* (†*American Bane-berry*, *Black Snake-root*, *Rattle-weed*), Sanicula *canadenſis* († *Canadian Sanicle*), Veratrum *luteum* (*Rattle-Snake-root*), Erigeron—*philadelphicum?* († * *Robin's Plantain*) Liriodendron *Tulipifera* († *Tulip-tree*, *Poplar* §), Crocus *ſativus* († *Common-*

§ Among the Cheerake, and probably among other American tribes, the inner bark of this tree, after being bruiſed, is infuſed in water, and the infuſion given to horſes which have been bitten by the RATTLE-SNAKE. It is not improbable that this medicine may ſometimes be of ſervice in theſe caſes, as it is certain that the bark of the *American Liriodendron* poſſeſſes very active powers, as a ſtimulant and ſudorifick. I have never heard that this bark has been employed for the bite of the RATTLE-SNAKE in man.

(† *Common-Saffron*), Fraxinus——(† *White-Ash*) Chrysanthemum? (*St. Anthony's cross*) Convallaria († *Solomon's seal.* Different species are used.), Ulmus—*Americana?* (*†? *American Elm*) Osmunda *virginiana* (*Virginian Osmunda, Fern-Rattle-Snake-root*), Jussiæa?—(*† *Wood-Plantain, Rattle-Snake-Plantain*) Hieracium *Kalmii* (*† *Rattle-Snake-Plantain, Poor-Robin's Plantain*).

N°. XII.

MAGNETIC OBSERVATIONS,

Made at the University of Cambridge (Massachusetts) in the year 1785,

BY DR. S. WILLIAMS.

Months.	Days.	Greatest Variation.	Days.	Least Variation.	Difference.	Mean Variation at 7 A. M.	Mean Variation at 1½ P. M.	Mean Variation at 9 P. M.
January	15 1½ P. M.	6° 50′	2, 31 } 9 P. M.	6° 28′	3½′	6° 36′	6° 42′	6° 34′
February	25 1½ P. M.	6 39	23 9 P. M.	5 49	50	6 34	6 39	6 32
March	1 1½ P. M.	6 52	1 9 P. M.	6 28	24	6 36	6 39	6 36
April	19 ½ P. M.	7 12	25 9 P. M.	6 20	52	6 34	6 53	6 34
May	3, 6 } 1½ P. M.	7 5	2 7 A. M.	6 28	45	6 38	6 55	6 38
June	7, 18 } 1½ P. M.	7 8	20 9 P. M.	6 29	39	6 44	6 57	6 40
July	11, 28 } 1½ P. M.	7 11	18 7 A. M.	6 33	38	6 46	7 1	6 49
August	6, 21 } 1½ P. M.	7 13	31 7 A. M.	6 25	48	6 42	7 2	6 48
Septem.	11, 30 } 1½ P. M.	6 55	8 7 A. M.	6 13	42	6 32	6 46	6 34
October	18 1 P. M.	7 11	5 7 A. M.	6 27	44	6 48	6 55	6 43
Novem.	2, 5 } 1 P. M.	6 59	29 9 P. M.	6 17	42	6 44	6 50	6 38
Decem.	1, 4 } 1 P. M.	6 58	19 7 A. M.	6 28	30	6 43	6 50	6 39
In the Year.	August 6 and 21.	7 13	February 23.	5 49	1 24	6 40	6 51	6 39

The above Observations were made with an excellent Variation Instrument, with a twelve Inch Needle.

N°. XIII.

Accurate determination of the right aſcenſion and declination of β *Bootes, and the Pole Star: in a Letter from* MR. ANDREW ELLICOTT *to* MR. R. PATTERSON.

Dear Sir, October 17th, 1788.

Read Nov. 7th, 1788. I HEREWITH ſend you the right aſcenſions and declinations of β Bootes, and the Pole Star. The Declination of β Bootes was determined by comparing its zenith diſtance, with the zenith diſtances of α Lyræ, Capella, α Cygni, γ Andromedæ, β Meduſæ, and δ Cygni, whoſe declinations have been accurately determined by the European aſtronomers. The zenith diſtances, were taken by the ſector which was uſed on the Northern boundary of this ſtate, and was made by our own countryman Mr. Rittenhouſe, and graduated by a method of his own; to ſay more in its favour, would be ſuperfluous. The right aſcenſion was determined by comparing its paſſage over the meridian, with the moſt convenient of thoſe contained in the 10th table, annexed to the firſt Volume, of the Rev. Doct. Maſkelyne's aſtronomical obſervations. This ſtar will be found very uſeful, in determining latitudes within the Northern, and Southern limits of the United States.

The right aſcenſion and declination of the Pole ſtar, I have deduced from the obſervations of the Rev. Doctor Maſkelyne. This ſtar is of ſuch conſequence in tracing a meridian, that it is a wonder ſo little attention has been paid to it by the European aſtronomers: it is however liable to one inconvenience, on account of the change in its annual variation in right aſcenſion; but this may be nearly corrected for many years, by uſing an arithmetical progreſſion, an example of which will be found at the end of the tables of aberration and nutation. In

In applying the corrections contained in the tables of aberration and nutation, it is only neccessary to observe this *rule*. When the Sun's place or place of the Moon's ascending node is on the left side of the first column,—use the sign on the left side of the column required, and *vice versa*.

The Right Ascension and Declination of β Bootes to the beginning of 1789.

Sun's place and place of the Moon's ascending node.		S	°	′	″		″
	Right Ascension,	7	13	30	3,5	Ann. Var.	+ 34. 1
	Declination,		41	13	47,94		− 14. 53

S. D. S.	Aberration in R. Ascension.	Aberration in Declination.	Nutation in R. Ascension.	Nutation in Declination.
O. VI.	″	″	″	″
0	+ 17. 70 −	− 14. 30 +	+ 6. 07 −	− 6. 57 +
10	20. 61	12. 34	3. 98	5. 57
20	22. 90	10. 17	1. 59	4. 41
I. 0 VII.	24. 48	7. 61	− 0. 79 +	3. 10
10	25. 32	4. 81	3. 09	1. 71
20	25. 40	1. 87	5. 30	0. 26
II. 0 VIII.	24. 70	+ 1. 13 −	7. 43	+ 1. 19 −
10	23. 25	4. 10	9. 39	2. 62
20	21. 09	6. 94	10. 21	3. 96
III. 0 IX.	18. 30	9. 57	12. 10	5. 18
10	14. 95	11. 90	12. 92	6. 24
20	11. 14	13. 88	13. 43	7. 11
IV. 0 X.	6. 99	15. 44	13. 51	7. 77
10	2. 61	16. 53	13. 11	8. 19
20	− 1. 79 +	17. 11	12. 38	8. 36
V. 0 XI.	6. 18	17. 11	11. 30	8. 28
10	10. 37	16. 72	9. 83	7. 95
20	14. 30	15. 75	8. 03	7. 37
VI. O.	17. 70	14. 30	6. 07	6. 57

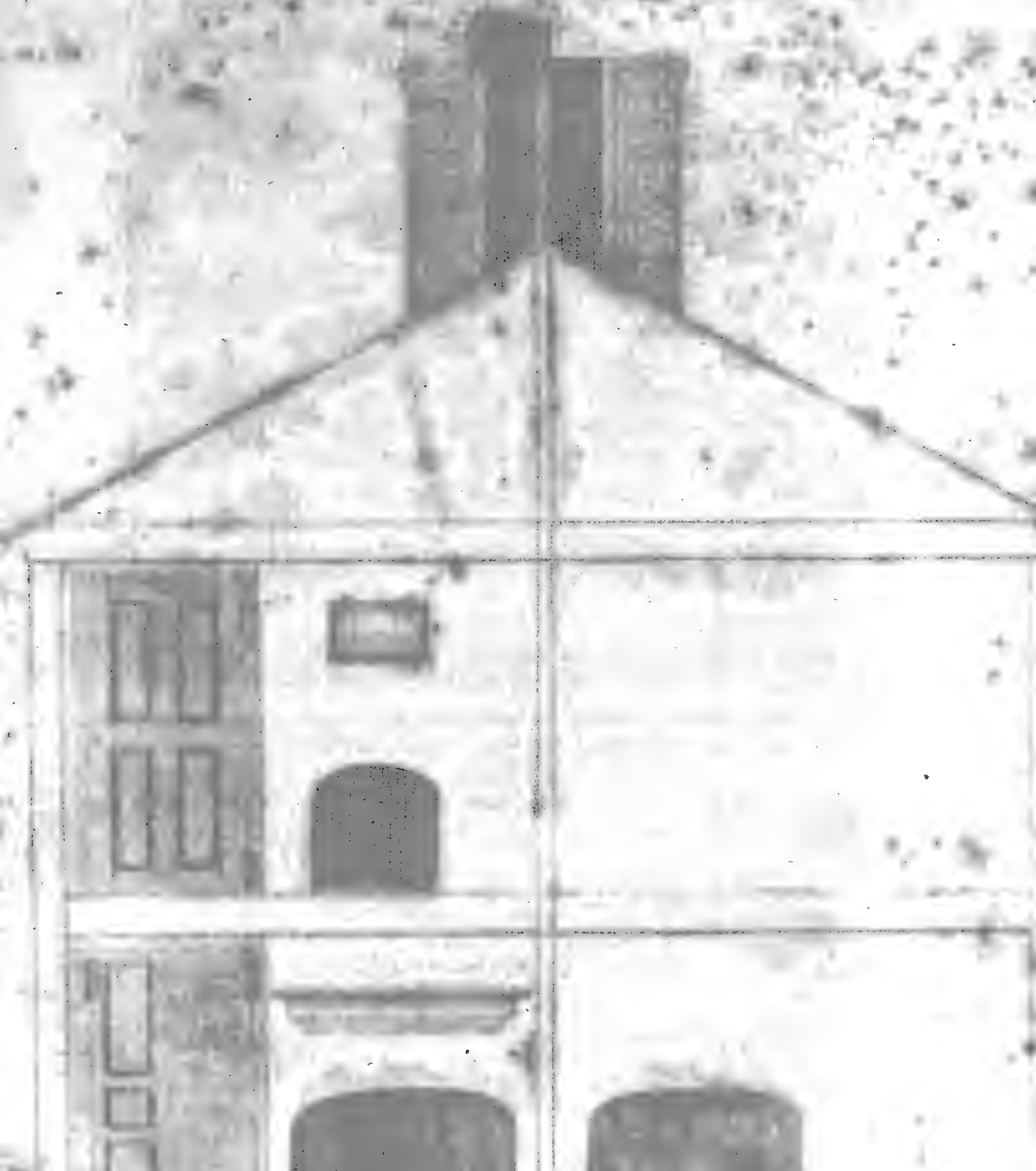
The

Sun's place and place of the Moon's ascending Node.	The Right Ascension and Declination of the Pole Star to the beginning of the year 1789.		
		S ° ′ ″	″
	Right Ascension,	0 12 32 7,06	Ann. Var, + 183,03*
	Declination,	88 10 40,8	+ 19,4

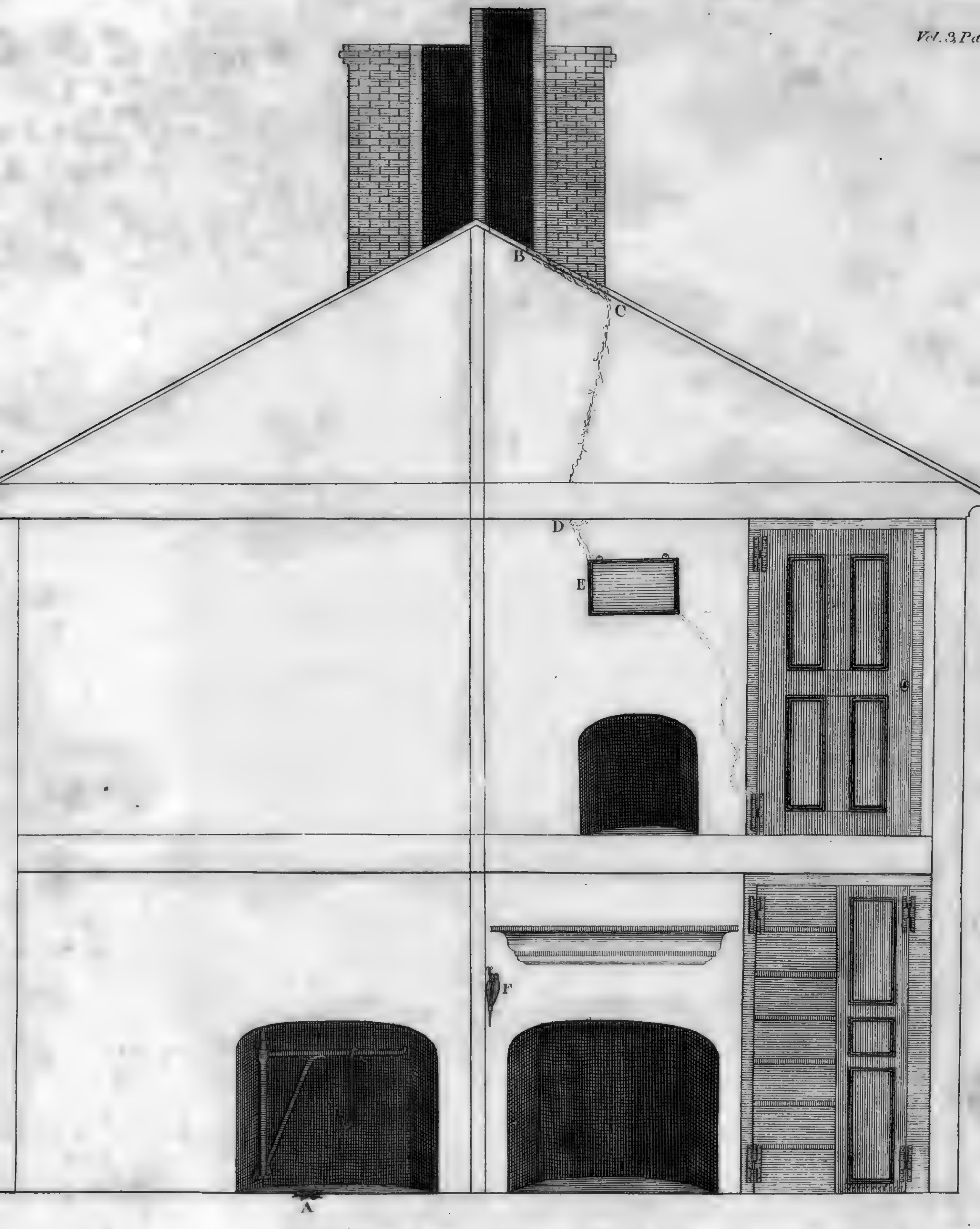
S. D. S.	Aberration in R. Ascension.	Aberration in Declination.	Nutation in R. Ascension.	Nutation in Declination.
O. VI.	′ ″	″	′ ″	″
0	−9. 19+	+3. 72−	−4 49+	+ 2. 11−
10	9. 34	0. 27	5. 00	0. 86
20	9. 32	−3. 18+	4. 54	−0. 41+
I. 0 VII.	9. 12	6. 54	4. 43	1. 67
10	8. 35	9. 69	4. 23	2. 86
20	7. 43	12. 56	3. 55	3. 98
II. 0 VIII.	6. 35	15. 04	3. 20	4. 98
10	5. 18	17. 07	2. 39	5. 82
20	3. 50	18. 57	1. 55	6. 49
III. 0 IX.	2. 15	19. 51	1. 4	6. 96
10	0. 36	19. 86	0. 13	7. 22
20	+1. 40−	19. 61	+0. 39−	7. 26
IV. 0 X.	2. 42	18. 75	1. 29	7. 08
10	4. 16	17. 30	2. 17	6. 69
20	5. 41	15. 39	3. 1	6. 09
V. 0 XI.	6. 57	12. 97	3. 39	5. 31
10	7. 59	10. 16	4. 9	4. 36
20	8. 47	7. 05	4. 34	3. 28
VI. O.	9. 19	3. 72	4. 49	2. 11

* The right Ascension of this Star (independent of the Ann. Var.) must be increased by an arithmetical progression, the first term and common difference of which is 1″.01, and the number of terms will be the years elapsed since 1789:—as for example, let it be required to find the Right Ascension of the Pole Star, on the 1st of January 1800. Then 1.″01 X 11 = 11.″11 the last term, and 11.″11. + 1.″ 01 = 12.″12 = the sum of the extremes;—then $\frac{12''12.}{2}$ X 11 = 66.″66 which is the sum of the progression,—then the Annual Variation 183″.03 X 11 = 2013″,83 = 33′ 33,″ this added to 0s. 12° 32′ 7″. 06. will give 0s. 13° 5′ 40.″ 39, and this sum increased by the sum of the progression 1′ 6.″ 66 will give 0s. 13 6′ 47.″ 05, for the mean Right Ascension of the Star: but if the Right Ascension of the Pole Star is required before the beginning of the year 1689, then the Ann. Var. and sum of the progression will be deductive.

Account



Vol. 3 Pl



N°. XIV.

Account of several Houses *in Philadelphia, struck with* Lightning, *on June 7, 1789. By* Mr. David Rittenhouse, *and* Dr. John Jones.

Read July 17, 1789.

ON Sunday the 7th of June, 1789, whilst a thunder-gust from the South-west was passing over this city, a flash of lightning struck two adjoining buildings, the kitchens of houses on the South side of Drinker's Alley.

The annexed drawing represents an inside view of part of the South end of these buildings. The funnels of the two kitchen chimneys, and those of the two chambers over them are carried up separately by the side of each other. They had been originally of the same height, but that on the right hand next the middle has been raised since about two feet higher. There was a fire burning at the time in the two kitchen chimneys, whose funnels are carried up in the midst of the stack. The lightning at the same instant passed through these two funnels, and by rarifying the enclosed air, forced out the wall on the North side of each down to the roof. It continued down that to the left, until it came to the iron hook suspended on the crane, where a woman, who was standing by the fireside, says she saw it like a large ball of fire. From thence it passed either along the hook or the crane, or probably both, and entered the hearth at A. close to the back wall, throwing up the bricks and earth, and making a cavity as large as a man's head. That part of the lightning which came down the right hand funnel, came out of it at B. making a slight erasure of the roof, close along the chimney, until it came to C. where it proceeded through the roof, and along the surface of the wall to D.

Here

Here it entered the chamber, tearing off ſome of the cieling and plaiſtering of the wall. At E. hung a glazed picture with a gilded frame, which was ſhivered to pieces. It appears to have paſſed both ways along the gilding of the frame to the oppoſite corner, from thence it paſſed along the ſurface of the wall in a crooked line, which it has marked pretty ſtrongly, about half an inch wide, to the upper end of the lower hinge of the cloſet door. From the bottom of this hinge it ſeems to have paſſed, by the rivets through to the inſide of the cloſet, and probably by a nail through the floor, burſting off the cieling and lathing of the cloſet of the kitchen below. This cloſet door was broken to pieces, and thrown to a diſtance by the exploſion, the left hand ſtile only remaining. From this cloſet it ſeems to have diſperſed in every direction. No traces of it are to be ſeen on the walls of the cloſet, but a number of pewter plates and diſhes which were ſtanding on the ſhelves were a little melted where they touched each other only. Part of the lightning appears to have paſſed along the ſhelf over the fire place, on which ſtood a coffee-pot and other kitchen furniture, which it only diſplaced without injuring them. At F. a large hand bellows was ſuſpended by a ſtring on a nail, the back board of which was ſplit through, apparently with great violence.

Both the kitchens were filled with ſmoke, ſoot, and aſhes by the exploſion, but no perſon hurt. The woman who ſaw the ball of fire at the upper end of the pot hook, is confident that it proceeded upwards. This opinion was probably founded on the exploſion of the bricks and earth upwards at A. We know not any appearance which could determine whether its progreſs was upwards or downwards.

A young woman who was ſitting on the right ſide of the cloſet door, within a foot of the ſhivered part, received

ceived no other injury than a ſlight diſcoloration in one of her feet, with a ſenſe of numbneſs in both, which diſappeared the following day.

From this ſtack of chimneys, in the direction of the ſtorm, that is Southweſt, there is no lightning rod, nor any more elevated building, for a conſiderable diſtance, which might have intercepted the ſtroke; but immediately to the North and North Eaſt, the adjoining buildings are much higher, and there is one pointed rod, at no great diſtance.

It is remarkable that the lightning paſſed through the two chimneys only which had fire in them, though two others were contiguous. And we were told that the chimney which it quitted at the roof had very little fire in it. The late Mr. Henry, in a paper read before the Philoſophical Society, has endeavoured to ſhew that heat is the conducting medium of the electrical fluid. It may perhaps be doubted whether it is the matter of heat, or the effects of it in rarefying bodies that diſpoſes them to conduct electricity. It is however certain that barely rarefying the the air, without any additional heat will make it conduct the electrical matter readily, and probably it was the column of rarefied air which conducted the lightning down theſe chimneys. Whilſt volcanos are throwing forth prodigious columns of fire ſmoke and aſhes, corruſcations of lightning are frequently ſeen amongſt them: the extenſive rarefaction of air, produced by theſe immenſe fires, affording the means of reſtoring the equilibrium of the electrical fluid to very great diſtances. We may from hence conclude that it is ſafer to be near a chimney that has no fire in it, during a thunder-guſt, than one that has fire.

The houſes above deſcribed were ſtruck in the beginning of the thunder-guſt, and before it had rained any. Sometime afterwards, in the greateſt fall of rain, the lightning ſtruck Mr. Blanchard's houſe, in third ſtreet. This is a three ſtory houſe, having two ſtacks of chimneys, Eaſt and Weſt of each other one on each ſide of the higheſt part of the roof. Several bricks were thrown off one corner of the weſtermoſt ſtack. The lightning is ſuppoſed to have come down a wooden rod, furniſhed with an iron ſpindle and vane, the whole about fourteen feet in length which ſtood by the ſide of this chimney top, though no marks of it are viſible on the rod. From near the foot of this rod it proceeded down a rafter on the Eaſt ſide of the roof, ſplitting it through its whole length, and breaking up the ſhingles over it. From the foot of this rafter it proceeded quietly down a copper ſpout without injuring the building or leaving any other traces on it.

N°. XV.

An Account of the effects of a ſtroke of Lightning on a Houſe furniſhed with two Conducters,—in a Letter from Meſſrs. DAVID RITTENHOUSE *and* FRANCIS HOPKINSON; *to Mr.* R. PATTERSON.

Read Oct. 15, 1790.

ON Tueſday evening, the 17th of Auguſt, 1789, the dwelling houſe of Mr. Thomas Leiper, at his Mills, near Cheſter, was ſtruck by lightning. As this is a remarkable caſe, the houſe being furniſhed with two good conducters, Mr. Leiper requeſted us to view the ſituation of the building and the effects of the lightning, which we did three days after the accident.

The houſe ſtands at the foot of a pretty ſteep aſcent, on the Weſt ſide of Crum creek, and within a few yards of the mill dam. It is a regular ſtone building 36 feet by 32, two ſtories high at the Weſt end, above ground, and

three

three ftories at the Eaft end. At each end there are two ftacks of chimnies, which rife from the roof about half way between the eaves and the ridge. The pointed conductors, one at each end, are faftened to the two moft Southerly chimnies, and are brought directly down the outfide of the wall to the ground, which they enter probably but a few feet, on account of the rock. The rods are well made the pieces being fcrewed together and not connected by hooks.

The cloud which difcharged the lightning came from the Weft, and the fluid appears to have proceeded down the Weftern conductor, at leaft in part, for the point is melted down to a confiderable thicknefs. The next perceptible effect of it is on the South fide of the fame chimney, where it has torn up the fhingles of the roof nearly 18 inches in breadth, from the chimney directly down to a water gutter, covered with copper, which runs along the roof from Weft to Eaft a foot above the eaves, and at the Eaft end is connected with a copper fpout which comes directly down along the wall, within four feet of the earth, where it difcharges the rain water into a cedar tub, bound with iron hoops.

The lightning appears to have paffed quietly along the copper, the whole length of the gutter and fpout. About a hands breadth below the end of the fpout it tore off and fhivered in pieces an inch board, which paffed down between the fpout and the wall and had been lower down than the fpout, partly paffing into the tub, it made its way through to the outfide, and thence into the earth, throwing off many fmall fplinters from different fides of the tub.

Another part of the lightning appears to have proceeded along the Weftern rod until it came directly oppofite to the copper gutter, from which it is diftant 6 or 7 feet: it then ran along the cornifh, part of which it threw off in its courſe, to the end of the gutter, where it united with that part firſt mentioned. That ſome part was diſcharged into the earth by this conductor is evident, for the ſurface of the earth was thrown up at the foot of it.

Immediately Weſtward from the houſe the garden riſes pretty ſteep, ſo that at the diſtance of leſs than 20 rods the ſurface of the ground is higher than the chimney tops, and immediately adjoining is a grove of oaks and other trees, of the uſual height.

It may ſeem extraordinary that the electric fluid was not diſcharged through ſome of thoſe trees, which are ſo much higher than the houſe, and over the tops of which the cloud muſt have paſſed before it reached the houſe. But perhaps, on account of the vicinity of the water, the houſe, with its conductors, including the copper ſpout, afforded a more ready conveyance. The hill, Weſt of the houſe is one continued rock, covered with a few feet, or rather inches of earth. The rock is probably but a bad conductor, and the earth on its ſurface pretty dry, for it had not yet rained at that time. Had the earth been ſufficiently moiſt at the foot of the conductor, it is likely we ſhould not have ſeen any effects of the lightning.

This caſe ſeems to give ſome force to an objection made long ago to the uſe of pointed rods. That is, that they may ſometimes invite a diſcharge of the electric matter, which would otherwiſe have paſſed elſewhere, and which they are nevertheleſs inſufficient to convey, without injury to the building. But it is by no means certain that the houſe would have eſcaped had it not been furniſhed with rods; for we very often ſee the lightning ſtrike low trees and buildings in the neighbourhood of others much higher; and, beſides, had not the copper gutter and ſpout furniſhed ſuch an excellent conductor, the fluid might have paſſed quietly through one or both of the rods. But by whatever means the diſcharge was promoted in that particular manner, the damage done to the building was trifling,

ling, and no part of the inſide ſuffered in the leaſt, notwithſtanding that the ſtroke, by the prodigious noiſe which accompanied it, ſeemed to be very powerful.

It is remarkable that a perſon was ſitting at the time in a door on the ground floor, not more than 4 feet from the lower end of the copper ſpout, who received no injury, though he very ſenſibly felt the ſhock.

From our obſervations on the above caſe, as well as ſome others that have occurred, we would ſtrongly recommend to thoſe who put up pointed rods, that the lower end be ſunk ſufficiently deep to reach moiſt earth in the dryeſt ſeaſons. And we ſubmit it to thoſe converſant with electrical philoſophy, whether, when there are more rods than one to a building, it might not conduce much to its ſafety to form a good communication between the rods, and likewiſe between them and a copper water ſpout; carrying an iron or copper rod from the lower end of the ſpout a ſufficient depth into the ground.

Thinking it poſſible that the above may afford ſome hints for improving the means, now pretty generally in uſe, for guarding againſt the fatal effects of thunder ſtorms, we have thought proper to lay it before the Society, and ſhall be happy if it receives their approbation.

Nº. XVI.

Experiments and Obſervations on Evaporation in cold Air, by C. WISTAR, M. D.

Read Sept. 21 1787.

DURING an experiment with a frigorific mixture, I frequently had occaſion to introduce my hand when it was wet, into a cold veſſel, and obſerved that while it was in this ſituation, a ſmoke or viſible vapour aroſe from the moiſture on it, which ceaſed when it was withdrawn into warmer air, and returned upon my replacing it in the veſſel. In

In order to obſerve this proceſs with more accuracy, I fixed an empty tin jar in a tub, and filled the tub with a mixture of ſalt and ſnow, ſo that the veſſel was completely ſurrounded with the mixture, and the air in it was ſoon reduced to the temperature of ſalt and ſnow, or to 0° of Fahrenheit's ſcale.

In this ſituation, I ſuſpended in it, a rag which had been dipped in water of the temperature of 40°—as ſoon as it deſcended within the veſſel, it began to emit ſmoke or ſenſible vapour, and continued doing ſo, a conſiderable time.—While ſmoking it was drawn out, and the ſmoke ceaſed.—After this, it was replaced in the veſſel, and again began to ſmoke.

This was repeated frequently, and always with a ſimilar reſult, ſo that I had no doubt of the fact.—In the firſt caſe in which I obſerved this ſmoke to ariſe, the moiſt body muſt have enjoyed a heat of 98° or near it, as it was my hand; by this experiment it appeared that a moiſt body of 40° would ſmoke alſo in the ſame circumſtances, and I now wiſhed to know whether this would be the caſe with a body ſtill colder.—For this purpoſe a ſmall piece of Ice was ſuſpended in the veſſel, as the rag had been before—it ſmoked when firſt ſuſpended there, this ſmoking ceaſed when it was drawn out, and returned when it was placed in the veſſel again; preciſely as it had happened when the rag was uſed.—Another lump of ice was dropped into the veſſel and allowed to remain there, it ſmoked for twelve or fifteen minutes and then ceaſed.—Snow ſmoked in the ſame manner, but not ſo long.

To be certain that this vapour really aroſe from the ice, a ſmall mirror was ſuſpended horizontally in the cold veſſel—It continued ſo a long time without contracting any moiſture or dullneſs on its ſurface—The ice was then introduced under it, and, although there was a conſiderable diſtance between them, the mirror ſoon became encruſted with hoar froſt. To prevent deception, I varied this experiment by placing a tumbler inverted in the cold veſſel—It remained there a long time, and its ſurface, both within, and without, continued free from any moiſture or froſt—I then introduced under it a piece of ice, and in a few minutes, the whole internal ſurface was covered with froſt.

This proved clearly that the vapour aroſe from the ice alone; and during this experiment, another fact of the ſame nature occurred.—When the mirrors or tumblers were removed from the cold veſſel into the air of the room, which was 34°, they ſoon attracted moiſture from it, which appeared on their ſurfaces in the form of ice or froſt; they were replaced in the veſſel when thus encruſted, and the ice ſoon diſappeared, their ſurfaces becoming as bright as before.

The whole of this proceſs was pleaſing,—while the mirror remained in the cold veſſel, its ſurface continued bright, very ſoon after it was placed in the air of the room, it became dull, as if breathed upon, this dullneſs increaſed to an evident moiſture conſiſting of ſmall drops of water, a fibre of ice then formed ſuddenly in the moiſture, a ſecond appeared to ſhoot from this, a third from the ſecond, and ſo on, until the whole was congealed. When this congelation was completed, the mirror was returned to the cold veſſel, and the ice diſappeared in about the ſame ſpace of time in which it had formed.

This collection of moiſture on the ſurfaces of bodies cooled to 0°, and then expoſed to air of 34°, is analogous to the formation of drops of water on the ſurfaces of cool bodies expoſed to the warm air of ſummer, it proves, that even in cold weather, a large quantity of moiſture exiſts in our atmoſphere.

When the ice was in the cold veſſel, I obſerved that it ſmoked but about twelve or fifteen minutes, and ſuſpected

that

that perhaps the evaporation continued no longer, to determine this point, I placed two tumblers in the cold veſſel, and when they were cooled, placed a lump of ice in the ſame ſituation and inverted one of them over it—this tumbler became encruſted with froſt as before; it remained twenty minutes and then being removed, the other was inverted over the ice in its place, but although the ſecond tumbler remained a long time in this ſituation, its ſurface continued perfectly free from any moiſture or ice whatever. This reſult appeared to me a full proof that the actual, as well as the apparent evaporation, ceaſed in a few minutes after its commencement; but from the whole of the experiments I was induced to believe that, while the evaporation went on, it was much more rapid in the cold veſſel, than in the open air which was ſo much warmer—to determine this accurately, two lumps of ice of the ſame weight and form, ſhould have been expoſed a given time, one to the air of the veſſel, and the other to the air of the room, and then weighed accurately; but having no nice ſcales, I was reduced to another expedient much leſs exact.—As moiſture is very conſpicuous on mirrors or poliſhed ſurfaces, I thought of comparing one of them which had been moiſtened and placed in the cold veſſel, with another which had been equally moiſtened, but placed in warmer air,—for this purpoſe I took two razors highly poliſhed, and, after expoſing them to my breath ſo that each was equally dull, I placed one of them in the cold veſſel, and at the ſame time, held the other in air of 34°—in ſeveral inſtances the razor in the cold air loſt its moiſture ſooneſt, and in ſome other inſtances, both of them loſt their moiſture ſo quickly, that it was difficult to compare them.

I refrain however from drawing a concluſion from theſe reſults, becauſe when the ſame razors were expoſed to my breath, and then placed, both of them in air of 34°, one loſt its moiſture in leſs time than the other—although this circumſtance

circumſtance leſſened my confidence in the reſult of the laſt experiments, it may be explained upon the ſame principles which explain the others: in the mean time it is certain, that when both, razors after being cooled to 0°, were moiſtened with my breath, and in that ſituation expoſed, one to the open air of 34°, and the other to the air of the cold veſſel, that which was in the veſſel loſt its moiſture, while that in the open room appeared to receive additional moiſture from the air around it.

It has long been known that evaporation continues when the air is below 32°; beſides the familiar fact of drying linen in freezing weather, Mr. Boyle found that the weight of a piece of ice was diminiſhed, by expoſing it to the open air during a cold night—Captain James who wintered at Charlton Iſland in Hudſon's Bay, has related that the ſnow, in that *bitter* cold country, often diſappears without melting. Mr. Wilſon, profeſſor of aſtronomy at Glaſgow, obſerved that a thin cruſt of ice on the caſe of his teleſcope diſappeared while he was making an obſervation, during an intenſely cold morning: he has related this fact in the Philoſophical Tranſactions, and infers from it that evaporation continues in very cold weather.

It therefore is not ſurprizing that evaporation ſhould go on in the cold veſſel, but from all the circumſtances, and eſpecially from that laſt related, reſpecting the razors, I cannot refrain from inferring, that there was more evaporation in the cold veſſel, than in the air of the room, and believe that this fact may be explained without deviating from the true principles of evaporation.

Water unites with the atmonſphere, or evaporates by three proceſſes, which are (to appearance at leaſt,) different from each other.

1. If it be expoſed to air of its own temperature, or warmer than itſelf, it diminiſhes inſenſibly.

2. If its heat be increafed a certain degree above that of the air to which it is expofed, a vifible vapour or fmoke will arife from it, which will appear more or lefs in quantity in proportion to the heat.

3. If it be heated to 212°, while expofed to the preffure of the Atmofphere, or to 98° in vacuo, fmall tranfparent globules are formed fuddenly, and with a crackling noife, in that part of it which firft receives the heat; thefe globules, which are compofed of elaftic vapour, afcend through the water as quickly as air would do, if in the fame circumftances: as foon as they efcape from water into air, which is colder, they are converted from tranfparent elaftic vapour, into vifible inelaftic vapour or fmoke, which paffes through the air as other vifible vapour does: the formation and paffage of thefe bubbles through the water, produces that motion in it which we call boiling. * Any perfon may be convinced of this, by applying a candle to the bottom of a flafk or thin glafs veffel which has a fmall quantity of water in it.

The evaporation produced by immerfing moift bodies or ice, in cold air, refembles the fecond kind which I have defcribed (or that which produces fmoke,) in feveral refpects. In order to make water fmoke, you need only render it warmer than the air to which it is expofed; thus, to give a very familiar example, a difh of tea, when firft poured out, fmokes at the fire fide, when it has loft fome of

* I have ftated that water will boil in vacuo, with a heat of 98° upon the authority of Mr. Watt; but an elaftic vapour will arife from water in vacuo when the heat is much lower—Some Gentlemen have related in the Philofophical Tranfactions, that when they were making experiments with the Barometer in an exhaufted receiver, an elaftic vapour arofe from the moift leathers, and compreffed the mercury in the Barometer. They alfo refer to the experiments of Lord Cavendifh, and from thefe they fay it appears, that water of 72° yielded an elaftic vapour when the receiver was fo much exhaufted, that the Barometer funk to $\frac{3}{4}$ of an inch, or when 1-40 of the common preffure of the Atmofphere remained; and that when the Barometer funk to $\frac{1}{4}$ of an inch, or that 120 only of the common preffure remained, the fame kind of vapour arofe from water of the temperature of 41°. This fluid therefore when its temperature is 41°. or upwards may be confidered as in a conftant nifus to affume the form of elaftic vapour, which nifus is counteracted by the weight of the atmofphere. See Nairn's accounts of experiments with the air pump, in Phil. Tranfactions, part 2d, 1777.

of its heat this ſmoking ceaſes, but if removed to a colder place, (as the outſide of the window on a froſty day,) it will ſmoke again. Many other familiar facts tend to ſhow, that viſible evaporation or ſmoking, does not depend upon any poſitive degree of heat, but merely upon an exceſs of it in the moiſt body, when compared with the air to which it is expoſed.

The ſmoking of water has been aſcribed by Mr. de Luc, to the paſſage of heat or fire, from the moiſt body into the air around it: he ſuppoſes this fire to carry ſome water diſſolved in it into the air, thus forming ſmoke.

Without entering into the circumſtances of this union of water and heat, I think it may be aſſumed as a general fact, that whenever water and air are in contact, and the heat of the water exceeds that of the air in any conſiderable degree, the paſſage of heat from the water to the air is attended with ſmoking, or the aſcent of inelaſtic viſible vapour.

If this motion of heat and ſmoking are inſeperably connected, the reaſon why ice ſmoked when firſt introduced into the cold veſſel, is very clear, as its temperature was 32° above that of the air in the veſſel.

I do not pretend that this paſſage of heat from moiſt ſubſtances into air is the only cauſe of evaporation, we have already obſerved that water will evaporate into air which is warmer than itſelf as in the ſpecies of evaporation firſt deſcribed, and in the third ſpecies, the elaſtic vapour forms at the bottom of boiling water without any contact with air. But the viſible ſpontaneous evaporation appears different from theſe, and I think that the hypotheſis which ſuppoſes it to depend upon the paſſage of heat, is rendered probable by the following facts which occurred during the above experiments.

1. The ice ſmoked for a few minutes only after it was dropped into the cold air.

2. The ſecond tumbler which was inverted over the ice continued perfectly free from any moiſture or froſt, although the firſt was lined with it.

3. If one of the razors when placed in the cold veſſel, was encruſted with a ſmall quantity of ice or moiſture, this moiſture would ſoon diſappear, but if it was in large quantity, a part only would diſappear, and the remainder continue unchanged, although the razor was kept a long time in the cold veſſel.

Now it is probable that in the firſt and ſecond of theſe inſtances, the evaporation commenced as ſoon as the heat began to flow from the ice to the air, and ceaſed as ſoon as the ice was reduced to the temperature of the air, or as ſoon as the motion of the heat ceaſed.

The ſame I believe happened to the ice on the razor, but the razor being a ſmall body could have contained but little heat, of courſe therefore the evaporation from it muſt have ceaſed before much ice could have been removed.

I cannot think of any principle upon which we can account for the evaporation going on rapidly at one time, and ceaſing at another, except this motion of heat, and there are ſome other facts of conſiderable importance which may be explained by it equally well. Within the Polar regions, when the cold is very intenſe, a ſmoke ariſes from the ſea which is warmer than the air of the land; Crantz the Moravian miſſionary to Greenland, after deſcribing the effects of the violent cold, adds, that "at this time the ſea reeks like an oven," and that this ſmoke is diſtinguiſhed by the inhabitants by the name of *froſt ſmoke.* As the circumſtances attending this ſmoking are ſo ſimiliar to thoſe which attend the ſmoking ice, in the veſſel, there is reaſon to believe that they depend upon the ſame cauſe.

This explanation may alſo be rendered more probable, if it can be made to appear that a proceſs the reverſe of evaporation, depends upon a principle the reverſe of that

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we have mentioned as one of the caufes of evaporation. The procefs alluded to is that by which moifture is collected on the furfaces of cold bodies expofed to warm air—Dr. Franklin has explained this upon the principle that the water in the atmofphere is combined with heat, and that it is collected on the cold furface in confequence of the paffage of this heat into the cold body. This explanation is the reverfe of that which I have adopted, and as it explains to the fatisfaction of every one, a procefs the reverfe of evaporation, it ftrengthens that explanation.

When confidering this theory of our great philofopher, and the pleafing application of it to many important proceffes of nature, it occurred to me to try the converfe of the propofition; for if the collection of moifture on the furface of a body depends upon the abftraction of heat from the air by it, it follows, that when a body is not in a condition to receive heat from the atmofphere, no moifture can collect upon it.

As mirrors fhow the prefence of moifture with fo much accuracy I heated one of them, and found that although, when below 98°, they are covered with mift, if expofed but a moment to the breath, yet when heated but little above 98°, I could not imprefs any moifture upon it, although it was applied clofe to my mouth and breathed upon very frequently. Dr. Franklin's propofition requires nothing to confirm it, but if it were doubtful, this laft experiment would furnifh a ftrong argument in its favour.

N°. XVI.

Postscript to Mr. Barton's * *Letter, to* Dr. Rittenhouse, *of the 17th of March*, 1791.

Read Dec. 2d, 1791.

SINCE the date of my letter, on the subject of population and the probabilities of the duration of human life, in this country, an actual enumeration has been made, of the inhabitants of the United States; and the returns of the census have been transmitted to the secretary of state, from all the districts in the union, excepting the state of † South-Carolina.

I beg leave, therefore, to subjoin four tables, deduced from those returns; inasmuch as they may serve to establish some of the positions, which were advanced in the letter referred to, and to verify the observations resulting from the facts therein stated.

The table, N°. 1, gives the ratio of free white males, under sixteen years of age, to the intire number of free white males, in each state, respectively: And N°. 2 gives proportions, of the like kind, for four several sections of the state of Pennsylvania.

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* The reader is requested to correct, in that letter (see page 25), the following errors, which were overlooked until after the paper was printed----viz. page 27, line 6th from the bottom; for *on* read *ou*.---Same page, line 4th, from the bottom, for *hist. royal read sciences*—read *hist. royal acad. sciences*.—Same page, line 3d from the bottom; for *probabilities*—read *probabilités*.—Page 30, last line; erase the words *in that state*.—Page 31, line 3d, from the bottom; for *Versailes*—read *Versailles*.—Page 35, lines 24th and 25th from the top; read the proportion of free white males, *under* 16 *years of age*, to the whole number of *free white males, of all ages*, in Massachusetts, &c. Same page, line 4th, from the bottom; for 1783—read 1683.—Page 37, line 20th, from the top; for 1536—read 1535.---Page 35, line 14th, from the bottom; for *country, Virg.* read *county Virginia*.---Page 47, line 19th, from the top; for 925 *whom*---read 925 *of whom*.---Page 59, lines 7th and 9th, from the bottom; the letters *(j)* and *(k)*, referring to notes, should be transposed, in order to designate the notes to which they properly refer:--And the note marked *(l)*, (page 61, last line, and ending with the word "inhabitants,") should be placed at the conclusion of the whole; the table, at the top of page 62, being a *continuation* of the note marked *(k)*.

† Since this paper was read in the society, the census for South-Carolina has been compleated, and the result published by authority. Such alterations have therefore been made, in the subsequent part of the observations, as to accommodate them to that circumstance.

The table, N°. 3, exhibits the ratio of free white males to free white females, in the ſeveral ſtates, reſpectively, including the South-Weſtern territory: And N°. 4, ſhews ſimilar proportions, for the before mentioned four ſections of this ſtate.

By the cenſus, it is found, that the intire number of free white male inhabitants, in all the ſtates, collectively, is, to the number of that deſcription under ſixteen years of age, in the ſame, as 100 of the former to 49. 52, of the latter: and it may be preſumed, that nearly the ſame ratio obtains among the females. It is alſo found, that the number of free white male, to that of the free white female inhabitants, in all the ſtates, collectively (and including therewith, the South-Weſtern territory), is, as 100 of the former to 96. 35, of the latter.

Although there are in the United States, (taking the South-Weſtern territory, likewiſe, into the calculation) nearly 59,000 more free white males than free white females; yet it appears, that the ſtates of Maſſachuſetts, Rhode-Iſland and Connecticut, contain nearly 9,000 more of the latter than of the former. In general, there is the higheſt proportion of females in thoſe ſtates, *from* which there have been the greateſt emigrations; becauſe more men than women migrate:—Hence we find the higheſt proportions of males in Kentuckey, Vermont and the South-Weſtern territory, *to* which the moſt numerous migrations have recently been made.

We obſerve, alſo, the higheſt proportions of perſons under ſixteen years of age, in the ſtates of Kentuckey, North-Carolina, Georgia, South-Carolina, and Virginia; where the population is thin, in compariſon with the extent of territory, and where—owing to the facility of acquiring lands, from which ample and certain ſubſiſtence is readily obtained— people marry earlier in life and produce the more children.

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The ſame obſervations will apply to the ſtate of Pennſylvania. This ſtate contains twenty-one counties:—The capital contains the higheſt proportion of females to males; the nine oldeſt counties—comprehending the moſt populous part of the ſtate, and excluding the capital—have a lower proportion of females; the eight counties next ſettled, in point of time, give one ſtill lower; and the four counties, laſt ſettled, give the loweſt proportion of all.

This order is directly inverted, with reſpect to the ratio of perſons, under ſixteen years of age, to the intire number of all ages, in thoſe ſeveral ſections of this ſtate; the four tranſmontane counties containing the higheſt proportion of males under ſixteen, and the city of Philadelphia having the loweſt.

The courſe of the migration of our inhabitants, is from the long-ſettled and moſt populous parts of the country, towards the extenſive tracts of yet unimproved lands in the new ſtates, and on the frontiers of moſt of the older ones. This is, evidently, the principal courſe of the various proportions in the number of males to females—and of perſons under ſixteen years of age, to the intire number of all ages,—which are found in different parts of the union: And the operation of this cauſe is, alſo, plainly diſcernible in Pennſylvania; the progreſs and actual ſtate of its population, correſponding with the principle.

Other cauſes undoubtedly concur, in producing thoſe inequalities of ratio in different ſituations, which have been noticed; but theſe, it is not neceſſary to inveſtigate.

It may not be improper to obſerve, in this place, that, in calculating the ratio of annual deaths to the living, for the city of Philadelphia, the eſtimate of $\frac{1}{45}$ dying annually was made, on the preſumption of this city containing 41,580 white inhabitants. The cenſus makes the number only 40,442;—at which rate, the annual deaths would amount to one out of every $43\frac{77}{100}$, of the living. But,

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as a very conſiderable number of thoſe who reſide in the vicinity of Philadelphia—probably for ſeveral miles around—bury their dead in the city; and as the cenſus is generally ſuppoſed to fall ſhort of the real numbers of our inhabitants; the conjectural eſtimate, before mentioned, cannot be much too high, if any.

Many other obſervations, relative to the ſubject of this enquiry, will be ſuggeſted by an examination of the annexed tables, and of the cenſus itſelf: but, if ſuch as have been offered ſhould ſerve to elucidate that ſubject, it will be a gratification to me, to have contributed my mite on the occaſion.

W. BARTON.

(TABLE, N°. 1.)

States.	To 100 free white males of all ages.	Free white males, under 16 years of age.
Kentuckey,	To 100	52.95
N. Carolina,	100	52.54
Georgia,	100	51.73
S. Carolina,	100	51.46
Virginia,	100	51.14
Delaware,	100	50.75
Vermont,	100	49.88
Rhode-Island,	100	49.65
New-Hampshire,	100	49.12
Pennsylvania,	100	49.11
Massachusetts,	100	48.31
New-York,	100	48.27
Maryland,	100	47.86
New-Jersey,	100	47.78
Connecticut,	100	47.33

South-Western territory,——not ascertained by the census.

(TABLE, N°. 2.)

The state of Pennsylvania, divided into four sections.	To 100 free white males of all ages.	Free white males, under 16 years of age.
The four westernmost counties,	To 100	53.44
Eight counties settled prior to the preceding four, & after the remaining counties of the state.	100	51.57
The nine oldest counties, exclusive of the capital.	100	47.82
The city and suburbs of Philadel.	100	42.05

(TABLE, N°. 3.)

States.	To 100 free white males of all ages.	Free white females, of all ages.
Rhode Island,	To 100	102.62
Massachusetts,	100	102.10
Connecticut,	100	102.94
New-Hampshire,	100	98.90
New-Jersey,	100	96.10
N. Carolina,	100	95.40
Pennsylvania,	100	94.77
Georgia,	100	94.77
Virginia,	100	94.70
Maryland,	100	94.53
New-York,	100	94.12
Delaware,	100	93.55
South-Western territory,	100	92.85
S. Carolina,	100	91.24
Vermont,	100	90.49
Kentuckey,	100	89.78

(TABLE, N°. 4.)

The state of Pennsylvania divided into four sections.	To 100 free white males of all ages.	Free white females, of all ages.
The city and suburbs of Philadel.	To 100	106.29
The nine oldest counties, exclusive of the capital.	100	96.03
The eight counties settled next after the preceding nine.	100	91.63
The four westermost and last settled counties.	100	89.09

N°. XVII.

New Notation of Music, in a letter to FRANCIS HOPKINSON, ESQ. *by* MR. R. PATTERSON.

Read Mar. 7, 1788.

THE happy influence of music on the human character is universally acknowledged: whatever, therefore, may have a tendency to facilitate the progress of this science will not, I am persuaded, be thought unworthy of your notice.

I have long regretted that the art of printing, which more than any other modern invention, has contributed to the progress of useful knowledge among men, has, in the science of music, been hitherto exercised in so limited a degree. It is true there is a method of printing music, by types made for the purpose; few printers, however, especially in America, are furnished with founts of this kind, and in general, when one would publish a piece of music, he is obliged to have recourse to the troublesome and expensive mode of a copperplate impression; and hence it is that publications of this kind are so very rare among us: and yet, I apprehend, that no good reason can be given why musical sounds might not be represented by the common alphabetical characters, as well as the articulate sounds of a language.

In musical sounds, two things, you know Sir, are chiefly to be considered; namely, *tone* and *time*. The latter, according to the common notation, is denoted by peculiar characters appropriated to the different lengths or intervals of the musical sounds, and the tones themselves by lines and spaces on which the aforesaid characters are placed. Musicians have been long agreed to denominate these lines and spaces by the seven first letters of the alphabet: now if the tones of musical notes, instead of being reprefented by lines and fpaces, were denoted by the letters which denominate thefe, and their times by the common ftops or marks of paufe in reading, fubjoined to the letters, this notation of mufic would certainly be as natural as the common one, and would moreover have this great advantage, that mufic might then be printed with the common alphabetical types; by which means all the inconvenience and expence attending the publication of mufic, according to the ufual notation, would be avoided; a magazine or common news-paper, would then become a convenient vehicle for publifhing the moft celebrated airs or pieces of mufic (which any one might afterwards, if he fhould think it neceffary, prick off for himfelf in the common form) and thus contribute to diffufe a more general knowledge of this ornamental and humanizing fcience.

To explain this matter more fully. Let the feven notes, a, b, c, d, e, f, g, on one of which the cliff is placed, be printed in fmall Roman letters; the feven notes next above thefe, in fmall Italics; the next feven, when any of them fhall occur, in Italic capitals; and the feven notes below the cliff-octave, in Roman capitals. Thefe four octaves, viz. A, B, C, D, E, F, G; a, b, c, d, e, f, g; *a*, *b*, *c*, *d*, *e*, *f*, *g*; *A*, *B*, *C*, *D*, *E*, *F*, *G*; will be more than fufficient to exprefs all the compafs of tone on any particular cliff. The governing flats or fharps which are ufually placed at the beginning of a tune, when tranfpofed from its natural key; as alfo the cliff, time, mood or other circumftance, may be expreffed in words at length after the title of the tune. Accidental flats, fharps and naturals, to deviate as little as poffible from the common notation, I would exprefs as follows: the flat by a fmall b, placed before the note affected, and fet a little higher than the other letters in the line. This may be done either by ufing a letter of a fmaller body and fpacing it up, or or by what printers call a *superior letter*, ſuch as are commonly uſed for notes of reference. The poſition and ſize of this b, will ſufficiently diſtinguiſh it from the note of that name. The aſteriſm, or if it ſhould be thought better, a ſmall x, placed before the note, will very well expreſs an accidental ſharp; and the letter n, a natural; and though theſe characters for ſharps and naturals can never be miſtaken for notes, yet for the ſake of uniformity, and to prevent all poſſible embarraſſment in reading, I would place them alſo a little higher than the other letters in the line. Two or more notes ſounded together, as is frequent on clavicords, harps and other ſtringed inſtruments, may be expreſſed by ſetting ſuch notes one over the other.

As for the times of notes, which is the ſecond thing to be conſidered in muſical ſounds, they may I think be very naturally expreſſed by the following marks, which are uſed for a ſimilar purpoſe in common reading.

Semi-demi-quavers, which are ſung or played as rapidly as the ſyllables of a word are pronounced, may be expreſſed by the hyphen (which in reading only ſeparates ſyllables) placed after ſuch notes. (-)

Semi-quavers, by the comma (,)
Quavers, by the ſemicolon (;)
Crotchets, by the colon (:)
Miniums, by the period (.)
And ſemi-breves, by the m daſh (—)

A pricked note may be expreſſed, as in common notation, by an inverted period ſet after the mark ſignifying the time of the note.

When two or more notes of equal time come together in the ſame bar, the mark of time need only be expreſſed after the laſt of ſuch notes, and underſtood to the reſt; and the different ſyllables in a bar may, when it is thought neceſſary, be diſtinguiſhed by interpoſing a ſpace between ſuch ſyllables.

Reſts

Refts will be very well expreffed by the foregoing refpective marks of time fet alone, or not immediately preceded by a note.

A fingle bar may be intelligibly expreffed by the m dafh fet fide-wife accrofs the line. |

A double bar by what printers call a parallel. ||

A repeat by a parallel, or the letter S, placed between two colons. :||: :S:

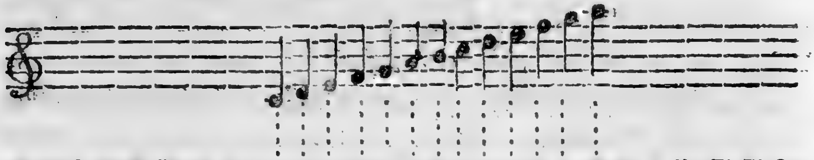
All the common marks of graces in mufic may be very well expreffed, or imitated, by the common printing types: thus a *trill*, by tr, fet above the note; a *beat*, by the afterifk +, and a *turn*, by the letter S turned fide-wife ∽, and fet above their refpective notes; a *flur*, by inclofing the flured notes in a parenthefis ( ) *ftaccato-notes* by a period or hyphen fide-wife, fet over, or under fuch notes; a *paufe*, by a parenthefis and period together, fet fide-wife, over the note ⌒ *diminutives, or notes of tranfition*, as they are not counted in the time of the bar, will be very naturally expreffed by enclofing fuch notes in a parathefis. [ ]

When three notes are reduced to the time of two, or fix to the time of four, the figure 3 or 6 may be refpectively fet above fuch notes, as in the common notation.

All terms of execution or expreffion as, adagio, andante, piano forte, &c. and figures marking the chords in thorough bafs, may be alfo expreffed as in the common notation.

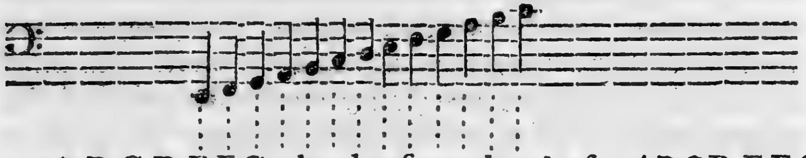
Explanatory Examples.

Scale of Notes on the G Cliff.



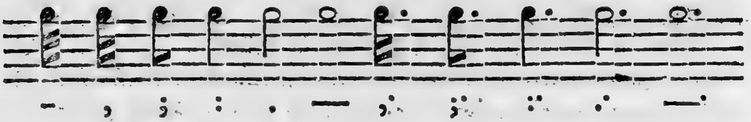
ABCDEFGabcde fg *a b c d e f g A B C D E F G*

Scale of Notes on the F Cliff.



A B C D E F G a b c d e f g *a b c d e f g A B C D E F G*

Rests, and Marks of Time.



Auld Robin Gray. 1st Mood of common Time, G Cliff, F and C sharp.

:S:

d; | f;·g,a;·b,[b;]a:·a; | b;·g,d;·b,ba; ;d; | (f;·g,)a;·b,[b;]a:g;·

f, | e;·d,g;·f,(f:ed;) | f;·g,a:·b,([b;]a:·)a; | bb;·c,d;·f,[a;]g:e;·

e, | (f,a;·)d;·f,(g,e;·) (c;·d,) | (f;·g,) (e;·)f,d: ;nf; | nf:e;·f,d:

(f;·g,) | a:bb;·g,([bb;]a:)e;e, | nf;·e,f(xf gf) gxg; | aaxg dg; a:

tr

;a; | f,d;·a;·b,a:·a, | bagf;g: ;e; | (f,a;·)d,f;·(g,e;·)c;·d, | f:e;·

Sym. :S:

d,d: ;f; | gfga babc dAfd afda fdaf edef, d: ;||

N°. XVIII.

Obſervations on the Theory of Water Mills, &c. by W. Waring.

Read June 15, 1792.

BEING lately requeſted to make ſome calculations relative to mills; particularly Doct. Barker's conſtruction, as improved by James Rumſey, I found more difficulty in the attempt than I at firſt expected. It appeared neceſſary to inveſtigate new theorems for the purpoſe, as there are circumſtances peculiar to this conſtruction, which are not noticed, I believe, by any author; and the theory of mills, as hitherto publiſhed, is very imperfect, which I take to be the reaſon it has been of ſo little uſe to practical mechanics.

The firſt ſtep, then, toward calculating the power of any water-mill (or wind-mill) or proportioning their parts and velocities to the greateſt advantage, ſeems to be,

The correction of an eſſential miſtake adopted by writers on the Theory of Mills.

This is attempted with all the deference due to eminent authors, whoſe ingenious labours have juſtly raiſed their reputation and advanced the ſciences; but when any wrong principles are ſucceſſively publiſhed by a ſeries of ſuch pens, they are the more implicitly received, and more particularly claim a public rectification; which muſt be pleaſing, even to theſe candid writers themſelves.

George Atwood, M. A. F. R. S. in his maſterly treatiſe on the rectilinear motion and rotation of bodies, publiſhed ſo lately as 1784, continues this overſight, with its pernicious conſequences, through his propoſitions and corollaries (page 275 to 284,) although he knew the theory was ſuſpected: for he obſerves (page 382) " Mr. Smea-

" ton

" ton in his paper on mechanic power (publiſhed in the " Philoſophical Tranſactions for the year 1776) allows, " that the theory uſually given will not correſpond with " matter of fact, when compared with the motion of ma- " chines; and ſeems to attribute this diſagreement, rather " to deficiency in the theory, than to the obſtacles which " have prevented the application of it to the complicated " motion of engines, &c. In order to ſatisfy himſelf con- " cerning the reaſon of this diſagreement he conſtructed a " ſet of experiments, which, from the known abilities " and Ingenuity of the author, certainly deſerve great con- " ſideration and attention from every one who is inter- " eſted in theſe inquiries." And notwithſtanding the ſame " learned author ſays, " The evidence upon which the " theory reſts is ſcarcely leſs than mathematical." I am ſorry to find, in the preſent ſtate of the ſciences, one of his abilities concluding (page 380) " It is not probable that the theory of motion, however inconteſtible its principles may be, can afford much aſſiſtance to the practical mechanic," although indeed his theory, compared with the above cited experiments, might ſuggeſt ſuch an inference. But to come to the point, I would juſt premiſe theſe

Definitions.

If a ſtream of water imping againſt a wheel in motion, there are three different velocities to be conſidered, appertaining thereto, viz.

First, the abſolute velocity of the water:

Second, the abſolute velocity of the wheel:

Third, the relative velocity of the water to that of the wheel, *i. e.* the difference of the abſolute velocities; or the velocity with which the water overtates or ſtrikes the wheel.

Now the miſtake conſiſts in ſuppoſing the momentum, or force of the water againſt the wheel, to be in the *duplicate ratio of the relative velocity*: Whereas.

Prop. I.

The force of an invariable ſtream, impinging againſt a Mill-Wheel in motion is in the *ſimple direct proportion of the relative velocity*.

For, if the relative velocity of a fluid againſt a ſingle plane be varied, either by the motion of the plane, or of the fluid from a given aperture, or both, then, the number of particles acting on the Plane in a given time, and likewiſe the momentum of each particle, being reſpectively as the relative velocity, the force on both theſe accounts, muſt be in the *duplicate* ratio of the relative velocity, agreeably to the common theory, with reſpect to this *ſingle plane*; but, the number of theſe planes, or parts of the wheel acted on in a given time, will be as the velocity of the wheel, or *inverſely as the relative velocity*; therefore, the moving force of the wheel muſt be in the ſimple direct ratio of the relative volocity. Q. E. D.

Or, the propoſition is manifeſt from this conſideration; that, while the ſtream is invariable, whatever be the velocity of the wheel, the ſame number of particles or quantity of the fluid, muſt ſtrike it ſome where or other in a given time; conſequently, the variation of force is *only* on account of the varied impingent velocity of the ſame body, occaſioned by a change of motion in the wheel; that is, the momentum is as the relative velocity.

Now, this true principal ſubſtituted for the erroneous one in uſe, will bring the theory to agree remarkably with the notable experiments of the ingenious Smeaton, before mentioned, publiſhed in the Philoſophical Tranſactions of the Royal ſociety of London for the year 1751, Vol. 51, for which the honorary annual medal was adjudged

judged by the ſociety, and preſented to the author by their preſident. An inſtance or two of the Importance of this correction may be adduced as follow.

Prop. II.

The velocity of a wheel, moved by the impact of a ſtream, muſt be half the velocity of the fluid, to produce the greateſt poſſible effect.

For, let { V = the velocity, M = the momentum of the fluid
v = the velocity, P = the power of the wheel.

Then, $V - v$ = their relative velocity, by definition 3d. and, as $V : V - v :: M : \frac{M}{V} \times \overline{V - v} = P$ (*Prop.* 1.) which $\times\, v = P\, v = \frac{M}{V} \times \overline{Vv - v^2}$ = a maximum; hence $Vv - v^2$ = a maximum, and its fluxion, (v being the variable quantity) $= V\dot{v} - 2v\dot{v} = 0$; therefore $v = \frac{1}{2} V$, that is, the velocity of the wheel = half that of the fluid, at the place of impact, when the effect is a maximum. Q. E. D.

The uſual theory gives $v = \frac{1}{3} V$; where the error is not leſs than one third of the true velocity of the wheel!

This propoſition is applicable to underſhot wheels, and correſponds with the accurate experiments before cited, as appears from the Author's concluſion, (Philoſophical Tranſactions for 1776 page 457) viz. "The velocity of "the wheel, which, according to M. Parents determina- "tion, adopted by Deſaguliers and Maclaurin, ought to "be no more than one third of that of the water, varies "at the maximum in the experiments of Table I. be- "tween one third and one half; but in all the caſes there "related, in which the moſt work is performed in propor- "tion to the water expended and which approach the near- "eſt to the circumſtances of great works when properly "executed, the maximum lies much nearer one half than "one third, *one half ſeeming to be the true maximum*, if "nothing were loſt by the reſiſtance of the air, the ſcatte- "ring of the water carried up by the wheel, &c." Thus

T 2 he

he fully ſhews the common theory to have been very defective; but, I believe, none have ſince pointed out wherein the deficiency lay, nor how to correct it; and now we ſee the agreement of the true theory with the reſult of his experiments.

I might proceed with this correction through ſeveral propoſitions, &c. and ſhew their coincidence with thoſe experiments; but muſt leave that, at preſent, for ſuch as have more leiſure; my view being only to ſhew where this perplexing difficulty crept in, in order that thoſe who may have occaſion to uſe the theory in future, or inſtruct young men in the principles of mechanics, may make any uſe of theſe hints they pleaſe: I will, however, juſt add one problem, as I have it by me; though it may not be the moſt ſuitable I could have choſen.

Prop. III. Fig. 1. Plate 4.

Given, the momentum (M) and volocity (V) of the fluid at I, the place of impact; the radius (R=IS) of the wheel ABC; the radius (r=DS) of the ſmall wheel DEF on the ſame axle or ſhaft; the weight (W) or reſiſtance to be overcome at D, and the Friction (F) or force neceſſary to move the wheel without the weight; *required* the velocity (x) of the wheel, &c.

Here we have $V : V-x :: M : M\times\frac{V-x}{V}$ = the acting force at I in the direction KI, as before. (prop. 2.) now, $R : r :: W : \frac{rW}{R}$ = the power at I neceſſary to counterpoiſe the weight W; hence, $\frac{rW}{R}+F$ = the whole reſiſtance oppoſed to the action of the fluid at I; which deducted from the moving force, leaves $M\times\frac{V-x}{V}-\frac{rW}{R}-F$, = the accelerating force of the machine; which, when the motion becomes uniform, will be evaneſcent or $=0$; therefore, $M\times\frac{V-x}{V}=\frac{rW}{R}+F$, which gives $x=V\times\overline{1-\frac{rW}{MR}-\frac{F}{M}}$ = the true velocity required; or, if we reject the friction, then $x=V\times\overline{1-\frac{rW}{MR}}$ is the theorem

orem for the velocity of the wheel. This, by the common theory would be $x=V\times\overline{1-\sqrt{\frac{rW}{MR}}}$, which is too little by $V\sqrt{\frac{rW}{MR}}-V\frac{rW}{MR}$: No wonder why we have hitherto derived so little advantage from the theory.

Corol. 1. If the weight (W) or resistance be required, such as just to admit of that velocity which would produce the greatest effect; then, by substituting $\frac{1}{2}V$ for its equivalent x (by prop. II.) we have $\frac{1}{2}V=V\times\overline{1-\frac{rW}{MR}-\frac{F}{M}}$; hence $W=\frac{\frac{1}{2}M-F}{r}\times R$; or, if F=o, $W=\frac{MR}{2r}$; but theorists make this $\frac{4MR}{9r}$, where the error is $\frac{MR}{18r}$.

Corol. 2. We have also $r=\frac{\frac{1}{2}M-F}{W}\times R$; or, rejecting friction, $r=\frac{MR}{2W}$, when the greatest effect is produced, instead of $r=\frac{4MR}{9W}$, as has been supposed: this is an important theorem in the construction of Mills.

WM. WARING.

Philadelphia, 7th, 9th mo. 1790.

Astronomical

N°. XIX.

Astronomical Observations, Communicated by DAVID RITTENHOUSE.

Observations of a lunar Eclipse, Nov. 2d, 1789, and of the transit of Mercury over the Sun's disk. Nov. 5th the same year, made at the University of William and Mary, By the Revd DR. JAMES MADISON.

Read Feb. 4th, 1791.

AS the observatory in which the transit instrument had been formerly placed, was not, at this time, rebuilt, I was not enabled to attend to the going of the time-keeper, by means of such observations as I wished to have made. I therefore had recourse to correspondent double altitudes, taken with a sextant. In taking them, treacle was used, which not only gave a well defined image of the sun, but was of sufficient consistency to prevent undulation, especially as the observations were made in a room, where the wind could have but little effect. From the great care employed, I think the time and rate of the clock were known with very considerable accuracy.

Nov. 2d, A mean of the corresponding altitudes taken this day, made the clock 17′, 17″ slower than apparent time; to which 9″½ being added for change of declination in the half interval, hence the clock was slow of the sun, - - - 17′ 26″ 30‴

Observations of the lunar Eclipse.

	App. Time. H.	′	″
Penumbra--thought to touch the ☽ at	6	8	46
Eclipse begins, - - -	6	21	0
Tycho begins to immerge -	6	38	45
wholly immerged - -	6	43	″

Shadow

	App. Time. H. ′ ″
Shadow reaches mare nectaris	7 34 0
Tycho begins to emerge,	7 57 44
wholly emerged,	8 1 26
End of the Eclipse.	8 30 0

These observations were made with an achromatic telescope, magnifying about 60.—The immersion and emerrien of tycho were particularly noted, as those times may be more accurately ascertained, than either the beginning or end of a lunar eclipse—The weather was remarkably favourable for astronomical observations.

November 3d. Cloudy no Observations could be made.

November 4th Corresponding altitudes.

A. M.			P. M.				′	″	‴
8	23	52	3	0	16	Clock slow by each observations,	17	56	
	25	34		50	35	- - -	17	55	30
	27	15		56	55	- -	17	55	
8	29	35	2	54	36	- -	17	54	30
	31	12		52	50	- -	17	55	
	32	34		51	16	- -	17	55	
8			2						
	36	24		47	54	- -	17	56	
	38	10		46	1	- -	17	54	30
A mean of the above observations, =							17	55	11
Add equal for ½ Interval, =						- -		9	30
Hence the clock at apparent noon was slow of the ☉						- - -	18	4	41

November 5th, Corresponding Altitudes.

A M.			P M.				′	″	‴
8	34	39	2	38	54	Clock two slow,	18	11	30
	36	14		41	5	- -	18	15	30

8

						′	″	‴
8	40 43	2 45 12	-	-		18	11	30
	42 32	47 15	-	-		18	11	30
	44 30	48 58	-	-		18	18	
A mean, =			-	-	-	18	13	36
Equal of ½ interval, = +			-	-				9
Hence the clock was slow of the, ⊙						18	22	36

It appears that the clock, by comparing the observations, lost, between the 2d. and 4th. 38″ 11‴ or 19″ per day, and between the 4th. and 5th. 17″ 55‴ or 18″.— Hence we may conclude that its rate of going was regular, and that it lost 18″½ in 24 hours. The following observations were corrected accordingly, and reduced to apparent time.

Observations of the Transit of Mercury.

The 1st internal contact, was not seen. When I first discovered ☿, he was somewhat advanced upon the sun's limb, and had an oval appearance, the longer axis directed towards the body of the sun.—But at 8ʰ. 3′. 10″ The planet suddenly assumed a round figure, and the first internal contact was accordingly noted.

The 2d, internal contact, 12. 53 42.

The 2d, external contact could not be determined with any tolerable accuracy on account of the remarkable undulatory motion which appeared upon the sun's limb, soon after the 2d internal contact. Mercury disappeared to me, at, 12ʰ 55′. 2″. I made use of an achromatic, magnifying about 150.

Mr. Andrews, professor of mathematics, with a reflector made by short, and with a magnifying power of 90—made the following observations.

The 2d internal contact - - 12ʰ 53″ 48″
2d external contact - 12 55 19

The

The ſame undulatory appearance was not ſeen in the reflector, and therefore the 2d external contact obſerved by it, may be more relied upon—The times of our obſervations were taken from the ſame clock, but noted in different rooms—The day was remarkably favourable, being clear, and ſufficiently calm.

By *D. Rittenhouſe*, at Philadelphia,

Lat. 39°. 57′. 10″. Long. weſt of Greenwich 5ʰ. 0′. 35″.

November, 2d, 1789. Moon eclipſed

Beginning	6ʰ	12′	P. M. mean time
End at	8	20	
Digits eclipſed,		$4\frac{1}{2}$	

Tranſit of Mercury November 5th, 1789.

Firſt external contact	7ʰ	51′	50″	A. M.	Mean time
Internal	7	53	20		
Second internal contact	12	43	24	P. M.	
End of the tranſit	12	45	4		

The undulation of the ſun's limb was ſo great that no micrometer meaſures could be taken with accuracy, but the leaſt diſtance of the centers ſeemed to be 7′. 15″.

October 22, 1790. Moon eclipſed

Beginning at	5ʰ.	41′.	+″	P. M. mean time
Beginning of total darkneſs	6.	49.	9	
End of total darkneſs	8.	30.	16	
End of the eclipſe	9.	37.	25	

November 6th, 1790. Sun eclipſed.

Beginning at	12ʰ.	2′	55″	P. M. mean time.
End at	2.	1	54	

If this eclipſed be computed from Mayer's tables it will be found advanced 33″, at the time ſet down above for the beginning, and by Maſon's new tables 29″. And it is certain that an eclipſe muſt make ſome progreſs before it will be perceived by the moſt attentive obſerver. The end was no doubt obſerved with more accuracy, and at that time

Mayer's tables give the limbs ſeperated 8″, and Maſon's the eclipſe ſtill remaining 6″. Therefore Maſon's tables repreſent both the beginning and end of this eclipſe more accurately than Mayer's, but the difference is very little. Mr. Maſon has placed the moon's nodes 51″, more forward, but this eclipſe will be better repreſented by retaining the place of the node as given by Mayer.

Tranſit of Mercury, obſerved at Waſhington College November 5th, 1789. By the Rev. Dr. *William Smith.*

N. B. The clock was cleaned and ſet a going P. M. November 4th, its rate of going, as to mean time, uncertain; but at ſun riſe November 5th, as nearly as could be gueſſed, it was about 2′. 30″ faſter than apparent time.

External contact	8h. 3′. 50″	}	A. M.
Internal	8. 5. 0	}	Magnifying power 95.

Micrometer meaſures of neareſt limbs.

h	′	Inch.	16ths.	20ths.	50ths.	′	″
9.	19 =	0.	6.	1.	19. =	6.	4
	54 =	0.	9.	0.	0. =	7.	57
10.	31 =	1.	0.	0.	0 =	8.	50
	53 =	0.	9.	1.	9 =	8.	23
11.	38 =	0.	7.	0.	6 =	6.	17
12.	0 =	0.	5.	0.	20 =	4.	46

Second internal contact	12h. 55′. 10	}	P. M.
Total egreſs	12. 56. 35	}	Magnifying power 130.

	h	′	Inch.	10ths.	20ths.	′	″
☉'s diameter at	12.	15. =	3	6	1 = =	32	14,5

Annular Eclipſe of the Sun, April 3d, 1791. Obſerved at Philadelphia, by *D. Rittenhouſe.*

Beginning (ſun juſt above the horizon) about - -	5h. 45′. 30″	}	A. M. Mean time.
Ring formed nearly, at	6. 50. 30		
The ring broken	6. 54. 47		
End of the eclipſe,	8. 7. 2		

At the middle of the eclipſe the ring was nearly twice as broad at the ſouth ſide as at the north ſide.

No.

N°. XX.

Dr. Rittenhouſe, to Mr. Patterſon, relative to a method of finding the ſum of the ſeveral powers of the Sines, &c.

DEAR SIR,

Read May 18, 1792. I Had diſcovered a very elegant theorem for determining the times of vibration of a pendulum in given arches of a circle; but it included a problem the ſolution of which I do not remember to have met with, though I cannot ſuppoſe that it has eſcaped the notice of mathematicians. It is, to find the ſums of the ſeveral powers of the ſines, either to a radius of unity or any other.

I was induced to attempt the means of doing this ſolely by its uſefulneſs, but in proſecuting the enquiry I found much of that pleaſing regularity, the diſcovery of which the geometrician often thinks a ſufficient reward for his labours.

The ſums of the odd powers of the ſines bear a very ſimple relation to each other, and ſo do the ſums of the even powers. But all the ſums of the odd powers are incommenſurable to all thoſe of the even powers.

If we take the radius equal to unity the ſum of all the ſines, or their firſt powers, will be $=1$, and the ſum of all their ſquares $=\frac{1}{2}$ multiplied by the arch of 90°. The ſum of all their cubes is $=\frac{2}{3}$, and the ſum of their fourth powers $=\frac{3}{8}$ multiplied by the arch of 90°. The ſum of the fifth powers is $=\frac{8}{15}$, and the ſum of the 6th powers $=\frac{5}{16}\times$ by the arch of 90°.

I have not been able ſtrictly to demonſtrate any more than the two firſt caſes. The others were inveſtigated by the method of infinite ſeries ſo far as to leave no doubt of the ultimate ratio which the ſum of the given power of the ſines bears to a known power of the radius.

Having proceeded ſo far as the 6th power the law of continuation became evident; ſo that, ſhould any problem in mathematical philoſophy require it, we may proceed as far as we pleaſe in ſumming the powers of the ſines. The law is this,

Make a fraction whoſe denominator is the index of the given power, and its numerator the ſame index, diminiſhed by unity, and multiplied by the ſquare of the radius; by this fraction multiply the ſum of the next but one lower power, and we have the ſum of the given power.

Thus 1ſt, the ſum of the 1ſt power of the ſines is $= rr$, or the ſquare of the radius
2d, ſum of the 2d, power or ſquares is $= \frac{1}{2} rr \times$ by the arch of 90°.
} By Demonſtration.

3d, ſum of the 3d, power or cubes is $\frac{2}{3}rr$ of the 1ſt, or $= \frac{2}{3}r^4$.
4th. ſum of 4th. powers is $= \frac{3}{4}rr$ of the 2d or $= \frac{3}{8}r^4$. $\times$ by the arch of 90°.
5th, ſum of 5th. powers is $= \frac{4}{5}rr$ of the 3d, or $= \frac{8}{15}r^6$.
6th, ſum of 6th. powers is $= \frac{5}{6}rr$ of the 4th or $= \frac{5}{16}r^6$. $\times$ by arch of 90°.
} By Infinite Series.

7th, ſum of 7th. powers is $= \frac{6}{7}rr$ of the 5th, or $= \frac{16}{35}r^8$.
8th, ſum of 8th. powers is $= \frac{7}{8}rr$ of the 6th, or $= \frac{35}{128}r^8$. $\times$ by the arch of 90°.
} By the Law of Continuation.

&c. &c.

Should your leiſure permit you to give any attention to this ſubject I ſhall be glad to ſee you furniſh a demonſtration for the 3d, or any ſubſequent caſe abovementioned.

I am, Sir,

Your moſt obedient humble ſervant,

DAVID RITTENHOUSE.

Index

Index Florae Lancastriensis, auctore HENRICO MUHLENBERG, D. D.

Dedicated to the Philosophical Society at Philadelphia, by the author.

GENTLEMEN,

Read Feb. 18th, 1791. I Did myself the honour to lay before the Philosophical Society a Specimen Florae Lancastriensis, some time in the year 1786, collected from actual observations from 1780.

Since that time, I have had an opportunity of adding some supplements, and I now make bold to send you an index of such plants as I could find, after the strictest search, growing either wild or cultivated in, or near, Lancaster. The whole number is very near 1100. All such plants as I never found growing wild, but are imported from other countries, or even from other American States, I have marked with a †.

If I found no name in Linne's system, I took it from other works lately printed, or from Doctor Schreber's letters, with whom I have opened a correspondence. He is professor Botanices et Historiae naturalis at Erlangen, editor of the Genera Plantarum Linnaei, and, without doubt, one of the first botanists in Europe. If I could find no name by these means, I was forced to make one myself adding N. S. until better informed by abler botanists.

I repeat my former wish, that some of my learned countrymen would join in botanical researches, and send in their Floras, for perusal or publication, to your Society, so that by gathering the Floras of the different States, we may have a general Flora of the United-States, drawn from good

good and certain obſervations. May I be ſo happy as to find your approbation in this ſecond ſpecimen! I have the honour to remain, with great reſpect,

Gentlemen,

Your moſt Obedient

Humble Servant,

HENRY MUHLENBERG.

Lancaſter, Nov. 17th, 1790.

Catalogus librorum quibus uſus eſt auctor hujus indicis.

1. Linnaei ſyſtem, a vegetabilium, curante Murray, 1784.
2. Linnaei ſpecies plantarum et genera plantarum, curante Reichard
3. Linnaei genera plantarum, curante Schreber Vol. 1. 1789.
4. Marſhalli Arbuſtrum. 1785.
5. Walteri Flora Caroliniana. 1787.
6. Aitoni Hortus Kewenſis. 1789.
7. Wangenheim von amarikamipt ſolzartan. fol. cum figur. 1787.
8. Miller Gardner's dictionary, et cet.

Pleniorem plantarum deſcriptionem, cum calendario et uſu medico et oeconomico, brevi tempore v. D. daturus.

Claſſis

CLASSIS 1.
Monandria,
Digynia.

1. Callitriche, Stargrafs.
verna.
2. †Blitum, Blite.
capitatum,
3. Cinna.
arundinacea.

CLASSIS 2.
Diandria, Monogynia.

4. †Liguftrum, Privet.
vulgare.
5. Chionanthus, Fringetree.
virginica.
6. †Syringa, Lilac.
vulgaris.
perfica.
7. Circaea, Entchanters-wort.
lutetiana.
8. Veronica, Speedwell.
virginica.
officinalis.
ferpyllifolia.
Beccabunga.
Anagallis.
arvenfis.
marilandica.
9. Diathera, Baftard Hedge-hyfop
americana.
10. Gratiola, Hedge-hyfop.
virginica.
11. Utricularia, Water-milfoil.
gibba?
12. Verbena, Vervain.
nodiflora.
haftata.
urticifolia.
carolina?
13. Lycopus, Gypfiewort.
europaeus.
virginicus.
14. Cunila, Pennyroyal.
mariana, Dittany,
pulegioides, Pennyroyal
15. Monarda.
fiftulofa.
didyma, Ofwego-Tea.
punctata.
16. Salvia, Sage.
lyrata.
† officinalis.
† Horminum.
† Sclarea.
17. Collinfonia, Horfe-weed.
canadenfis.

Digynia.

18. Anthoxanthum, Spring-grafs.
odoratum.

CLASSIS 3.
Triandria, Monogynia.

19. Valeriana, Valerian.
Locufta.
20. †Crocus, Saffron.
fativus.

21. Ixia?
aquatica. N. S.
22. Iris, Flag.
versicolor.
† pumila.
23. Xyris.
indica.
24. Schoenus, Rushgrass.
fuscus.
glomeratus.
albus:
lithospermus. N. S.
25. Cyperus Galingale.
mollis. N. S.
strigosus.
alternifolius.
pumilus?
nutans. N. S.
26. Scirpus, Club-grass.
palustris.
capitatus.
acicularis.
lacustris.
setaceus.
capillaris.
autumnalis.
triqueter.
mucronatus.
echinatus?
sylvaticus.
27. Eriophorum, Cotton-grass.
cyperinum.

Digynia.

28. Phalaris, Canary.
arundinacea.
oryzoides.
29. Paspalum.
distichum.
30. Panicum, Panicgrass.
glaucum.
viride.
italicum.
crus galli.
sanguinale.
filiforme.
dichotomum.
capillare.
latifolium. }
clandestinum. }
virgatum.
heterophyllum. N. S.
31. Phleum, Timothy.
pratense.
32. Alopecurus, Foxtail.
† pratensis.
33. Muhlenbergia, (Schreberi.)
diffusa. N. S.
erecta. N. S.
34. Milium, Millet.
paradoxum.
35. Agrostis, Bentgrass.
cylindrica. N. S.
diffusa. N. S.
capillaris.
alba.
virginica.
mexicana.
36. Aira, Hairgrass.
cespitosa.

flexuosa.

Trigynia.

53. Holosteum, Chick-weed.
succulentum.

54. Mollugo, Carpet-weed.
verticillata.

55. Queria.
canadensis.

56. Lechea.
minor.

CLASSIS. 4.

Tetrandria,

Monogynia.

57. Cephalanthus, Globe-flower-Shrub.
occidentalis.

58. Dipsacus, Teasel.
† fullonum.

59. Scabiosa.
† succisa.
† atropurpurea.

60. Houstonia.
caerulea.
purpurea.

61. Galium, Goosegrass.
trifidum.
tinctorium.
Mollugo.
boroale.
rotundifolium.
bermudianum.
Aparine.
pilosum, Aitoni.

62. Rubia, Madder.
† tinctorum.

63. Mitchella.
repens.

64. Plantago, Plantain.
major.
media.
virginica.
lanceolata.

65. Sanguisorba, Blood-wort.
canadensis.

66. Cornus, Cornel.
florida, Dog-wood.
alba.
sericea. }
amomum. }
alternifolia.
stricta, Aitoni.
paniculata, Aitoni ?

67. Ludwigia.
alternifolia.

68. Isnardia.
palustris.

Digynia.

69. Hamamelis, Witch-hazel.
virginica.

70. Cuscuta, Dodder.
† europaea.
americana.

Tetragynia.

71. Potamogeton, Pond-weed.
natans.

perfoliatum.

perfoliatum.
crifpum ?
compreffum.

CLASSIS 5.

Pentandria, Monogynia.

72. Myofotis, Scorpion-grafs.
fcorpioides.
virginiana.
73. Lithofpermum, Gromwell.
officinale.
arvenfe.
virginicum.
74. Anchufa, Alkanet.
virginica ?
75. Cynogloffum, Houndstongue.
officinale.
virginicum.
76. Pulmonaria, Lungwort.
virginica.
77. Symphytum, Comfrey.
† officinale.
78. Borago, Borage.
† officinalis.
79. Lycopfis.
virginica.
80. Echium, Viper-grafs.
vulgare.
81. Primula, Primrofe.
† veris.
82. Dodecatheon.
Meadia.
83. Menyanthes, Buckbean.
trifoliata.
84. Hydrophyllum, Waterleaf.
virginicum.
85. Lyfimachia, Loofeftrife.
ciliata.
punctata.
86. Anagallis, Red Pimpernel.
arvenfis.
87. Spigelia.
† marilandica, Carolina Pink-root.
88. Azalea, Rofebay.
nudiflora.
vifcofa.
89. Phlox.
paniculata.
maculata.
pilofa.
divaricata.
fubulata.
90. Convolvulus, Bindweed.
fepium.
panduratus.
purpureus.
† Batatas.
fpithamaeus.
repens.
fibiricus ?
91. Polemonium, Jacobs-Ladder.

 reptans.

reptans.

92. Campanula, Bell-flower.
rotundifolia.
americana.
perfoliata.
aculeata. N. S.

93. Samolus, Brook-weed.
valerandi.

94. Lonicera, Honeyſuckle.
media ?

95. Trioſteum, Fever-root.
perfoliatum.

96. Mirabilis.
† dichotoma.

97. Verbaſcum, Mullein.
Thapſus.
Blattaria.

98. Datura, Thorn-apple.
Stramonium.

99. Hyoſcyamus, Henbane.
† niger.

100. Nicotiana, Tobacco.
Tabacum.

101. Phyſalis, Winter-cherry.
pubeſcens.
viſcoſa.

102. Solanum, Nightſhade.
† tuberoſum.
† Lycoperſicum.
nigrum.

103. Capſicum, Spaniſh-Pepper.
† annuum.

104. Rhamnus, Buckthorn.
alnifolius ? Aitoni.

105. Ceanothus, New-Jerſey Tea, Redroot.
americanus.

106. Celaſtrus, Staff-tree.
ſcandens.

107. Evonymus, Spindle-tree.
atropurpureus, Aitoni.

108. Ribes, Currant.
† rubrum.
† nigrum.
floridum, Aitoni.
gloſſularia.

109. Hedera, Ivy.
† Helix.
quinquefolia.

110. Vitis, Vine.
vinifera.
Labruſca.
vulpina.

111. Claytonia.
virginica.

112. Celoſia, Cocks-comb.
† caſtrenſis.

113. Theſium, Flax-weed.
umbellatum.

114. Vinca, Periwinkle.
† minor.

Digynia.

115. Cynanchum, Baſtard Dogs-bane.
ſuberoſum.

116. Apocynum, Dogs-bane.
androſaemifolium.

androſaemifolium.
cannabinum.
117. Aſclepias, Swallow-wort.
ſyriaca.
purpuraſcens.
incarnata.
variegata.
quadrifolia, Jacquini.
† Vincetoxicum.
† nigra.
verticillata.
tuberoſa.
118. Chenopodium, Gooſe-foot.
album.
viride.
Botrys.
anthelminticum.
119. Beta, Beet.
† vulgaris.
† Cicla.
† altiſſima, Beckmanni, Scarcity-Root.
120. Gomphrena.
† globoſa.
121. Ulmus, Elm.
americana, Linnaei.
rubra. N. S. americana, Marſhalli.
122. Heuchera.
americana.
123. Gentiana, Gentian.
Saponaria.
Centaurium.
phoenicea. N. S.
glanduloſa. N. S. varietas ciliatæ ?
124. Hydrocotyle, Penny-wort.
americana.
125. Sanicula, Sanicle.
canadenſis.
marilandica.
196. Bupleurum, Thorow-wax.
† rotundifolium.
127. Daucus, Carot.
Carota.
128. Conium, Hemloc.
maculatum.
129. Heracleum.
Sphondylium, Cow-parſnep.
130. Ligufticum, Lovage.
† Leviſticum.
131. Angelica.
atropurpurea.
lucida.
132. Sium, Water-parſnep.
rigidius.
ſuave, Walteri ?
133. Siſon. Honewort.
canadenſe.
134. Cicuta, Cowbane
maculata.
135. Coriandrum, Coriander.
ſativum.
136. Scandix, Shepherds-needle.
† cerefolium.

† cerefolium.
procumbens?
137. Chaerophyllum.
138. Imperatoria, Mafter-wort.
† Oftruthium.
139. Thapfia.
trifoliata.
140. Paftinaca, Parfnep.
fativa.
141. Smyrnium, Alexanders
aureum.
integerrimum.
luteum. N. S. aureum, Walteri.
142. Anethum.
† graveolens, Dill.
† Foeniculum, Fennel.
143. Carum, Caraway.
† Carvi.
144. Apium.
† Petrofelinum, Parfley.
† graveolens, Cellery.

Trigynia.

145. Rhus, Sumach.
typhinum.
glabrum.
Vernix.
copallinum.
radicans.
Toxicodendron.
146 Viburnum, Mealy-tree.
prunifolium.
dentatum.
Lantana.
acerifolium.
† Opulus.
trilobum, Marfhalli.
Lentago.
147 Sambucus, Elder,
canadenfis.
nigra.
148 Staphylea, Bladder-nut.
trifoliata.
149. Sarothra
gentianoides, Ground-pine.
150. Aralia.
† fpinofa, Angelica-Tree.
racemofa, Pettymorrel.
nudicaulis, Saffaparil.
151. Linum, Flax.
† ufitatiffimum.
virginianum.
152. Drofera, Sundew.
rotundifolia.

Polygynia.

153. Zanthorrhiza.
† fimpliciffima. } Marfhalli.
apiifolia. } Aitoni.

CLASSIS 6.

Hexandria, Monogynia.

154. Tradefcantia.
virginica.
155. Pontederia.
cordata.
156. Narciffus.
† poeticus.

† Jonquilla.

† Jonquilla.
157. Allium, Garlic.
† Porrum.
† ſativum.
vineale.
canadenſe.
† Cepa.
montanum. N. S.?
158. Lilium, Lily.
† candidum.
† bulbiferum.
† pomponium.
canadenſe.
philadelphicum.
159. Fritillaria, Fritillary.
† imperialis.
160. Uvularia, Bell-wort.
perfoliata.
ſeſſilifolia.
161. Erythronium, Dogſ-tooth.
luteum. }
album. }
162. Tulipa.
† ſylveſtris.
† geſneriana.
163. Hypoxis.
erecta.
164. Ornithogalum,
umbellatum.
165. Leontice.
Thalictroides.
166. Aſparagus.
† officinalis.
167. Convallaria, Solomons-Seal.
† majalis.
Polygonatum.
multiflora.
racemoſa.
168. Hyacinthus, Hyacinth.
† orientalis.
† Muſcari.
169. Aletris, Star-root.
farinoſa.
170. Yucca.
† filamentoſa.
171. Hemerocallis.
† flava.
172. Acorus, Myrtle-graſs.
Calamus.
173. Orontium.
aquaticum.
174. Juncus, Ruſh.
effuſus.
nodoſus.
articulatus.
bulboſus.
bufonius.
campeſtris.
ſpicatus.
175. Prinos, Winterberry.
verticillatus.
176. Berberis, Barberry.
† vulgaris.

Trigynia.

177. Rumex, Dock.
† Patientia.
ſanguineus.
Britannica.
criſpus.

perſicarioides.

persicarioides.
obtusifolius.
alpinus.
Acetosella.
178. Melanthium.
virginicum.
179. Medeola.
virginica.
180. Trillium.
cernuum.

Polygynia.

181. Alisma, Thrum-wort.
Plantago.

CLASSIS 7.
Heptandria,
Tetragynia.

182. Saururus, Lizards-tail.
cernuus.

CLASSIS 8.
Octandria, Monogynia.

183. Tropaeolum.
† minus.
† majus.
184. Rhexia, Soap-wood.
mariana.
185. Oenothera, Night-willowherb.
biennis.
fruticosa.
186. Gaura.
biennis.
187. Epilobium, Willow-herb.
tetragonum.
palustre.
188. Vaccinium, Whortle.
stamineum.
corymbosum.
frondosum.
resinosum, Aitoni.
album.
189. Dirca, Leather-bark.
palustris.

Trigynia.

190. Polygonum, Knotweed.
virginianum.
Lapathifolium.
Hydropiper.
persicaria.
barbatum?
† orientale.
pensilvanicum.
aviculare.
erectum.
linifolium, Shreberi. N. S.
sagittatum.
arifolium,
Fagopyrum.
convolvulus.
dumetorum.
scandens.

Tetragynia.

Anonymos.
verticillata.

CLASSIS 9.
Enneandria, Monogynia.

191. Laurus, Bay.
aestivalis, Spice-wood.
Sassafras.

Trigynia.

hybridum, N. S?

Decagynia.

215. Phytolacca, Poke.
decandra.

Classis 11.

Dodecandria,

Monogynia.

216. Asarum.
canadense.
virginicum.

217. Portulaca, Purslane.
oleracea.

218. Lythrum, Grasspoly.
petiolatum.

Digynia.

219. Agrimonia, Agrimony.
parviflora, Aitoni.
minor. N. S.

Trigynia.

220. Euphorbia, Spurge.
maculata.
Chamaesyce.
Peplus.
† Lathyris.
† helioscopia.
corollata.

Dodecagynia.

221. Sempervivum, House-leek.
† tectorum.

Classis 12.

Icosandria, Monogynia.

222. Philadelphus, Mock-Orange.
† coronarius.

223. Amygdalus.
† Persica, Peach.

224. Prunus, Plumb.
virginiana.
pumila.
† Cerasus.
americana, Marshalli.
† domestica.

Digynia.

225. Crataegus, Hawthorn.
coccinea.
Crus galli.
cordata, Aitoni.
pyrifolia, Aitoni.
flava, Aitoni?

Pentagynia.

226. Mespilus, Medlar.
arbutifolia.
canadensis.

227. Pyrus, Pear.
† communis.
† Malus.
coronaria, Crab-apple.
† Cydonia.

228. Spiraea, Meadowsweet.
opulifolia, Ninebark.
trifoliata, Indian-physic.

Polygynia.

229. Rosa, Rose.
rubiginosa, Sweet-Briar.
carolina.
pendulina, Aitoni?
† centifolia.

 quinquefolia.

quinquefolia.
talictroides.
nemorosa.
252. Clematis, Travellers-Joy.
virginiana.
pensilvanica. N. S.
253. Thalictrum, Rue-weed.
dioicum.
purpurascens.
polygamum. N. S.
254. Ranunculus, Crow-foot.
Flammula.
reptans.
abortivus.
sceleratus.
pensilvanicus.
repens.
lanuginosus.
aquatilis.
255. Trollius ?
americanus. N. S.
256. Helleborus, Hellebore.
† viridis.
257. Caltha, Meadow-bout.
palustris.
258. Hydrastis.
canadensis.

CLASSIS 14.
Didynamia, Gymnospermia.

259. Teucrium, Germander.
canadense.
260. Satureja, Savory.
hortensis.
261. Hyssopus, Hyssop.
† officinalis.
nepetoides.
262. Nepeta, Nep.
Cataria.
263. Mentha, Mint.
crispa.
† piperita.
arvensis.
264. Glecoma, Gill.
† hederacea.
265. Lamium, Archangel.
† album.
amplexicaule.
266. Betonica, Betony.
† officinalis.
267. Stachys, Wound-wort.
sylvatica.
palustris.
268. Marrubium, Hore-hound.
vulgare.
269. Leonurus, Lions-tail.
Cardiaca.
270. Moluccella.
† spinosa.
271. Clinopodium, Basil-weed.
vulgare.
incanum.
272. Origanum, Marjoram.
vulgare.
† Majorana.
273. Thymus, Thyme.
† Serpyllum.
† vulgaris.

† vulgaris.
virginicus.
274. Dracocephalum, Dragons-head.
virginianum.
† Moldavica.
275. Ocymum.
† basilicum, Sweet-Basil.
276. Trichostema.
dichotoma.
277. Scutellaria, Skull-cap.
lateriflora.
integrifolia.
hyssopifolia.
elliptica, Claytoni. 92. N. S.
pubescens. N. S.
278. Prunella, Self-heal.
vulgaris.
279. Phryma.
Leptostachya.
Angiospermia.
280. Bartsia.
coccinea. }
lutea. }
281. Pedicularis, Louse-wort.
asplenifolia. N. S.
canadensis.
282. Gerardia.
purpurea, Walteri.
erecta, Walteri.
flava.
pedicularia.
283. Chelone.
glabra.
Pentstemon.
284. Antirrhinum, Snapdragon.
† Linaria, Ransted.
285. Scrophularia, Fig-wort.
marilandica.
286 Digitalis, Fox-glove.
† purpurea
287. Bignonia, Trumpet-flower.
† Catalpa.
radicans.
288. Lindernia, Sweet-weed.
pyxidaria.
289. Obolaria.
virginica.
290. Orobanche, Broom-rape.
americana.
virginiana.
291. Mimulus, Dogs-snout.
ringens.
alatus, Aitoni.
292. Ruellia.
strepens.

CLASSIS. 15.

Tetradynamia,
Siliculosa.

293. Myagrum, Camline.
sativum.
294. Draba, Whitlow-grass.
verna.
bifolia. N. S.
295. Lepidium, Dittander.
† sativum.

virginicum.

virginicum.

296. Thlaſpi, Shepherdſ-purſe.
Burſa Paſtoris.

297. Cochlearia.
† Armoracia, Horſe-radiſh.

Siliquoſa.

298. Dentaria, Coralwort.
enneaphylla.

299. Cardamine, Ladieſ-mock.
virginica.

300. Siſymbrium, Water-creſs.
naſturtium.
amphibium.

301. Eryſimum, Worm-ſeed.
officinale.
† Barbarea.

302. Arabis, Turkey-pod.
lyrata.
hiſpida ?
canadenſis.
bulboſa, Schreberi. N. S. Clayton 99, n. 45.
integrifolia, Clayton 99. n. 745 ?

303. Turritis ?
glabra.

304. Braſſica, Cabbage.
† Napus.
† Rapa.
† oleracea.

305. Sinapis, Muſtard.
nigra.

306. Raphanus, Radiſh.
† ſativus.

307. Cleome.
dodecandra.

CLASSIS 16.

Monadelphia,

Decandria.

308. Geranium, Cranes-bill.
maculatum.
carolinianum.

Polyandria.

309. Sida, Indian mallow.
ſpinoſa ?
rhombifolia.
abutilon.

310. Althaea, Wymote.
† officinalis.

311. Alcea.
† roſea, Holly hock.

312. Malva, Mallow.
rotundifolia.
† criſpa.
† parviflora.

313. Hibiſcus.
paluſtris.
† ſyriacus.

CLASSIS 17.

Diadelphia,

Hexandria.

314. Fumaria, Fumitory.
cucullaria.
† officinalis.

Octandria.

Octandria.

315. Polygala, Milkwort.
Senega.
ſanguinea.
verticillata.

Decandria.

316. Lupinus, Lupine.
perennis.
317. Phaſeolus, Kidney-bean.
† vulgaris.
† alatus.
† nanus.
perennis. N. S.
318. Glycine.
monoica.
Apios.
319. Clitoria.
mariana.
320. Piſum, Pea.
† ſativum.
321. Vicia, Vetch.
† piſiformis.
ſylvatica.
† Faba.
322. Cicer.
† arietinum.
323. Robinia, Locuſt.
Pſeudacacia.
† hiſpida.
324. Glycyrrhiza, Liquorice.
† glabra.
325. Hedyſarum, Saintfoin.
marilandicum.
fruteſcens.
viridiflorum.
hirtum.
violaceum.
paniculatum.
nudiflorum.
repens.
triflorum?
viſcidum?
et alia.
326. Galega, Goats-rue.
virginiana.
327. Trifolium, Trefoil.
† Melilotus officinalis.
reflexum.
repens.
pratenſe.
arvenſe.
biflorum.
328. Medicago, Medic.
† lupulina.
† ſativa.

CLASSIS 18.

Polyadelphia,

Polyandria.

329. Hypericum, Johns-wort.
Kalmianum.
canadenſe.
perforatum.
quinquenervium, Walteri?
maculatum, Walteri?

CLASSIS

CLASSIS 19.

Syngenesia,

Polyyamia aequalis.

330. Tragopogon, Goats-beard.
† porrifolius.
331. Sonchus, Sow-thistle.
oleraceus.
floridanus.
332. Lactuca, Lettuce.
canadensis.
† sativa.
333. Prenanthes, Wild-Lettuce, Ivy-leaf.
altissima.
alba.
334. Leontodon, Dandelion.
Taraxacum.
335. Hieracium, Hawk-weed.
venosum.
Gronovii.
paniculatum.
Kalmii.
336. Hyoseris, Swine-succory.
virginica.
337. Cichorium, Endive.
† Intybus.
† Endivia.
338. Arctium, Burdock.
Lappa.
339. Serratula, Saw-wort.
praealta.
spicata.
340. Carduus, Thistle.
lanceolatus.
pectinatus?
virginicus.
spinosissimus, Walteri?
luteus. N. S.
341. Carthamus, Sas-flower.
† tinctorius.
342. Bidens, Double-tooth.
tripartita.
cerua.
bipinnata.
343. Cacalia.
suaveolens.
atriplicifolia.
344. Eupatorium, Hemp-weed.
scandens.
album.
sessilifolium.
hyssopifolium?
trifoliatum.
purpureum.
maculatum.
perfoliatum.
aromaticum.

Polygamia superflua.

345. Tanacetum, Tansy.
† vulgare.
346. Artemisia, Southern-wood.
† Abrotanum.

† Absinthium,

† Abſinthium, Wormwood.
† vulgaris, Mug-wort.
347. Gnaphalium, Cudweed.
obtuſifolium.
margaritaceum.
plantagineum.
purpureum.
348. Conyza, Plowmanswort.
aſteroides.
349. Erigeron, Fleabane.
canadenſe.
philadelphicum.
camphoratum ?
350. Senecio, Groundſell.
hieracifolius ?
aureus, *et alii.*
351. Aſter, Starwort.
hyſſopifolius.
rigidus.
novae angliæ.
undulatus.
grandiflorus.
cordifolius.
puniceus.
novi belgii.
miſer.
macrophyllos.
divaricatus.
et aliae forſan hybridae ſp.
352. Solidago, Goldenrod.
canadenſis.
altiſſima.
lateriflora.
bicolor.
lanceolata.
caeſia ?
flexicaulis. }
latifolia. }
rigida ?
odora, Aitoni.
aſpera, Aitoni ?
et aliae forſan hybridae.
353. Inula, Elecampane.
† Helenium.
354. Helenium.
autumnale.
355. Zinnia.
† multiflora.
356. Chryſanthemum, Goldins.
† Leucanthemum.
357. Matricaria, Fever-few.
† Parthenium.
† Chamomilla.
358. Anthemis, Chamomile.
Cotula.
† nobilis.
359. Achillea, Yarrow.
Millefolium.
360. Buphthalmum, Oxeye.
Helianthoides.

Polygamia fruſtanea.

361. Helianthus, Sun-flower.
† annuus.

† annuus.
multiflorus.
decapetalus.
tuberoſus.
giganteus.
362. Rudbeckia.
digitata, Aitoni.
hirta.
fulgida, Aitoni?
363. Coreopſis.
bidens.
alternifolia.
364. Centaurea, Centaury.
† Cyanus.
† benedicta.
365. Polymnia.
Uvedalia.
366. Filago, Cats-foot.
germanica.

Monogamia.

367. Lobelia, Cardinal-flower.
Kalmii
pallida, Schreberi. N. S.
Cardinalis.
ſiphilitica.
inflata.
368. Viola, Violet.
palmata.
pedata.
primulifolia.
paluſtris?
ſagittata, N. S. Aitoni.
† odorata.
canadenſis.
aſarifolia, Schreberi. N. S.
† tricolor.
ſtricta. N. S.
369. Impatiens, Touch-me-not.
noli tangere.

CLASSIS 20.

Gynandria.

Diandria.

370. Orchis, Fool-ſtone.
ciliaris.
ophioglossoides, Walteri.
pallida. Clayton, 136. n. 200?
371. Ophrys, Tway-blade.
corallorhiza.
cernua.
maculata. N. S.
virginiana, Schreberi.
hyemalis. N. S.
372. Arethuſa.
bulboſa.
373. Cypripedium, Ladies-ſlipper.
Calceolus.
album, Aitoni.
acaule, Aitoni.

Triandria.

374. Siſyrinchium.
Bermudiana.

Hexandria

Hexandria.

375. Ariſtolochia, Birth-wort.
ſerpentaria.

Polyandria.

376. Arum, Cuckow-point.
Dracontium.
triphyllum.
377. Dracontium.
foetidum.

CLASSIS 21.

Monoecia.

Diandria.

378. Lemna, Duck-meat.
minor.
arhiza.

Triandria.

379. Typha, Cats-tail.
latifolia.
380. Sparganium, Burr-weed.
erectum.
381. Zea, Indian-corn.
† Mays.
382. Tripſacum, Seſame-graſs.
dactyloides.
383. Coix, Jobſ-tears.
† Lacryma.
384. Carex, Seg.
patula, Hudſoni ?
pulicaris.
leporina.
vulpina.
muricata.
loliacea.
paniculata.
varia, Schreberi. N. S.
tomentoſa.
panicea.
ſylvatica, Hudſoni.
Pſeudocyperus.
paleacea, Schreberi ? N. S.
acuta.
ariſtata, Schreberi. N. S.
curvicollis, Schreberi. N. S.
veſicaria.
ceſpitoſa.
et aliae.
385. Tragia.
Mercurialis ?

Tetandria.

386. Betula, Birch.
nigra.
lenta.
Alnus.
387. Buxus, Box.
† ſempervirens.
388. Urtica, Nettle.
pumila.
† dioica.
cylindrica.
divaricata.
canadenſis.
389. Morus, Mulberry.
† alba.
rubra.

Pentandria.

390. Xanthium, Clott-weed.
ſtrumarium.

391. Ambroſia.
trifida.
elatior.
artemiſifolia.

392. Amaranthus.
albus.
hybridus.
ſanguineus.
hypochondriacus.

393. Sagittaria, Arrow-head.
ſagittifolia.
obtuſifolia.
lancifolia.

394. Quercus, Oak.
Prinus.
aquatica, Aitoni.
nigra.
rubra.
diſcolor, Aitoni.
alba.

395. Iuglans, Walnut.
alba.
nigra.
cinerea, Wangenheimi.
ovalis, Wangenheimi, ovata, Marſhalli.
glabra, Wangenheimi?
odorata, Marſhalli.
amara, minima, Marſhalli.
obcordata.

396. Fagus.
Caſtanea, Cheſnut.
pumila, Chinquapin.
ferruginea, Aitoni. Beech.

397. Carpinus, Horn-beam.
Betulus.
Oſtrya.

398. Corylus, Hazle.
† avellana.
americana, Marſhalli.
cornuta, Marſhalli, roſtrata, Aitoni.

399. Platanus, Plane-tree.
occidentalis.

400. Liquidambar, Sweet-gum.
peregrinum.

Monadelphia.

401. Pinus, Pine.
inops, Aitoni.
Taeda.
americana, Wangenheim, fig. 36.
† laricina, Wangenheim, fig. 37.

402. Thuja.
† occidentalis, Arbor vitae.

403. Acalypha.
virginica.

404. Ricinus.
† communis.

Syngeneſia.

405. Momordica.
echinata. N. S.

406.

406. Cucurbita, Pumpkin.
† lagenaria.
† Pepo.
† verrucoſa.
† Melopepo.
† Citrullus.
407. Cucumis, Cucumber.
† ſativus.

CLASSIS 22.

Dioecia,

Diandria.

408. Salix, Willow.
† vitellina.
† babylonica.
nigra, Marſhalli.
humilis, Marſhalli.
ſericea, Marſhalli.
alpina, Walteri, triſtis, Aitoni.
† viminalis.

Tetrandria.

409. Myrica, Gale.
cerifera.

Pentandria.

410. Zanthoxylum.
fraxinifolium, Marſhalli, Prickly-aſh.
411. Spinacia, Spinach.
† oleracea.
412. Cannabis, Hemp.
† ſativa.
413. Humulus, Hop.
Lupulus.

Hexandria.

414. Smilax.
rotundifolia.
laurifolia.
Pſeudochina.
415. Dioſcorea.
villoſa.

Octandria.

416. Populus, Poplar.
tremula.
balſamifera.

Dodecandria.

Meniſpermum, Moon-ſeed.
virginicum.
carolinum.

Monadelphia.

417. Juniperus, Juniper.
† Sabina
† communis.
virginiana? Red-Cedar.

CLASSIS. 23.

Polygamia,

Monoecia.

418. Veratrum, White-Hellebore.
album.
luteum.
419. Andropogon, Beard-graſs.
nutans.
bicorne.
digitatum. N. S.

420. Holcus, Soft-grafs.
† Sorghum, Guinea-corn.
† Sacharatus, Broom.
lanatus.
tener, Schreberi. N. S.
edoratus.
421. Cenchrus, Hedge-hog-grafs.
echinatus.
422. Atriplex, Orach.
† hortenfis.
423. Acer, Maple.
rubrum.
facharinum.
negundo.
424. Celtis. Nettle-tree.
occidentalis.

Dioecia.

425. Gleditfia, Honey-locuft.
† triancanthos.
426. Fraxinus, Afh.
americana, Marfhalli.
alba.
nigra.
penfilvanica.
427. Diofpyros, Perfimmon.
virginiana.
428. Nyffa, Tupelo-tree.
multiflora, Walteri, integrifolia Aitoni.
429. Panax.
quinquefolium, Ginfeng.
trifolium.

Classis 24.

Cryptogamia,

Filices.

430. Equifetum, Horfe-tail.
arvenfe.
fluviatile.
hyemale.
431. Onoclea.
fenfibilis.
432. Ophiogloffum.
vulgatum.
433. Ofmunda, Flowering-Fern.
virginica.
ternata.
regalis.
claytoniana.
cinnamomea.
434. Pteris, Brakes.
aquilina.
caudata.
talictroides, Schreberi.
434. Afplenium, Spleen-wort.
rhizophyllum.
falicifolium.
Trichomanoides.
ebeneum, Aitoni.
436. Polypodium, Polypody.
virginianum.
Lonchitis.
cicutarium.
phegopteris.

cristatum.

calcarius.
ericetorum.
fagineus.
ſaxatilis.
parietinus.
granoſus, Schreberi.
phyſodes.
ciliaris.
pulmonarius.
calicaris.
caperatus.
crinitus, Schreberi.
aphthoſus.
caninus.
ſylvaticus.
miniatus.
puſtulatus.
cocciferus.
pyxidatus.
gracilis.
foliaceus, Hudſoni.
rangiferinus.
uncialis.
paſchalis.
plicatus.
hirtus.
floridus.
et alii multi novi.

447. Tremella.
juniperina.
meſenteriformis.
et aliae.

Fungi.

448. Agaricus.
campeſtris.
violaceus.
viſcidus.
fimetarius.
acicularis.
quercinus.
ochraceus.
et permulti alii.

449. Boletus.
ſuberoſus.
ſanguineus.
verſicolor.
luteus.
et alii.

450. Hydnum.
paraſiticum.
imbricatum.

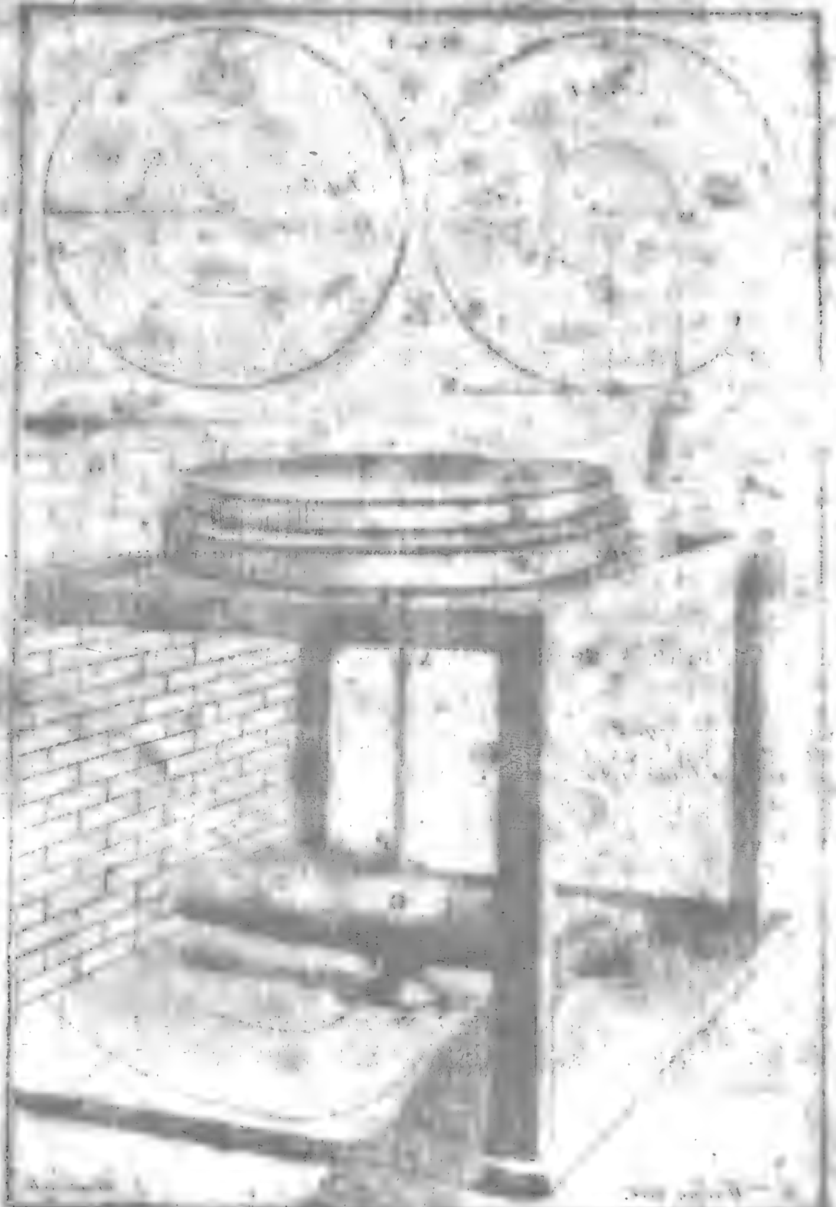
451. Phallus, Morille.
eſculentus.
impudicus.

452. Peziza, Cup-Muſh-room.
lentifera.
auricula.
et aliae.

453. Clavaria, Club Muſh-room.
militaris.
digitata.
Hypoxylon.
coralloides.

454. Lycoperdon, Truffle.
Tuber.
boviſta.

N°.



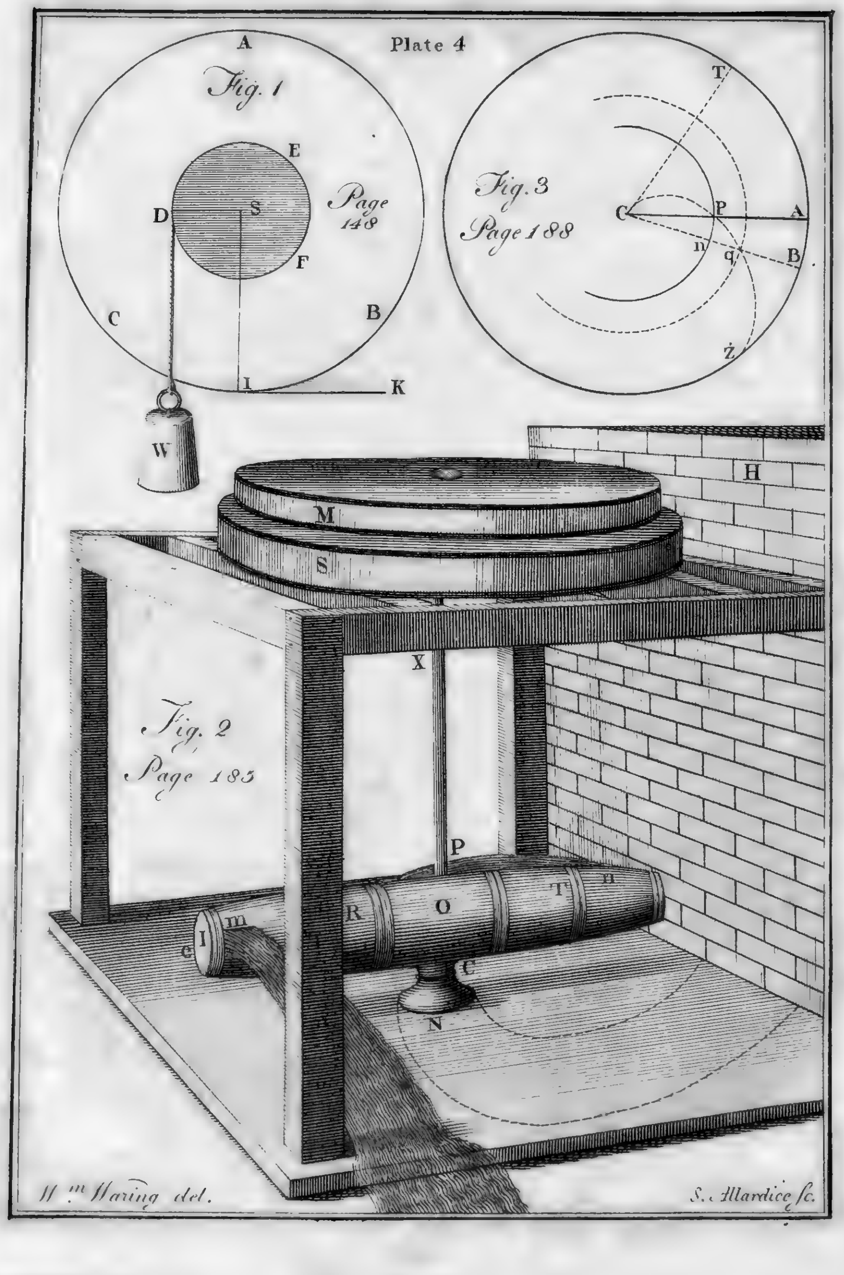


Plate 4
Fig. 1
Page 148
A
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Fig. 3
Page 188
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Fig. 2
Page 185
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N°. XXII.

Investigation of the Power of DR. BARKER'S, *Mill, as improved by* JAMES RUMSEY, *with a description of the Mill, by* WM. WARING.

Description *of the* Mill. *Plate* 4. *Fig.* 2.

Read Sept. 21st, 1792.

RT. Is the rotatory; being a tube or trunk into which the water is conveyed by a pipe from the head H, through the neck N and collar C, to the apertures m, n, on contrary sides; where, by its reaction in passing off, it occasions a forcible rotation round the axis or spindle X P, which passes through the lower millstone S and turns the upper one M, or effects other purposes.

Of the proper capacity of the pipe by which the water is conveyed from the head H to the rotatory at N.

Let e= the area of the water's passage at N
h= the perpendicular height of H above N
u= the perpendicular depth of any part of the pipe below H
x= the area at the depth u below H

Then, the areas in the several parts of the pipe (being inversely as the velocities) must be in the inverse subduplicate ratio of the depths below the head; wherefore $\frac{x}{e}=\frac{\sqrt{h}}{\sqrt{u}}$, which gives $x=e\sqrt{\frac{h}{u}}$; so that the pipe must widen towards the head H in the proportion of 1 to $\sqrt{\frac{h}{u}}$; and if the area at any given height be less than $e\sqrt{\frac{h}{u}}$ the water will be obstructed in its passage.

This theorem ($x=e\sqrt{\frac{h}{u}}$) also applies to the pipe of a fire-engine, &c. h being = height of the nozzle from the bottom of the air veſſel toward which the water is uniformly accelerated, u = the height of any other part.

If p = the preſſure of the fluid by its gravity, at the depth h, in a pipe, the area of which is every where $= e\sqrt{\frac{h}{u}}$, it will be, as $eh : ue\sqrt{\frac{h}{u}} : : p : p\sqrt{\frac{u}{h}}$, = the preſſure or momentum at the depth u below H.

*Of the initial power of the machine or force with which it begins to move.**

Given,
- a = area of either aperture
- h = height of the water above the centres of the apertures } in feet.
- w = 62,5lb. avoirdupois = the Wt. of a cubic foot of water,

Required, I = the initial force, or that with which the machine begins to move.

If we conceive the water preſſing in the tube from O toward I, previous to the opening of the apertures, it is evident it will not produce any motion, becauſe the action againſt each ſide is the ſame: wherefore the preſſure againſt the part m, which is to be removed for an opening, is equal that oppoſed to the ſame area e in the oppoſite direction; now, when the part m is opened, the re-action thereof ceaſes, and the equal impulſe remaining on the contrary ſide e, will be the force required. Viz. a h w for each brachium; conſequently, I = 2hwa = the power with which the rotatory commences its motion. But, as the velocity of rotation increaſes, the relative velocity of the water to that of the tube, and conſequently the power, is diminiſhed, notwithſtanding what is gained by

The

* Benjamin Martin, in his Philoſophia Britannica Vol. I. page 217, has attempted to compute the power of ſuch a machine, by the weight and velocity of water emitted per ſecond, &c. without finding the force neceſſary to expel it; but it is not the force accumulated during a ſecond, or any given times, we require, but the power acting continually or at any inſtant conſidered abſtractedly from the idea of time.

The centrifugal force.

Let x=diſtance of any point in the radius from the centre of motion } in feet
r=radius or length of the arm, } in feet
a and w as before,
t=time of a revolution in ſeconds.

Then a will alſo be the area of a ſection of the water paſſing through the tube, at right angles to its direction (or of ſo much of it as we muſt compute the centrifugal force for) which multiplied by the fluxion of x, and by w will be $wa\dot{x}$=the Wt. of the evaneſcent quantity or moving plane $a\dot{x}$, which is the fluxion of the current water in the tube; and, by the doctrine of central forces, as $t^2 : 1.228x :: aw\dot{x} : \frac{1.228awx\dot{x}}{t^2}$=the centrifugal force thereof at x Ft. from the centre of motion, or the fluxion of the whole centrifugal force of the quantity paſſing through either brachium at any time; the fluent of which, when x=r, being doubled, is $\frac{76.75ar^2}{t^2}$=the central force of the water in both arms; which is equal to the augmentation of power thereby occaſioned at the apertures, becauſe fluids preſs equally in all directions. But this force is greatly counteracted by

The Inertia of the Fluid.

The Inertia of the rotatory tube, with the contained fluid, would not continue to reſiſt the moving power, after the velocity became uniform, were the ſame fluid retained therein to which the motion had been at firſt imparted; but as this paſſes off, and there is a continual ſucceſſion of new matter acquiring a motion in the direction of the rotatory, there muſt be a conſtant reaction againſt the inſide of the tube, by the inertia of the fluid, equal to the communicating force. Now this reaction is very different from that of a fluid confined in the tube when it begins to move, becauſe a particle at the extremity of the tube is not to receive its whole circular motion there, but has gradually acquired it by a uniform acceleration during its paſſage along the tube: ſo that inſtead of the uſual way of computing inertia by the centre of gyration, I muſt inveſtigate a new theorem for the purpoſe (at leaſt new to me) which may be thus;

Suppoſe a particle P (plate 4. fig. 3,) * moving iniformly in the line and direction C A, while this line has a uniform horizontal motion toward the poſition CB; then P deſcribes the common ſpiral of Archimedes to Q, &c. and the velocities in P and Q, in the direction of the circumferences paſſing through thoſe points, are as thoſe circumferences, or as their radii CP, CQ, &c. in which ratio are alſo the times of its moving from C to P, Q, &c. And ſince the velocities are as the times of moving from C, (as is the caſe of a body falling from reſt) the particle P muſt be uniformly accelerated, in the direction P n by a conſtant equable force, like that of gravity; therefore its reaction againſt the moving line CA, by its inertia, muſt be the ſame in every point from C to A; hence the middle point of the radius is to be conſidered as the centre of reſiſtance in this caſe.

Let $x =$ C P, the diſtance in feet of a particle P from the centre at any inſtant.

$v =$ the velocity of P per ſecond, in the direction of the radius C A.

$c = 3.1416$; a, r, t and w, as before.

Then the moving plane or particle P will be $a\dot{x}$, and its weight $wa\dot{x}$ lbs. as before, alſo its velocity $= \frac{2cx}{t}$ and the time

* The velocity muſt be uniform if the tube be priſmical; but the effect in this caſe will be the ſame if it taper, and the water be accelerated; for the ſame quantity in the ſame time paſſes through (and is acted upon) by every part. Otherwiſe we ſhould uſe the logarithmic ſpiral.

time of its acquiring that velocity, *i. e.* of paſſing from C to P, $= \frac{x}{v}$: now the accelerating force neceſſary to communicate a velocity of $\frac{2cx}{t}$ feet per ſecond, to a body weighing $a\dot{w}x$ lb. in $\frac{x}{v}$ ſeconds will be $\frac{cwav\dot{x}}{16t}$ lb.=the fluxion of the inertia, and the fluent, when x becomes = r, will be $\frac{12.272avr}{t}$ lb.=the reſiſtance oppoſed to either brachium, to be eſtimated as if accumulated at $\frac{1}{2}$ r from the centre of motion; conſequently equal to the effect at both apertures when reduced to their diſtance, Q. E. F.

This may be obtained independently of fluxions; by conſidering, that the whole quantity of water (r w a) in the time $(\frac{r}{v})$ of its paſſing through the rotatory, acquires a velocity $(\frac{2crv}{t})$ equal to, and in the direction of, the apertures, as it is carried with the tube out of its natural courſe; to produce which the neceſſary force will be $\frac{12.272avr}{t}$, as before.

Acquired velocity of the water.

The velocity of the water through the apertures at the beginning of rotation is $8\sqrt{h}$ (by the eſtabliſhed principles of hydroſtatics) and, as $2\,w\,a\,h : \overline{8\sqrt{h}}|^2 = 64h :: 2awh + \frac{76.75ar^2}{t^2} : 64h + \frac{39{,}296r^2}{t^2}$ = the ſquare of the augmented velocity; the ſquare root of which is $8\sqrt{(h + \frac{.614r^2}{t^2})}$ = the acquired velocity of the water.

Proportion

Proportion of the central force to the Inertia.

By fubftituting $8\sqrt{(h+\frac{.614r^2}{t^2})}$ for v, in $\frac{12.272avr}{t}$, it becomes $\frac{98.176ar^2}{t^2}\times\sqrt{(\frac{ht^2}{r^2}+.614)}$ = the inertia; and, as the central force $\frac{76,75ar^2}{t^2}:\frac{98.176ar^2}{t^2}\times\sqrt{(\frac{ht^2}{r^2}+.614)}::1:1,28\sqrt{\frac{ht^2}{r^2}+.614}=\sqrt{1+(\frac{1.638ht^2}{r^2})}$; that is, the power gained by centrifugal force is to the obftruction occafioned by the inertia, in theproportion of 1 to $\sqrt{(1+\frac{1.638ht^2}{r^2})}$; by which it appears that the latter is the greatter, except when t or h=o, or r infinite; cafes never occuring in practice; and that the longer the brachia, the lefs the fall of water, and the greaterthe velocity of rotation are, the nearer thefe forces approach the ratio of equality; but as we always find fomething in practical machanics to prevent our "running into infinitecimals," fo here we are particularly limited; for in the

Adjuftment of the parts and motion.

The centrifugal force fhould not exceed the gravity of the rotating water, or this water would be drawn into the tube fafter than the natural fupply at its entrance, by the velocity proper to that depth; confequently muft lofe the preffure of the column above it: nor fhould the velocity of the apertures, be greater than half that of the water through them; for the apertures being ftill adapted to the velocity, the effluent quantity or number of acting particles is as the time; confequently the momentum is in the fimple ſimple ratio of the relative velocity as before demonſtrated (at page 146) for the underſhot wheel: hence, the greateſt effect will be produced when the central force = gravity, and the velocity of the apertures = $\frac{1}{2}$ that of the water; that is, $\frac{76.75ar^2}{t^2} = 2war$; and, $\frac{2cr}{t} = 4\sqrt{h+r}$. from which equations we have the following.

$$\text{Viz.} \left\{ \begin{array}{l} h = 3r = 5t^2 \\ r = 1.63t^2 = \frac{1}{2}h \\ t = \sqrt{.614r} = \sqrt{\frac{1}{3}h} \end{array} \right\} \text{nearly, where we find, } h,\ r,\ \&\ t^2, \text{ about the}$$

conſtant ratio of 5, 3 and 1.

Yet we may obſerve here, that while r and t are preſerved in a conſtant ratio, the value of $\frac{76,75ar^2}{t^2}$ and $\frac{12.272avr}{t}$ *i. e.* the central force and inertia muſt remain the ſame; ſo that the brachia may be made to any length at pleaſure (not leſs than $\frac{1}{3}$ h) if the time of revolution be proportional, viz. if $t = \sqrt{.614r}$, *i. e.* if the velocity of the apetures be not varied; for a double radius, rotating in a double time, or with $\frac{1}{2}$ the angular velocity, has the ſame abſolute velocity at the extremity; and, with the ſame power, there applied, will produce the ſame effect. Wherefore, to find,

The moving force and velocity of the Machine, when the effect is a Maximum.

If we put. 614r for t^2 and 3r for h, as before, in the expreſſion $\sqrt{(1+\frac{1.638ht^2}{r^2})}$ it becomes $\sqrt{1+3} = 2$; in which caſe the reſiſtance of inertia is juſt double * the central force, or the

* It is demonſtrable, that the centrifugal force will be to the inertia, as the velocity of the apertures, is to that of the effluent water; hence alſo, in the preſent caſe, they bear the proportion above ſtated, exactly.

the gravity of the water in the tube, $= 125ar$, which taken from the impelling force, leaves $62,5(ah+r) - 125ar = 62,5a \times \overline{h-r}$ (taking $r = \frac{1}{3}h$) $= 41\frac{2}{3}ah$ lb. avoirdupois = the real moving force, at the diſtance of the centres of the apertures from the centre of motion. And, by a like ſubſtitution, the velocity $4\sqrt{h+r}$ becomes $4\sqrt{1\frac{1}{3}h} = 4,62\sqrt{h}$ feet per ſecond, Q. E F.

Area of the apertures.

If $A =$ the area of a ſection of the race, perpendicular to the direction of its motion; $V =$ its velocity per ſecond, both in feet; a and h as before; then it will be, $AV = 8a\sqrt{h}\frac{.614r^2}{t^2}$ cubic feet = the quantity of water emitted per ſecond; hence, $a = \frac{AV}{8.924\sqrt{h}}$ the area proper for one of the apertures.

Scholium.

Were the apertures quieſcent, their area ſhould be enlarged in the proportion of $\sqrt{h}$ to $\sqrt{1\frac{1}{3}h}$, or of 1 to $\sqrt{1\frac{1}{3}}$ to diſcharge the ſame quantity; but then the effluent velocity would be diminiſhed in the ſame ratio; wherefore, $\frac{2wah}{2} = 41\frac{2}{3}ah$, with the ſame velocity, $4,62\sqrt{h}$ as above, will be alſo very nearly the true moving force of a well conſtructed underſhot wheel (J. Smeaton, &c.) Wherefore may be conſidered, in effect, nearly, if not exactly tantamount, when they have the ſame quantity and fall of water; the beſt overſhot being nearly double to either.

From the preceding calculus are deduced the following

Eaſy

Easy practical rules.

1. Make the arm of the rotatory tube, from the centre of motion to the centre of the aperture, of any convenient length, not less than $\frac{1}{3}$ of the perpendicular height of the water's surface above these centres.

2. Multiply the length of the arm, in feet, by .614, and take the square root of the product for the proper time of a revolution in seconds, and adapt the other parts of the machinery to this velocity; or,

3 If at the time of a revolution be given, then, multiply the square of this time by 1.63 for the proportional length of the arm.

4. Multiply together the breadth, depth and velocity per second of the race, and divide the last product by 8.924 times the square root of the height, for the area of either aperture.

5. Multiply the area of either aperture by the height of the head of water, and the product by $41\frac{2}{3}$ (or by 40 on common occasions) for the moving force, estimated at the centres of the apertures in pounds avoirdupois.

6. The power and volicity at the apertures may be easily reduced to any part of the machinery by the common rules of mechanics.

N°. XXIII.

A Thermometrical Journal of the temperature of the atmosphere and Sea, on a voyage to and from Oporto, with explanatory observations thereon.

Philadelphia, Sept. 18, 1792.

SIR,

Read Sept. 21st, 1792.

ON the 15th of June last Capt. William Billings of this city, commander of the ship Apollo, presented the journals of his voyages to and from Oporto, for the inspection of the American Philosophical Society. As they were not accompanied by any explanatory memoir, I have extracted from them what alone differs from sea reckoning in general, and inclose a thermometrical journal of the temperature of the atmosphere and sea, which evidently appears to be the object of the communication. As it was proper to show that these observations were not imaginary, and had arisen in the course of his voyages, Capt. Billings presented his whole journals, consisting of 73 pages in folio, with all the detail of a log book, which in original are deposited among the society's papers. *

As the experiments of this intelligent navigator, appear to be repetitions of those I made near two years before, which are related in my memoir No. X. page 82 of this volume, I beg leave to make the following observations on them.

By these journals it appears that in June, 1791, the water on the coast was at the temperature of 61°. by Fahrenheit, and in the Gulph stream at 77°. By my journals it will be found that in November, 1789, the water on the coast

* The temperature of the water was tried several times every day, but in this extract it was thought proper only to notice the important changes, a succession of similar results being thought unnecessary.

coaſt was at 47°. and in the gulph ſtream at, 70°. viz.

By Capt. Billings,		By my experiments		diff. between June and Nov.
1791, June, coaſt,	61	1789 Nov. coaſt,	47	14°.
do. Stream,	77	do. ſtream,	70	7
do. ſtream warmer,	16	do. ſtream warmer	23	

Hence it may be concluded that although this difference of heat is more remarkable in winter than in ſummer, yet it is ſufficient at all times to guide navigators, ſo as to take the benefit of its current in going from, and to avoid its oppoſition in coming to America.—In the latter caſe, it has this additional convenience in correcting a reckoning; for if a navigator can, by this means, know the moment he is within the ſtream, he knows at the ſame moment his relative ſituation as to the coaſt; and if by repeated experiment this mode of correction ſhould be found ſolid, it amounts, in effect, to a certainty of the longitude, at the preciſe time when it is important to be accurate.

Captain Billings' courſe being nearly along the ſtream, he found only ſuch alteration in the heat of the water as may be accounted for by the cooling of the ſtream itſelf, in its courſe to the northward, 'till he came to lat. 39. 00. N. long. 56. 00. W. (a breaſt of the Banks of Newfoundland) when the mercury fell 10°. Doctor Franklin, in November, 1776, on board of the Repriſal, in lat. 41. N. long. 46. W. found about the ſame difference; but the Repriſal had kept a courſe farther ſouth and came into this cool water in a N. N. E. direction; while Captain Billings being farther North, came in an eaſterly direction, and of courſe might be as much within the influence

 of

of that chain of banks which extends from the longitude 45 W. along the American coaſt, as the Repriſal was when ſo much farther to the caſtward. In November 1789, I found the ſame difference in lat. 40. N. long. 49. W. after ſailing in a direction about N. E. and a line being drawn from the place where Captain Billings's change happened, to that where Doctor Franklin's thermometer fell (in a direction about E. N E.) would nearly interſect the place where I obſerved the ſame alteration; this is about the ſweep of the banks, known by frequent ſounding, as will be found by conſulting the beſt charts.—By the coincidence of theſe three journals, at ſo great a diſtance of time, and without any knowledge of, conſequently without any connection with each other, this important fact ſeems to be eſtabliſhed. *A navigator may diſcover his approach towards objects of danger, when he is at ſuch a diſtance as to be able eaſily to avoid them, by attentively examining the temperature of the ſea.*

After having paſſed the banks, Captain Billings found but little difference during 18 days ſail, till he came near the European coaſt. The ſame uniformity appears in my journal on a voyage to England, Page 85 of this volume.

Captain Billings found the water to grow cooler three days before he made the land, and the mercury fell gradually from 65 to 60° when the land appeared: this was in June. In November I found on approaching the Engliſh coaſt a gradual fall from 53 to 48° and then we ſtruck ſoundings. Here the difference between the ſea and coaſt water was in both caſes the ſame, though the heat of both varied with the ſeaſon.

Returning from Oporto, Captain Billings marked his approach to, and departure from the weſtern Iſlands by the changes of his thermometer, but in this caſe the difference was ſmall; becauſe, owing to the climate and ſize of of theſe Iſlands, the land cannot be ſo cold as a northern continent naturally muſt be. Indeed, the uſefulneſs of the thermometer ſeems to be applicable to the more dangerous ſituations, and not to Iſlands in warm climates; I ſhould ſuppoſe, for obvious reaſons, that the changes would not be great about the Iſlands ſituated between the tropics. The ſhore of theſe Iſlands is generally bold, and the land being very high, may be ſeen at a great diſtance. The climate is not ſubject to fogs, ſnow ſtorms, Iſlands of Ice, long nights, &c. ſo that, except hurricanes, (which are more fatal to ſhips in port than at ſea) there ſeems to be but little danger in ſuch navigation.

After leaving the weſtern Iſlands, Captain Billings ſteered to the weſtward, being in nearly the ſame lattitude on the 30th (37° 47° N.) that he was on the 17th of Auguſt. (37° 53° N.) but during the intermediate time he was driven, as winds prevailed, in a zig zag courſe, as far North as 39° 04 N. and as far ſouth as 36° 26 N. It appears alſo during this time that his thermometer varied from 1° to 5°; but it is to be remarked that there is a medium in his thermometrical variations anſwering to the medium of his lattitude. When he was in 39° 04. the thermometer marked 75° and when in 36° 26. it alſo marked 75° but when in 38° 12. it marked 70°. Now conſidering that he had the warm influence of the gulph ſtream to the Northward, and that the ocean water to the ſouthward muſt naturally be warmer than that more North, out of the ſtream, there ſeems to be a perfect agreement between theory and fact with regard to the uſefulneſs of the thermometer in diſcovering the courſe of this current. The ſame thing occurred in the courſe of my paſſage in the London Packet with Doctor Franklin, (ſee Vol. 2 page 329 of the Tranſactions of this ſociety) in

June

June 1785. The mean there was 73 while to the northward and fouthward the thermometer marked 77.

Returning towards the coaft of America, Captain Billings difcovered his paffage acrofs the gulph ftream by a fudden fall in the mercury of 5° from noon to night, and about 5° farther Weft, by a further fall in the fpace of 8 hours run, he difcovered the coaft, where he got foundings, before he faw the land.

The ufefulnefs of the thermometer as a nautical inftrument is not confined to the difcovery of an approach towards objects of danger *known to exift;* but it, may if attended to, difcover others *not at prefent fuppofed to exict*, againft which a navigator cannot be on his guard. Several charts, particularly one made by Governor Pownall, in September 1787, point out rocks and breakers in the middle of the ocean; fome are faid to be uncertain, others have been feen but once, and preferve the names of their fuppofed difcoverers. Thefe facts are generally doubted, and by fome mariners have been ridiculed; but it fhould be confidered that in every inftance where the difcovery of thefe hidden dangers have been fatal, no one could efcape to tell the melancholy tale, and furely the number of miffing fhips juftifies a conjecture that fuch misfortunes have happened, and ought to influence every navigator to make accurate obfervations on the temperature of the fea during the *whole* of his voyage.

A gentleman of undoubted veracity related to me fome time fince, the following fact, which I mention on account of its aptitude to this fubject.

On a voyage from the Weft-Indies to England, the fmall veffel he was in, touched at Bermuda. On leaving that ifland, having fine weather and a fmooth fea, they failed along a ridge of rocks, feeing the bottom very plain-

ly

ſy all the time, till the iſland was out of ſight; in this place they ſpoke a large ſhip, the Captain of which, had no idea of his ſituation; he had not noticed the bottom, and was ſailing in full confidence of being far from danger. On being deſired to look over the ſide of his ſhip, the whole crew was in the utmoſt conſternation, and hove the ſhip too, with all her ſails ſett. He was ſoon informed of his true longitude, and took a new departure. Had this Captain kept a thermometrical journal he would not, probably, have been ſo deceived, and had he at this time been in a gale of wind, his error might have been fatal. Every body in this city remembers the dreadful cataſtrophe of the ſhip Faithful Steward, which was loſt, on this coaſt, with near 500 people on board, about ſeven years ſince. The Captain was ſo ſure of having ſufficient ſea room, that he did not think of ſounding, the weather was not boiſterous and had he known his ſituation he might have ſtood off during the night. But fearleſs of a danger he did not know, he ſtood on with full ſails, and was in an inſtant loſt: I think there were not above twenty ſouls ſaved. A thermometer regularly uſed would have given warning in time, and probably have ſaved theſe lives.

The impreſſion ſuch events have made on my mind, has induced me to be thus particular, and I the more readily do juſtice, to the judicious example given to other Captains, by Captain Billings, becauſe I think the obſervations of a mariner, are more likely to be attended to by mariners, than any inſtruction given by a landſman. I think beſides, that the merit of Captain Billings, ought to be rewarded, by a publication of his laudable conduct,

that

that he may enjoy the reputation to which he is justly entitled.

I am with great respect, Sir
Your most obedient and
Most humble Servant,
JONATHAN WILLIAMS,
{ One of the Secretaries of the American Philosophical Society. }

A Thermometrical Journal of the temperature of the atmosphere and sea on a passage from Philadelphia to Oporto in the Ship Apollo, by Captain William Billings.

1791 Dates.	Time.	Places in at Noon				Temp. of		Notes.
		Latt. N.		Lon. W.		Air.	Water.	
June 6.	Sun-rise.	38	56	75	07		61	
	2 P. M.	38	38	74	28		66	
	Sun sett.					65	66	
8	10 A. M.						70	
	Noon.	37	18	72	34	75	72	
10	Noon.	38	03	68	49	73	77	
11	Noon.	38	51	65	57	66	75	
12	Noon.	39	02	63	22	71	71	
14	Noon.	39	11	56	48		62	
15	Noon.	39	37	53	43	71	65	
{ From this date to the 2d July the variations in the heat of the sea water do not exceed two degrees, they need not therefore be noticed. }								
July 2d	Noon.	40	16	15	34	68	65	
3	Noon.	40	05	13	23	68	64	
4	Noon.	40	28	11	13	68	63	
5	2 P. M.					68	63	
	7 P. M.						60	Land in sight, but frequently obscured by fog.
	8 A. M.						57	Land distant about 6 leagues.
	Noon.						55	Land distant about 2 leagues being the high land of Braganea nova

Notes:

Off Cape Henlopen.—N. B. The thermometer is on Fahrenheit's scale and the longitude West from London.—The days are reckoned to begin at Noon and to end at the succeeding noon according to the usage of navigators.

June 8th. at 10 A. M. being the first alteration in the heat of the water after leaving the coast it is supposed we entered the gulph stream. The course is not across, but rather along this current, somewhat diagonally however.

June 10th at noon it is supposed we are in the middle of the gulph stream.

June 14th noon this sudden fall of 9° is supposed to be owing to the influence of the banks of Newfoundland which bear about N.

July 4th the water appears to have changed colour.

A Thermometrical

A Thermometrical Journal of the temperature of the atmosphere and sea, on a passage from Oporto to Philadelphia, in the Ship Apollo, by Captain William Billings.

1791 Dates.	Time.	Places in at Noon.		Temp. of		Notes.
		Lat. N.	Long. W.	Air.	Wat.	
Aug. 4,	10 A. M.				57	Port barr: bearing E S E dist. 7 leagues.
	Noon.	41 07	9 04		60	
5	Noon.	40 39	13 06	69	61	
6	8 A. M.			69	65	
	Noon.	40 35	17 06	69	67	But about half of degree difference
7	10 P. M.	40 29	20 24	68	68	of latitude during 5 days, and little
8	Noon.	40 24	22 01	69	68	or no change in the temperature of the
9	Noon.	41 00	22 49	68	68	sea.
10	Noon.	40 13	22 39	68	68	
11	Noon.	38 42	24 02	69	71	N. B. 1 and ½ degree southing water 3° warmer.
	10 P. M.				70	At 4 P M made the island St. Michael
	Midnight				69	Island dist. 4 leagues, tack'd and stood
12	Noon.	37 57	24 55	72	70	off, at 5 A M. tack'd and stood to
14	Noon.	38 45	27 07	73	71	the southward.
15	2 P. M.			72	70	Made the island Tercera. at 4 P. M.
	Sunset.			72	69	
	Sunrise.				68	Near Tercera, St. Georges and Pico in
16	2 P. M.	38 24	27 51	73	70	sight:
	Sunset.				69	
	10 P. M.				68	Close in with St. Georges.
	Midnight				69	
	Noon.	37 53	27 20	73	71	Land out of sight.
17	10 P. M.			70	72	
	Noon.	37 07	27 39		73	
18	Noon.	36 36	28 44		73	
19	Noon.	36 09	31 39		73	
20	Noon.	36 26	34 31	74	75	
21	10 P. M.			74	74	
	10 A. M.				70	
	Noon.				69	
22	Noon.	38 24	36 48		69	
23	Noon.	38 43	38 49	74	73	
24	10 P. M.	38 43	38 49	74	73	
	Noon.	38 44	41 32		71	
25	Noon.	39 04	44 17		75	
26	Noon.	38 56	46 44		75	
27	Noon.	38 12	50 10		70	
28	Noon.	37 02	51 28		75	
29	Noon.	38 08	52 31	74	74	
30	Noon.	37 47	53 20	74	75	
31	10 P. M.			72	70	
	Noon.	39 20	53 20		69	
Sept. 1,	Noon.	40 41	54 07	71	74	
2	Midnight			72	71	

A Thermometrical Journal of the temperature of the atmoſphere and ſea, on a paſſage from Oporto to Philadelphia, in the ſhip Apollo, by Capt. William Billings, continued.

1791 Dates.	Time.	Places in at Noon.		Temp. of		Notes.
		Lat. N.	Long. W.	Air.	Wat	
Sept. 2	Noon.	40 57	55 26	70	72	
3	Midnight				71	
	Noon.	40 56	57 51	70	73	
4	Noon.	39 10	59 18	74	74	
5	Noon.	39 17	61 11	74	76	
6	Midnight				77	This riſe indicates the gulph ſtream.
	Noon.	40 06	63 20	74	78	
7	Noon.	40 36	66 03		75	
8	Noon.	40 01	67 23	73	77	
9	10 P. M.			71	73	This fall indicates the weſtern ſide of the gulph ſtream.
	Midnight				72	
	4 A. M.				71	
	Noon.	39 29	71 17		73	
10	Noon.	39 19	72 08	73	73	
11	Noon.	39 04	72 33	74	75	
12	Noon.	38 57	73 21	74	74	
13	Noon.	38 53	72 31	74	75	
14	Noon.	39 21	73 31	75	73	
15	6 P. M.			74	69	
	8 A. M.				68	Sounded in 25 fathoms.

Nº. XXIV.

Firſt Memoir of Obſervations on the Plants denominated *Cryptogamick*.

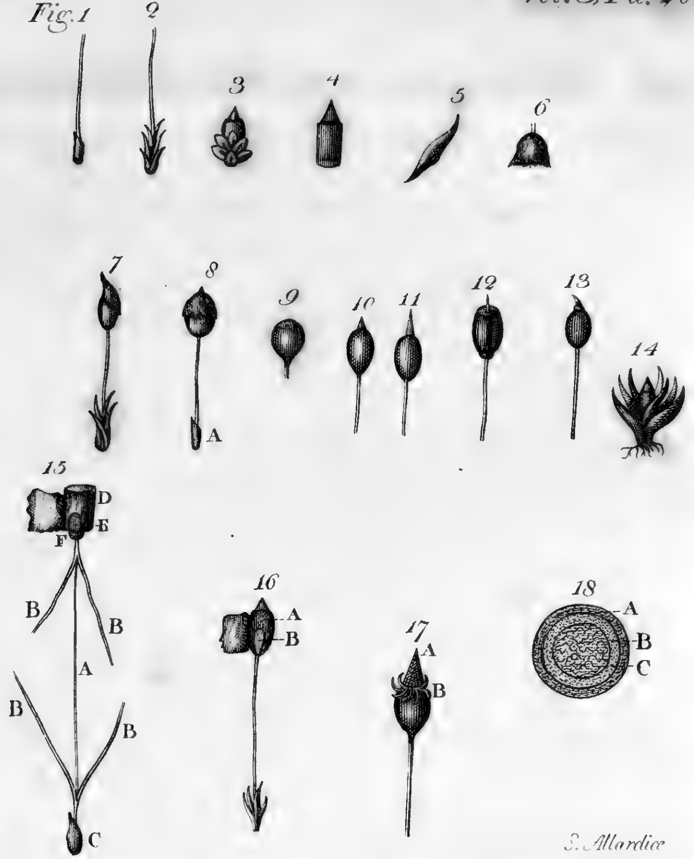
Nuſquam natura major quam in minimis.

PLIN.

Read Feb: 17, 1792.

ALTHOUGH the proceſs of nature in the formation and reproduction of all organiſed bodies is evidently uniform, yet there are philoſophers and naturaliſts who ſcruple to admit this general principle in all inſtances, and think it ſtill liable to ſome exceptions,

More



1. The calyx (perichœtium) of only one piece, at the bottom of the tube.
2. The same of many pieces, or folioles.
3. The flower of the *Fontinalis*, surrounded by the calycine folioles.
4. The cawl (calyptra) of the *Bryum extinctorium* of Linnæus.
5. Another species of cawl which is more common.
6. The hairy cawl of the *Polytrichum*.
7. The complete flower of the *Hypnum*.
8. The same in the *Mnium Polytricboides* (Linn.), the cawl of which is hairy.
9. A very small tubular corolla, the opercule of which is obtuse. *Sphagnum*.
10. A corolla, of which the opercule is conic. *Hypnum*, *Bryum*, &c.
11. A corolla, of which the opercule is pointed. *Bryum*, *Mnium*.
12. A corolla, the opercule of which is in the form of a chapiter, flattened at the base. *Polytrichum*.
13. A corolla the opercule of which is in the form of a chapiter, rounded at the base. *Bryum*.
14. The corolla, stalk, leaves and root of the *Phascum*.
15. The corolla of the *Polytrichum commune*, opened after its explosion.

A. A thread shut up in the tube.
B. The tube opened.
C. The calyx.
D. The flower opened.
E. The capsule torn off, after maturity.
F. The apophysis.

16. The corolla of the *Hypnum velutinum* (Linn.) opened after the escape of the pollen.

A. The pollen, or fecundating powder.
B. The capsule, surrounded with the fecundating powder.
C. The calyx.

17. The corolla of the *Hypnum* at the moment of fecundation.

A. The interior cills.
B. The exterior cills.

18. An horizontal portion of the urne, seen with the microscope.

A. The epidermis.
B. The fecundating powder.
C. The capsule and seeds.

More than nineteen twentieths of the animals and vegetables which are known to us are regenerated by means of certain essential parts, inherent in their organick constitution. These parts or organs of generation are so apparent, and so easy of demonstration, that no plausible system can be founded on the contrary hypothesis. This is not the case with those individuals, the organization of which is more simple, and of which the sexual parts especially are so extremely minute, and so concealed from the eye, that they have hitherto escaped the observation of philosophers. Hence have sprung those more or less ingenious, but always erroneous, systems, which, at the same time that they do credit to the genius of their authors, are clearly repugnant to reason. Hence, those numerous dissertations filled with captious reasonings, and in some respects not without depth of research, but in direct opposition to the eternal laws of nature. Hence, again, the endeavours of some systematical men, to destroy that principle so generally recognized, and which so many facts concur to demonstrate, *omne vivum ex ovo.*

Notwithstanding the very great probability of the regeneration of all animals by the conjunction of two individuals of different sexes, as in quadrupeds, in birds, and in insects; or by the aspersion of the seminal liquor of the male on the spawn ejected by the female as in the fishes; notwithstanding it is proved to demonstration, that the seed of vegetables are fecundated by the pollen of the antheræ; notwithstanding the conviction of these and many other facts, equally well known and ascertained, still some philosophers refuse to extend this principle to the whole of the animal and vegetable creation. The simplicity and minuteness of the organs of worms, and especially of the polypi, and the singular faculty which some observers have attributed to the latter of regenerating themselves by the

 section

fection of their parts, have induced fome naturalifts to believe, that thefe little animals were not fubject to the general law by which all the others are governed. Thence, they concluded that the principle of regeneration by means of the fexual organs was not exclufively neceffary for the multiplication and reproduction of every individual.

This fyftem, however oppofed to what comes under our daily obfervation, has, neverthelefs, found, and ftill continues to find, many warm fupporters, and has been much ftrengthened by the analogy which has been difcovered between the moffes and the mufhrooms, the fexual organs of which were not determined till I made my obfervations on the fubject, fo that thefe plants were thought to be to the vegetable, what worms ‡ and polypi are to the animal world.

I fhall not, in this place, undertake to refute this opinion with regard to the polypi, which do not come within the limits of thefe obfervations, but until more accurate experiments fhall have brought us to the certain difcovery of the manner by which thefe little animals are reproduced, I fhall remain fatisfied with the obfervation of Bernard de Juffieu on the polypus, and fhall reject every fyftem which tends to favour an opinion, that nature, who in all other things, and in thofe which are moft within the reach of our obfervation, ever acts by conftant and by uniform laws, could have become fo different from herfelf and have adopted partial rules in favour of a very fmall number of individuals. Here I fhall confine myfelf to fome of thofe plants denominated *Cryptogamick*, which I have obferved with great care and attention, and which (as I fhall endeavour

‡ I might have difpenfed with mentioning the Polypi in particular, as they are comprehended under the general appellation of worms; but I thought it beft to make fpecial mention of them, as of all animals they are thofe of which the moft fabulous accounts have been given, and which have afforded the greateft fcope to the wild ideas of fanciful imaginations.

vour to demonſtrate) are provided with the ſame organs of reproduction which we obſerve in other vegetables.*

It has never yet been controverted, at leaſt as to the moſſes, that theſe individuals are eſſentially a part of the vegetable kingdom. They all have very diſtinct and obvious organs, which are eaſily diſtinguiſhable from the roots, the leaves, and the branches, and which, by analogy, muſt be conſidered as bloſſoms, containing ſuch parts as are neceſſary to the reproduction of every individual.†

The oppoſers of the ſyſtem of ſexual regeneration, have conſidered theſe organized parts as an uſeleſs *ſupervegation*; "for," ſays a zealot of this ſect, "there are moſſes which are deſtitute of thoſe parts which the ſexualiſts call fructification‡." On the contrary, the friends of the ſexual ſyſtem are all agreed in conſidering theſe parts as the real organs of reproduction, although they differ as to the nature and uſe of thoſe parts. Some are of opinion, that the urn§ (Fig. 3. 7. 14.) is the male part, and that the ſtars which appear at the extremities of the branches, as in the *Polytricum* and ſeveral ſpecies of the genius *Mnium*, are the female-organs¶. Others, with more reaſon, ſuppoſe that the urn contains both ſexes. According to theſe naturaliſts,

* I have not only ſubmitted theſe obſervations to the Academy of Sciences of Paris, in the years 1782, 1783, 1784, and 1785, but I have ſhewn them the objects themſelves in detail, eſpecially to Meſſrs. Adanſon, de Juſſieu, and de la Marck. I have repeated before the Academy ſeveral of my experiments; I have demonſtrated to them the exiſtence of the Capſule within the Urn of the Moſſes, the irritability of the Cilia and their ſpontaneous convulſive motions immediately after the falling of the Opercule, which is the moment of fecundation. I have ſhewn them the irritability of ſeveral Muſhrooms when they emit their ſeeds, and eſpecially in the *Peziza*, the *Neſtoc*, &c. the Capſule which is formed at the extremity of the point of a non deſcript ſpecies of *Hydnum;* and laſtly, I have ſhewn the duplicity of the blades of the *Agaricus* of Linnæus, which, in the manner of pods or ſiliquæ, contain a prodigious quantity of ſmall oval bodies, which I take to be the ſeeds. If theſe authorities are not ſufficient to convince certain ſkepticks, I exhort them to make the ſame obſervations themſelves, and I have no doubt but that they will very ſoon be convinced of their truth.

† The ſtructure of the muſhrooms being different from that of the moſſes, theſe general obſervations cannot be applied to them. When I treat of thoſe plants, in another memoir, I ſhall be particular in the deſcription of their organical parts.

‡ M. Necker, botaniſt to the Elector Palatine, in his Phyſiology of Organized bodies.

§ This is the name which has been given to the fructification of the moſſes.

¶ Linnæus and his followers have adopted the opinion of Dillenius.

lifts, the cilia are the male organs, and the pollen contained in the urn is the feed§. Others, again, adopt an opinion entirely different, and pretend that the urn is a capfule which contains the feed, and that the glandular parts fituated under the foliola, or little leaves, of the ftellated branches (as in the *Polytricum* and *Mnium*) are the antheræ, or organs which contain the prolifick liquor. The queftions which now divide the naturalifts on this fubject are the following:

1ft, Whether the parts of which we are fpeaking are in fact the fexual organs of the moffes.

2dly, To determine the ufe and the nature of each feparately in regard to the functions which are attributed to them.

Thefe two queftions being folved, there can remain no doubt as to the mode of regeneration of thefe plants, and every contrary fyftem muft fall to the ground. Of this I have become fully convinced by means of fome very fimple and very eafy obfervations, which may be made by others, with the greateft facility.

I fhall not here attempt to refute the feveral opinions which I have thus flightly mentioned. Men of information, and thofe devoid of prejudice, will eafily determine how far thefe opinions are worthy of confidence, particularly after they fhall have read the following detail of my obfervations on the fubject.

Of

§ Hill and Meefe. Their fyftem, the moft ingenious of all, is extremely plaufible, but it cannot be admitted, 1ft. becaufe the Pollen, which they confider as feeds, has all the characteriflicks of a fecundating pollen, fuch as its convulfive and impetuous emiffion, its inflammability, and its great difficulty of incorporating with water. 2d. Becaufe the Cilia not being uniform or conftant in all the moffes, and being fometimes found of two different fpecies in the fame individual, cannot be direct organs of generation, but only (as I fhall prefently demonftrate) acceffory and fecondary organs, intended to protect and facilitate the act of fecundation.

The other fyftems are ftill lefs admiffible, becaufe they cannot be applied to all the fpecies of moffes, and are liable to exceptions which are fufficient to demonftrate their fallacy.

Of the MOSSES.

The fructification of these vegetables, commonly known by the name of *Anthera*, or Urn, is uniform and constant in all the family. It has the shape of a little club, more or less elongated (See Fig. 3. 7. 14).

It is composed

The *Perichætium*.	of a single piece in the form of a tube, in the *Bryum*, the *Mnium*, and *Polytricum* (Fig. 1. 8A. Fig. 15. C.): of several pieces, or foliola, more or less imbricated, as in the *Hypnum* and the *Fontinalis* (Fig. 3. 7. 16. C.).
An Anthera, or Urn.	It is sessile in the *Phascum* and the *Fontinalis* (Fig. 3. 14.): standing upon a filament of different lengths in the *Bryum*, the *Hypnum*, the *Polytricum*, the *Splachnum* and the *Mnium* (Fig. 7. 13.).

The urn before its maturity is composed

Of an *Operculum*, or Opercull:	more or less subulated in almost every one (Fig. 9. 13.); and in the form of a chapiter of a column in the *Polytricum*, and some species of the *Bryum* (Fig. 12. 13.).
Of a *Calyptra*, or Cawl,	It is smooth and more or less transparent in the greater part (Fig. 4. 5. 7.): hairy and coloured in the *Polytricum*, and in the *Mnium Polytrichoides* (Fig. 6. 8.). There is none in the *Sphagnum*, and it is very caducous in the *Phascum*.

When these parts are ripe, the opercule and calyptra fall off; then the urn appears mutilated at its extremity, and the orifice, or opening, is either naked or covered with cilia.

Such

Such is the detail of that part of the moſſes which we call the fructification, and which Dillenius and Linnæus believed to be the male organs. I ſhall here annex a table, in order to enable the reader, by a comparative view of the whole ſubject, to form a more preciſe judgment of my obſervations*.

Being led by a natural inclination to the ſtudy of this family of vegetables, which, I am afraid, has not been ſufficiently attended to, I have devoted my whole attention to it. I have obſerved them in their different ſtates and periods of vegetation, as well in the places of their ſpontaneous growth, as at my own home, that I might the better diſcover the moment when the pollen was burſting from the urn. The following is the reſult of my obſervations.

I found that what the naturaliſts have conſidered as a thread, or filament, ſupporting the urn, is, in fact, a real tube, continued to the urn, which is a part, and the end, of it. I denominated the whole a corolla. This tube being carefully opened with a very ſharp penknife, diſcovers a white tranſparent filament, extending itſelf to the urn (Fig. 15. A.). The urn being opened, in like manner, when fully ripe, is found to contain the fragments of the dilacerated capſule (Fig. 15. E.). Theſe fragments are of the ſame colour and nature as the filament contained in the tube.

After having diſcovered theſe veſtiges of an unknown organization, I was deſirous of obſerving the ſame in the urn before the emiſſion of the pollen. I made choice of the *Polytricum commune* of Linnæus, as being larger and more proper for my obſervations. I took off the opercule, without injuring the other parts, and, for this purpoſe, I always

* I have made no particular mention of Hedwig's ſyſtem, which ſeems to have been adopted by ſeveral naturaliſts. It is not, however, more admiſſible than the reſt: it is liable to an infinity of exceptions, which are a ſufficient reaſon for rejecting it. At a future period, I ſhall demonſtrate the fallacy of this new opinion, which miſtakes for male organs the glandular bodies, which are ſituated at the extremities of the ſtellated branches.

I always preferred a bloſſom almoſt ripe. I then opened the urn on the ſide; I carefully took out the pollen, and by this method, I diſcovered an oval body, of an herbaceous colour, ſituated in the centre. This kind of capſula, as I call it, is ſtrongly fixed to the bottom of the urn, and although I did not obſerve it ſticking to the internal filament, I am much inclined to think it is the termination of it. At another time, I cut off horizontally, a part of a ripe bloſſom, and expoſing it to a magnifying glaſs, I diſcovered 1. the epidermis of the corolla (Fig. 18. A.), 2d. the pollen ſurrounding the capſule (Fig. 18. B.), 3d. ſmall globules ſitting between the fibres of a kind of net, which appeared to me to be the ſeeds (Fig. 18. C.). Theſe obſervations, I have ſucceſſively repeated on all the moſſes to be found in the neighbourhood of Paris, and Liſle in Flanders, and I obſerved, with ſatisfaction, that every one, without an exception, was organized in the ſame manner.

Having arrived at this important diſcovery, I determined to proceed farther. I examined and tried the yellow duſt which ſurrounds the capſule, and I became convinced, from its inflammability, and from the difficulty with which it mixed with water, that it was of the ſame nature with the pollen of other vegetables. It now remained to prove that the ſmall oval body ſurrounded by the pollen is a true capſule, including the ſeeds. The obſervation which I had formerly made with the microſcope proved it, indeed, but not in a manner ſufficiently ſatisfactory, as there did not appear to be any direct communication between the pollen and the ſeeds, which are contained in the capſula. I had recourſe, again, to obſervation, and I fortunately caught nature, as it were, in the fact, and diſcovered the uſe and operation of each of the parts of which the urn of the moſſes is compoſed. As I was, one day, examining, with attention, the *Hypnum velutinum*, of Linnæus,

 I endeavoured

I endeavoured gently to take off the opercule with my fingers, which was very eaſily done, as the bloſſom was fully ripe. The opercule having fallen off, the cilia which detained it being thus free, and looſened from their former ſtate of tenſion, I was a witneſs to their curious manner of operating: they were in an almoſt continual convulſive agitation, and contraction, approaching to, and alternately receding from, the internal cilia, which ſeemed to me to open a little towards their extremity, at the ſame time that the others contracted themſelves by a contrary motion. I diſtinctly obſerved the pollen thrown out through the ſpace that opened between the internal cilia, near their baſis, as faſt as the external cilia fell back. Hence, it occurred to me that the poſition and motion of theſe various organs are intended to reſtrain the impetuoſity of the pollen: and if we conſider how the pollen and ſeeds are diſpoſed, it will be eaſy to conceive that the former cannot come out without meeting the latter. Thus, nature, ever conſiſtent in her productions, has formed theſe cilia to moderate the convulſive emiſſion of the pollen, and to bring it into contact with the ſeeds before it eſcapes.

There is nothing more admirable than the operations of nature in theſe little plants. I have made the ſame experiment on an infinite variety of moſſes, and it has always ſucceeded when the bloſſom had attained its full maturity. I have repeated it in the preſence of ſeveral perſons, as well as in private for my own amuſement, and every time, I had additional reaſon to admire the wiſe diſpoſitions of the Great Lord of the Univerſe, who, by conſtant and by uniform rules, preſerves and multiplies all the individuals of his Creation.

O JEHOVA,

O JEHOVA,
Quam ampla sunt Tua Opera!
Quam sapienter Ea fecisti!
Quam plena est Terra possessione Tua!
David *Psal. CIII.* 24.

From the preceding observations, it follows

1st. That these plants are endued by nature with the same organs of fructification as all others, to wit, a *flower* (Fig. 3. 7. 14.).

2dly. That this flower has two essential parts, which seem to be the organs of generation, viz. a fecundating pollen, and a capsule containing the seeds (Fig. 15. 16. 18.):

3dly. That besides the pollen and the seeds, there are other accessary parts, relative and proportioned to the construction of that flower, and destined (Fig. 7. 14. 17.):

1st. To protect the sexual parts when young, the cawl (fig. 4. 8.), the opercule (fig. 9. 14.), the cilia (fig. 17.):

2dly. To prevent the too rapid emission of the pollen, that thus the business of generation may be the better accomplished, the internal cilia (fig. 17. A.).

3dly. To diminish the effect of the impetuosity of the same pollen, by checking its motion, and by detaining it for a moment at the orifice, when the fecundation is performed. This is done by the external cilia, by means of their irritability and oscillatory motion (fig. 17. B.).

4thly. It appears that the urn is a bi-sexual flower, containing a capsule more or less pedunculated, according to the length of the tube.

5thly. That the smallest mosses, as well as all other vegetables, are reproduced by their own particular organs; that they observe the general law of all organized bodies, and that they furnish an additional proof of the great axiom, *omne vivum ex ovo.*

I have ſomething more to add concerning that part which I have denominated the *Star*, and which ſome naturaliſt have ſuppoſed to be the female, whilſt others have imagined it to be the male, part.

The ſmall glandular parts included under the foliola of the branches, certainly poſſeſs the faculty of reproduction; and I have very frequently obtained a few individuals from them. Still, I cannot admit that they are the only ſeed of the moſſes, and much leſs that they are antheræ containing the prolifick liquor.

We are, indeed, acquainted with ſome plants which, beſides their hermaphrodite flowers, have on the ſame or another ſtalk, ſemi-ſexual flowers, either male or female: why, therefore, may not the ſame thing take place in the moſſes?—why may not the *Polytrichum*, the *Mnium*, and the *Splachnum* be polygamous plants, like the *Parietaria*, *Acer*, and ſeveral of the *Mimoſæ*, or like the *Dioſpyros*, the *Ginſeng*, &c?

We alſo know ſome plants, as the *Lilium bulbiferum*, the leaves of which are furniſhed with ſmall bulbous glands, which being put into the ground ſhoot up into individuals of their ſpecies, without altering in the leaſt, the fructification of the flowers of the ſame plant. Why, then, may not the moſſes have the ſame faculty of reproducing themſelves?

Whether we conſider the ſtar of the moſſes as a true flower, or as containing bulbs, like thoſe of the *Lilium bulbiferum*, which is more probable and natural, it cannot affect the fact which I have eſtabliſhed reſpecting the reunion of both ſexes in the urn. Why ſhould we look upon that part as being either the male or female organ, ſince the greater number of moſſes have no ſtarred branch? how then, could thoſe ſyſtematiſts conceive or explain the re-production in the *Phaſcum* (Fig. 14.), which conſiſts only

only of ſome roots, and of a few ſmall leaves, in the center of which is the urn, which is not *tubulated?* all the moſſes, on the contrary, bear an urn, or flower, in which any one may obſerve a pollen, or fecundating powder, and a capſula, containing ſmall round bodies, which much reſemble ſeeds: thence follows their analogy to other vegetables, with reſpect to their fructification.

The emiſſion of the pollen, and the irritability of the cilia, may be exactly compared to thoſe convulſive motions which are common to all organized bodies, when they arrive at the moment of their re-production. Is it poſſible, then, after what I have demonſtrated, to follow other opinions, which cannot apply alike to every individual? From thence, I am authoriſed to conclude, that the opinion which reſults from my obſervations is preferable to all the former ſyſtems, not excepting that of Mr. Hedwig, which is two inconſiſtent to be admitted.

De BEAUVOIS,

Member of the Society of Sciences and Arts of St. Domingo, and Correſpondent Member of the Academy of Sciences of Paris.

N°. XXV.

A letter from Major Jonathan Heart, to Benjamin Smith Barton, M. D. Correſponding member of the Society of the Antiquaries of Scotland, Member of the American Philoſophical Society, and Profeſſor of Natural Hiſtory and Botany in the Univerſity of Pennſylvania,——containing obſervations on the Ancient Works of Art, the Native Inhabitants, &c. of the Weſtern-Country.

Fort-Harmar, 5th January, 1791.

SIR,

Read Feb. 3, 1792.

AGREEABLE to promiſe, I now enter on the different ſubjects of enquiry contained in your favour of the 24th of January laſt, but find myſelf unable to give that ſatisfactory information which the nature of your work may probably require: however, ſuch obſervations as opportunity has enabled me to make, I am happy in laying before you.

With reſpect to ANCIENT WORKS. Thoſe at the mouth of the Muſkingum are the only veſtiges of any conſiderable works I have very particularly attended to, a plan of which, with ſome remarks, is publiſhed in the *Columbian Magazine*. Thoſe remarks, not having been made under an expectation of their being publiſhed, were not ſo accurate as I could now wiſh they had been; but improvements having ſince been made over the whole extent of the works, no very conſiderable inveſtigation has ſince been made. We did, at that time, open the big mount and ſome of the graves, dig into the caves, on the walls, elevated ſquares, and at different places within the compaſs of the works, but nothing

nothing was found more than I mentioned in thofe remarks.

The works at Grave-Creek I have carefully viewed, but never traced the lines with fuch accuracy as to enable me to give you a plan. They are very extenfive, commencing about four miles below Grave-Creek, and continuing, at intermediate diftances, for ten or twelve miles, along the banks of the Ohio. The principal works are adjoining the big-grave, which is about half a mile from the Ohio, and about the fame diftance north of the mouth of Grave-Creek. The works are very fimilar to thofe at the mouth of Mufkingum. The continuation of works each way confifts of fquare and circular redoubts, ditches, walls, and mounts, fcattered, at unequal diftances, in every direction, over extenfive flats. The big-grave, fo called, has been opened, and human bones found in it; but not of an extraordinary fize; neither have I ever heard of bones of an extraordinary fize being found in any of thofe graves, many of which have been opened, and generally found to contain human bones.

Thefe are the only confiderable remains which I have myfelf examined. The common mounts, or Indian graves, or monuments (for they are not always found to contain bones), are fcattered over the whole country, particularly along the Ohio, and its main branches: indeed, I have fcarcely ever feen an handfome fituation on an high flat, adjoining any large ftream, where there were not fome of the above mentioned veftiges of antiquity.

Travellers, whofe authority I depend on, inform me that on a branch of the Scioto, called Paint-Creek, are works much more confiderable than thofe at Grave-Creek, or Mufkingum, a mount much larger, a greater variety of walls, ditches and enclofures, and covering a much greater extent of country; that they continue for nearly fixty miles along the Scioto to its junction with the Ohio, oppo-

fite

ſite which, on the Virginia-ſide, are extenſive works, which have been accurately traced by Colonel George Morgan, and I have been told there are remains of chimneys, &c.

The next works of note are on the Great-Miami, about twenty miles from its junction with the Ohio. A Mr. Wells, a gentlemen of nice obſervation and philoſophical enquiry, who had viewed them, and had alſo examined the works at Muſkingum, informed me, they were very ſimilar, though he thought theſe more extenſive, the walls higher, and the ditches deeper, than thoſe of Muſkingum. He alſo obſerved, there were ſimilar works on the Little-Miami, about twenty miles from its junction with the Ohio, which would be about the ſame diſtance from the remains laſt mentioned.

Theſe are the only traces of *ancient works* of which I have received ſuch authentic information as will juſtify me in reporting them as undoubted facts. Many other remarkable veſtiges of antiquity have been deſcribed to me, particularly, on the eaſt ſide of a ſmall branch of the Big-Black, a river which empties itſelf into the Miſſiſſippi, nearly in latitude 33. north, an elevation of earth about half a mile ſquare, fifteen or twenty feet high, from the north-eaſt corner of which a wall of equal height, with a deep ditch, extends for near half a mile to the high lands. This information I had from the Chacktaw-Indians, who inhabit that country, and it is confirmed by many white people, who reſided with the Chacktaws, and had often been on the ſpot.

The tradition of the Chacktaws with reſpect to this elevation is as follows, viz. that in the midſt is a great cave, which is the houſe of the *Great-Spirit*; that in that cave he made the Chacktaws; that the country being then un-

der

der water, the great ſpirit raiſed this wall above water, to ſet the Chacktaws on to dry, after they were made.

The ſame perſons and others aſſured me that on the low grounds of the Miſſiſſippi, which are ſubject to overflow, at a place called Bio-Piere, is a very large mount encompaſſed by a number of ſmaller ones, in a perfect circle, at equal diſtances from each other, and at about two hundred yards from the centre, or Grand-Mount. Theſe circumſtances I have the more reaſon to believe, as every information aſſures me that country is covered with veſtiges of ancient ſettlements: as far ſouth as the head waters of the Yazoo and Mobile, my own obſervations confirm it.

Who thoſe inhabitants were, who have left ſuch traces; from whence they came, and where they are now; are queries to which we never, perhaps, can find any other than conjectural anſwers. I can only give my opinion *negatively*, that they were not conſtructed by Ferdinando de Soto. He was not on the continent a ſufficient time to conſtruct even the works at Muſkingum, and from every circumſtance it appears that he was no farther north than Chattafallai, a Chickaſaw-village, on the Tombigbee-branch of the Mobile. 2dly. Theſe works were not conſtructed by any European, Aſian or African nation ſince the diſcovery of America by Chriſtopher Columbus: the ſtate of the works, the trees growing on them, &c. point to a much earlier date. 3dly. They were not conſtructed by the preſent Indians or their predeceſſors; or ſome traditions would have remained as to their uſes, and they would have retained ſome knowledge in conſtructing ſimilar works. 4thly. They were not conſtructed by people who procured the neceſſaries of life by hunting: a number ſufficient to carry on ſuch works never could have ſubſiſted in that way. 5thly. I may venture to add, the people who conſtructed them were not altogether in a ſtate of uncivilization: they muſt have been under the ſubordination of law, a ſtrict and well governed police, or they could not have been kept together in ſuch numerous bodies, and made to contribute to the carrying on ſuch ſtupendous works. But my buſineſs is to give you facts, and not to form conjectures.

There are other matters with reſpect to this country worthy attention, viz. the quantities of SHELLS, CONCRETIONS, PETREFACTIONS, BONES, &c. the marks of high water, and the NATURAL MEADOWS, or as they are called *Praires*. On the head waters of the Mobile is the true oyſter-ſhell of a monſtrous ſize, and in ſuch quantities that I cannot conceive that they were tranſported from the ſea, which is three hundred miles off. The Chickaſaw ſay theſe ſhells were there when they came into the country. They uſe theſe ſhells in making their earthen-ware. The foſſile-ſhells are found in great plenty in all parts of the country, and petrefactions are very frequent, particularly at the falls of the Ohio. Near the bottom of the falls there is a ſmall rocky iſland which is overflowed at high water. This iſland is remarkable for being the ſeat of petrefactions. I ſaw no petrefactions on it myſelf but wood, fiſh-bones, and the roots of ſhrubs which grow on the iſland: of theſe there was a great plenty. Gentlemen who have reſided near, and whoſe veracity is not to be doubted, aſſured me that they had ſeen many different articles petrified, as part of a hornet's neſt, fiſhes, and in one inſtance an intire bird. But what is more particularly to be remarked is that this petrefying quality is confined to the iſland, and does not ſo often afford ſamples of it on the oppoſite ſhores: yet, there is no ſpring of running water, and ſcarcely a green thing on the iſland. Neither does this quality exiſt, in any remarkable degree, either above

above or below the falls. There is a like inſtance up the Tenaſſee of a particular ſpot, extraordinary for petrefacti-ons, whilſt nothing of the kind takes place either above or below.

The BIG-BONES, found at a place called the Big-Bone-Lick, are now to be ſeen in the different muſeums of the ſtates. It is unneceſſary for me, therefore, to make any remarks on them. At P. Lewis, on the Miſſiſſippi, I ſaw a number of gentlemen who had travelled up the Miſſouri: they ſaid, there are many of theſe bones to the weſtward, and the Indians told them the animal was ſtill to be found farther weſt.

The NATURAL MEADOWS cannot be accounted for: ſome of them have, doubtleſs, emerged from the waters of the Miſſiſſippi, which I preſume was an arm of the ſea, ſome diſtance above the mouth of the Ohio. Other of theſe meadows appear to have been lakes, the waters of which, in proceſs of time, finding ſome out-let, have become dry lands. But ſome of theſe *Praires* are high lands, ſurrounded by an extenſive timbered country, in many places much lower than the clear lands. Major Wyllys informed me that he had the moſt unequivocal proof, from the appearances of rocks and other veſtiges a little above the mouth of the Miſſouri, that the waters of the Miſſiſſippi had, in paſt ages, flowed ſeventy feet higher than the preſent high-water marks. On the French Broad-River, a branch of the Tenaſſee, are perpendicular rocks, on which, more than one hundred feet above the preſent high-water, are artificial characters of beaſts, birds, &c. A Mr. Williams, a gentlemen of reputation, aſſured me, that he had been at the place, and that there could be very little doubt of the characters being artificial, and that it was abſolutely impoſſible that any perſon could get to the ſpot on any other ſuppoſition, than that the waters of the river had, at ſome time, flowed ſo much higher.

With reſpect to the POPULOUSNESS of the natives, I cannot give you any ſatisfactory account; and from whence they came it is ſtill more difficult to determine. The Chickaſaw ſay they came from where the Sun ſets in the water, and that they were ſeven years on the way, marching only one moon in a year, remaining the other part of the time at the ſame camp, preparing for the next year's march. The ſimilarity between their language and that of the Chacktaw evidently proves that they are from the ſame origin. The languages of the different tribes of the Six-Nations are alſo very ſimilar to each other, as are the languages of many of the Weſtern nations and the Creek-nations, or Muſcows, *with very little alteration Muſcovites.* But the languages of the Six-Nations, the Weſtern nations and the Chickaſaw are ſo different even in ſound and in conſtruction, that they never could have been derived from, or any way dependent on, each other.

With reſpect to their CUSTOMS and MANNERS, I am equally unable to give you any ſatisfactory information. I cannot help thinking it a great misfortune, that no meaſures have ever been taken which held out ſufficient inducements for men of abilities to travel amongſt the tribes which are ſo far removed from the nations of Europe, that we might be aſſured their cuſtoms were not borrowed from, or any way intermixed with, ours. It is equally a misfortune that we are ſuffering ſo many of their languages to become extinct, without preſerving their radical characteriſticks: for there is a certain characteriſtick peculiar to different languages, not dependent on each other, which, though diſguiſed with a variety of ſounds, or different dialects, on accurate examination, will give ſome grounds to conjecture from what language they are derived;

derived; and I cannot help thinking that a full inveſtigation of the different languages of the nations will be the moſt probable means for forming reaſonable conjectures from whence this continent was peopled. A knowledge of their cuſtoms and manners might alſo give us ſome light. Thoſe, however, who argue that the Indians are deſcended from the ten tribes of Iſrael, from a ſimilarity of ſome cuſtoms, do not conſider that the children of Iſrael were but little removed from a ſtate of nature; that nature is uniform, and that all things being equal ever operate the ſame. It is true that many cuſtoms of the Indians are the ſame as thoſe of the children of Iſrael: but they were ſuch as nature herſelf pointed out.

As to the GENIUS of the Indians, I believe they are as capable as any other nation in learning any art, either mechanical or liberal. Indeed, I never could find that they poſſeſſed any original ideas different from our own, or had any bias of mind, propenſity to particular vices, or predominancy of any paſſion, which could not be traced to their origin in the human mind, and be found to ariſe from the different ſtages, between the abſolute ſtate of nature and the higheſt degree of civilization. In fact, we find them poſſeſſed of every paſſion, propenſity, and feeling, of man.

With regard to the ARTS of the ancient inhabitants, there is very little ground for us to form conjectures. I wiſh meaſures had been early taken to collect and preſerve the different articles which have been found in different places, and that all other artificial, as well as natural, curioſities, together with accurate deſcriptions of all the veſtiges of antiquity, could have been collected and preſerved. Perhaps, from the whole, ſome future inquiries might have led us to an inveſtigation of the hiſtory of this country.

I might

I might have added a great number of informations, from travellers, concerning various tribes of Indians; their cuftoms, their languages, &c. fuch as that there are Indians who fpeak the Welfh language; that there are others who live in works fimilar to the ancient remains, already defcribed; that there are Indians who live a fhepheard-life, and others who entirely cultivate the foil. But I have not fuch full affurance of the truth of thefe things as to authorife me in reporting them.

I have, thus, according to the beft of my abilities, given every information in my power, on the various inquiries in your favor. I have little expectation of there being any thing new in them, or which will give light on the fubjects: but fuch as they are, pleafe to accept them as my earneft endeavours to ferve you.

With every fentiment of refpect,

I am, Sir,

Your moft Obedient and

Humble Servant,

JONATHAN HEART.

N°. XXVI.

An Account of fome of the principal Dies employed by the North-American Indians. Extracted from a paper, by the late Mr. Hugh Martin.

Read Oct. 4th, 1782.

THE Indians die their *red* with a flender root, which is called in the language of the Shawanoes *Hau ta the caugh.* Upon my fhowing a fpecimen

men of this root to the diers in Philadelphia, they informed me that it was madder, and that by tranſplanting and cultivating it, for a few years, it would become exactly ſimilar to the imported madder of the ſhops. In its natural ſtate, it grows in low ſwampy grounds, and ſpreads along the ground, near the ſurface. The roots are of various lengths, ſome of them being not more than an inch or two, whilſt others are two feet, long: their thickneſs ſeldom exceeds that of a ſtraw.

Theſe roots, when freſh, for the moſt part, put on an orange appearance, though ſome of them are yellow; but after they are dried, which they muſt be, before they can be uſed with ſucceſs, the outſide appears of a dark brown: when broken, however, the inſide appears red. From every root ariſes one limber ſtalk, which is commonly from ſix to eighteen inches high: at the diſtance of about half an inch there are four ſmall leaves, and on the top is the ſeed-veſſel, which comes to maturity in September, and is of a conic form. In ſome ſwampy ſituations, I have found, this vegetable growing ſo plentifully, that ſeveral handfulls of it might have been gathered within the compaſs of a yard or two.

The Indians pound the roots of the *Häu ta the caugh* in a mortar, with the addition of the acid juice obtained from the crab-apple. They, then, throw the whole into a kettle of water along with the ſubſtance to be died, and place the veſſel over a gentle fire, until the colour is properly fixed.

It is by this proceſs that the Indians die the white hair of deer-tails and the porcupine-quills, with which they ornament themſelves, of a red colour. I have alſo ſeen a ſpecimen of wool which one of them had died of a beautiful red in the ſame manner. I made experiments with this red and the vegetable-acid, and ſucceeded. I alſo employed

ployed the vitriolic-acid in alum, &c. which made it of a darker colour.

The *orange colour* employed by the Indians, is obtained from the root of the *Poccon*, the outſide being pared of, and alſo from the plant called *Touch-me-not*. The vegetable-acid, before mentioned, is likewiſe uſed as a fixer to the colour of theſe two plants. I found that by mixing the red colour of the *Hau ta the caugh* with the yellow colour of the plant of which I am next to ſpeak, I made an orange.

The Indians die their *bright yellow* with the root of a plant which grows ſpontaneouſly in the weſtern woods, and which might, very properly, be called *radix flava Americana*. This root is generally from one to three inches long, and about one half of an inch in diameter, and ſends out a great number of ſmall filaments in every direction except upwards: theſe filaments are as yellow as the body of the root itſelf. From the root there grows up a ſtalk about a foot from the ground, and at the top is one broad leaf. A red berry, in ſhape and ſize reſembling a raſpberry, but of a deeper red, grows on the top of the leaf: this berry is ripe in July.

I made ſome experiments with this root and the vegetable-acid, on ſilk, linnen, and woolen, and ſucceeded. I tried it again with the vitriolic-acid and, likewiſe ſucceeded. I alſo tried it with the vegetable-alkali, and without any of theſe ſubſtances, and was ſucceſsful in obtaining a good yellow in its ſimple ſtate. I preſented a ſpecimen of this root to the diers, who found it to be a valuable article in making a yellow, and with the addition of Indigo in making a green.

Their *green* is made by boiling various blue ſubſtances in the liquor of *Smooth-Hickery bark*, which dies a yellow. In this manner, I have ſeen blue cloth, and yarn changed ed to a green; but the goodneſs of the green depended on that of the blue. There are other ſubſtances which die a yellow colour, and with which the Indigo will form a green; but as they are found to be inferior to the *radix flava*, or Yellow-Root, in making a yellow, and with the Indigo a green, nothing need be ſaid of them.

In making their green the Indians diſcover great œconomy. They carefully unravel ſmall pieces of green cloth, and pieces of old green garments. Theſe they throw into a kettle with a ſufficient quantity of water, and the cloth to be died. The whole is then ſet over a gentle fire, until the colour is made. They informed me that by this proceſs they die their Porcupine-quills green.

The *blues* are ſo well known to be made by the *Indigo* of our own continent that nothing need be ſaid concerning them here. Under this head, however, I beg leave to obſerve, that the *Woad* is the natural produce of our weſtern ſoil, and that without it no deep or laſting blue can be made.

The Indians die their *black* with the *Sumach* of this country. They, likewiſe, make a beautiful black with the bark of the *White-Walnut*, and the vegetable-acid; for they have no knowledge of the mineral acids. With this bark I have ſeen them die their woolen cloths, and the inteſtiries of various ſpecies of animals, as bears, &c.

N°. XXVII.

An account of the beneficial effects of the CASSIA CHAMÆCRISTA, *in recruiting worn-out lands, and in enriching such as are naturally poor: together with a botanical description of the plant. By* DR. JAMES GREENWAY, *of Dinwiddie-County, in Virginia.*

Read May 2d, 1788.

IN Maryland, and on the Eastern-Shore of Virginia, they have long been in the practice of sowing a seed, which they call a *bean*, for the sake of recruiting their worn-out lands, and enriching such as are naturally poor. The best information, that I have, is that, they sow a pint of the bean with every bushel of oats. The oats ripen, and are cut, in July, at a time when the young beans are small, and escape the injury of the scythe. The beans flower in August and September. In October, the leaves fall off, the seeds ripen, and the pod opens with such elasticity as to scatter the beans to some distance around. The year following, the field is cultivated with corn; the beans, which sprout early, are all destroyed with the plow and hoe; but the more numerous part not making their appearance, above ground, until the corn is laid by, spring up, unhurt by the instruments of agriculture, and furnish seed for the ensuing year, when the field is again sowed in oats. The ground is, alternately, cultivated with corn and oats, annually, and, in the course of eight or ten years, so greatly improved that, without any other manure than the mouldered leaves and stalks of the beans falling on it, the produce will be three* barrels to the acre, on such as, prior to this management, would

* A barrel is a measure of five bushels, much used in Virginia.

would not have produced more than one. This is ſaid to happen from the quick mouldering of the leaves and ſtalks of the bean plant, and its aptitude to mingle and unite with the earth, without undergoing a fermentation. Thus, the ſoil is yearly and gradually enriched by this ſimple and eaſy proceſs of nature, without the labour and expence of accumulating animal and vegetable matters, to undergo the tedious operation of fermentation and putrefaction; by which the diſſolution of thoſe ſubſtances is brought about, and filled for manure, in the uſual way. Notwithſtanding this extraordinary character of the Eaſtern-Shore-bean, I am clearly of opinion, that our common corn-field-pea is far preferable to every thing, that I have ſeen tried for this purpoſe. Every farmer, who leaves his pea-vines on the ground, and does not, in the accuſtomed manner, pull them up for fodder, muſt often have obſerved that they quickly moulder and fall to pieces; furniſhing a covering to the ground, which readily unites and blends with it, in the manner mentioned of the bean. If a piece of exhauſted land, ſufficiently level to prevent its waſhing away with the rain, be annually cultivated in peaſe, leaving the ſtalks and leaves to moulder and crumble to pieces upon it, the ground will improve beyond expectation; the crop of peaſe increaſing, every year, and the ſoil becoming richer and richer, without any other manure. I was told, by an eminent planter, that poor ground might, by this management alone, be made rich enough to produce good tobacco.

Theſe hints, on the culture of the Eaſtern-Shore-bean, and the improvement of the land thereby, are related from the beſt information, I could get. If any gentlemen, experimentally acquainted with it, would favour the public with a more ample account, it will, no doubt, be well received, and be of utility: my principal deſign, in this

 paper,

paper is to assist the farmer, as well as the naturalist, by pointing out the plant, and describing it so, that it may be distinguished, with certainty, from all others. The Eastern-Shore-bean,* so called from its being first cultivated there, is found in all parts of Virginia and Carolina; upon all sorts of lands, high and low, except where they are too wet. It has been mistaken, by some, for the common tare, or partridge-pea; to which it bears some resemblance, but is not the same; it belongs to a different class of plants. In describing this plant I shall, first, consider the lovers of science, and give a botanical description, in such terms as are most familiar to them, adding afterwards, for the farmer, a description and explanation, in English, as plain and easy as I possibly can. Being shewed a row of these plants, in September (produced from seed procured by a neighbouring gentleman from the place of cultivation) sown in a drill, and then flowering and filling their pods, I immediately discovered it to be a plant that I had long been acquainted with, having collected, and sent it, with many others, before the war, to a professor of one of the European universities. Upon looking into my botanical catalogue, I find it described, and arranged in the Decandria, or tenth class of Linnæus; in the Monogynia, or first order of that class; in the genus, Cassia; and it is that particular species to which he has given the specific name Chamæcrista. Doctor Hill, in his Eden, page 54, calls it Golden-Cassia, and has exhibited a good engraving of it, in his 5th plate, fig. 5. It is mentioned by Gronovius (in the collection made by the late Mr. Clayton of Virginia), in his *Flora Virginica*, fol. 64. Cassia foliolis multijugatis, &c. It has been noticed by several other authors. In my catalogue it stands thus:

Cassia

* Called also the Magotty-Bay-bean.

Cassia Chamæcrista Linnæi. Decandria Monogynia.

Radix annua fibrosa. Caulis susquipedalis, erectus, teres, lævis, ramosus, coloratus. Folia alterna, pinnata, multijuga, abrupta; foliolis oppositis, ovalibus, glaberrimis, æqualibus, cum forma et sensibilitate Mimosæ; foliis simillimis. Flores sparsi, pedunculati, speciosi aureo colore, antheris purpureis. Stipulæ binæ laterales, erectæ, lanceolatæ, acutæ. Glandula super medium petioli, in plantis majoribus, pedicellata. Pedunculus spatio supra petiolum egreditur. Ab mense Augusti ad finem æstatis floret; solis omnibus habitat, sed humilis maxime gaudet. The Golden-Cassia, or Peacock-Flower, is an annual plant, the root and stalk dying every year. The root is small, consisting of fibres, or threads. The stem is upright; in small plants, not more than eight inches high; but in richer ground, where level and moist, the stem rises to a foot and a half, or two feet; a little crooked, round, smooth and coloured; branching out at the upper part, and bearing many flowers standing, on bending foot stalks, scattered all over the main stem and branches. The petals, or flower-leaves, are five, of a fine golden colour, with ten male stamina, or threads, in the middle, crowned with antheræ, or buttons, of a red or purple colour. These filaments, somewhat resembling the crest or plumage on the head of a peacock, have led some botanists to name it crista pavonis, or peacock-flower; but the plant, we here treat of, being a smaller species, they have added Chamæcrista pavonis, or Dwarf-Peacock-flower.

In the middle of the ten male filaments, above mentioned, will be readily observed another single thread or style, which is the female part of the flower, producing the seed-vessel, or bean; each pod containing a single row of black shining seeds, fixed to the upper suture or backseam of the bean: these seeds are nearly flat, four-corner-

ed,

ed, and, not in the leaſt reſembling a bean, or pea. The partridge-pea may be eaſily diſtinguiſhed from this, by colour and ſhape, the latter is brown, and kidney-ſhaped. The leaves are pinnated or winged, (viz. like the Locuſt, Senna, Partridge-pea, &c.) grow alternately from the ſtem, on a ſlender foot-ſtalk, which has a ſmall gland or wart, placed upon the middle of every one; and theſe glands, upon the larger plants, are elevated on a pedicle, or ſhort ſtalk, conſpicuous to the naked eye. At the baſe of every foot-ſtalk, upon the ſtem, are found two very ſmall upright ſpear-pointed leaves called ſtipulæ, which, by the help of a glaſs, appear to be hairy. The ſmall leaves are placed oppoſitely on the midrib, to the number of twenty pair, or more; oval-ſhaped, ſmooth, ending in an even number, in ſhape and ſenſibility, reſembling the leaves of the mimoſa, or ſenſitive plant. They ſhut up at night and expand in the morning, until through age, they loſe this ſenſibility. Frequent ſhaking or ſtriking with the hand will cauſe them to ſhut up; and in like manner, when gathered, they cannot be carried far before they collapſe; ſo that if the botaniſt wants to preſerve the leaves expanded, in *horto ſicco*, he muſt encloſe the plant when gathered on the ſpot, with as gentle a motion as poſſible.

The month of October being the ſeaſon for gathering the ſeed, the leaves then falling off, the farmer will readily find the plant, upon all ſorts of ground, amongſt the weeds, and even in Broomſtraw old fields; and will eaſily diſtinguiſh it, by the brown colour of the pods, and the redneſs of the ſtalks. Let it be pulled up by the roots, dried on a cloth in the ſun, and then thraſhed out with a ſtick, and preſerved in a bag, hung up in a dry place, until the ſeaſon for ſowing it with oats.

N°. XXVIII.

An account of a Hill, on the borders of N. Carolina, ſuppoſed to have been a Volcano. In a Letter from a Continental Officer, reſiding in that neighbourhood, to DR. J. GREENWAY, *near Peterſburg, in Virginia.*

DEAR DOCTOR,

Read Feb. 19, 1790.

AGREEABLE to promiſe I have viſited the Volcano on Dan-River, or the *Burſted-Hill*, as the people there call it; and here ſend you a deſcription of it as accurate as I could take on the ſpot.

The baſe of the hill is about three quarters of a mile in circumference in form of a cone or ſugar loaf one hundred and thirty feet high. It appears to be formed of lava, mixed with round white ſtones, that break with a ſmall ſtroke. There are large rocks or maſſes of the melted matter, weighing a thouſand weight or more, lying on the ſummit of the hill, mixed with pebbles, ſuppoſed to be the place where the lava burſted out; from which it took its courſe, downward, and through the ſecond low grounds of Dan-River, for near half a mile.

This ſtream appears to have been ſix or eight inches deep, but is now crumbled to pieces, upon which there is a mould of rich earth formed five or ſix inches thick. The lava, iſſuing from the hill, has ſpread over all the adjacent level ground which is not leſs than one hundred and fifty yards wide.

This level plain, or ſecond low grounds, was covered with large timber-trees, but has been cleared ſince, and cultivated. The hill itſelf is covered with trees, ſome of which appear to be old. There

There are a number of round ſtones, thrown to the diſtance of half a mile from the hill, that ſeem to have felt the force of fire to a conſiderable degree: theſe, I ſuppoſe, were thrown out of the hill, by the violence of the eruption.

It is the opinion of ſome, that the hill has burſted twice; and that, the ſecond time, it did not run with melted matter, as at the firſt eruption; but only threw out the large lumps of lava, which appear on the top of the ground.

I remain, Sir,

With great reſpect,

Yours, &c. T. D.

Additional remarks on the ſame ſubject, by the author of the foregoing account: addreſſed to DR. GREENWAY.

Read Feb. 19, 1790.

THE crater is nearly filled up, and covered with large trees: one ſide ſtill ſhews the hollow appearance of a crater.

The lava covers the top in many places, but in others the congealed lava has been thrown out in large pieces around the hill, which ſeems to be done by an eruption ſubſequent to the melting and boiling. Pieces, weighing one thouſand pounds or more, lie around the hill; ſome near, others more diſtant.

The ſtream of lava terminates within twenty yards of a creek and is nearly uniform in thickneſs, without any large ſtones, toward the end, but only gravel congealed in it.

The mouldered lava is of the colour of ruſty iron, and is covered with a rich mould of ſix inches, of a different appearance, and the ſame as covers the adjacent ground.

It

It appears that this covering of mould has been laid upon the lava by inundations of the river. The mouldered part of the ſtream of lava is, in many places, ploughed up, and ſeems to moulder and crumble away much faſter when thus expoſed to the air.

The lava has iron in its compoſition, and when pulverized is attracted by the magnet; and wherever a pebble-ſtone is ſtruck out from it, there remains a cavity, greatly reſembling a caſt iron veſſel: ſo that this congealed matter muſt have ſuſtained a great degree of fire to keep it in a ſtate of liquefaction, boiling and running over the top of the volcano, in a ſtream of liquid fire, for half a mile, on the level ground, before it congealed. After ſubjecting it to the magnet, as mentioned above, we ſubmitted it to the crucible, where it melted and ran as we are told the lava of Ætna does.

Farther remarks: extracted from a letter from DR. GREENWAY *to* DR. BARTON.

Read May, 18, 1792.

THE gentleman who examined this extinguiſhed volcano, and furniſhed me with his deſcription of it, has ſince brought me a piece of the lava, of which, he ſays, there are coagulated maſſes, on the ſummit of the hill, that will weigh a thouſand or fifteen hundred pounds. It is compoſed of earth, common pebble-ſtones, ſome metallic ſubſtance, particularly iron attracted by the magnet; and the whole melts into a confuſed liquid maſs in a crucible placed in the heat of a common ſmith's furnace.

N°. XXIX.

An account of a poiſonous plant, growing ſpontaneouſly in the ſouthern part of Virginia. Extracted from a paper, by Dr. James Greenway, of Dinwiddie-County, in Virginia.

Read Feb. 19, 1790.

TO point out an article of the creation, fraught with noxious qualities, dangerous to mankind, and hurtful to animals, is equally as ſerviceable to the public, as to inform them of the medicinal virtues of the moſt ſalutary vegetable, or celebrated antidote.

As the virtues of plants have been generally diſcovered, by accident; ſo likewiſe have deleterious qualities been detected, in others, where no ſuſpicion had ever been entertained of ſuch. The plant, here mentioned, is an inſtance of this: the deleterious quality, from outward appearance, ſmell, or taſte, of this vegetable, can hardly be ſuſpected unleſs by a botaniſt; and even *he* muſt judge, on the bare conjectural foundation of ſimilar virtues, in plants of the ſame genus; which is perpetually found to fail, in numerous inſtances.

I have heard this poiſonous herb, called by the names of Wild-Carrot, Wild-Parſnep, Fever-Root, and Mock-Eel-Root. The Engliſh names of plants are, in this country, frequently miſapplied, and do not diſtinguiſh them, with any certainty.

It does not reſemble a carrot or parſnep, in the ſtalks, leaves, or flowers; though the root has ſome reſemblance to a parſnep, in colour and ſmell; and the ſeeds have alſo a great likeneſs. It reſembles the Angelica, and the miſ-

chief

chief that has been done by it, has proceeded from miſtaking one for the other.

I will here inſert the deſcription, as it ſtands in my catalogue, firſt, in botanical terms, for ſuch as are lovers of that ſcience, and then in language, as plainly Engliſh as the ſubject will admit, for the ſake of thoſe to whom thoſe terms are leſs familiar.

Cicuta Venenoſa. Claſſis, Pentandria. Ordo, Digynia.

Radix perennis, fuſiformis, perpendicularis; colore et odore paſtinacæ radicis prædita. Caulis erectus, herbaceus, quatuor pedes altus, teres, fiſtuloſus, geniculatus, ſubnudus, ſtriato-canaliculatus, purpureus, ſupernè tomentoſus.—Folia petiolata, petiolis ſemi-amplexicaulibus, membranaceis, ſulcatis, triternata, bipinnata, cum impari terminatrice, ſæpe bilobo; foliolis ſeſſilibus, oblongo-lanceolatis, ſerratis.—Folia ima longiſſimè petiolata, triternata, foliolis ovalibus ſerratis, ſerraturis denticulatis.

Flores albi, in umbellis compoſitis ſubrotundis, ſine involucro univerſali cum partiali polyphyllo. Locis campeſtribus et collibus apricis gaudet: menſibus Julii Auguſtique floret.

Hemlock, Poiſonous Mock-Eel-Root, &c.

The root is perennial; of the colour and ſmell of a parſnep, but much ſmaller. The ſtalk riſes four feet high, upright, round, lightly channelled, as if fluted; of a purple colour, hairy or downey on the upper part; hollow and jointed. There are only two, three, or four pair of leaves, placed oppoſitely, at the joints, on membranaceous hollowed ſtalks, which embrace the main ſtem. The leaves are winged, terminated with an odd one, which is frequently divided into two lobes.

The folioles are oblong, and ſpear-ſhaped, ſawed on their edges. The flowers are white, compoſing a large compound umbel, without any involucrum; containing many ſmaller or partial umbels, each with an involucrum of many ſmall narrow leaves. The filaments and ſtyles may be ſeen projecting beyond the flower leaves, being longer than the petals are. It grows on hilly barren lands, on dry grounds and open fields; though ſometimes I have found it in moiſt places. It blooms in July and Auguſt.

I have, lately, obſerved ſeveral of theſe plants, with their lower leaves growing on very long ſtems, or petioles, the petiole encreaſing in length is divided into three; and each of theſe ſubdivided again into three more. Each ſmall ſtem, of this laſt diviſion, bears three leaves; which at their firſt putting out ſeem to be joined in one: but as they increaſe, with age, the lobes divide, and expand themſelves into three diſtinct leaves, which are oval ſhaped, ſawed on the edges; with denticles, or ſmall points, at every ſerrature. Thoſe which do not fully expand, remain in two lobes, or three lobes, whence proceeds the great variety of the leaves, in this plant. The expanſion of the petiole varies very much, alſo in its diviſions; from whence it happens, that the leaves are often ſimply pinnate, ternate, doubly ternate; triply ternate; which may vary the deſcription, but the habit of the plant is ſo ſtriking, and ſimilar, in every one, that no miſtake can poſſibly happen in diſtinguiſhing it.

This plant is endued with a poiſonous quality. Its operation, on the human body, has been pointed out by an accident, that happened, very lately, in my neighbourhood; the relation of which is as follows.

Sometime in the month of May laſt, three negro-boys were ſearching, in the woods, for Wild Angelica, or, as they commonly call it, Eel-Root. They found a plant, and dug

dug up the root, but upon tafting it, the two elder of the boys perceived it was not the root, they wanted. They, therefore, threw it down and left it. The youngeft boy took it up, faid it was Eel-Root, and he would eat fome of it. They went on fearching and digging for fome time: at length their young companion was miffing; they turned back the way they came, and found him lying on the ground, fpeechlefs and fenfelefs. They took him up, to carry him home: a neighbour met them, on the way, to whom the boys related the ftory, as above. This gentleman upon whofe veracity I relate this fact, being a man of reputation and character, and in whofe integrity I place the greateft confidence, told me the ftory, a few days after it happened. He fays, he ordered the boy to be laid down, under a tree; poured down fome milk and oil, and fent him home to his owner, who lives within a mile. He was utterly deprived of fenfe; there was no convulfion, or fpafm; nor any degree of tenfion, or ftiffnefs: his limbs were perfectly limber and loofe; he appeared to be in a deep fleep, deprived of all motion, except that of refpiration. The boys fhewed this gentleman the plant, that the difeafed one had eaten of. Some of the leaves were fhewn to me, which I immediately difcovered to be the fpecies of Hemlock, here mentioned. The boy was carried home; and, after a day or two, came to his fenfes again; but they think he has never perfectly recovered: a fmall degree of dullnefs and ftupidity ftill remains on his brain.

The Cicuta, or Hemlock of the ancients, ufed for putting malefactors to death, particularly at Athens, is unknown to us at this day. The celebrated Dr. Mead, in his Effay on Poifons, thinks it was not a fimple, but a compound of anodyne juices, with others of a corrofive nature.

Throphraftus.

Throphraſtus ſays that Thraſyas, a great phyſician, had invented a compoſition, which would cauſe death, without any pain; and that this was prepared with the juice of Hemlock, and Poppy together; and did the buſineſs, in a ſmall doſe. Plato relates the noble death of his maſter Socrates, ſo as to evince it was brought on by a compound of this nature; viz. the ſymptoms were eyes fixt, heavineſs and inſenſibility of the legs, great coldneſs, which, by degrees, ſeized the vital parts.

The famous poiſon, kept by the public of Marſeilles had Hemlock, or Cicuta, as an ingredient in it; a doſe of which, was allowed by the magiſtrates, to any one, who could ſhow a reaſon why he ſhould deſire death.

The Cicuta, or Hemlock, here mentioned, and of which, this boy had eaten but a very ſmall quantity of the root, ſeems to be of ſufficient ſtrength, without any addition. We are told that, vegetable poiſons, ſuch as Hemlock and Monkſhood, occaſion convulſions, and bring on a painful death; and that, this deadly quality conſiſts in juices of a corroſive nature, affecting the ſtomack and firſt paſſages with a violent pain and inflammation: that this active, acrimonious, ſtimulating, or corroſive property was corrected in the celebrated poiſons above mentioned, by the admixture of anodynes and narcoticks, that ſhould weaken the vellicating, and painful part of their operation, and blunt the ſenſibility of the nervous ſyſtem; ſo as to render their effects inſenſible until they brought on an eaſy death.

The plant, here deſcribed, ſeems to be poſſeſſed of all the powers above mentioned. A very ſmall quantity of the root was eaten: It operated upon the nervous ſyſtem, ſo as to deprive the boy of all ſenſe and motion, except reſpiration; and had he taken a larger doſe, death would

have

have been the confequence. This is a plain indication of its narcotick quality, and ftupefactive powers.

N°. XXX.

Defcription of a Machine for meafuring a fhip's way: in a letter from FRANCIS HOPKINSON, ESQ. *to Mr.* JOHN VAUGHAN.

Read Dec. 17, 1790.

IN the 2d. volume of our Philofophical Tranfactions, I publifhed a defcription of an inftrument for meafuring a fhip's way through the fea. I have not heard of any objection to the principles on which fuch a machine may be conftructed, but it may, probably, have been thought too complex for general ufe.

As this object, fhould it be accomplifhed, would be of great importance, I have made another attempt to the fame purpofe; in which, if there fhould be no other objection, the want of fimplicity cannot reafonably be complained of.

Clofe along the fhip's bow is a copper pipe, about two inches in diameter, extending downward as low as the keel, and upward above the water line when the veffel is loaded. This pipe muft be fo bent at the bottom as that it's orifice may be directly oppofed to the line of the fhip's progrefs, and project but a little way beyond the keel or cut-water. The upper part of this pipe muft alfo be fo bent as that it may enter into the fore-caftle, through a hole made for the purpofe, above the water line. The pipe fhould be fecured in its place by ftaples or clamps.

On the top of this copper pipe fhould be a cover to be fcrewed on, and through the cover a hole muft be made

for

for the admiſſion of a glaſs tube, of the ſize of a common barometer tube, and cemented there. The ſea water will riſe in the copper pipe to the general level of the ſea, but will not appear in the glaſs tube becauſe the copper pipe enters the ſhip above the water line, as before obſerved. But if a quantity of oil be poured down the glaſs tube, the ſurface of the oil will riſe and become viſible in the tube, on account of the ſpecific difference between oil and ſea water.

This glaſs tube muſt alſo be furniſhed with a ſcale for meaſuring the different heights of the oil, the cypher, or (o) of the ſcale being on a line with the ſurface of the oil when the ſhip is at reſt, or makes no way. But when ſhe is in a progreſſive motion, the water contained in the copper tube, together with the column of oil in the glaſs tube, will be forced upward, in proportion to the velocity with which the veſſel proceeds; which will be aſcertained by the different altitudes of the ſurface of oil, viſible on the graduated ſcale.

The glaſs tube ſhould be made to run ſome depth into the copper pipe, and alſo be of a ſufficient height above, to allow room for the vibrations of the column of oil, when the ſhip is agitated by the waves.

When the ſhip has got every thing on board and whilſt ſhe is under no way, the ſurface of the oil muſt be regulated by bringing it even with the (o) or cypher of the ſcale; and this examination, ſhould be frequently made on account of the conſumption of proviſions and other waſte, that may alter the ſhip's draught of water.

In taking down the reckoning from the ſcale, the moſt favourable moment ſhould be watched for a fair obſervation, viz. when the ſhip is proceeding with an average velocity, not when ſhe is in the act of plunging into, or

rising

riſing above the level of the waves, as this would ſenſibly affect the truth of the ſcale. But a little experience would ſoon make the uſe of the inſtrument familiar.

N°. XXXI.

An Inquiry into the Queſtion, whether the APIS MELLIFICA, *or* TRUE HONEY-BEE, *is a native of America.*

Read Feb. 1, 1793.

SO many animals and vegetables have been introduced into the countries of America, ſince the great diſcovery of Columbus, that naturaliſts are frequently at a loſs to determine, which ſpecies are natives, and which are foreigners. This is particularly the caſe with reſpect to plants. Many of thoſe ſpecies which are now diſtributed, in profuſion, through extenſive tracts of country; which are not merely confined to the gardens, the meadows, the fields, and waſte places, but have even inſinuated themſelves into the thickeſt foreſts and the moſt lofty mountains, growing luxuriantly in their new ſituations, are, undoubtedly, European and other colonies, which have been introduced either by accident or by the hands of man. At ſome future day, I ſhall communicate the reſult of my inquiries on this ſubject to the Philoſophical Society. Meanwhile, I ſhall mention a few inſtances, which more readily occur to me. The Plantago *major*, or *Greater-Plantain*, the Verbaſcum *Thapſus*, or *Great White-Mullein*, the Chenopodium *album*, or *Common Wild-Orache*, the Antirrhinum *Linaria*, or *Yellow Toad-Flax*, the Hypericum *perforatum*, or *Common St. John's wort*, the Leontodon *Taraxacum*, or

Common-Dandelion, and the Chryſanthemum *Leucanthemum*, or *Greater-Daiſy**, are, certainly foreigners, which have extended the empire of their growth ſince the diſcovery of the new-world, though they are generally conſidered, both by the vulgar and by the more enlightened, as truly indigenous to our country.

Within the term of three hundred years, many animals originally not natives of this country have likewiſe made their way into it. Thus, it may be doubted whether the *Rat*, the *Mouſe*, the *Tinea*, or *Moth*, ſo pernicious to our clothes, the *Flea*, the *Bed-Bug*, and many others, were known in the countries of America before the arrival of the Europeans in this continent. It has lately been aſſerted that the TRUE HONEY-BEE, the *Apis mellifica* of Linnæus, is not a native of America, and, I think, the opinion is well founded, though it has recently been controverted by the reverend Dr. Belknap, in a diſſertation which he has publiſhed on the ſubject †. This diſſertation I have read with attention; but ſo far from weakening it has ſtrengthened the opinion that this ſpecies of Bee was not found in the new-world before Columbus conducted us to the knowledge of it.

The ingenious Mr. Jefferſon ſeems to have given riſe to this inquiry. In his valuable work, entitled *Notes on the State of Virginia*, this reſpectable author has the following words. "The honey-bee is not a native of our continent. Marcgrave indeed mentions a ſpecies of honey-bee in Braſil. But this has no ſting, and is therefore

* My learned and ingenious friend Mr. Pennant has mentioned the Leontodon *Taraxacum* and the Chryſanthemum *Leucanthemum* among thoſe plants which are common to Kamtſkatca and the eaſt ſide of America. See his *Arctic Zoology*, Introduction, page cxxxiv. As theſe two plants are natives of Kamtſkatca, it is highly probable that they may be indigenous on the *weſt* ſide of America. Be this, however, as it may, I am confident that they are not natives of the Atlantic parts of the northern continent.

† It is annexed to an ingenious and well-written paper, entitled *A diſcourſe intended to commemorate the diſcovery of America by Chriſtopher Columbus*. Boſton: 1792. 8vo.

fore different from the one we have, which resembles perfectly that of Europe. The Indians concur with us in the tradition that it was brought from Europe; but when, and by whom, we know not. The bees have generally extended themselves into the country, a little in advance of the white settlers. The Indians therefore call them the white man's fly, and consider their approach as indicating the approach of the settlements of the whites*."

Dr. Belknap admits that these facts, adduced by Mr. Jefferson, are true; "but they will not", says he, "warrant his conclusion that the honey-bee, meaning the one resembling that of Europe, is not a native of our continent†." I shall examine the grounds of the doctor's objections.

On his return to Europe, after having discovered the American islands, Guanahani, Cuba, Hispaniola, &c. Columbus finding his ship endangered by a violent storm, and fearing that the knowledge of those countries to which he was conducting the nations of Europe, was likely to perish, is said to have written an account of his discovery on parchment, which he enclosed in a cake of wax, and then committed the whole to the sea, "in hopes," to use the words of Robertson, "that some fortunate accident might preserve a deposit of so much importance to the world‡." This wax Columbus procured in Hispaniola§.

A naturalist cannot but be surprized to find Dr. Belknap considering this story of the cake of wax as a proof "that bees were known in the islands of the West-Indies," when they were discovered by Columbus, if by the word

 "bees"

* See page 121 of the English, and page 79 of the American, edition.
† See the Dissertation, page 117.
‡ The History of America. Vol. I. p. 126. Basil: 1790. 8vo.
§ See the *Life of Columbus*, written by his son, chap. xxx. Columbus also mentions this story of his intrepidity and the cake of wax, in a letter which he wrote to Ferdinand and Isabella. See Robertson's *History of America*. Vol. I. note xvi.

"bees" the doctor means, what I presume he does, the true honey-bees. The genus *apis*, or bee, it should be remembered, is very extensive. The learned entomologist Fabricius, in his *Species Insectorum*, which was published in 1781, has given us the names and discriminative characters of eighty-two species. Of this number sixteen are said to be natives of the two continents and islands of America. There can be little doubt that there are many more. Many of these bees, beside the *apis mellifica*, form honey. We shall presently see, from Clavigero, that in the country of Mexico, there are, at least, six species. Nor is the bee the only insect which forms honey. Some species of the genus *vespa*, or wasp, do the same, depositing their stores in trees, in the earth, &c. Without, therefore, something more particular concerning the wax which was procured by Columbus in Hispaniola, we ought not to conclude that it was the production of the honey-bee, and with the lights which we have already received, we are nearly authorised to affirm that it was not.

It is much more probable, that this wax was the fabric of some other species of the bee. It is not impossible, however, that it was the produce of a vegetable, since we are acquainted with some plants which furnish large quantities of wax: such is the Myrica *cerifera*, which grows very commonly in various parts of the new-world, as well as in the southern countries of Africa.

Dr. Belknap's second argument seems to deserve more attention. "The indefatigable Purchas," says he, "gives us an account of the revenues of the empire of Mexico, before the arrival of the Spaniards, as described in its annals; which were pictures drawn on cotton cloth. Among other articles he exhibits the figures of covered pots, with two handles, which are said to be pots of "bees ho-

nie*."

nie*." Of these pots, two hundred are depicted in one tribute-roll, and one hundred in several others†."

The learned Abbé Clavigero confirms this account, in his excellent *History of Mexico*, lately published. He informs us that the Mexican kings received as a tributary payment, a part of every useful production, both of nature and art, and, among other articles of revenue, he mentions six hundred cups of honey, which were annually paid by the inhabitants of the southern parts of the empire of Mexico‡.

In the first book of his work, which is devoted to the natural history of the country, Clavigero mentions six different species of honey-making bees, four of which are said to be destitute of stings: one of the two others, he says, "agrees with the common bee of Europe, not only in size, shape and colour; but also in its disposition and manners, and in the qualities of its honey and wax§".

In answer to these objections of Dr. Belknap, it is obvious to remark, that as there are, at least, six distinct species of honey-making bees in Mexico, five of which are said, by Clavigero, to be different from the *apis mellifica*, or true honey-bee of Europe, we are certainly not warranted to conclude, that the honey which was paid in tribute to the monarchs of Mexico, was the fabric of this most important species of the family.

I will not deny that the true honey-bee is *now* found in Mexico; not only because so respectable an author as Clavigero has asserted that it is, or at least a bee agreeing with it, but because we can hardly suppose that the Spaniards, in the long period of more than two centuries and an half, would have neglected to introduce an animal of so

* Purchas. Vol. iv.
† See the Dissertation, p. 128.
‡ See book vii. p. 351.
§ Book I. p. 68.

ſo much importance. But it muſt be recollected that Clavigero only informs us, that this true honey-bee is now found in Mexico. He has not attempted to prove that it was found there *two or three hundred years ago*. In order to aſcertain this point, with more certainty, it is neceſſary to recur to the more early writers concerning America, particularly Mexico. I am ſorry that I have it not in my power to conſult the work* of Hernandez, who was ſent to Mexico, at the expence of Philip the ſecond, king of Spain, and who devoted much time to the natural hiſtory of the animals, vegetables, and minerals of that rich country. This phyſician, however, does not appear to have been a very accurate naturaliſt; ſo that even though he may have given an account of the bees of Mexico, it is more than probable, that the information which we might derive from him would not enable us to throw much light on the ſubject. The only early author, in my poſſeſſion, who ſeems to give us any information on the queſtion is Joſeph Acoſta. This learned Jeſuit, who has been ſtyled, by Father Feyho, the Pliny of America, reſided for ſome time in Mexico, in Peru, and in other parts of America, towards the cloſe of the ſixteenth century. In his *Hiſtoria Natural y Moral de las Indias*, which was publiſhed at Madrid, in 1590, a few years after his return from Mexico, he tells us that in the Indies, under which general name he comprehends the countries of America, " there are few ſwarmes of Bees, for that their honnie-combes are found in trees, or under the ground, and not in hives as in *Caſtille*. The honny combes," he continues, " which I have ſeene in the Province of *Charcas*, which they call *Chiguanas*, are of a grey colour, having little juyce, and are more like unto ſweete ſtrawe, than to honey combs. They ſay the Bees are little, like unto flies; and that

* Plantarum, Animalium & Mineralium Mexicanorum Hiſtoria. Romæ: 1651. fol.

that they ſwarme under the earth. The honey is ſharp and black, yet in ſome places there is better, and the combes better faſhioned, as in the province of *Tucuman* in *Chille*, and in *Carthagene**."

The buccaneer Lionel Wafer mentions bees among the productions of the Iſthmus of Darien; but the information which he has given us will not decide the queſtion, which I am examining. He ſuppoſes, that ſome of the bees of this country are deſtitute of ſtings, becauſe he ſaw the Indians put their naked arms into the neſts, without being ſtung†. Wafer was in Darien in the year 1679.

The next argument employed by Dr. Belknap is extremely feeble. He finds, in Purchas, that when Ferdinand de Soto came with his army to Chiaha, which was in July 1540, he found among the proviſions of the native Indians of that place, "a ſpot full of honie of bees‡." As there were no Europeans ſettled on the continent of America at this time except in Mexico and in Peru, the doctor ſeems to think this ſolitary pot of honey favours his opinion, for immediately after he ſays "it is evident" that honey-bees (meaning the true honey-bees) were found as far to the northward as Florida, before the arrival of the Europeans in the iſlands and on the continent of America.

Let us examine this argument. If the exiſtence of the true honey-bee in Florida as early as the year 1540, was ſupported by nothing more than the pot of honey found at the village of Chiaha, I think, the ground of argument is very feeble indeed: for it no more follows that this honey was the fabric of the *apis mellifica* than that the tributary honey of the Mexicans was the production of that animal.

But

* The Naturall and Morall Hiſtorie of the Eaſt and Weſt Indies, &c. p. 303 and 304. Engliſh tranſlation. London 1604. 4.

† Deſcription of the Iſthmus of America. London 1704. 8vo.

‡ Purchas. Vol. v. p. 1539.

But the following quotation renders it probable, that at the period which I have juſt mentioned, the true honey-bee was not found in Florida. In a curious little work, entitled *A Relation of the invaſion and conqueſt of Florida by the Spaniards, under the command of Fernando de Soto*, which was written by a Portugueſe gentleman, who accompanied the Spaniſh general in his "mad adventures"‡ in Florida, we are informed that the Indians of Chiaha "had a great deal of Butter, or rather Sewet, in pots that run like Oyl; they ſaid it was Bear's greaſe: we found Walnut-Oyl there alſo, as clear as the Sewet, and of a very good taſte, with a pot of Honey, though before nor after we found neither Bees nor Honey in all *Florida*." *

This ſimple relation of a fact is very pointed. Soto and his ſucceſſor Louis Moſcoſod, Alvarado had rambled over an extenſive tract of country from the end of May, or the beginning of June, 1539 to July 1543. The granaries and the ſtore-houſes of the unfortunate natives were conſtantly ranſacked by an army of needy Spaniards. The troops paſſed through extenſive foreſts, and yet they never ſaw but one pot of honey, and no bees at all. If the honey-bee had been a native of the countries which were the ſcene of Soto's villanies, the valuable products of this little inſect would have been more frequently met with, and the bees, in territories pregnant with a profuſion of ſweet-ſmelling and nectareous plants, would, doubtleſs, have been ſeen very often, and in great numbers.

Thus far the opinion of Mr. Jefferſon ſeems to be ſtrongly ſupported by hiſtorical evidence; and, I think, we are warranted to aſſert that the true honey-bee was not originally an indigenous animal of the ſouthern parts of the American continent. But this opinion may be ſupported by other arguments. My

‡ The Modern Univerſal Hiſtory. Vol. XL. page 393. Edition of 1763.
* See page 72.

My friend the ingenious and accurate Mr. William Bartram informs me, that when he was in West-Florida, in the year 1775, he was shown, as a curiosity, a bee-hive, which, he was told, was the only one in the whole of that extensive country. It had been introduced there from England, when the English took possession of Pensacola, in the year 1763. Mr. Bartram, however, allows, that the honey-bee is now found wild in the country of East-Florida, where, he says, it has been known for a considerable time, perhaps an hundred years. But he is persuaded, from his inquiries, that it is not a native of the country. Mr. Le Page Du Pratz says "the bees of Louisiana lodge in the earth, to secure their honey from the ravages of the bears. Some few indeed," he continues, "build their combs in the trunks of trees, as in Europe; but by far the greatest number in the earth in the lofty forests, where the bears seldom go §." The bees here spoken of as lodging their honey in the earth, I am persuaded, are not the true honey-bee, and Mr Du Pratz's idea that they make choice of the earth to secure it from the bears requires to be better supported. The honey would be as secure from bears in the cavities of trees as it would in the earth. I have had an opportunity of seeing many of these honey-insects, which lodge their fabric in the earth. They are not the *apis mellifica*, nor do they belong to this family. They are more nearly allied to the vespa, or wasp-tribe. The bears prove very destructive to their habitations, devouring their honey, and killing great numbers of the insects.

"As to the circumstance of the bees" extending themselves a little in advance of the white settlers," it cannot, says Dr. Belknap, "be considered as a conclusive argument in favourof their having been first brought from Europe.

§ The History of Louisiana, &c. page 284. English Translation. London: 1774. 8.

It is well known," he continues, "that where land is cultivated, bees find a greater plenty of food than in the foreſt. The bloſſoms of fruit trees, of graſſes and grain, particularly clover and buck wheat, afford them a rich and plentiful repaſt; and they are ſeen in vaſt numbers in our fields and orchards at the ſeaſons of thoſe bloſſoms. They therefore delight in the neighbourhood of "the white ſettlers," and are able to increaſe in numbers, as well as to augment their quantity of ſtores, by availing themſelves of the labour of man. May it not be from this circumſtance that the Indians have given them the name of "the white man's fly;" and that they "conſider their approach (or frequent appearance) as indicating the approach of the ſettlement of the whites?*

I agree with Dr. Belknap, that the circumſtance of the bees "extenting themſelves a little in advance of the white ſettlers," is not "a concluſive argument" in favour of the opinion, that theſe little inſects are not natives of America. Still, however, in my opinion, the argument has conſiderable weight.

It has juſt been obſerved that the Indians call the bee, *the white man's fly*. I have always conſidered this circumſtance as a ſtrong argument in ſupport of Mr. Jefferſon's aſſertion, that this inſect is not a native of America. For notwithſtanding the fewneſs of arts and the rude ſtate of the ſociety of theſe people, they are by no means incurious obſervers of the animals and vegetables of their country, and they mark the progreſs of thoſe which the whites have introduced with the moſt accurate attention. Thus, they call the *Greater-Plantain* by a name which ſignifies the *Engliſhman's foot*, and ſay, that wherever an European has walked, this plant grows in his foot-ſteps, meaning, by this figurative mode of expreſſing themſelves, that before the

* See the Diſſertation page 121 and 122.

the arrival of the Europeans in America, the *Plantain* was not known in the country. In like manner, when the Indians call the honey-bee the white-man's fly, it is evident that the mean to convey an idea, that this insect is not a native of America, but that it has been introduced by the Europeans. Whenever the southern Indians see the honey-bee in the woods, they immediately conclude that the whites will soon follow.

Although Dr. Belknap believes that the honey-bee is a native of Mexico, and of the islands, and that it had extended itself as far to the northward as Florida and Georgia, yet he admits that this insect was not found in the more northern regions of America, previously to their discovery by the Europeans. "The first European settlement in Virginia", he observes, "was made about seventy years after the expedition of Soto, in Florida, and the first settlement in New-England, was ten years posterior to that in Virginia. The large intermediate country was uncultivated for a long time afterward. The southern bees therefore could have no inducement to extend themselves very far to the northward, for many years after the settlements were begun; and within that time bees were imported from Europe*."

That the honey-bee is not a native of the northern parts of America is, I think, incontestibly proved by a variety of circumstances. These I shall consider under the two heads of *negative* and *positive* evidences.

Lawson does not mention this insect among the native animals of Carolina†.

The founder of Pennsylvania, in a long and interesting letter which he wrote to his friends, in the year 1683, takes no notice of bees. It is evident to any one who

 has

* See the Dissertation, page 122.

† See his Voyage to Carolina, &c. London 1704. 4to.

has read this letter, that the great object which its author had in view, was to exhibit a flattering picture of the Province, with the design of inticing emigrants to make settlements in it. An insect whose products are so valuable as those of the bee would not, I think, have been omitted in the list of animals indigenous to the country of Pennsylvania, if Mr. Penn had had any certain intimations of its existence there. Neither do I find the bee mentioned by any of the early Swedish writers who published accounts of Pennsylvania.

I do not find that any of the writers on Virginia mention the honey-bee among the indigenous animals of the country. The little that Mr. Beverley has said on the subject, in his *History of Virginia*, rather authorises the supposition that this author did not consider the honey-bee as a native. "Bees, says he, thrive there abundantly, and will very easily yield to the careful Husewife a full Hive of Honey, and besides lay up a Winter-store, sufficient to preserve their Stocks"†.

Dr. Belknap says, that in the languages of the Indians of New-England, there are no words for either honey or wax. Accordingly, when Mr. John Elliot, who was called *the Indian Evangelist*, undertook the arduous task of translating the Bible into the Natic-language, wherever these two words occurred, as they frequently do in the scriptures, he used the English words, though sometimes, indeed, with an Indian termination.

I consider this circumstance as a strong argument in favour of our common opinion, that the honey-bee is not a native of New-England. At the same time, however, I cannot help observing that as Mr. Elliot confined himself in the translation, which I have mentioned, to the language

† See page 282. Second edition. London: 1722. 8vo.

language ſpoken by the Natic-Indians*, who uſed a dialect of the Mohegan, it does not follow, that none of the New-England nations had words in their languages for honey and wax. Since our intercourſe with the Indians, their languages have become much more copious. As new objects, both of nature and of art, occurred, new words were formed. Thus, in the vocabulary of the Delaware-Indians, we find the words *gok*, *la pe chi can*, *poak ſa can*, *wi ſach gank*, *chey i nu tey*, all which have moſt probably been introduced into their language ſince their intercourſe with the Europeans; for theſe words which I have mentioned, and it would be eaſy to mention many more, ſignify *money*, *a plough*, *a gun*, *rum*, *ſaddle-bag*: now we well know that before our acquaintance with theſe people, they had neither money, ploughs, guns, rum, or ſaddle-bags, among them. The Indians do not continue long acquainted with new objects, without giving names to them. As, therefore, the Natics had no words for honey and wax, it is highly probable, that about the year 1648, when Mr. Elliot was employed in tranſlating the Bible, the honey-bee had not been introduced into that part of New-England which theſe Indians inhabited.

The Delaware-Indians call bees *a mo e wak*. Waſps are likewiſe, known by this name among theſe Indians. Several ſpecies of waſps are natives of our country: it ſeems very probable, therefore, that when the honey-bees were firſt introduced among them, the Delawares to ſave the trouble of inventing a new word for theſe little animals, thought the name by which they were accuſtomed to call the waſp ſufficiently applicable to the bees; between which and

* This is the ſpelling adopted by Dr. Douglaſs, &c. I ſuſpect, however, that it ought to have been *Nahantics*. I find mention made of the Nahantics, and I know that they ſpeak a dialect of the Mohegan. Of the Natics I know hardly any thing, but what Dr. Douglaſs has told us, viz. *that they exiſted*, and that about the year 1747, the nation was almoſt entirely extinct. See his *Summary*, &c. Vol. I. p. 172, *note*. London: 1760. 8vo.

and ſome ſpecies of waſps the reſemblance is ſo great. Inſtances of this trouble-ſaving diſpoſition of the Indians are numerous. The Cheerake, for inſtance, call a priſoner, or captive, or ſlave, *eeankke*, and they apply the ſame name to a pin, and an awl. It is difficult to ſay, what ſecret connection there is between a captive and a pin, or an awl. Theſe ſame Indians call the penis *wato 'hre*, and a corn-houſe is known by the ſame name among them. In this inſtance, the uſe of only one word for two ſuch oppoſite objects is more eaſily accounted for. Savages always think and ſpeak metaphorically. They could not but reflect that whilſt a corn-houſe is a depoſit of the food of men, the penis is the organ by which the eternity of the human ſpecies is maintained.

I do not find the words honey or wax in the copious language of the Delaware-Indians*. If this tribe have not words for theſe ſubſtances, my opinion, that the honey-bee is not a native of America, receives conſiderable additional ſupport.

The Muhhekaneew, commonly known by the name of the Mohegans, ſpeak a language very cloſely allied to that of the Delawares, as I ſhall fully demonſtrate in my *Comparative view of the languages of the American nations with each other, and with the languages of the nations of the north-eaſt parts of Aſia.* In the language of the Mohegans, the honey-bee is called *aum waw*, honey *aum waw weh ſocat*, and bees-wax *aum waw weh pe mey*. Perhaps, it will be imagined, that the exiſtence of theſe words in the Mohegan language is a proof that the bee is a native of their country. My opinion, however, is quite different, and, I think, it reſts upon an unerring foundation.

In the firſt place, the reſemblance between the Delaware and Mohegan words for the honey-bee is obvious.

I

* They call the *Honey-Locuſt-Tree* (*Gleditſia triacanthos* of Linnæus) *pi te la we min ſchi*.

I have already obſerved that the firſt of theſe nations call bees and waſps by the ſame name. It is probable that this is alſo the caſe among the Mohegans. If ſo, it would ſeem likely, that from the reſemblance between the bee and ſome ſpecies of our native waſps, it was not thought neceſſary to impoſe a new name upon the honey-bee after it became a denizen of our woods. But this, it will be ſaid, is treading on the ground of hypotheſis. I ſhall, therefore, relinquiſh it.

The Mohegans, I have juſt ſaid, call honey *aum waw weh ſocat.* This is, undoubtedly, an Indian word. But let us analyſe its preciſe, ſpecific ſignification. The real meaning of the word *ſocat* is *ſugar*, or *ſweet.* Long before the nations of America had any intercourſe with the Europeans, they made ſugar from the *Acer ſaccharinum*, or *Sugar-maple*, and from ſome ſpecies of the genus *Juglans*, or *Walnut.* An appropriate word for this agreeable ſubſtance, of courſe, exiſted in their languages. When the honey of the bee was firſt examined by them, they could not fail to remark that its moſt ſtriking property was its ſweet taſte. An aſſemblage of words was now formed for the newly-introduced ſubſtance. This aſſemblage, in the Mohegan tongue, reads thus, *ſweet or ſugar of bee*, for the word *weh* ſignifies *of.* In like manner, the real meaning of *pe mey* is greaſe, fat, or tallow. All theſe are ſubſtances with which ſavages are but too familiar. When the Mohegans became acquainted with the wax of the bee, obſerving its reſemblance to the different ſubſtances juſt mentioned, they ſeem to have thought it unneceſſary to create a new word excluſively characteriſtic of it. The ſtrict meaning of the word *aum waw weh pe mey* is *greaſe*, *fat*, or *tallow*, *of bee.*

I am confirmed in my opinions on this part of my queſtion by finding that the Natics, or Nahantics, had no words

words in their language for honey or wax*. For, as I have already obſerved, theſe Indians and the Mohegans ſpake dialects of the ſame language. It is not probable, therefore, that one of the tribes would have theſe words and the other not, when we conſider that ever ſince our acquaintance with them they have lived at no great diſtance from each other. And we have known them for more than one hundred and fifty years.

Theſe are the principal *negative* evidences which I am able to adduce in ſupport of my opinion, that the honey-bee is not an indigenous animal in the northern countries of the new-world. I call them *negative* evidences, becauſe to moſt perſons, I preſume, they will not appear to be more. In my opinion, however, ſome of them run cloſely into the evidences of the *poſſitive* kind.

The *poſſitive* evidences and circumſtances which ſupport my opinion, are numerous. I ſhall confine myſelf to the chiefeſt of them.

Mr. John Joſſelyn, who was in New-England, for the firſt time, in the year 1638, and afterwards in 1663, and who wrote an account of his voyages, together with ſome very imperfect ſketches of natural hiſtory in 1673, ſpeaks of the honey-bee in the following words: "The honey-bees are carried over by the Engliſh, and thrive there exceedingly†."

Dr. Belknap ſays, "there is a tradition in New-England, that the perſon who firſt brought a hive of bees into the country was rewarded with a grant of land; but the perſon's name, or the place where the land lay, or by whom the grant was made, I have not been able to learn‡."

Perhaps,

* See page 252 and 253.
† See his *Voyage to New-England*, p. 120.
‡ See the Diſſertation, p. 123.

Perhaps, it will be ſaid that theſe two circumſtances by no means prove that the honey-bee was not a native of the countries of New-England. They only prove, it may be urged, that this little inſect *was not known to be a native of thoſe countries.*

They do not *abſolutely prove* much more. But, on the one hand, I think it is highly improbable that the people of New-England would have been at the trouble of importing bees from Europe, if they were natives of the country; and, on the other hand, it is certainly not likely that a perſon would have received a grant of land, as Dr. Belknap has mentioned was the caſe, according to tradition, if the bees were already in the country. Had they been there, their exiſtence could not but have been well known, unleſs we ſuppoſe that among them, as certain European writers have ſaid of the aboriginal Americans, the principle of ſocial union was extremely weak; ſo that theſe little inſects, whoſe government has, for ages, excited the admiration of philoſophers, may have been ſcattered, like the ſavages, in ſmall families through vaſt tracts of uncultivated country, and not aſſociated in large, civilized communities. It has been ſo much the rage to ſpeculate falſely on the ſubject of America, that I ſhould not be ſurpriſed to find ſuch a writer as De Pauw, aſſigning a weakneſs of their political union as the reaſon why honey-bees were not diſcovered in the new-world. Raynal would, probably, reaſon thus likewiſe, had not this fine writer believed that there is ſomething in the climate of America, that is unfavourable to the generation of good things. Ye philoſophers of Europe! come viſit our countries.

The Reverend Mr. Heckewelder informs me, that although he has ſeen the true honey-bees wild in various parts of the United-States, at ſome diſtance from the ſettlements of the whites, he has always been aſſured by the Indians, that theſe inſects were not known in theſe countries before the whites began to ſettle them. This alone is a very heavy load of evidence in ſupport of my opinion on the ſubject. The Indians, as I have already remarked are by no means incurious obſervers. Is it probable, therefore, that they ſhould be miſtaken on the ſubject, eſpecially when it is remarked that they are, in general, extremely fond and voracious of honey?. The bears are not more ſo.

The honey-bee was not found in Kentuckey, when we firſt became acquainted with that fine country. But about the year 1780, a hive was brought, by a Colonel Herrod, to the Rapids of the Ohio, ſince which time theſe little inſects have encreaſed prodigiouſly. Not long ſince, a hunter found thirty *wild* ſwarms in the courſe of one day*.

Honey-bees were not known in that part of the ſtate of New-York which is called the Jeneſſie-Country, when it was firſt viſited, nor even for a conſiderable time after. Of late, a few hives have been introduced, and theſe will, doubtleſs, ſoon extend themſelves through the country; for there are always ſome diſcontented bees, which may be called deſerters from the hive or colony; which roam in ſearch of flowers in the woods, and ſeem to prefer as an habitation, the cavity of a tree to the artificial hive, in common uſe.

Theſe deſerters are, I think, peculiarly diſpoſed to ſpread themſelves along the courſes of the creeks and rivers of our country, becauſe the ſides of theſe waters are frequent-ly

* It is worthy of obſervation, however, that as yet the bees of Kentuckey do not make much honey. To thoſe which have relinquiſhed the habitations of the ſettlers, and have encreaſed in the woods, taking poſſeſſion of the cavities of the foreſt-trees, the ſpontaneous flowers of the woods afford but a ſcanty portion of thoſe ſubſtances from which the honey is formed. Nor do the cultivated bees manufacture a much larger quantity of this moſt agreeable and uſeful article. The country of Kentuckey is but a recent ſettlement; and although, in the ſhort term of twenty-three or twenty-four years, the encreaſe of its inhabitants has been aſtoniſhingly rapid, great tracts of it ſtill continue nearly in the wild and unvaried ſtate in which it came from the hands of him who made it. The cultivation of the *Buckwheat* is but little attended to in Kentuckey. This, I have no doubt, is one of the principal reaſons why the bees of this country do not manufacture much honey; for there is, perhaps, no plant to which the honey-bees in North-America are more attached than to the *Buckwheat*.

ly decorated with fine, rich, low grounds, commonly called *bottoms*, abounding in a variety of plants, which are agreeable to the bees, ſuch as the Polygonum *ſcandens*, or *Wild-buckwheat*, and many others. So great is the attachment of the honey-bees to theſe ſituations, that ſometimes they form a file, for a conſiderable diſtance, along a creek, or river, quaffing the nectar of the plants, but not venturing to extend themſelves far from theſe agreeable ſituations.

The following quotation, from the Abbé Raynal's *Philoſophical and Political Hiſtory of the ſettlements and trade of the Europeans in both the Indies*, ſhall conclude what I have to ſay in ſupport of my opinion, that the honey-bee is not an indigenous animal of the American continents. "North America," ſays this elegant writer, "was formerly devoured by inſects. As the air was not then purified, the ground cleared, the woods cut down, nor the waters drained off, theſe little animals deſtroyed, without oppoſition, all the productions of nature. None of them were uſeful to mankind*. There is only one at preſent, which is the bee; but this is ſuppoſed to have been carried from the old to the new world. The ſavages call it the Engliſh fly; and it is only found near the coaſts. Theſe circumſtances announce it to be of foreign original. The bees fly in numerous ſwarms through the foreſts of the new world. Their numbers are continually increaſing, and their honey, which is converted to ſeveral uſes, ſupplies many perſons with food. Their wax becomes daily a conſiderable branch of trade†."

* What wretched philoſophy! But, it is not my buſineſs, in this place, to expoſe the puerile weakneſs of theſe aſſertions of Raynal. I am not ignorant, indeed, that they nicely fit the ſyſtem of certain writers who, in the fulneſs of a miſguided zeal, or in that debaſement of mind which almoſt neceſſarily ariſes out of the ſtrong partialities for ſyſtem, in the productions of the new-world, have been able to diſcover no energies of matter, and only an embryo-ſtate of mind. I leave theſe philoſophers to the enjoyments of their dreams.

† See Vol. VII. page 392 and 393. Engliſh Tranſlation, by Juſtamond. London: 1788.

It appears, then, that the *apis mellifica*, or true honey-bee *is not* a native of America, but that we are indebted to Europe for this useful insect. It is difficult to tell at what time this species of bee was introduced into the different countries of America. I think it probable, however, that, in general, the emigrant-settlers would turn their attention to the honey-bee soon after they found themselves pretty well established in their new and happy territories.

I have already observed, that William Penn has made no mention of bees in his account of the natural productions of Pennsylvania*. It is probable, therefore, that in the year 1683, when he wrote the letter, which I have mentioned, these insects had not been introduced into the Province. But their introduction does not appear to have been long subsequent to this period; for one Gabriel Thomas, a Quaker-preacher, who resided in Pennsylvania, for about fifteen years, viz. from 1681 to 1696, speaks of them in the following words: "*Bees* thrive and multiply exceedingly in those parts, the *Sweeds* often get great store of them in the woods, where they are free from any Body. Honey (and choice too) is sold in the Capital City for Five Pence *per* Pound†. Wax, is also plentiful, cheap, and a considerable Commerce‡". The same author, in his *Historical description of the province and country of West-New-Jersey*, says this province is "well provided" with bees§.

Perhaps, it will be thought that I have devoted more time to this inquiry than the subject merited. I will allow, that the question is not of much consequence to mankind, at large; but to a society of philosophers, every elucidation of a disputed point in natural history cannot but be, in-

* See page 251.
† He means sterling.
‡ An historical and geographical account of the province and country of Pensilvania, &c. page 23. London: 1698. 8vo.
§ See page 25. London: 1698. 8vo.

in ſome degree, intereſting. If any farther apology ſhould be thought neceſſary for my troubling you, gentlemen, with my ſentiments on this queſtion, I beg leave to remind you, that in almoſt every cultivated age and country, philoſophers have thought that they were not altogether uſeleſsly employed in collecting materials for the natural hiſtory of an animal ſo intereſting to mankind as the BEE.

Benjamin Smith Barton.

Nº. XXXII.

An Account of a Comet.

DEAR SIR,

Read Feb. 15th, 1793.

ON the 11th of January laſt, in the evening, I diſcovered a comet in the Conſtellation Cepheus. That night and the following it appeared, to the naked eye, ſuperior in brightneſs to a ſtar of the 2d. magnitude. On the 13th, it was evidently diminiſhed, and it continued to grow more faint until about a week ago, when it diſappeared. It paſſed very rapidly through Caſſiopea, Andromeda, the Triangle and Aries. January the 17th, it was near the firſt ſtar of Aries, and on the 31ſt very near Flamſteed's 84th ſtar of the Whale, and a little further ſouth I ſaw it, for the laſt time, on the evening of the 8th of February.

Dear Sir,
Yours, &c.
DAVID RITTENHOUSE.

To Robert Patterſon, Secretary to the Philoſophical Society.

N°. XXXIII.

PRIZE DISSERTATION,

which was honored with the Magellanic Gold Medal, by the Philosophical Society January, 1793.

CADMUS, *or a* TREATISE *on the* ELEMENTS *of* WRITTEN LANGUAGE, *illustrating, by a philosophical Division of* SPEECH, *the Power of each Character, thereby mutually fixing the Orthography and Orthoepy.*

CUR NESCIRE, PUDENS PRAVE, QUAM DISCERE MALO?
Hor: Ars Poet: v. 88.

With an ESSAY *on the mode of teaching the* DEAF, *or* SURD *and consequently* DUMB, *to* SPEAK.

PERHAPS there is no subject of which the generality of men are so ignorant, as the subject of the following paper: indeed there is scarcely one that ignorance affects so much to despise; but, though unexpanded minds may not deem it worthy of a thought, some of the greatest philosophers have considered it of such importance as to claim their particular attention. The learned Bishop Wilkins, in his treatise on a philosophical language, informs us, that besides the famous Emperors Caius Julius Cæsar, and Octavius Augustus, who both wrote upon this subject, Varro, Apian, Quintilian and Priscian bestowed much pains upon the alphabet: since them Erasmus, both the Scaligers, Lipsius, Salmasius, Vossius, Jacobus Matthias, Adolphus Metkerchus, Bernardus Malinchot, &c.—also Sir Thomas Smith, Bullokar, Alexander Gill, and Doctor Wallis†; the last of whom Wilkins thinks, had considered with the greatest accuracy and subtlety the philosophy of articulate sounds. He also acknowledges

† I am sorry that my remoteness from any library prevents my perusing most of these authors, as I write this in *Tortola*, my native place. 1792.

knowledges his obligations to the private papers of Doctor William Holder, and Mr. Lodowick. We find in the Bishop's work a great display of ingenuity and good reason; and on this subject many excellent observations. Since him several eminent authors have engaged in the study, and have favored the world with useful remarks. Among many who have published I will particularly mention Dr. Kenrick, Thomas Sheridan, Doctor Beattie, and Doctor Franklin, some of whose judicious and forcible reasons may be seen in the dissertations of Noah Webster.

An attentive consideration of this theme has many and important objects.

We see hundreds of nations whose languages are not yet written. We see millions of children born to labour for years to acquire imperfectly, what children of good capacity would acquire perfectly in a few weeks.

We see mountains of volumes printed, and no man can produce, in the English language, a single sentence, of ten words, properly written, if in the received mode of spelling.

To reduce the languages of different nations to writing it would be necessary to invent an *Universal alphabet*, the mode of constructing and applying of which I shall only here give an idea of, as the bounds of this paper will not permit me to exemplify more than the English.

An Universal alphabet ought to contain a single distinct mark or character, as the representative of each simple sound which it is possible for the human voice and breath to utter.

No mark should represent two or three distinct sounds*; nor should any simple sound be represented by two or three different characters†.

Language

* As *a* in *call*, *calm*, *came*.
† As *c*, *k*, *q*, *&c*.

Language appears common to nature. Almoſt every beaſt and bird and inſect conveys its feelings by ſounds uttered in different ways. The language of man is however the moſt extenſive: his ideas are conveyed by words, formed either by ſingle or connected ſounds; theſe ſounds are produced by modifications of the voice and breath. Every modification is called a letter, which, repreſented by a mark, and the marks known by the eye to be the repreſentatives of the ſounds, an idea is as intelligibly conveyed by the marks as by the ſounds.

¡How much have the learned to lament the imperfect ſtate in which human genius has yet left the alphabet! It has been the cuſtom to conſider the reduction of language to the eye as an art bordering ſo much on divine, as almoſt to ſurpaſs human invention. If we examine the ignorance, in this reſpect, of even the moſt learned men, we may with ſome propriety aſcribe to the ſubject much difficulty, but, when the firſt ſources of error are conquered, every thing appears plain and ſimple.

I am confident the Hebrew language was not formed before that alphabet; [the alphabet was probably the Ethiopic,] for the radicals of the Hebrew are compoſed each of three characters, and by permutation might form ten thouſand words. Theſe *verbs* have all eighteen flexions, and might form one hundred and eighty thouſand words, which would be more comprehenſive than human genius.

It is impoſſible that a language ſo mechanically and ſo artificially formed could be the effect of chance, it muſt have been formed upon the alphabet, and more eſpecially as it is formed by three characters in all caſes and not by three diſtinct letters or ſounds; for the בּ *beth*, גּ *gimel*, דּ and *daleth*, without the point, have the powers of B⊐*,

G⊐

* ⊐ is the Vocal of the H.

GI and DI; capable of forming by permutation twenty nine words, but twenty four without repeating the ſame character three times in a word, each containing ſix letters, and but *three characters:* if theſe characters were primarily conſidered as only each the repreſentative of one letter, this reaſon is not valid, but the next becomes ſtronger, and the difficulties increaſe; for, to form a language of exactly three letters in every radical word, pre-ſuppoſes a perfect acquaintance with a diſtinct ſet of ſounds, beſide a general conſent of the perſons engaged in the compoſition of the language, and memories ſufficient to retain one compoſed by permuting twenty two letters by three. It requires more genius to effect it without, than with characters: by an alphabet it might be the compoſition of one man, but is however the production of a great effort of genius, and approaches towards a philoſophical language.

All the world have to lament that not only the circumnavigators of different nations, but even of the ſame nation, who make vocabularies of the languages they hear, are ſo little acquainted with the philoſophy of ſpeech, as never to write them alike: indeed the ſame perſon cannot read in his ſecond voyage, but with difficulty, what he wrote in the preceding one, with a pronunciation intelligible to a native: yet moſt people are capable of repeating with tolerable correctneſs what they hear others pronounce immediately before, even in a different language, provided the ſame ſounds, contained in the word be found in the language of the imitator, otherwiſe new ſounds muſt be attempted, and every perſon is not ſufficiently accurate in his obſervations, to perceive the effort made by the ſpeaker when he utters ſuch ſounds, as we may obſerve daily in the attempts of foreigners to ſpeak the *th* of the Engliſh D Θ, &c.

Shew a ſentence in the Roman alphabet to an individu-al of each nation that makes uſe of theſe characters, and two perſons cannot be found to read it alike: nor can a perſon who underſtands the powers of the letters in one language, be capable of reading a ſentence in each language properly.

Moſt of the nations of Europe have received more or leſs the Roman alphabet, yet there is not one language to which it is perfectly adapted; however, although in the different languages of Europe the ſame ſound is often re-preſented in each by two or three characters, we find in moſt of them ſome words which contain the ſame character to repreſent the ſame ſound; therefore the formation of an extenſive, fixed alphabet, for the uſe of Europe, will not be ſo difficult, as if we could furniſh no inſtances from the different languages, in which they all concurred to give the ſame ſound to the ſame character. But this will only ſerve while we attempt to preſerve the Roman characters, and produce as little innovation as poſſible in printing: were we to go as far as common ſenſe would direct, and lay aſide the Roman alphabet, which is exceedingly com-plex, adopting one that might be reduced to ſuch ſimpli-city, as to require only one fourth of the time to write the ſame matter, we muſt firſt fix all the ſounds, by making for each language a correſpondent table in diſtinct columns, then adapt the ſimplicity of the character, as much as poſ-ſible, to the frequency of the ſound in the different lan-guages. The moſt certain mode of fixing the ſounds, is by adopting in each table the ſimpleſt monoſyllables in which they are found, ſuch as are commonly pronounced alike, and are the moſt frequently uſed. The ſame letter or character ſhould ſtand at the head of each correſponding perpendicular column, in the ſeveral tables, and the ſame alſo at the beginning of each horizontal line, thus repre-ſenting

ſenting always the ſame ſound, as far as theſe ſeveral characters can be applied. If the ſame ſound cannot always be found in one language that a letter in another repreſents, this letter muſt not be uſed in the firſt, on any account, as it would produce confuſion; for it makes part only of an univerſal alphabet. Such characters might however ſoon come into uſe, by adopting, with all future diſcoveries, the names given by the inventors, either in arts or ſciences, and in whatever language. Any ſubſequent improvements in the arts would be more eaſily comprehended in writings, were the names and terms every where the ſame. If one nation only take this advantage one only will enjoy this benefit: but were more nations to do it, languages would in time aſſimilate as knowledge became more diffuſed by intercourſe; the origin of the diſcoveries would be more eaſily traced, and all the world ſeem more nearly allied. Nothing indeed can be more ridiculous, than to alter a proper name, merely to make its termination more correſpondent to the general laws of a language: ¡yet in how many inſtances have the French, Engliſh, Germans and other nations done this! At the ſame time they urge the neceſſity of preſerving an orthography which has very few traces left of the radicals, and has little more affinity with the ſpoken language than two different languages have with each other: thus, to read and write, and to ſpeak the ſame things, are arts as different and difficult as to learn two diſtinct languages; for they are in general written by miſerable hieroglyphics; and, it is as difficult for a perſon to remember that a particular written word ſignifies a certain vocal one, as to remember that the ſame word ſignifies a particular object. We cannot then but lament the many miſpent years of our youth, and the continual exerciſe of cruelty which is inflicted to make them imbibe the ignorance of their anceſtors, and for ever ſhackle their minds with falſe and abſurd prejudices.

Voltaire, that gilder in literature, who never wrote any thing ſolid upon any ſubject, but what may be attributed to the much injured and obſcure Pere Adam, or the celebrated Durey de Morſan, gave ſome pieces in favor of a reformation in ſpelling, but did not exceed a few terminations of words, which he urged to the French Academy; they however argued for the propriety of retaining the old mode, leſt they ſhould not know the derivations of words; which are, indeed, as ſolely the province of antiquarians, as the derivations of cuſtoms and things; but were they really requiſite to Scholars, they have only to turn to dictionaries, and fag through a few references.

Many urge the utility of the old orthography to prevent obſcurity in writing, but ſ though half a dozen words of different acceptation had the ſame orthography, where would be the difficulty of obtaining the meaning? for in ſpeaking we find none, and many words in Engliſh have the ſame ſound; for inſtance *beer* to drink, and *bier* to carry the dead upon; alſo *bear* the verb to carry, *bear* the beaſt, and *bare* naked, are never miſtaken in converſation, the compoſition of the ſentences conveying perfectly the diſtinction. If any obſcurity be perceived, an alteration ſhould be made in the words themſelves, and the orthography regulated thereby: inſtances may be pointed out where it would be highly proper to adhere, not only to particular diſtinctions in the preſent orthography, but to conform to them in ſpeaking— ſ *If you ſpeak like moderns, why would ye write like ante-chriſtians?* pronounced, ante not ant*i*, otherwiſe there would be no difference between, *before* Chriſt, and *againſt* Chriſt.

Several of the Engliſh argue for the preſervation of derivatives, but it is the laſt argument that ought to have been uſed, in delicacy to their own feelings, for none of their

their most learned grammarians or lexicographers, except, perhaps, James Robertson* knew the derivation of even the commonest monosyllables, 'till John Horne Tooke cleared away all the obscurities, under which ignorance was veiled, and detected the learned absurdities of Harris, Johnson, Lord Monboddo, and many others.—James Robertson, in his Hebrew grammar, (the first edition of which was published fifty years ago) gives hints which indeed could not escape a person of much less learning and penetration than John Horne Tooke, but I would by no means infer thence, that any hints have been borrowed, because his name, I am confident, would have been mentioned.

Some of the most learned men are men of the least knowledge—take away their school learning, and they remain children. As all their consequence in life consists in their acquaintance with dead languages, they, no doubt, would condemn any attempt to lessen the dignity of such acquirements. 'You must not alter the orthography of languages, because we cannot afterward derive the words; then all the learning we have taken so much pains to acquire will be useless.'—We must thus preserve bad spelling to render dead languages useful in its derivation, and we must learn dead languages to derive bad spelling.—¡When does the lady (who speaks the most elegant language) ask the pedant whence the words are derived! He has spent two minutes in two languages to know the meaning of the word, and she has spent two minutes in one language; and ¿where is the difference? A child must spend many years in learning dead languages, that he may know more perfectly his own.—Few acquire more than one language with its elegancies. I have known good latin scholars, in England, incapable of writing English tolerably.—¡How much

* Professor of the Oriental languages in the University of Edinburgh.

much more rational would it be, to ſtudy the Engliſh twice as long, than to ſtudy another language to obtain the Engliſh! There is ſcarcely one man in fifty, even among the learned, that writes every word with what is, *moſt erroneouſly*, called a correct orthography, without a lexicon, among the unlearned none, and few among well educated ladies. Theſe difficulties depend greatly upon falſe ſpelling, becauſe they all pronounce much more alike than they write; and that falſe ſpelling, in its origin, depended as much upon a want of knowing the alphabet, as upon the change of language for the ſake of euphony. People are more aſhamed of expoſing bad orthography than bad writing: the only difference, however, between what the world calls bad ſpelling and good, is, that the firſt contains the blunders of the writer only, the latter contains the blunders of every body elſe.

Dr. Johnſon, in the grammar which is prefixed to his dictionary (under letter Z,) ſays "*For pronunciation the* "*beſt rule is, to conſider thoſe as the moſt elegant ſpeakers* "*who deviate leaſt from the written words.*" If the Doctor, with all his learning, had heard any page of his own works read correctly, (according to the orthography) he would with difficulty, if at all, have been able to conſtrue it, and would have been even more at a loſs than foreigners are when the Engliſh ſpeak Latin. I am ſorry that the vague opinion of an eſtabliſhed character can impoſe upon the generality of men, and I lament how much ſooner the errors of the great are embraced than the truths of the little. The Doctor immediately after this allows "*our* "*orthography to be formed by chance, and is yet ſufficiently* "*irregular.*" I cannot conceive by what rule the irregularity can be determined, but by its non-conformity to the ſpeech, which would thus deny his previous aſſertion. "*Some reformers*" he adds, "*have endeavoured to accom-*

modate

"*modate orthography better to the pronunciation, without* "*confidering that this is to meafure by a fhadow, to take* "*that for a model or ftandard which is changing while they* "*apply it.*" If language change, the orthography ought alfo to change; but if orthography were once properly accommodated to language, even this would not be liable to change, confequently that: and it would then be confidered, by all but Johnfonians, as great an impropriety to *mifcall* a written word, as now to pronounce it *properly*. "*Others,*" he fays "*lefs abfurdly indeed, but with equal* "*unlikelihood of fuccefs, have endeavoured to proportion the* "*number of letters to that of founds, that every found may* "*have its own character, and every character a fingle found.* "*Such would be the orthography of a new language to be* "*formed by a fynod of Grammarians upon principles of fcience.* "*But who can hope to prevail on nations to change their* "*practice, and make all their old books ufelefs? or what ad-* "*vantage would a new orthography procure, equivalent to* "*the confufion and perplexity of fuch an alteration?*" In anfwering the above I will firft afk the fimple queftion what is the *ufe* of writing? It is to exhibit to the eye the fame words that are fpoken to the ear: and it is impoffible to do this without giving a diftinct mark for every diftinct found: to deviate from this rule is to run into error. A fynod of grammarians would not require a new language to accommodate true fpelling to, it may be fo eafily accommodated to * all languages; and if falfe orthography does not

* In a tour through Scotland, I vifited the Hebrides, and met with many old men who neither fpoke a word of Englifh, nor could they read a word in any language; thefe men repeated many of the poems afcribed to Offian, and other ancient bards. One of thefe Poems I wrote with fuch orthography and characters, as I thought might anfwer to the founds which were repeated by an old man. I afterwards read it flowly to a fenfible old woman, who underftood it, and the Englifh, well enough to give me a tranflation; this was as regular a poem as any I have feen tranflated, poffeffing alfo much genius, but fhe often lamented the poverty of the Englifh language, which fhe faid was incapable of expreffing the fublimity of many of the paffages. It might be fo, but I conceived there was another, and a more forcible reafon, viz. her being more extenfively acquainted with the gaelic than the Englifh. I will here digrefs

not change a language, it is very improbable that correct orthography would alter, but rather ſerve to fix it; and to ſuppoſe the contrary is abſurd. As to "*making all their old books uſeleſs*," I anſwer, that the Doctor, though he reaſons thus, could read Chaucer and other ancient poets with ſufficient facility. All good authors whoſe works are too voluminous or expenſive, or too abſtracted for new editions, would ſtill afford ample matter for the learned and ingenious, and they would be read, with as much eaſe as the ancient Engliſh or French. If they were books of more general uſe, and worthy of new editions, they would no doubt be republiſhed; if not, the riſing generation would be much benefited by their ſuppreſſion. Some of "*the advantages which a new orthography would procure*," ſhall be enumerated. 1ſt. Travellers and voyagers [Page 265.] would be enabled to give ſuch perfect vocabularies of the languages they hear, that they would greatly facilitate all future intercourſe. 2dly. Foreigners would, with the aſſiſtance of books alone, be able to learn the language in their cloſets, when they could not have the benefit of maſters; and would be able to converſe through the medium of books, which at preſent are of no ſervice whatever, in learning to ſpeak a language; and if this were to be adopted by the AMERICANS, AND NOT BY THE ENGLISH, the beſt Engliſh authors would be reprinted in America, and every ſtranger to the language *even in Europe*, who thinks it of more conſequence to ſpeak the Engliſh correctly, than to write it with the preſent

greſs ſo far as to declare, that I ſaw and heard more unpubliſhed poems, of this kind, than have been printed by James Macpherſon, and John Clarke (Tranſlator of the Caledonian Bards) and have heard alſo ſome of the poems which theſe Gentlemen tranſlated. Though I wrote tolerably faſt, I learnt by ſome of my acquaintance, that the venerable old man could repeat ſuch a variety as to keep me writing half a year. I will not attribute the intelligible manner in which I repeated the poem, entirely to the orthography and characters made uſe of; for my memory, as I read it ſoon after, aided me much, and I had not then made the ſubject of this treatiſe my ſtudy: but at preſent there is no language, that I can pronounce, which I cannot write intelligibly, and this may be learnt by any one in a very ſhort time.

present errors, would purchase American editions, and would be *ashamed* to spell incorrectly, when he could acquire the mode of spelling well; for he would not be partial to difficulty, and would examine the old and new modes with more philosophy, than our blind prejudice will allow us to make the test of reason.

3d. Dialects [page 279] would be utterly destroyed, both among foreigners and peasants.

4th. Every one would write with a perfectly correct orthography [p. 279.]—

5th. Children, as well as all the poorer classes of people, would learn to read in so short a time, and with so little trouble, having only to acquire the thirty letters, *that this alone ought to silence all the objections that can be brought*, and, particularly with the foregoing reasons, must be deemed more than "*equivalent to the confusion* "*and perplexity of such an alteration.*" But, independent of what is said above, I admit neither confusion nor perplexity to be the consequences of such a change: those who were never before taught to read, could have no idea of any other method, and these who now read would find no more difficulty in the two modes, than is found in reading by any secret character. Even short-hand writers, if in practice, find no difficulty in reading words which do not contain a single common vowel: simple marks are used, and they attend not to the present absurd orthography of any word i how much more easy then to read words which contain the symbols of every sound, and especially when most of the common characters are used! besides, those whose thirst after knowledge is quenched, may hereafter amuse themselves with the books now published. I should have been astonished at the Doctor's observations, if I had not been acquainted with his prejudices.

He gives some specimens of the reformed orthography, of Sir Thomas Smith, secretary of state to Queen Elizabeth;—of Doctor Gill, the celebrated master of Saint Paul's school in London;—of Charles Butler;—and shows that Milton was inclined to change the spelling: finally, he mentions Bishop Wilkins, as the last general reformer. The specimens however which he exhibits as a "*guide to reformers, or terror to innovators*" I am afraid will answer neither intention, being too inperfect to serve the former, and too incorrect to deter the latter; but some of the imperfections he attributes to the want of proper types; yet by these instances, we find, at so early a time, many advantages over the barbarous spelling of the present age. To examine the common-place observations, of even the generality of prosodial writers, would be too tedious a task for the author, to give any account of them, too tedious to the reader, who shall therefore be subjected to as few remarks as possible, upon what others have written on the doctrine of articulate sounds; but as Thomas Sheridan is one of the latest authors on the subject, and his pronouncing dictionary, in which he has much merit, is more generally known than any other, a few observations on different parts of his work will be indispensable.

The distinction which he* and other grammarians make, between a *vowel* and a *consonant*, is, that the first can be uttered or pronounced by itself; the latter cannot. How harmless soever this may appear, it has been more fatal to scholars than Sylla or Charybdis were to Mariners.

If a consonant cannot be pronounced by itself, it must be part of a compound; therefore Mr. Sheridan should have made nineteen additional compounds to the † *j* and *x* in his scheme of the alphabet—yet, he says ‡ "there are "*twenty eight simple sounds* in our tongue; *six of which however,*

* See his dictionary.
† Page 1st of his prosodial grammar.
‡ Page IX. Id.

"*however, are mutes:*" *h* he ſays, is no letter—I think he might have claſſed it with his mutes; at the idea of ſpeaking and hearing of which, reaſon revolts.—If *h* be rejected as a letter, merely becauſe it is a mark of aſpiration, the *k*, *p*, *t* and ʘ ought as well to be omitted, becauſe they are only marks of aſpiration: ɾ, *f*, ʘ, *ʃ* are alſo aſpirates, but more forcibly made than the former. If a letter be not neceſſary to mark the ſimpleſt aſpirate, there is no difference between *heating* a cake and *eating* it; but if even a dot be neceſſary to mark it, and if in every other inſtance that dot have the ſame ſignification, it would be as much a letter as any other character; for every mark which is pronounced, diſtinguiſhing thereby one word from another, is really a letter, becauſe, it ſubjects to the eye what the ear requires of the voice.—I do not however conſider accents, of which the French and ſome other nations are ſo liberal, as letters, but as notes by which the high ſound of particular letters may be directed.

He makes nine vowels—but there does not appear to be any difference between the ſound of his ſecond *a*, as in *hate*, and his firſt *e* as in *bet*, except in length; for, ſubſtitute the laſt for the firſt, and the word *het* will make by prolongation *heet*, written at preſent *hate*.—His third *e* as in *beer*, appears to be preciſely the firſt *i* as in *fit*, for by lengthening the *i* in *fit* we make *fiit*, written *feet*; (beer, *biər*; beet, *biit*,) nor can we make it otherwiſe.

He follows the Scotch mode of naming the conſonants, by placing before each a common vowel, inſtead of adopting the *more irrational* plan of the Engliſh, who ſometimes put the vowel before, and ſometimes after the character to give it a *name*: but here is the rock of error, upon which all grammarians have ſtruck, who have attempted to give a rational account of the formation of language.

guage. The Hebrews and Greeks led Europe into this miſtake, which prejudice ſince has taken great care to preſerve. The Phenicians, and after them the Hebrews, not diſtinguiſhing ſufficiently the ſimple formation of the elements, adopted words which began with the ſounds, without conſidering, in ſome inſtances, any relation that the ſound has with the object. Thus X begins the name of the ox, which is *alpha* in the Phenician (and א aleph in the Hebrew) hence the Greek name *alpha*, when Cadmus introduced letters into Greece.—The *B* being the firſt letter of the voice of the ſheep, was repreſented among the Egyptians, by a Hieroglyphick in the form of a ſheep. The *NAMES of the letters, inſtead of the POWERS, have been hitherto invariably ſtudied; we conceive them therefore, not to be ſimple ſounds, and hence the ridiculous diviſion of the alphabet into vowels; conſonants; mutes, pure and impure; ſemivowels and their numerous ſubdiviſions.

The characters ought all to be divided into two claſſes; VOWELS and ASPIRATES.

A vowel is a letter that is ſounded by the voice,† whence its name. An aſpirate is a letter that cannot be ſounded but by the breath. Of the former there are twenty one in the Engliſh Language; of the latter nine, making thirty letters.

The

* I have been aſked how we ſhall be able to ſpell words to each other, without *naming* the letters.—It would be thought ridiculous to aſk the names of the words that compoſe a ſentence, but the queſtions are exactly parallel, or of one form; *by this mode the mere pronouncing of the word ſlowly is ſufficient, and there is no other ſpelling;* thus a child, that reads the letters, reads words compoſed of them, as he reads ſentences compoſed of words. If I were to teach a child, not by affinity of ſound or reaſon, but by mere repetition, to call the letter *s ſeven*, the *e ten*, and the *x ſix*, to ſpell the word *ſex*, it would be deemed very irrational, but it is much leſs ſo, than the mode by which moſt of the words in the Engliſh language are taught;—for inſtance, *double-u—aytſh—ai—ſee—aytſh*, are to be hammered, by *name*, into a child's head to produce the word *which!* Oh, cruelty, ignorance, and loſs of time!——(See ⊙ table of ſounds line 13.

† *Speaking* is rendering ideas audible by the voice; *whiſpering* is rendering them audible by the breath; and a perſon cannot therefore, with propriety, be ſaid to ſpeak in a whiſper. Voice is derived from *vox* a ſound, but we have fixed the idea to a *certain claſs of ſounds*, otherwiſe it would be as proper to call any ſouud whatever, *voice*, as to call by that name the particular ſounds uttered by the human organs of ſpeech.——

The Characters.

Common nasal ſtopt ſibilant ſhort

ƎꟷAEIOU YZRLJVÐW MNŊ GBD ſFΘS KPT ʘH

Vowels Aſpirates

əꟷaeiouyzrljvw ð mnŋ gbd ſfθs kpt ʘh

The following characters are particularly recommended.

ƎꟷAEIOUYZRLJVÐɯm n ŊGɑDſFΘSKPTʘH

It were much to be wiſhed that one ſet of characters be uſed inſtead of capitals and ſmall letters, for they only increaſe the difficulty of finding a ſufficient number of eaſy forms, for an univerſal, or even a copious alphabet. The ſame letters made larger at the beginning of an emphatic word, or the whole made a larger ſize, or in Italics, would be ſufficiently characteriſtic. The printing letters, as in the third line of characters, above, neither aſcending nor deſcending out of the line, would render books, printed in this type, the moſt beautiful that ever yet appeared, and the lines would be more diſtinct.

The written characters may be accommodated to the others by degrees; at preſent I ſhall make little innovation in them.

ə	Pronounced like,	e	as in herd,
[script w/a]		a	law
a		a	rat
e		e	red
i		i	fit
o		o	fog
u		o	fool
y		y	ye
z		z	zeal
r		r	red
l		l	let
j		g	judge
v		v	vaſt
ð		th	that
w		w	wolf
m		m	met
n		n	nap
ŋ		ng	king
g		g	get
b		b	bat
d		d	dim
ʃ		ſh	ſhip
f		f	fit
θ		th	thin
s		ſ	ſet
k		k	kiſs
p		p	pen
t		t	ten
ʘ		wh	when
h		h	hat

Rules

Rules for pronouncing * theſe letters, † ſhewing the formation of each diſtinct ſound, in the Engliſh language, to which it is thought neceſſary to appropriate a character; *having a true knowledge of which, it will be impoſſible to write incorrectly whatever is heard in any language, containing only theſe letters*; *and as impoſſible to read incorrectly any language written in theſe characters*; for, by this method, the orthography and orthoepy determine each other; and, if the orthography of language were to be corrected, the pronunciation of the ſcholar, would, by reading alone, be perfectly attained by the peaſant and the foreigner; deſtroying thus, *in the moſt effectual manner*, all vulgar and local dialects, and fitting even for oratory, every man of good capacity and utterance.

The reader is now to reject all prejudices reſpecting NAMES of letters, and is to ſtudy only their POWERS, which *in all caſes may be prolonged*, except in the ſtopt vocals and their aſpirates; and a good mode of obtaining preciſely the true power of each, is, to tranſpoſe the letter to the end of any word which that letter begins, then, by repeating the word rapidly, the letter will take its proper place, and the ear will determine if it poſſeſſes the true ſound.

Pronounciation

* Though it is ſaid Pronunciation is ſuch *quæ nec ſcribitur, nec pingitur, nec haurire eam fas eſt, niſi vivâ voce.*

† It will be obſerved in the line which I ſo particularly recommend, that ſome of the letters have been a little altered to render them more ſimple, and that ſome of the Characters are merely common letters reverſed. The middle line of the A of the E and F have been omitted which will render them more eaſy for the type-founder, and leſs liable to blot in printing. The V and ʃ are the A and J inverted, the Ǝ is the E reverſed. The long S (ſ) ſhould be totally omitted, it has ſo much the appearance of ʃ. The Đ is the ſame as the Saxon, but rather more diſtinct: the Θ of the Greeks is alſo a little altered in the printing letters. The ⊙, of the Goths, may be ſomewhat altered in *writing* for the ſake of expedition. U W M N are made like the ſmall letters, u being the inverſe only of n, and ʍ of m, filling the line with great beauty, and avoiding diſagreeable angles.

Pronounciation of the Letters

ɪ

Is made by opening the mouth a very little, juſt ſufficient to ſhew the edges of the upper teeth, producing a *vocal* ſound low down in the throat, and ſuffering the tongue and lips to remain at reſt, the epiglottis only being raiſed by the breath, which by a contraction of the glottis, by the ſurrounding muſcles, occaſions a tremulous motion and ſound called voice, that can be felt by applying the fingers to the throat; but this tremulous motion can only be felt when vocals are ſounded, ſo that thoſe who are born deaf, may be made ſenſible of the difference, by feeling only, and can thus diſcover, when they are learning the elements of ſpeech, whether or not they pronounce properly. The Engliſh *h* is the aſpirate of this vocal: it is a vowel much uſed in that language, taking the place of *o* very often when ſhort, but it was not repreſented by a character.—Its power may be found in the firſt perpendicular column of the ſucceeding table in *ſun*, SɪN; *ruff*, RɪF; &c.

Ⅱ

To pronounce the ſecond common vowel, the mouth muſt be more open than for ɪ, but the lower lip muſt not diſcover the lower teeth: the ſound is made in the throat, more eaſily continued, and is fuller than in pronouncing ɪ, and the tongue is drawn back, the tip of it reſting on the bottom of the mouth. It is alſo a very common vowel in the Engliſh language, though there was no character

aſſigned

assigned to it. The power of ¤ may be found in the second perpendicular column of the table of sounds, in *yawn*, Y¤¤N;—*saw*, S¤¤;—*raw*, R¤¤; &c.—

a

The third common vowel: the mouth must be still more open than for ¤ the lower lip descends a little below the tips of the under teeth; and the tongue must lie flat. Its power may be found in the third perpendicular column in the words, YARN;—ZAG;—SAT;—RAT &c.

e

The fourth common vowel—The mouth a little more shut than for *a*, but the lower lip exposing still more the lower teeth, and the tip of the tongue gently pressing the under teeth. Its power may be found in the fourth perpendicular column of the table, in, y*e*ll, YEL;—z*e*phyr, ZEFƎR;—SET;—RED, &c.

i

Fifth common vowel—the mouth rather more contracted than for *e*, but the under lip so low as to shew the insertion of the lower teeth; the corners of the mouth a little extended; the tongue pressing gently upon the edges of the lower teeth. Its power may be found in the fifth perpendicular column, in, *ye*, YI;—*zea*l, ZIIL;—SIT;—RIP, &c.

o

Sixth common vowel—the mouth is nearly in a natural state, the lips brought rather closer together—the tongue drawn back a little, and the sound resembles the ¤, but

 the

the *o* is made more in the mouth than in the throat. The Greeks use two characters for this sound, though really one is only longer than the other, and the original intention was good, because the long sound was denoted by the same character being marked twice (oo ω), and it ought not to have been admitted as a new letter, as it indicates thereby, not a continuance, but a difference, of sound. The ancient Greeks, as mentioned by Plato, made no distinction in the long and short *O* (called now the *great* and *little o*) nor in the long and short *E* as may be seen in the word *ΣΤΡΑΤΕΓΟΝ written at present ΣΤΡΑΤΗΓΩΝ. The power of *o* may be found in the sixth perpendicular column in the words, y*o*ke, YOOK;---z*o*ne, ZOON;---SOT;---ROT, &c.

u

Seventh common vowel: the organs are continued in the same position as in pronouncing *o*, except that the lips are so much contracted as to leave only a very narrow aperture, and are much protruded.—*u* is pronounced in the same manner as the Greek ȣ. Its power may be found in the seventh perpendicular column of the table of sounds, in the words, ye*w*, YUU;---ze*u*gma, ZUUGMA;—s*ou*p, SUUP;—r*oo*t, RUUT; &c.

y

The eighth vocal sound, is pronounced in the same manner as the fifth common vocal *i*, except that *y* requires a more forcible effort of voice, and the back part of the tongue rises a little, to intercept the sound, which thus becomes tremulous. It is the vocal of the German ch, and of the *gh* of the Gaelic, Scotch, &c.—Its power is found in the first horizontal line of the table of sounds, in the words, *y*awn, Y□□N;—*y*arn, YARN;—*y*ell, YEL; &c. Ninth

* Parkhurst's Lexicon of the New-Testament (H.)

z

Ninth vocal—The lips are ſufficiently open to ſhew part of the upper and under teeth, which are nearly ſhut, and the edges perpendicular: the tip of the tongue is placed gently againſt the roof of the mouth, near the inſertion of the upper teeth; the corners of the mouth a little drawn up, and a tremulous vocal ſound produced; the power of which is exhibited in the ſecond horizontal line, in the words, ZΛG;---zephyr, ZEFↃR;---zeal, ZIIL; &c.—It is the vocal of the aſpirate *S*.

r

Tenth vocal—the mouth a little open—the tongue raiſed ſo near to the roof of the mouth, that the voice cannot paſs between them without occaſioning a rapid vibration or tremor of the tongue. The ſound imitates the ſnarling of a dog. The aſpirate of *r* is not in the Engliſh language, but in pronouncing gives the ſame tremulous motion to the tongue, and imitates the flight of the partridge and ſome other birds: this aſpirate is however in the Ruſſian language, though it has no letter or character. The power of *r* may be found in the fourth horizontal line of the table of ſounds, in the words, *r*uff, RↃF;—*r*aw, R□□;—RAT;—RED, &c.

l.

Eleventh vocal—the mouth a little open; the tip of the tongue touching the roof of the mouth, and the ſound iſſuing by its ſides. It is very ſimple, requiring little effort, and is ſimilar to *n*, except that the ſound of the latter paſſes by the noſe. The power of *l* may be found in the fifth horizontal line of the table of ſounds, in the words, *l*ump, LↃMP;—*l*aw, L□□;—*l*aſs, LAS;—LET, &c.

j

Twelfth vocal—the middle of the tongue a little raiſed; the teeth brought nearly together; the ends of the under lip raiſed, the aperture of the mouth becoming thereby more circular. This is the true French *j*, and is the vocal of the aſpirate *ſh* (page 287,) expreſſed by one character, which is the *j* inverted. The power of *j* may be found in the ſixth horizontal line of the table of ſounds, in the words, ma*j*eſty, MADJƐSTI;--trea*ſ*ure, TREJƐR;--zei*z*ure, SIIJƐR; &c.

V

Thirteenth vocal—The edges of the upper teeth, which are diſcernable, are placed upon the lower lip; the tip of the tongue nearly touches the under teeth, and a vocal ſound is made, the power of which may be found in the eighth horizontal line of the table of ſounds in the words, *v*ery, VƐRI;—*v*aunt VƐƐNT;--VAST;--*v*ain, VEEN, &c. This is the vocal of the aſpirate *f*. Some of the ancient latin monuments ſhew that the *b* has often been put for the *v* by confounding the ſounds, and thereby confounding the ſenſe of the word; as in acer*b*us for acer*v*us, and *v*eneficium for *b*eneficium.—The Engliſh in the time of Chaucer, wrote *ſaff*, *ſaaf*, for *ſave* or *except*; and in the reign of Queen Elizabeth the *f* was written for the *v*, as may be ſeen in Spencer *ſafe* pro *ſave*. The Spaniards, even now in the moſt polite companies, often confound them.

Ð

Fourteenth vocal—the mouth is a little opened, ſo that the tip of the tongue touches the edges of the upper teeth, and ſcarcely reſts upon the under teeth. Though ſome old Engliſh authors give this as the vocal of θ, it is not thus

thus ufed among the Saxons; for ᴅ*orn* is pronounced *thorn* with two afpirates; thus alfo they pronounce ᴅᴀu (dew)—ᴅun (to do)—ᴅᴇɪʟ (a part), &c. I however adopt it as the vocal of θ, and exhibit its power in the tenth horizontal line of the table of founds, in the words, *th*e, ᴅɪ;--*th*at, ᴅᴀᴛ;---*th*em ᴅᴇᴍ; &c. People who lifp make ufe of this found in all cafes inftead of z.

w

Fifteenth vocal—The organs the fame as in pronouncing the *u* except that the lips are a little more protruded and contracted; the air is alfo forced into the mouth with more ftrength, and not being permitted to efcape with fuch facility, a hollower found is produced, and if pronounced very full, the cheeks are a little expanded, and the voice becomes fomewhat tremulous. This is the true vocal of the Gothic afpirate ⊙ (p. 291.) reprefented in modern Englifh by *wh*, but more properly in ancient Englifh by *hw*. *W* is fo feldom ufed in the Englifh language, that I had doubts whether I fhould admit it, or fubftitute the *u*, as it is only neceffary in cafes where the *found* of the *u* follows. It is not however what Mr. Sheridan fuppofed—*viz.* the French * *ou* as in *oui*; for thefe make the fimple *u* as in *blue*, bl*u*;——Its power will be found in the twelfth horizontal line of the table of founds, in the words, *w*olf, wuʟꜰ;--*w*ool, wuʟ;--*w*ould, wuuʟᴅ.

m

Sixteenth vocal---The lips are fhut---the found confequently paffes through the nofe, and this is therefore called a nafal vowel---by fome *mugitus*, from its refembling the lowing of cattle.---Its power is found in the fourteenth

* Profod: Gram: xiv.——

teenth horizontal line of the table of ſounds, in the words, *m*uff, mɔɪf ;--*m*aw, mɔɔ ;---*m*aſs, mas ; &c.

n

Seventeenth vocal : the mouth is a little open ; the tip of the tongue raiſed to the roof of the mouth, and the ſound paſſes through the noſe; this is therefore another naſal vowel.---Its power may be found in the fifteenth horizontal line of the table of ſounds, in the words *n*ut, nɔɪt ;--*n*aught, nɔɔt ;--nap ;--*n*eck, nek ; &c.

ŋ

Eighteenth vocal : the mouth remains open as in the laſt (*n*) the tip of the tongue is drawn back, the middle being raiſed to the back of the mouth, and preventing the ſound from iſſuing but by the noſe. This is therefore the third naſal vowel. This ſound is very common in the Engliſh language, though there was no appropriated character, but it was generally expreſſed by *ng* as in lo*ng*i*ng*, or by *n* as in lo*n*ger. Its true power may be found in the ſixteenth horizontal line of the table of ſounds, in the words, to*ng*ues, tɔɪŋz ;--ha*ng*, haŋ ;--le*ng*th, lɔɪŋθ, &c.

g

The nineteenth vocal---the mouth remains as in the two laſt, but the tip of the tongue is a little raiſed by the dilatation of the tongue behind, which ſtops the ſound entirely,* till the lungs have made ſuch a vocal effort as to force the air between the tongue and the back part of the roof of the mouth, at which time the *g* ceaſes, and, by opening

* When the voice, by paſſing the Glottis, has filled the Cavity with air between that and the part preſſed by the middle of the tongue, the ſound ceaſes or ſtops, and cannot be continued as in other vowels; therefore I have called this a ſtopt vocal. Of ſimilar formation are *b* and *d*, therefore of the ſame denomination. Theſe three vowels can alſo be pronounced intelligibly, although the mouth and noſe ſhould both be ſtopt.

opening the paſſage and ſtrongly aſpirating, the *k* is heard. The modern Greeks even put the laſt for the firſt---the ancient Greeks wrote ΑΓΡΥΠΤΟΣ the modern ΑΚΡΥΠΤΟΣ.----The power of the *g* may be found in the ſeventeenth horizontal line of the table of ſounds, in the words, *g*un, G⊐N;---*g*all, G⊟⊟L;---GAP;---GET, &c.

b

Twentieth vocal---the lips muſt be ſhut, and a vocal ſound made, which muſt not paſs through the noſe, but have a determination to the lips: it is there ſtopt, but when the lips open the vocal ceaſes, and an effort of breath terminates in the *p*, its aſpirate.† The power of *b*, may be found in the nineteenth horizontal line of the table of ſounds, in the words, *b*ut, B⊐T;---*b*all, B⊟⊟L;---BAT;---BET, &c.

d

Twenty-firſt vocal---the tip of the tongue is raiſed to the roof of the mouth, which is a little open---the ſound is alſo ſtopt, and the moment it ceaſes as a vocal, by opening the paſſage to the breath and aſpiring ſtrongly, the *t* is produced, which is its aſpirate. The power of *d* may be found in the twenty-firſt horizontal line of the table of ſounds, in the words, *d*ull, D⊐L;---*d*aub, D⊟⊟B;---DARK;---*d*ebt, DET;---&c.

f

Twenty-ſecond letter, and firſt aſpirate---This is formed exactly in the ſame manner as the letter *j*, only it is an aſpirate, and *j* is its vocal. The ſound is very common in the

† The *b* is often put for the *p*, and *vice verſa*, by the Spaniſh, the Germans, the Welſh and other Moderns, as well as formerly by the Armenians and other Orientals; and by the Romans for *v*.

the English language, but there was no particular letter to expreſs it, being repreſented in a ſtrangely inconſiſtent manner by *ſh* as in *ſh*ell, ꞅEL ;---by *ſs*, as in a*ſſ*urance, AꞅU-RANS ; by *s*, as in A*ſ*ia, AꞅIA; by **ti*, as in na*ti*on, NEEꞅƎN; by *ch*, as in pin*ch*, PINTꞅ ;---by *ci*, as in ſuſpi*ci*on SUS-PIꞅƎN ;---by *ce*, as in O*ce*an, OꞅƎN ;---and its vocal *j* is alſo abſurdly repreſented by *s*, as in trea*s*ure ; *z* as in ſeizure ; *g* as in lodge ; (table of ſounds) *ſi*, as in conclu*ſi*on, perſua*ſi*on ; and where the *j is* written, it is always pronounced wrong, being ever preceded in pronunciation by *d*. Erroneous applications of this ſound are made by the Engliſh in many inſtances, in ſeveral languages, not only in living ones, but even in the latin.——The letter ꞅ is very common in the Ruſſian, and is thus made ш : The French ſubſtitute *ch* ; the Germans *ſch* ; and the Italians *ſc* before *e* and i.---It is, as well as the three following, called a *ſibilant* aſpirate; becauſe the breath, paſſing forcibly, makes a hiſſing. This letter is the ש (ſhin) of the Phenicians and Hebrews ; and is the aſpirate of *jaddi*.---It is alſo the *sjin* of the Arabians. The power of ꞅ may be found in the ſeventh horizontal line of the table of ſounds, in the words, *ſh*ut, ꞅƎT ;---*ſh*awl, ꞅƎƎL ;---*ſh*all, ꞅAL ;---*ſh*ell, ꞅEL ; &c.

f

Twenty-third letter, and ſecond aſpirate. Let the organs be diſpoſed exactly in the ſame manner as in forming the vocal *v*, and by aſpiration only, the *f* will be produced. The latins called this the *digamma æolicum* on account of its figure (Ϝ) which now forms the (F); and, being inverted in the time of Claudius to ſignify the *v*, which is its vocal, (as in DIꟻAI, AMPLIAꟻIT) it appears that the Romans, though well acquainted with the affinity, made a

* Moſt of the words that now terminate in *tion* formerly ended in *cion*, as may be ſeen in all the writings of Chaucer.

a proper diſtinction between their powers. The true ſound of *f* commences the words, *f*un, FƆn;—*f*all, F□□L; —FAT;—*f*ame FEEm; &c. in the ninth horizontal line of the table of powers.

Θ

Twenty-fourth letter, and third aſpirate—The tip of the tongue is placed againſt the points of the upper teeth, exactly in the ſame manner as in pronouncing its vocal D; but this is only an aſpirate, yet ſtrong, and of the ſibilant or hiſſing kind, imitating exactly the hiſſing of a gooſe. The Engliſh aſſert this to be the ſound of the Greek *theta*, but no nation agrees with them, and but few individuals, among whom however is Eraſmus. They may be condemned by ſome for not adopting the general error, for it is certainly an error to give two ſounds to one character; and though many grammarians conceive it, in the Greek, to be a ſtrongly aſpirate *T* only, diſtinguiſhed thereby from the more gently aſpirated *tau*, they will find it on examination to be *th*, for ΘEὸs written *heoſt* and pronounced rapidly will produce *theos*.—People who liſp make uſe of this ſound in all inſtances where the *s* ought to be pronounced (ſee D). The power of Θ may be found in the eleventh horizontal line of the table of ſounds in the words *th*ird, ΘƆRD;—*th*aw, Θ□□; *th*ank, ΘAŊK;—*th*ane, ΘEEn; &c.

S

Twenty-fifth letter, and fourth aſpirate—The tip of the tongue muſt be raiſed to the roof of the mouth, near the inſertion of the teeth, as in pronouncing its vocal *z*, but it muſt be preſſed harder, and a forcible aſpiration producing a hiſſing ſound will form the *s*; the power of which may be found in the third horizontal line of the table of ſounds, in the words, *ſ*un, SƆn;—*ſ*aw, S□□;—SAT; &c.

k

Twenty-ſixth letter, and ſifth aſpirate---The middle of the tongue muſt be preſſed againſt the back part of the roof of the mouth, as in forming its ſtopt vocal *g*. It requires only a ſlight, but ſudden effort of, breath, as the paſſage opens from the ſtoppage neceſſary to form the *g*; and whenever *g* is pronounced, without being joined by another letter, the *k* is unavoidably formed as ſoon as the *g* ceaſes, and the tongue leaves its poſition.---*k* is to be always ſubſtituted for the *q* now in uſe, alſo the *x* when it has the ſound of *k*, (for it has often the ſound of *gz*,) and for the hard *c* which I reject entirely, for *c* is taken from the Greek ς, and this is from the Hebrew (Samech) ס, reverſed, when the mode of writing from the right to the left hand was changed to the contrary. The *c* is therefore as often uſed for *s* as for *k*, as in pea*c*e, PIIS; *c*anker, KAŊ-KƎR, beſides having the ſound of ʃ as in, ſpe*c*ial, SPEʃAL. It was alſo uſed by the Latins for, *g*, as in, ne*c*lecta, for ne*g*-lecta; and for *q* when ſhort, as, *c*otidie for *q*uotidie, as may be ſeen in Terence: and it was thought proper not to admit it here, leſt cuſtom might continue to ſupport error. The power of K may be found in the eighteenth horizontal line of the table of ſounds, in the words, *c*ome, KƎm;—*c*all, K□□L;—*c*alm, KAAm;—*c*ame, KEEm; &c.

p

Twenty-ſeventh letter, and ſixth aſpirate. The lips muſt be cloſed as in pronouncing its ſtopt vocal *b*, and by ſimply breathing with a ſmall effort, on opening the lips this aſpirate will be produced. It has the ſame affinity with *b* that *k* has with *g*, and is alſo formed in the ſame manner after the termination of *b*. Its power may be found in the twentieth horizontal line of the table of ſounds, in the words, *p*uff, PƎF;--*p*all, P□□L;--PAn;--PEG, &c.

Twenty-t

Twenty-eighth letter, and ſeventh aſpirate. The tip of the tongue is placed at the roof of the mouth, near the inſertion of the teeth, as in pronouncing its vocal *d*. A ſlight effort of breath only is requiſite to form this aſpirate, which has the ſame affinity with its vocal, that the two preceding have with theirs, and after the termination of *d*, will always be formed in like manner. Theſe three are called ſhort aſpirates, on account of the impoſſibility of continuing them. The *t* has not only been frequently ſubſtituted for *d* by the Germans and ſome other nations, but by the Romans themſelves, as in, ſe*t*, for ſe*d*; and apu*t* for apu*d*, which are common in Terence. The power of *t* may be found in the twenty-ſecond horizontal line of the table of ſounds, in, *t*un, TↃN;—*t*alk, T□□K;—TAN;--TEN; &c.

⊙

Twenty-ninth letter, and eighth aſpirate. This is the aſpirate of the *w*, the lips requiring only to be placed in the ſame poſition, and a moderately ſtrong breath given, as if going to whiſtle. This aſpirate is common in the Engliſh, though it had no character. It is the *hw* of the Goths, and words written in the old Saxon were with *hw*, which the Engliſh have erroneouſly and affectedly changed into *wh*.—Its power may be found in the thirteenth horizontal line of the table of ſounds, in the words, *wh*at, ⊙□T;—*wh*ile, ⊙AIL;—*wh*en, ⊙En;—*wh*ich, ⊙ITſ;—

h

Thirtieth letter, and ninth aſpirate---The mouth muſt be a little opened, without any particular effort, and by breathing a little more forcibly and ſuddenly than common, the *h*, the aſpirate of Ↄ will be produced.--This is the moſt ſimple aſpirate. Its power may be found in the twenty third horizontal line of the table of ſounds, in the words *h*ut, HↃT;—*h*all, H□□L;---HAT, *&c.*

Affinities of Letters.

Vowels		Aspirates
Ɔ	-	*h*
Z	- -	*s*
J	-	*ſ*
V	- -	*f*
Ð	-	*ϑ*
W	-	⊙
G	- -	*k*
B	-	*p*
D	- -	*t*

Vowels		Aspirates	
I	Y	ch	of the Germans.*
L	R	*	The Ruſſians have this aſpirate but no appropriated letter.
Naſal	ſtopt		
n	D	*t*	
m	B	*p*	
ŋ	G	*k*	

To render this alphabet uſeful, it will be proper for the teachers of Children to learn the true Pronunciation of the letters, by the preceding rules, which refer to the table of ſounds, in which the common vowels are placed at the top of the ſeven perpendicular columns, and the remaining vowels and aſpirates oppoſite the horizontal lines. The characters are generally at the beginning of the words, ſucceeded by the common vowels, except j and ŋ, which the common vowels precede. The commoneſt monoſyllables, and words of the moſt ſimple pronunciation that contain the ſounds, whether written or not, have been ſought for in compoſing the table, to illuſtrate the characters, and the true mode of ſpelling is placed under ſuch as are not written with a correct orthography, or that do not at preſent contain the written letters. When the true pronunciation of theſe ſeveral powers is learnt, it will be eaſy to teach them to children, of a moderate capacity, in a few days, and in a few weeks a child would be able to read perfectly, provided the language were correctly ſpelled.

The following table is intended to give a true idea of the power of each letter, by exhibiting a determinate ſound to each character, in ſeveral of the moſt familiar examples.

Table

* The Scotch and Iriſh have alſo this ſound.

T A B L E

(to face page 292.)

Of all the distinct sounds contained in the English Language.

	ɔ	ɒ	a	e	i	o	u	
y		*yawn* yɒɒn	yarn	*yell* yel	*ye* yi	*yoke* yook	*yew* yuu	1
z			zag	*zephyr* zefɔr	*zeal* ziil	*zone* zoon	*zeugma* zuugma	2
s	*sun* sɔn	*saw* sɒɒ	sat	set	sit	sot	*soup* suup	3
r	*ruff* rɔf	*raw* rɒɒ	rat	red	rip	rot	*root* ruut	4
l	*lump* lɔmp	*law* lɒɒ	*lass* las	let	lip	log	luup	5
j	*majesty* madjɔsti			*treasure* trejɔr	*seizure* siijɔr	*lodge* lodj	*jury* djuri	6
ɾ	*shut* ɾɔt	*shawl* ɾɒɒl	*shall* ɾal	*shell* ɾel	*ship* ɾip	*short* ɾort	*shoot* ɾuut	7
v	*very* vɔri	*vaunt* vɒɒnt	vast	*vain* veen	*victim* viktim	*vote* voot	uvula	8
f	*fun* fɔn	*fall* fɒɒl	fast	*fame* feem	fit	fog	*fool* fuul	9
ð	*the* ðɔ		*that* ðat	*them* ðɔm	*this* ðis	ðooz		10
θ	*third* θɔrd	*thaw* θɒɒ	*thank* θaŋk	*thane* θeen	*thin* θin	*thoral* θooral	*thew* θu	11
w	—wolf, wulf;—wool, wul;——would, wuuld;———							12
ʘ		*what* ʘɒt	*while* ʘail	*when* ʘen	ʘitr			13
m	mɔf	mɒɒ	mas	met	mis	moor	muun	14
n	*nut* nɔt	*naught* nɒɒt	nap	*neck* nek	nip	no	*noon* nuun	15
ŋ	*tongues* tɔŋz		*bang* haŋ	*length* leŋθ	*ink* iŋk	*longer* loŋgɔr		16
g	*gun* gɔn	*gall* gɒɒl	gap	get	gift	go	*groom* gruum	17
k	*come* kɔm	*call* kɒɒl	*calm* kaam	*came* keem	*kiss* kis	*cost* kost	*cool* kuul	18
b	*but* bɔt	*ball* bɒɒl	bat	bet	bit	bot	*blue* bluu	19
p	*puff* pɔf	*pall* pɒɒl	pan	peg	*pill* pil	pot	*pool* puul	20
d	*dull* dɔl	*daub* dɒɒb	dark	*debt* det	dim	dot	*doom* duum	21
t	*tun* tɔn	*talk* tɒɒk	tan	ten	tin	*tone* toon	*took* tuuk	22
h	*hut* hɔt	*hall* hɒɒl	hat	*hate* heet	hit	hot	*hook* huuk	23
	1	2	3	4	5	6	7	

[illegible]

As all future improvement in orthography, depends upon a perfect knowledge of the ſound of every letter, it is neceſſary to obtain them with great preciſion, and to fix them in the memory; *for on remembering, and being capable of repeating with propriety, theſe thirty ſounds, depends the whole art of reading*; which conſiſts in reading *letters, not words*, for we only ſpeak letters, and* never more than one at a time; but when they are rapidly connected, the general ſound of a word varies as much from another, though it poſſeſſes ſeveral of the ſame letters, as one word varies in appearance from another in ſhort hand. If then we fix a certain character to each ſound, there will be no more difficulty in writing with a correct orthography than in ſpeaking with one, as we ſpeak letters, which form words, that make ſentences; and I muſt repeat that thus ought we, in reading ſentences, to read words, by reading letters; and thus will the tongue and pen expreſs every idea with perfect uniformity.

Some letters are formed by the glottis being more or leſs dilated † while the mouth ſerves as the chamber of ſound, or body of the wind inſtrument; and is expanded or contracted, by its own action or that of the tongue, producing ſharper or graver tones, by a wider or narrower external aperture through either the teeth or lips; others are produced by permitting the ſound to eſcape only by the noſe, the paſſage through the mouth being ſtopt by the middle of the tongue, the tip of it or the lips; and ſome are made by ſo forcible a vocal ſound, as to produce tremor either in the throat or mouth. Aſpirates are formed in the ſame manner as their vocals, with reſpect to poſition of the organs, but are produced only by the breath, whence the derivation of their name: ſome aſpirates depend upon ſo violent an effort of the breath that a hiſſing noiſe is produced.

From

* See Digraphs and diphthongs-&-ſeq:

† See the theory of language, by my worthy and very ingenious friend Doctor Beattie.

From what has been already obſerved, it may perhaps appear difficult, in *whiſpering*, to diſtinguiſh between *vowel letters aſpirated* and *real aſpirates*; eſpecially, as the only diſtinction I pointed out, was in their being vocal or aſpirated; but no difficulty ariſes here; for, in ſpeaking, there is a leſs effort made by the breath to produce a real vocal ſound than an aſpirate; and in whiſpering there is no difference between vowel letters and their aſpirates, but that the firſt are more ſlowly and faintly aſpirated, while the true aſpirates remain undiminiſhed in force. The following line ſhews the truth of theſe obſervations.

1. ‡" I vow, by G-d, that Jenkin is a wizzard."
2. Ai vou, bai G-d, ᴆat Djeɒkin iz a uizzard.
3. Ai fou, pai K-t, θat ſeɒkin iſs a uiſſart.

The 1ſt line is written in the common manner, the 2d is written properly, and the 3d with aſpirates. If the 2d and 3d be *whiſpered*, no difference whatever will be found between them, except that the letters *f*, *p*, *k*, *t*, ϑ, *ſ*, *s*,--- in the third line, are pronounced much more forcibly than their correſpondent vocals in the ſecond line, when *aſpirated* or *whiſpered*; and it is eaſy to diſtinguiſh which line is repeated in a whiſper. The Welſh pronounce this line with aſpirates inſtead of vowels, and produce a ſtrange effect in ſpeech. The lower claſs of the ſaxons are ſo inattentive to the difference of the *p* and *b*, the *t* and *d*, the *f* and *v*, &c. that in Engliſh they rarely ſpeak without miſplacing them; but ſome go ſo far in error as to almoſt regularly put one for the other, and inſtead of

Boy bring both Pails to the pond,
(Properly) Boi briɒ boθ Peelz tu ᴆɔ pond;
(would ſay,) Poi priɒ poth Beels tu dɔ Pont.

The Iriſh, in ſpeaking the Engliſh language, aſpirate very frequently, where there are no true aſpirates; and perhaps in

‡ Diverſions of Purley.

in consequence of the Irish language abounding, like many others, in aspirates. One probable cause too of the mistakes they commit in speaking English, may be derived from the substantive being placed in the Irish *before* the adjective, not *after*, as in the more artificial language of the English.

Much has been written by many sages and learned men concerning the origin of language, which has generally been attributed to divinity, and the variety of tongues has been considered as the effect of the confusion at Babel. I will not pretend to descant on the subject, nor to deny such authority, but will humbly premise a few observations which will be sufficient to authorize a conjecture respecting the formation, and also the alterations, without the aid which is to be derived from the great lawgiver of the Jews. We know that men in different countries speak different languages.—but who does not know at the same time that the English language a few centuries ago, would not be understood now? and that if a small colony of English had been separated from the nation in general, they would have been taken for a different people? the manufacturers of England, who never go two miles from the place, for generations, cannot be understood by a Cockney. Languages differ so much in a few years, by the particular circumstances of the people, that there is no occasion for miracles to explain the varieties; and one half of our language is calculated to give ideas of arts and sciences, which have been invented during the memory of man. We have many instances of the invention of terms for new objects in the great South Sea---the Otaheiteans called a *gun*, *tik-tik-bou!* imitating thereby the cocking and report of the object; and we find among Savage nations, many things similar. The languages acquired by imitation are certainly the most natural and expressive, and I am confident that the

the language of man, was originally formed by imitating the objects of nature; and the names of many animals were given by imitating the voice of the individual: we find this even at present in all languages, but particularly in the less refined. Man, in a savage state, imitates birds and beasts to decoy them, and by imitation alone he forms a very extensive scale of sounds. The sounds of the *common* vowels, with *l*, *m*, *n*, ᴅ, we hear daily among cattle and domestic beasts; the *y*, *z*, *j*, *v*, ᴅ, are like the buzzing of beetles; *ſ*, *f*, ϑ, *s*, like the hissing of serpents, particularly the *s*, which might with propriety have signified the Generic name, till it became part of another appellative, and consequently a letter. In the most ancient alphabets the Phoenicians, Etruscans, Latins and Goths, adopted the form of the serpent for the character of *s*, which would have been a very expressive Hieroglyphic. The ϑ of the Greeks, *as pronounced by the English*, is exactly like the forcible hissing of a goose, and is found in very few languages: the English contains so many of these buzzing and hissing sounds, that some Foreigners have called it the language of snakes.

r imitates the snarling of dogs, and we find nations where there are no dogs that have not the letter *r* in their languages. The aspirate of *r** imitates the flight of the partridge and some other birds, as well as the voice of some locusts: Gutturals imitate the croaking of frogs or toads: the stopt vocals and their aspirates are generally joined to some of the common vowels by animals: *bee*, the sheep—*bou*, the dog—*kuu*, the dove, *krook*, the raven---*kuaak*, the duck---*piu*, the buzzard---*tiu-it*, the lapwing; *kuk-ku*, the cuckoo, &c. There are also a great variety of sounds among animals, which man has had no occasion to adopt, in forming a language of his own wants, as their articulation is too difficult for common

* See Page 283.

mon uſe, and there are already more than ſufficient for every uſeful purpoſe.

Indeed we find few languages which do not contain ſeveral characters that are uſeleſs, and to which the ſame ſounds are appropriated. The Engliſh contains the following; *c* which has ſometimes the power of *s*, ſometimes of *k*; *q*, which has always the power of *k*; and *x*, the powers of *ks*, of *gz*, or *z**.

Language does not require half the number of letters made uſe of by any nation; becauſe, were ten or twelve letters well arranged, they would be capable of expreſſing every idea we have acquired, or ſhould be able to invent. Wachter in his *Naturæ et Scripturæ Concordia*, endeavours to ſhow that ten letters are ſufficient for a very comprehenſive language. Tacquet the mathematician calculates the various combinations of the alphabet of twenty four letters to be no fewer than 620,448,401,733,239,439,360,000. Clavius however only makes them 5,852,616,738,497,664,000: they are both wrong; but the human mind cannot form an idea of ſuch apparent infinity of combinations, nor could the inventive faculties of man exhauſt them in language. Hence it does not follow that the moſt extenſive alphabet would be required by the moſt copious language.

We find among ſome ſavage nations ſuch a paucity of expreſſion, that they cannot be ſaid to have a more extenſive language than ſome beaſts ; and upon which would philoſophers reaſon, on the formation of language? ; on the beautiful, artificial Hebrew, or the confined expreſſions of the moſt ſtupid of the human race? among whom a few ſyllables compoſe the whole vocabulary, and expreſs all that

* Mr. Sheridan hath not only rejected the *c*, *q*, & *x*, but likewiſe the *j*, which he ought to have retained inſtead of the *ezh* taken from Wilkins, which is really not in the Engliſh language; but the *j*, as pronounced by the French, is a very common vowel, and I am the more aſtoniſhed at his not adopting it, as he knew ſo well the power of *j*:—But his error is uniform, never having uſed the *j* even in the words *occaſion*, *okeejən* (occazhun Sher:)—*adheſion*, *adhiijən* (adhezhun) *deciſion*, *exploſion*, *confuſion*—Proſod: gram: xlviii.—

their appetites crave. Shew theſe people new objects, and they will, as every traveller evinces, form new words to expreſs them: and, if the formation of any language can be thus proved, it is vain to look for another origin. I am alſo of opinion that alphabetical writing took its riſe in monoſyllables, to which hieroglyphicks could not be applied, and that theſe marks becoming the ſymbols of the ſounds and not of the things, were regularly put for the ſame ſounds in the compoſition of other abſtract terms and metaphyſical ideas, till the ſcale of marks increaſed, and led gradually to a mark for each ſound. Some authors, whoſe admiration of the invention bewilders them too much to permit an examination of the principles, declare that the diſcovery is perfect, but they can only ſpeak relatively; for the alphabets of ſome modern languages are ſo much more extenſive than many ancient ones, that theſe are very imperfect if we ſpeak of a general alphabet for human ſpeech, and not for particular languages. If a Chineſe were to ſtudy the Engliſh, he would be eaſily perſuaded that the alphabetical mode of writing was an invention of the Engliſh, and that it was not yet perfected, from the innumerable faults, deficiencies, ſuperfluities, irregularities, &c. of the written language. It is ſo ſhamefully incorrect, that, when read as it is written, an Engliſhman *cannot underſtand it**, and a foreigner reading it becomes the object of his laughter, although, as a good ſcholar, he reads it perfectly, according to the orthography. I have often heard the queſtion "¿do you ſpeak French?" with the anſwer "no ſir, but I read and write it." The ſame is ſaid of the Engliſh and ſome other languages; every ſtranger to them lamenting, that the learned bodies of men, eſtabliſhed in ſo many places for the benefit of mankind, ſhould ſo

* Eſpecially if the common vowels ſhould be read with their various powers miſplaced, for there are no marks to determine them.

ſo long have neglected to facilitate the intercourſe of nations, by rendering the mode of acquiring every language eaſy, which might be obtained as well by books as by travelling into the different countries where they are ſpoken, if thoſe books were correct.

SYLLABLES.

No word or ſyllable in the Engliſh language is formed by aſpirates alone, but many ſyllables are formed by what ſome of the moſt ingenious call conſonants, and their arguments upon them fall, becauſe built upon falſe data.

Th: Sheridan ſays "The terminating *ble* is always "accounted a ſyllable though in ſtrict propriety it is not "ſo; for, to conſtitute a ſyllable it is requiſite that a vow-"el ſhould be ſounded in it, which is not the caſe here; "for though there is one preſented to the eye at the end, "yet it is only *e* final mute, and the *bl* are taken into the "articulation of the former ſyllable; but in pointing out "the ſeat of the accent I ſhall conſider it in the uſual way "as forming a ſyllable."*

If Mr. Sheridan had conſidered the true power of either *b* or *l*, he would have found them both vowels, and that together they form a perfect ſyllable, as well as *l*, *zl*, *vl*, *ml*, *nl*, *gl*, *dl*, *fl*, *ſl*, *kl*, *pl*, *tl*, *m*, *n*, *zn*, *vn*, *dn*, *ſn*, *tn*, *nd*, *nt*, *ſnt*: If a Line of Poetry be ſcanned which contains any of the above *ſyllables*, the reader will be convinced of their being ſuch, by the impoſſibility of reading them otherwiſe.

"A wild, where weeds and flow'rs promiſc'ous ſhoot,
"Or garden tempting with forbidden fruit.
"Together let us beat this ample field,
"Try what the open, what the covert yield;
"The latent tracts, the giddy heights explore.
* * * * * *

Pope's Eſſay on Man line 7th.

* Page xliv. Proſod: Gram: (prefixed to his dictionary.)

Properly written thus.

A uaild, ɵeer uiidz and flourz promiſkɔs ſuut,
Or gar*dn* temtiŋ uiɵ forbid*dn* fruut.
Togeðɔr let us biit ðis am*pl* fiild,
Trai ɵʊt ði op*m* ɵʊt ðɔ kovɔrt yiild;
ðɔ leetɔnt trakts ðɔ giddi haits ekſploor, &c.

It is to be obſerved that the word *the* changes its termination ɔ or ə into *i* before words that begin with ɔ, ʊ, *a*, *e*, *o*, *u*, on account of the hiatus that muſt otherwiſe be made, to prevent it from ſliding into the next ſound, but this change is not made in any other inſtances. It is omitted totally in Poetry when the next word begins with *i*.

If only one letter divides two common vowels, the three letters form two ſyllables: if more than one divide them they alſo form two ſyllables only, unleſs two other vowels intervene, as in *ableneſs*, *e-bl-nes*.

Whenever two naſals, ſtopt vocals, or aſpirates of the ſame power follow any of the common or other vowels, and another of theſe vowels ſucceeds, a diviſion of the word takes place between the double letters.

The great diſtinction between one ſyllable and another, is, that if the organs of ſpeech be in their progreſs to the pronunciation of a letter, the voice may ſucceſſively in the ſame flexion embrace one or two vowels, naſal, ſtopt vocals, or aſpirates, provided theſe letters are ſuch as glide ſmoothly, and one commences where another ends; and the falling as well as riſing of that flexion may alſo embrace one or two more of theſe letters, and form only one ſyllable: but if the effort be interrupted by another vowel, *which gives a different flexion to the voice*, a diviſion will take place, and another ſyllable be formed. Quoties vox mutatur, toties mutatur ſyllaba.

In dividing words, the naſals, the ſtopt ſounds and aſpirates,

rates, have ſuch particular affinities, not only with each other, but with ſome of the other letters, that it is not difficult to compoſe ſyllables which contain ſix different letters, joined by a ſingle common vowel only; but, as ſoon as the voice has glided through a certain unity of ſounds, every additional change becomes another ſyllable. When a word, of two or three ſyllables, is compoſed of any of the ſtopt ſounds and their aſpirates, they are pronounced in the firſt ſyllable as the organs *leave* the poſitions uſed in producing theſe ſounds, and in the ſecond ſyllable they form the ſounds as they *advance* to, and juſt before they arrive at, their true poſitions; the third ſyllable takes another flexion, and is like the firſt, &c. as in *gib--bak--kad--dupt*. By this, ſeveral hiatus are avoided, though the ſyllables divide themſelves naturally, and without effort.

There appear to be laws to govern the diviſion of words, if we examine ſome; for there are few nations which have adopted a particular ſet of letters, that would not make the ſame diviſions if certain words were preſented; again, there are words that would not warrant any ſuch concluſion; therefore we muſt conſider their diviſion into ſyllables, arbitrary in many inſtances; and a multiplicity of rules would rather perplex and confound, than enlighten.

ACCENTS,

Ought only to be placed where a ſtreſs of the voice is abſolutely requiſite, to denote a difference in the letter or ſyllable, and which would otherwiſe be unintelligible, or would give a diſguſting tone; but if words be* properly written

* It is ſaid, in an extract from the journals of the Royal Society, reſpecting a letter from a Jeſuit at Pekin in China (Philoſophical Tranſactions, Vol. 59, page 494)——that "the Chineſe "tongue counts but about 330 words.—From hence the Europeans conclude, that it is barren, "monotone, and hard to underſtand. But they ought to know that the four accents called—"*ping*, uni *(even)*, *chung*, élevé (raiſed), *kiu* diminué *(leſſened)*, *jou*, rentrant, *(returning)*, "*multiply almoſt every word into four*, by an inflexion of voice which it is as difficult to make "an

written I think they will not be deemed neceſſary upon many occaſions; for, where the nouns and verbs are now perfectly ſimilar in their orthography, we ſhall generally find ſuch imperfection in ſpelling, as, when corrected, to reduce the neceſſity of accents to a very few inſtances; and where they appear to be requiſite, the exceptions will be ſo eaſily acquired, or make ſuch little difference in language, that they are ſcarcely worth attention: however, where no difference is obſerved in the orthography of verbs and nouns of two ſyllables, the ſtreſs is generally on the firſt ſyllable of the noun, and on the laſt of the verb; but attention to good ſpeakers will make more forcible impreſſions than any rules laid down, and were a foreigner to make no difference in uttering theſe particular words which grammarians think require accent, and the difference of which orthography does not point out, the defect would ſcarcely ever be noticed. Th: Sheridan gives many rules on accent, but they chiefly tend to point out the firſt, ſecond or third power of his vowels, which in good ſpelling would be rendered uſeleſs. He gives us many inſtances of nouns and verbs which receive accents by habit only, no difference being marked either by ſpelling or otherwiſe. I will give a few, which may ſhow that the ſpelling only of the words will be a ſufficient diſtinction, without any accents being marked; and the general rule of laying it upon the laſt ſyllable of the verb, or rather, upon the common vowel of the laſt ſyllable of the verb, and the common vowel of the firſt ſyllable of the noun, may ſerve.

Nouns

"an European comprehend, as it is for a Chineſe to comprehend the ſix pronunciations of "the French E. Theſe accents do yet more, they give a certain harmony, and pointed ca- "dence, to the moſt ordinary phraſes: with regard to clearneſs, let fact decide. The Chi- "neſe ſpeak as faſt as we do, ſay more things in fewer words, and underſtand one another."— From what is quoted we find that the accents multiply *almoſt* every word in four, but if *every* word were multiplied, there would be only 1320 which is but a ſmall number to compound into ſo copious a language; and I am certain that a perſon of good genius, who underſtands the ſymbols of ſpeech perfectly, would as eaſily reduce the Chineſe language to regular characters, as any other; but the hieroglyphics of the language would be as unintelligible as it is at preſent to the generality of that nation.

	Nouns	Verbs	corrected	
a or an	Ac′ cent	to accent′	akſnt	akſent
	Cem′ ent	cement′	ſemɔnt	ſiment
	Con′ cert	concert′	konſɔrt	kɔnſɔrt
	Con′ teſt	conteſt′	konteſt	kɔnteſt.

I had written a great number of rules on polyſyllabic words, as ſhort and ſimple as I thought it poſſible to compoſe them, but on reading what I had written, thought them too tedious, difficult, and liable to exception, therefore have omitted them wholly, by which I think I have not only done a juſtice to myſelf, but alſo a kindneſs to the reader.

Many words that grammarians have thought proper to accent, and for which they have given long-laboured, difficult, and complex rules, with as many exceptions, require no accent whatever; for, if they are pronounced with all the monotony and even-neſs of which the organs are capable, the very compoſition of the words, if correctly written, gives greater force to one part than to another, and it is impoſſible, without affectation, to pronounce them improperly, even according to the ideas of grammarians. Where the common vowels are long they ought to be written twice, as among the ancients, who wrote *amaabam*, *ſeedes*, &c.--The *I* inſtead of being written twice, was made twice as long, as in vIvus, pIſo, &c.--In Engliſh the * *common* or firſt claſs of vowels are often doubled at preſent, when long, but not univerſally; and in correct writing, the accent will alſo be laid, where the other vowels, or the ſecond claſs, and the aſpirates, are double.

A dictionary alone will contain the means of correcting all uncertainties with reſpect to the accent, as well as orthography of words; and attention to good ſpeakers is the only mode of correcting our ideas concerning the emphatic words of ſentences.

EMPHASIS

* Of the New Characters page 277.

EMPHASIS

Denotes the ſtreſs of voice upon the important or illuſtrative words of a ſentence, or upon a ſentence in a diſcourſe, but is no further connected with my ſubject, than by the diſtinctions which we ought to adopt in writing, and the following are what I would chiefly recommend. Let emphatic words and the name of either perſon or place, begin with a large letter, words of greater import be in italics, and the whole word occaſionally be a ſize larger than the common text; if of great importance let this commence with a ſtill larger letter. Emphatic ſentences may be diſtinguiſhed by italics or a larger type—In *writing*, words and ſentences may have one, two or three lines drawn under them, or writ in a larger hand, or both, according to the force of the intended expreſſion.—The cuſtom of writing all nouns with capitals ought to be diſuſed, as few of the *beſt* grammarians underſtand that nouns, verbs, and abbreviatives, compoſe the whole of language.*

Much has been written by ſome ingenious men on

DIGRAPHS AND DIPHTHONGS,

But if they had ſpent half as much time in *correcting* written language, as they have beſtowed in forming general rules, with ſuch a number of exceptions, to bring the *errors* of written language into order, it would have much facilitated our learning; for really a *language* is almoſt as eaſily learnt, as the *rules* by which it is at preſent taught. The appropriation of a ſeparate character to every ſound, will utterly deſtroy the idea of digraphs in correct writing; and as for diphthongs *they never exiſted in any language*:—they are ſaid, by Th: Sheridan, to be "a coalition of two "vowels to form one ſound—and triphthongs three"—but the ſame organs that are employed to form one ſound cannot

* See the ΕΠΕΑ ΠΤΕΡΟΕΝΤΑ of John Horne Tooke.

cannot be engaged to form another at the ſame inſtant.— It would be as difficult to allow this, as to admit that two atoms can occupy the ſame ſpace. No complex ſounds can be produced even on inſtruments, any more than complex ideas by the mind—When ſeveral inſtruments play a note, the ear either hears one ſound or more; if only one it is a ſimple ſound, if more than one, they cannot be called a ſound, ſimple or complex, but diſtinct ſounds. It is impoſſible for the mind to form a complex idea: there may be a rapid ſucceſſion of ideas, but that ſeveral ideas can be reduced into one is an abſurdity. The Mexicans, according to Clavigero, compounded ſometimes one word of the initials or firſt ſyllables of a great number of other words, which term became very long, and comprehended a whole ſentence; but this *abbreviated ſentence* gives no *complex idea*, it only gives a more rapid ſucceſſion of ideas than a ſentence compoſed of long words. If a new ſound interpoſe two others in ſpeech, a new character ought to be made; if it do not, we ought to conſider whether or not it is a ſound rapidly ſucceeding another, and the two or three miſtaken for one only: of this claſs many are to be found, particularly in very ancient languages, and ſome in the beſt written modern.

The celebrated Euler, attempts very ingeniouſly to prove, that a mixed ſound may be formed of two different ſounds, by ſtriking two ſtrings together, and next to each other, of different tone, which will prevent either of them from its natural vibration; that a note will be produced partaking of each, and that if one of the ſtrings be ſtopt, the vibrations of the other, will remain as a mixed ſound, for ſome moments, after which it will gradually recover its natural vibrations, and give its natural ſound. But the truth is, that the agitation of the air occaſioned by the firſt, within the verge of the ſecond, continues a few moments to mix with the agitations of the air made by this ſecond, and the mixed ſound dies as the firſt ceaſes: the mixed vibrations occaſioned by the continuance of both ſtrings, will be as much a compound ſound as if one of the ſtrings were to be ſtopt; but this ſound, though different from the two others, becomes a diſtinct and ſimple ſound, as much as purple, produced by a mixture of blue and red, becomes a diſtinct colour. If however I wave all this and admit that a diphthong can be produced by *two* perſons ſounding *two* different vowels, at the ſame time, as the derivation of the word literally imports, it does not thence follow that I ſhall grant a diphthong can *poſſibly* be made by the ſame perſon.

In Compoſing

Either poetry or proſe, attention is paid to the facility of uttering whatever is written, but without knowing that the ſounds depend upon certain letters which glide ſmoothly after each other; for there are ſome that cannot be read after particular ſounds without difficulty. The poet is directed by the ear, for the words are generally compoſed of ſuch claſhing materials, that if they were read as they appear the melody would be entirely defeated; and if rhyme be examined, we ſhall find, provided the words be properly ſpelled, exactly as much reſemblance in the appearance as in the ſound.

Poetry requires a certain number of ſyllables or variety in the voice conſonant with the time required in muſic, and not only ſeeks, when the ſubject demands, the moſt euphonical and flowing words, but thoſe whoſe diviſions and emphaſes correſpond with each other, and with the general tenor of the ſubject, whether quick or ſlow, ſoft and captivating—flowry and enchanting—ſonorous and elevating

elevating—or rough and terrific. Such words ought alſo to be choſen as when repeated neceſſarily produce in the features the paſſions dictated by the theme, and the hearer ſhould be led along by its variety. As all words are not, in certain ſituations, calculated for particular ſpecies of poetry, authors have taken many liberties, and have changed, not only the meaſure of the word but ſometimes its accent. Poetry has thus tended, in the opinion of ſome, to correct the emphaſis, and is thought in all languages, particularly the dead ones, to preſerve a knowledge of the true ſound of words.

It is, by no means, my intention to dwell upon theſe ſubjects, ſome of which would require diſtinct treatiſes, and the world hath already been favoured with ſeveral, by many ingenious men, (Thomas Sheridan, Noah Webſter, &c.) but I was obliged to purſue particular ideas into thoſe devious paths. I muſt now ſay a few words on the *Hieroglyphicks of writing*, among which I cannot but rank what are (improperly) called the *ſtops* [and ought rather to be termed *ſymbols of variation in ſpeech**] as well as the † Arabic numerals, chemical characters, and aſtronomical ſigns, &c.

Stops.

Many Chineſe words have different meanings according to their different ‡ tones; and ſome of our ſtops

 which

* As letters denote the component parts of words, the AGOPHASIS or AGOPHONIKS denote the pitch or key and tone of the letter, word, or ſentence; the flexions, force, and various meanings which are to be derived from cadence; and are to the letters in reading what the flats, ſharps, reſts, &c. are to the notes in muſic.

† Edward Gibbon obſerves (in his Hiſtory of the decline and fall of the Roman Empire, Vol. v. page 321.) that "under the reign of the Caliph Waled, the Greek language and characters "were excluded from the accounts of the public revenue. If this change was productive of the "invention or familiar uſe of our preſent numerals, the Arabic characters or cyphers, as they "are commonly ſtyled, a regulation of office has promoted the moſt important diſcoveries of "arithmetic, algebra, and the mathematical ſciences."

"According to a new, though probable notion, maintained by M. de Villoiſon (Anecdota Grœca, tom: ii: pag. 152, 157.) our cyphers are not of Indian or Arabic invention. They were uſed by the Greek and Latin arithmeticians long before the age of Boethius. After the extinction of ſcience in the weſt, they were adopted in the Arabic verſions from the original M. S. S. and *reſtored* to the Latins about the XI. century."

‡ See note page 301.

which ſeem calculated to command time, give a different tone to the voice; the notes of interrogation and exclamation are of ſuch importance as to give a different meaning to the ſentence; the Spaniards invert them before, as well as place them after the ſentence in their correct editions, and that rule ought to be adopted in all writings, otherwiſe it is impoſſible to read them properly the firſt time? who would think of marking a ſentence in *parentheſe* with only one mark of a parentheſis? or a ſentence of expoſition by only one crotchet, or mark of a paratheſis? and it is as neceſſary to adopt the Spaniſh mode in writing the Eroteſis ¿—? and Ecphoneſis !—¡ A mark of Irony ſhould be invented, for its uſe muſt be acknowledged, by thoſe who are acquainted with language; and it ſhould, like all the reſt, be placed before and after the ſentence--- (+) this mark may ſerve. A character to ſignify the *depreſſion of the voice* in ſentences ſpoken aſide, as in plays, dialogues, &c. ought alſo to be made to include the ſentence; and not write the word *(aſide)* at the end as is now done. At preſent a perſon reads a long ſentence aloud, and ſtopping ſhort at the end with ſurpriſe—he whiſpers '*this is aſide*'. This mark {- -} will anſwer, and may be called a Kaluptophaſis. Quotation may be repreſented at preſent by two inverted commas "——" and the ſpeech of any character in an author by one '——' which mark may be denominated a Proſepopeia.

Eroteſis—*Erooteſis*—Note of interrogation	¿—?
Ecphoneſis, *Ekfooneſis*---note of admiration or exclamation, - - - - -	¡—!
Parentheſis—Parenɵeſis, - -	(—)
Crotchet---*Krotſɔt* or Paratheſis--*Paraϑeſis*,	[—]
Quotation--Kuoteeſɔn, - -	"—"

Proſepopeia

Proſepopeia--action of making a ſpeech for another,	'—'
Accent--*Akſnt*,	´
Hyphen--*Haifən*,	-
Syntheſis--*Sinϑeſis*	=
Comma--Komma,	,
Semicolon--*Semikolon*,	;
Colon--*Kolon*,	:
Period--*Piiriod*--full ſtop or punctum,	.
Apoſtrophe--*Apoſtrofe* or mark of eliſion,	'
Caret -- wanting,	^
Aſteriſks,	* * *
Hiatus,	——
Zugoma--BRACE or tie,	{—}
Irony--*Aironi*,	+—+
Kaluptophaſis--*Kaluptofaſis*--to be ſpoken aſide,	{- -}

Emphaſis, *Emfaſis*. Expreſſed in writing by one or two lines, under the word or ſentence---in printing, by italics or large letters.

References may be made by figures, different alphabets, or arbitrary marks of any ſort, that do not interfere with thoſe that may be adopted in general, as agophonicks.

By ſome it has been thought neceſſary to appropriate ſymbols to the paſſions and geſtures. But the difference of characters and actions in men, would render ſuch an attempt leſs uſeful than might at firſt be ſuppoſed; the geſtures that are natural in one caſe, would be buffoonery in another, and it would be as difficult to reconcile opinions in this reſpect, as to join a Harlequin to a Burgomaſter.

On

On teaching the Surd, *or* Deaf *and consequently* Dumb, *to Speak.*

THE difficulties under which thoſe have laboured, who have attempted to teach the ſurd, and conſequently dumb to ſpeak, have prevented many from engaging in a labour that can ſcarcely be exceeded in utility; for ſome of thoſe to whom nature has denied particular faculties have in other reſpects been the boaſt of the human ſpecies; and whoever ſupplies the defects of formation, and gives to man the means of ſurmounting natural impediments, muſt be conſidered as a benefactor. There have been many ſucceſsful attempts, in divers nations, to procure to the deaf and dumb the modes of acquiring and communicating ideas.—The methods however are ſlow and imperfect.—The written and ſpoken languages are ſo different, that they become to ſuch pupils two diſtinct ſtudies. It is neceſſary that they acquire a knowledge of objects, by ſeeing their uſe, that they alſo become acquainted with the ſeveral words which when written become the repreſentatives of theſe objects, and beſides the difficulties which preſent themſelves in pronunciation, they are to remember that the different words which are written, and ſometimes with nearly the ſame letters, are of different ſignification; and in ſpeaking require different pronunciations of the ſame character—this is an obſtacle that cannot be poſſibly avoided by the preſent mode of writing, and the languages become as difficult as Hieroglyphics.

Some of the difficulties of acquiring a language when deaf, may be conceived by thoſe that are experienced in learning foreign tongues, where they are not commonly ſpoken, although aided by tranſlations and dictionaries; but

but the man that hears nothing, has not the advantage of a child who learns by the conſtant chat of his parents and attendants, and who can obtain no pleaſures but through the medium of ſpeech—he hears and is conſtantly learning—to teach him is the amuſement of every one; but the deaf receives his ſtated leſſons, difficultly and ſeldom.—There is no book which by the figures or drawings of things have appropriate terms, nor is there a language which has appropriate characters.—The more I revolve in my mind this ſubject, the more I am aſtoniſhed that even the moſt improved nations have neglected ſo important a matter as that of correcting their language; I know of none, not even the * Italian, that is not replete with abſurdity; and I ſhall endeavour to ſhew the facility with which the deaf might be taught to ſpeak, if proper attention were once paid to this important point.

I have attempted to ſhew that in the Engliſh language there are thirty characters, and muſt ſuppoſe a † dictionary according to this ſcheme of the alphabet, upon which I mean to build:

the Method of teaching the Surd and conſequently Dumb to ſpeak.

It is neceſſary to examine firſt, whether the dumbneſs be occaſioned by merely the want of hearing, or by malconformation of the organs of ſpeech. If the latter there is

* "Ciaſchedunio ſa, che, come, non v' è coſa, che più diſpiaccia a Dio, che l'ingratitudine, ed inoſſervanza de' ſuoi precetti; così non v' è niente che cagioni maggiormente la deſolazione dell' univerſo, che la cecità, e la ſuperbia degli uomini, la pazzia de' Gentili, l'ignoranza, e l'oſtinazione de' Giudei, e Sciſmatici."

Corrected.

Tſiaſkeduno ſa, *ke kome*, non v' è *coza*, *ke* piu *diſpiatſia* a Dio, *ke* l'ingratitudine ed *inossərvantsa* de ſuoi *preetſetti*; *coſſi* non v' è niente *ke kadjioni madjormennte* la *deſolatſione* dell' univerſo, *ke* la *tſetſita*, e la ſuperhia *del** *i omini*, la *patſia* de' *Djentili*, l'*iniorantſa*, e l' *oſtinatſione* de *Djudeei*, e *ſizmatitſi*.

† Mr. Sheridan's or Dr. Kenrick's may give ſome aid, till a dictionary be publiſhed upon this plan.

* Requires a new character (the aſpirate of *l*)

is no occaſion to proceed, but if the former be the cauſe, the method of attempting to remove ſuch an impediment may be purſued in the following manner.

1ſt, They muſt be led, if young, to attempt to pronounce, by imitating the motions of children in ſpeaking, and, as every thing at firſt would appear to them unmeaning, a child who can ſpeak muſt be told to pronounce the letters, which you deſire the deaf child to learn. If you ſucceed with difficulty, to prevent diſcouraging the deaf, the child who ſpeaks muſt be made to pronounce ſlowly, diſtinctly, and with many repetitions, that the deaf may ſuppoſe the other to be in the ſame predicament; but if you have two deaf perſons to teach at once, the firſt leſſons only need be given in this manner, for the progreſs of both will be at firſt perhaps much alike.

2dly. The pupil muſt be not only ſenſible when he makes the proper ſound himſelf, but muſt alſo be able to diſtinguiſh theſe ſounds in others. In teaching to pronounce, you muſt open the mouth, and ſhew the ſituation of your tongue as nearly as you can, then diſpoſe your lips in ſuch a manner as to give the ſound, making apparently a more forcible exertion than common. The pupil will try to imitate it. He will make no doubt a ſound of ſome ſort, either vocal or aſpirate—If that ſound be contained in the language you mean to teach him, point immediately to the letter which you find is the ſymbol, and repeat it ſo often, that he can neither forget it, nor have any idea of the ſymbol without that ſound, nor of the ſound without the ſymbol---If the ſound be vocal let him feel at his own throat, and at yours, that he may be made ſenſible by the external touch that the ſounds are the ſame, and he will with more facility be enabled to give the aſpirates by pronouncing them without a tremulous motion in the throat, which is the ſole external mode of learning him the difference.

ference. When you teach the aſpirate of any letter by a ſimple breathing, the organs being ſomewhat ſimilarly diſpoſed, he perhaps may ſtumble upon another vocal or aſpirate: if ſo, ſhew him the letter he obtains by the error, as if you had no intention, in that inſtance, to teach the letter in affinity with the laſt; and let him repeat the ſound, whether vocal or aſpirate, till he is perfectly acquainted with it, and the appropriated character. You muſt then turn to another, taking care, that while he acquires, he does not forget, and let him often repeat them. When you have proceeded through the greateſt part of the letters in this manner, and find that either the vowels or aſpirates which correſpond to each other are wanted, you muſt take ſuch as it would be proper to begin with, and I think that none would ſerve better than v—f; j—ſ; z—s; ᴅ—ꜱ; in which, if the pupil be ſenſible, he will ſoon diſcover a connection, and will be induced to ſearch for the ſame affinities in the other letters, whether the language he learns contains them or not—It will be neceſſary, according to the age and diſpoſition of the pupil, to uſe different methods of diſpoſing his organs; not only by letting him feel, how your tongue is raiſed to the roof of your mouth, puſhed forward, depreſſed, withdrawn, &c. but alſo to diſpoſe his, by your fingers, and have a looking glaſs always preſent, to ſhew him wherein he errs in not juſtly imitating you; and alſo to let him ſee when he is right in his efforts. This will teach him what is neceſſary

3dly, To know what others ſay, when they converſe with, or aſk him any queſtion. This is the moſt difficult in teaching the ſurd, becauſe moſt of the letters are formed in the mouth and throat, out of ſight; and here viſion alone obtains the meaning. The mirror, however, will facilitate much the mode of learning what others ſay, by the

 deaf

deaf man's converfing with himfelf before it, but in prefence of his teacher, to prevent his making miftakes, in the formation of the true founds: and there are more guides in acquiring what words are fpoken by others, than people in general imagine; for fo many of the letters which make a vifible effect upon the organs, in their formation, enter into the compofition of words, which may indeed contain many that do not make much effect, that if all the former were written down, it would give to the eye, a kind of fhort-hand; and is almoft as eafily caught by the watchful eye of the attentive deaf, as fhort-hand without vowels is read by the experienced ftenographer. Both arts require long practice, but both are very attainable.

When he has learned the true *founds of the thirty letters, in the Englifh language, he will be capable of reading as well as of fpeaking, and he ought to have a catalogue of objects, defigned or reprefented, that he may affix proper ideas to proper terms.—Thus a child may be taught to read, to fpeak, to underftand others, to write, and obtain a knowledge of things at the fame time.

The greateft difficulty that the deaf have to furmount, in making a quick progrefs, in general converfation, has been the want of a proper dictionary, or, rather, of a properly written language; for if they pronounce the letters well, and attempt to join them, fo as to read words as they are now written, it would be unintelligible.—The dictionaries of Dr. Kenrick and Mr. Sheridan, would very much affift at prefent, for the deaf fhould have an opportunity of acquiring the founds of words, whenever they were difpofed to learn, without being obliged to have recourfe to others: but there are many defects, as well as miftakes, in Mr. Sheridan's, and though I have not feen Dr. Kenrick's, I know the manner, and it muft alfo be defective,

* See the preceding differtation Page 280 et feq:—alfo the table of founds.

fective, becaufe in neither work, have letters been invented for the founds not before reprefented.---If the dumb had the advantage of learning a language properly fpelled, every time they read in a book, the founds would be impreffed upon the mind, and reading would offer an eternal fource of improvement, both in correct fpeaking, and in matter; and thus might a perfon, who had once learned his letters, be capable of reading every thing correctly, and a child would not have to learn a language in merely learning to read; thirty founds only would be required, and he would have no idea of the poffibility of fubftituting a wrong letter in writing, for one which he could properly pronounce; thus, fpelling would not be a ftudy in writing. I fpeak now, not only in favour of the deaf and confequently dumb, but of all others, who have not yet learned to read. Some of thefe ideas I have often repeated, but repetition is admiffible, when we confider with how much difficulty truth is made to grow in a foil where prejudice has permitted error to take deep root.

Many of the dumb learn to communicate by their fingers, forming an alphabet, by pointing at each finger, by fhutting them feparately, by laying various numbers of fingers upon the other hand, firft on one fide, then on the other, and by different figns, paffing through the whole fcale of founds---and compofing words by vifible motions, which are agreed upon by a friend. They alfo write, and learn the meaning of things, by referring to the reprefentatives of words inftead of the words themfelves, and the meaning of things would be as eafily taught by this mode as by the ear, provided there were as much repetition in one cafe as in the other.

It is neceffary, that the dumb have each a book, in which fhould be written under proper heads, the names of familiar objects, and under them thofe things which have a connection, beginning with genera, and defcending to fpecies.

It

It would be proper to have large tables of claſſes, in the following manner, which would occupy the ſide of a room.

ANIMALS

- Mankind
  - Man, woman child,
- Beaſts
  - Carnivorous
    - Lion
      - He-ſhe
    - Tyger, &c.
      - He-ſhe,
  - Graminivorous
    - Horſe
      - Horſe, Mare Foal
    - Horned Cattle
      - Bull, Cow, Calf
      - Sheep, &c.
        - Ram, Ewe Lamb
- Birds
  - water fowl
  - Birds of prey, &c.
- Fiſhes
  - Sea,
  - freſh water
- Rept:
- Inſects,
- Amph:

VEGETABLES

- Trees
- Shrubs
- Plants

MINERALS

- Platina
- Gold
- Silver
- Copper
- Tin
- Lead
- &c.

STONES

- Diamond
- Sapphire
- Ruby,
- Topaz
- Emerald &c.
- Flint
- Calcareous, &c.

EARTHS

- Vegetable
- Okres or Calces
- Clays
- Marles
- &c.

As

As the pupil will be taught to read, to ſpeak, to write and underſtand things at once, the teacher ſhould force him to leave no name unpronounced, unwritten, or unread; and the pupil ſhould be, at the ſame time, taught to obſerve the motions made by the organs of ſpeech in his preceptor, and likewiſe to examine his own in a glaſs, and to draw the object, which may be done in a book either arranged according to the uſe of the thing, or put promiſcuouſly with its name written under; and if the word be incorrectly ſpelled, to write it properly beſides, or look in one of the corrected dictionaries. All theſe methods will impreſs his mind ſo ſtrongly, that he will ſeldom have occaſion to refer to his book; and by this method he will alſo attain to a great proficiency in drawing.

The actions and paſſions ſhould be acted to the pupil, and no movement made without ſhewing its meaning, and noting it down by writing, that words may increaſe in exact proportion to the increaſe of knowledge, and the progreſs which a ſtudent will make by this method will in a ſhort time be aſtoniſhing.

If a teacher were to undertake the inſtruction of ſeveral at once, which would indeed be moſt adviſeable, it would be exceedingly proper to procure as many prints or drawings of common objects as could be had, and even of the ſame objects in different poſtures and poſitions, with the name and action written beneath, and theſe arranged under different heads according to their relation to each other. The walls of the room might be covered with them, ſcreens, port-folios and books alſo contain others, to which they might conſtantly have acceſs. Colours ought alſo to be painted in ſquares, with their names attached, after them the ſhades and the various colours obtained by mixing ſimple bodies. They ought alſo to go through various courſes of natural hiſtory, natural and experimental

perimental philofophy, including chemiftry, by which they will fee the extenfive variety that even artificial mixtures and combinations of bodies will produce. The names, the proceffes, and refults fhould be written, that nothing be loft. Space and time fhould be meafured, and all the parts of difcourfe made familiar by examples, as a fenfible man would fee occafion.

The utility of attempting to teach the dumb to fpeak, has indeed been difputed by many, not only on account of the difficulties which are judged infurmountable, the imperfect manner in which the pupils articulate, and the difagreeable noife they make in endeavouring to pronounce, but alfo on account of the difficulty with which they underftand what others fay, and more efpecially when they can be comprehended fo well by writing, and made ufeful members of fociety by drawing.—The imperfect manner in which they fpeak depends not upon the pupil, if of common capacity, but upon the teacher; and I am confident, from fhort trials I have made, that the art is to be perfectly obtained by the foregoing method. The difficulty of underftanding what others fay I have already confidered (page 313 art. 3d) and though writing is a very neceffary qualification, yet pen and paper are not always at hand. Drawing I approve of, as ufeful to every one, and perhaps more particularly fo to a perfon whofe want of natural faculties deprives him of many fources of amufement. But fpeech is fo ufeful upon every occafion, that to attain it is to facilitate the very means of exiftence: for if a deaf man was even always provided with a book and pencil he would often meet with perfons who could not read, and one fentence if only imperfectly fpoken would convey more meaning than all the geftures and figns which would be made.

A deaf

A deaf perſon not perfectly ſkilled in reading words from the lips, or who ſhould aſk any thing in the dark would be able to procure common information by putting various queſtions, and by telling the perſon that, as he is deaf, he requeſts anſwers by ſigns, which he will direct him to change according to circumſtances.—If he had loſt his way, if he enquired for any one, if he wanted to purchaſe any thing, and in all the common occurrences of life, his ſpeech would be ſo uſeful, that it would certainly more than repay the trouble of obtaining it; eſpecially as it would be a mode of facilitating every other acquirement.

WILLIAM THORNTON.

N°. XXXIV.

Obſervations on the Theory of Water-Mills, (continued from page 193) by W. WARING.

Read, April 5th 1793.

SINCE the Philoſophical Society were pleaſed to favour my crude obſervations on the theory of mills with a publication in their tranſactions, I am apprehenſive ſome part thereof may probably be miſapplied.

It being therein demonſtrated, that, "the force of an invariable ſtream impinging againſt a mill-wheel in motion is in the ſimple direct ratio of the relative velocity," ſome may ſuppoſe, that the effect produced, ſhould be in the ſame proportion, and either fall into an error, or, finding by experiment, the effect to be as the ſquare of the velocity, conclude the new theory, to be not well founded; therefore, I wiſh there had been a little added to prevent ſuch a miſapplication, before the ſociety had been troubled with the reading of my paper on that ſubject; perhaps, ſomething like the following.

The

The maximum effect of an underſhot wheel, produced by a given quantity of water in a given time, is in the duplicate ratio of the velocity of the water. For the *effect* muſt be as the impetus acting on the wheel, multiplied into the velocity of the wheel. But this *impetus* is demonſtrated to be, ſimply, as the relative velocity, [Prop. I. page 146] and the velocity of the wheel producing a maximum, being half that of the water, [by Prop. II. page 147.] is likewiſe as the velocity of the water: therefore, the power acting on the wheel multiplied into the wheel's velocity, or the effect produced, muſt be in the duplicate ratio of the velocity of the water. Q. E. D.

Corol. Hence the effect produced by a given quantity of water in a given time, will be as the height of the head, becauſe this height is as the ſquare of the velocity. This alſo agrees with experiment.

If the force acting on the wheel, were in the duplicate ratio of the water's velocity, as uſually aſſerted, then the effect would be as the cube thereof, when the quantity of water and time are given; which is contrary to the reſult of experiment.

When I attempted to compute the power, &c. of Doctor Barker's or James Rumſey's mill, as at page 185, the following ſimple demonſtration of its equivalence to that of the underſhot wheel, with the ſame quantity and fall of water, had not then occurred, viz.

Action and re-action are equal, &c.

But the underſhot wheel is propelled by the *action*, and the rotatory tube by the *re-action* of the ſame agent or momentum.

Therefore their mechanical effects muſt be equal.

The acting and counteracting forces which originate inſide the tube, not being from any external impulſe, can be no exception; becauſe, in any body, or ſyſtem of bodies, the

the mutual actions and reactions of the parts on each other do not alter the motion of their common centre of gravity. [Newt. Princip. B. 1. Law 3. and Corol. 4.]

Hence the increase of power from the centrifugal force, multiplied into the augmentation of velocity thereby occasioned, just equals the force necessary to move the water into its spiral direction; which corresponds with what was before deduced from a different calculus.

Note under the head *Area of the Apertures*, page 192, the resulting equation, which, by inadvertently using a for 2a, &c. is $\frac{AV}{8.924\sqrt{h}}$ should be $\frac{AV}{18.47\sqrt{h}}$; and, of course, the number 8.924, in rule 4th page 193, should be 18.47; but this oversight does not affect any other part of the calculation.

Philadelphia 4th 4mo. 1793.

Wm. WARING.

N°. XXXV.

An Improvement on metalic Conductors or Lightening-rods, in a Letter to Dr. DAVID RITTENHOUSE, *President of the Society, from* ROBERT PATTERSON *of Philadelphia.*

☞ *This Paper was honoured with the Magellanic Premium, by an Award, of the Society in December* 1792.

SIR,

Read Nov. 5, 1790. FROM the instances which now and then occur of houses being struck with lightening, that are furnished with metalic conductors, and the frequent inſtances of theſe conductors having their tops melted off by a ſtroke of lightening, it appears that this admirable contrivance for guarding houſes againſt the dangerous effects of lightning is, in ſome degree, ſtill imperfect. Some improvement ſeems yet to be wanting at both extremities of the rod—at the upper extremity, to ſecure it againſt the accident of being melted, which renders it afterwards unfit to anſwer its original intention, viz. drawing off the electric fluid, or lightening, from the paſſing cloud, in a ſilent, imperceptible manner; for it is only *pointed* conductors that poſſeſs this property—and at the lower extremity, to afford a more ready paſſage for the fluid into the ſurrounding earth.

The firſt of theſe intentions, would, I am perſuaded, be effectually anſwered, by inſerting in the top of the rod a piece of *black-lead*, of about two inches long, taken out of a good pencil, and terminating in a fine point, projecting but a very little above the end of its metalic ſocket; ſo that, if the black-lead point ſhould happen to be broken off by any accident, of which however I think there can be but little danger, ſtill the point of the rod would be left ſharp enough to anſwer the purpoſe of a metalic conductor.

This ſubſtance is well known to be infuſible, by the greateſt heat, and hence its uſe in making crucibles; nor is it evaporable, as remarked by Cronſtedt, in his mineralogy ſect. 231, except in a ſlow calcining heat, to which it could never be expoſed on the top of a lightning-rod.

At the ſame time its power as a conductor of electricity is perhaps equal, or but little inferior, to that of any of the metals. A line drawn on a piece of paper, by a black-lead pencil will, as I have often experienced, conduct an electric exploſion ſeemingly as well as a ſimiliar

line

line of gilding would do, and that without ever loosing its conducting power, which is not the case with gilding.

The second intention is, to facilitate the escape of the electric fluid, from the lower part of the rod into the surrounding earth. It is, in many cases, impracticable, from the interruption of rocks or other obstacles, to sink the rod so deep as to reach moist earth, or any other substance which is a tolerably good conductor of electricity. Nor even if this were practicable, would it, I presume, be alone sufficient to answer the desired intention. Iron, buried in the earth, and especially in moist earth, will presently contract a coat of rust, which will continually increase till the whole is converted into rust: but rust of iron, and indeed the calx of all metals, is a *non-conductor*, or at most but a very imperfect conductor of the electric fluid. Hence it is easy to see, that in a few years after a lightening rod has been erected, that part of it which is under ground will contribute little or nothing towards the safety of the building. Besides, the surface of this part of the rod is *too small* to afford an easy and copious discharge of the electric fluid into the surrounding earth, when this is but an imperfect conductor.

As a remedy for these defects, I would propose, that the part of the rod under ground be made of tin, or copper, which are far less liable to corrosion or rust, by lying under ground than iron. Or, which perhaps would answer the purpose better, let this part of the rod, of whatever metal it be made, be coated over with a thick crust of black-lead, previously formed into the consistence of paste, by being pulverized and mixed with melted sulphur (as in the manufactury of the ordinary kind of black-lead pencils) and then applied to the rod while hot. By this means, the lower part of the rod would, I apprehend, retain its conducting powers for ages, without any diminution.

In order to increaſe the ſurface of the lower part of the conductor, let a hole or pit, of ſufficient extent, be dug as deep as convenient; and into this pit, let there be put a quantity of *charcoal*, round the lower extremity of the rod. Charcoal poſſeſſes two properties which, in a peculiar manner, fit it for anſwering the purpoſe here in view. (1) It is a very good conductor of electricity, and (2) it will undergo little or no change of property by lying ever ſo long in the earth. Thus might the ſurface of that part of the conductor, in contact with the earth, be increaſed with little trouble or expence to any extent at pleaſure; a circumſtance which every one acquainted with electrical experiments, muſt acknowledge to be of great importance to the end here propoſed.

Whither the above hints may merit a place among the communications from candidates for the annual premium, is humbly ſubmitted.

By yours, &c.

PHILO FRANKLIN.

N°. XXXVI.

An eaſy and expeditious method of diſſipating the noxious Vapour commonly found in Wells and other ſubterraneous places, by EBENEZER ROBINSON, of Philadelphia.

Read Nov. 3d, 1786.

AFTER various unſucceſsful trials, (a detail of which has been already communicated,) I was led to conſider, how I could convey a large quantity of freſh air, from the top to the bottom of the well; ſuppoſing that the foul would neceſſarily give way to the pure air.—With this view I procured a pair of ſmiths bellows, fixed

fixed in a wooden frame, so as to work in the same manner as at the forge. This apparatus being placed at the edge of the well; one end of a leathern tube (the hose of a fire engine,) was closely adapted to the nose of the bellows, and the other end was thrown into the well, reaching within one foot of the bottom. At this time the well was so infected, that a candle would not burn at a short distance from the top; but after blowing with my bellows, only half an hour, the candle burned bright at the bottom; then, without further difficulty, I proceeded in the work, and finished my well.

Wells are often made in a very slight manner, owing to the difficulty of working in them, and there have been several fatal instances of the danger attending the workmen; but by the above method, there is neither difficulty nor danger in compleating the work, with the utmost solidity.

It is obvious, that in cleansing vaults, and working in any other subterraneous place, subject to damps, as they are called, the same method must be attended with the same beneficial effect.

No. XXXVII.

A method of draining Ponds in level Grounds, by JESSE HIGGINS, of Delaware.

Read July 15, 1791.

AT a certain distance below the surface of the earth, there is a stratum of loose sand, which freely admits the passage of water. This stratum is at various depths, in different elevations; but it will be generally

nerally found, that lands moſt ſubject to ſtagnant ponds, have but a ſhallow ſtratum of clay, over the ſand.

All that is neceſſary, therefore, is to dig a pit in the bottom of the pond, till you arrive at this ſtratum of ſand, when the water will be immediately abſorbed, and the pond emptied. Should there be too much water to permit a hole to be dug within the pond, it may be made at the edge of it, the communication afterwards made by a trench. It would be prudent not to make the ſides of the pit ſo ſteep, as to prevent cattle from getting out, ſhould they happen to go in.

The writer does not pretend to be the original author of this invention; the idea was ſuggeſted to him, by ſeeing it practiſed by a farmer, who enjoyed the benefit, though he did not appear to know the cauſe

N°. XXXVII.

Obſervations on the ſeverity of the winter 1779, 1780, *by the Rev.* MATHEW WILSON *of Lewis, dated* 22*d June* 1780.

Read June 1781.

THE extreme cold made great devaſtations on the animal and vegetable kingdoms. Such obſervations as were in my power to make, are,

1. The moles generally periſhed, many were found dead above ground.

2. The bees are almoſt all deſtroyed, but few hives have eſcaped.

3. The frogs ſuffered greatly, it is ſuppoſed that at leaſt two thirds of the ſpecies were cut off.

4. Our ſhell fiſh of all kinds, that run in ſhoal waters, were deſtroyed; after the thaw the air was infected by their putrifaction.

5. Bugs

5. Bugs, muſketoes, &c. &c. have generally died.

6. The graſshoppers I ſuſpect are gone, not having yet ſeen any.

7. Some ſnakes yet live, but they are not ſo numerous as formerly.

A multiplicity of buſineſs prevented me from extending theſe obſervations; but if I had had leaſure, I ſhould doubtleſs have diſcovered many more animals and inſects that ſuffered from the ſame cauſe.

8. I muſt add ſomething remarkable reſpecting fiſh, though I know not whether to refer it to the cold or ſome other cauſe.

From 14th to 24th of May after continued eaſterly winds, fiſh were driven on the coaſt in ſuch abundance that in Rehoboth only two or three hundred buſhels were daily collected and eaten by the people. Some ſeemed at firſt to be alive, but far the greater part were dead, and many had one eye picked out by the birds while floating on the water. The ſound, or air bladder, of them all was remarkably diſtended, ſo that they could not ſink in the water; this ſeemed to be the cauſe of their death. Theſe fiſh were generally ſea crocus, a few cats and ſome ſea trout.

The vegetable ſeems to have ſuffered more than the animal kingdom.

Roſemary, of which there were many large and flouriſhing hedges, is totally extinct.

The *Pink* is deſtroyed, except a few ſmall roots, covered with leaves, in narrow places.

Grape Vines both native and foreign are killed, except where they were ſheltered from the winds.

Moſt of the ever greens, the ſmall *Laurel*, the *Holly*, the *Juniper*, *Bear buſhes* and ſome ſmall *pines* have ſuffered in the general calamity; and what is ſtill more remarka-

ble

ble many young *black oaks* and ſome *white oaks* from twelve feet high and under are dead, in bleak places.

Sage, *Rue*, *Lavender*, *Prickley pears*, *Southern wood* and *Silk graſs* (a ſpecies of the Aloes) are dead to the roots. *Comfrey roots and Parſley* are much damaged, and the *Catauba* tree is killed in all its ſmaller branches. Two thirds of the *Wheat* and *Rye* in our country are loſt, and *Hoar hound*, which generally grows all winter, is deſtroyed.

In the ſalt marſhes I found the large *triangular graſs* and the *bent graſs* generally dead from the roots. The marſh at preſent (June) looks red and ſeems rotten.

N°. XXXIX.

A Deſcription of a new Standard for Weights and Meaſures, (in a Letter from Mr. JOHN COOKE, *of Tipperary in Ireland, to* THOMAS JEFFERSON, ESQ.

Dated Mar. 28, 1791.

THE want of uniformity in weights and meaſures is a ſubject of general complaint at preſent; it is an infinite ſource of fraud, and the great obſtacle to domeſtic and foreign commerce.

The firſt ſtep neceſſary to remove this evil, is to appoint an univerſal, perpetual, and immutable ſtandard, for length, ſuperficies, weight, and capacity; whereby the inſtruments of meaſurement may be adjuſted, and alſo whereby they may be deſcribed to diſtant countries, and to future ages.

Natural ſubſtances are incapable of furniſhing one of this deſcription. Every thing in the material world is in a ſtate of gradual alteration, it differs from itſelf under different circumſtances, and differs from every individual of the ſame ſpecies.

General

General and permanent immutability is to be found only in our abſtract ideas; and none of theſe can define dimenſions but our ideas of geometrical diagrams; therefore, if we could diſcover ſuch relations or qualities in a geometrical figure, as are peculiar to it, and as would diſtinguiſh it from all other ſimilar figures, we ſhould have a correct ſtandard; but as every attempt to accompliſh this has failed, we are obliged to reſort to theſe general qualities of matter which are the moſt durable and leaſt variable.

Of this claſs are coheſion, motion, gravity, &c. upon the laſt of which the following theorem depends, and from which alſo Mr. Huygens has deduced the pendulum ſtandard.

But the pendulum is ſubject to many imperfections; the principle of which are.

1ſt That the variation of the weight of the atmoſphere affects it.

2dly. It is of different lengths at different diſtances from the Equator.

3dly. It requires a force in addition to its gravity to preſerve it in motion a ſufficient time, and as this may be greater or leſs, in different experiments, it may accelerate or retard the vibrations, and conſequently render the length uncertain.

4thly, Unleſs the pendulum move in a cycloidal arch, its oſcillations will not be perfectly iſochronous, and this has not been effected hitherto.

5thly. Since the pendulum is a meaſure of length only, the meaſures of capacity and weight, if they be deduced from it will be erroneous in a triplicate proportion of the errors of the pendulum.

The two firſt of theſe faults are common to the ſcheme here propoſed alſo, and if the following theorem ſhould be

 thought

thought to deſerve attention, it is becauſe the ſtandard deducible from it, is not ſubject to the three laſt mentioned defects.

THEOREM.

If there be a cubic veſſel with an aperture in the bottom, which aperture is in a given ratio to the baſe of the veſſel; and if the ratio between the weight of the water which this veſſel contains when full, and the weight of the water diſcharged from it, through this aperture, in a given time be given, the cube itſelf is given.

DEMONSTRATION.

No other ſimilar veſſel will diſcharge a proportionate quantity through a proportionate aperture in the ſame time; for if ſo, the weights of water diſcharged by two ſuch cubes in the ſame time, would be in the ſame ratio to their diſcharging cubes reſpectively, and conſequently the weights of the diſcharged waters muſt be to each other, as the weights of the cubes, that is in a triplicate ratio of their altitudes; but by the laws of Hydraulicks the weights of the water diſcharged in the ſame time from different altitudes and through different apertures will be to each other in a ratio compounded of the ſimple ratio of the apertures, (which is equal to the ratio of the baſis, which is equal to the duplicate ratio of the altitudes) and the ſubduplicate ratio of the altitudes; that is, the weights of the water diſcharged muſt be to each other in the triplicate ratio of the altitudes, which is abſurd.

In making an experiment according to this theorem, it is to be obſerved that the edges of the orifice ſhould be as thin as poſſible, and that the veſſel ſhould not be ſuffered

to

to diſcharge ſo much of its contents that the ſurface would approach the bottom.

It is evident, that by this method, a ſtandard may be formed for any length, ſuperficies, or capacity, and alſo for any weight, if the ſpecific gravity of the water made uſe of be given.

N°. XL.

Deſcription of a SPRING-BLOCK, *deſigned to aſſiſt a veſſel in Sailing. By* FRANCIS HOPKINSON, ESQ. *of Philadelphia.*

Honoured with the Magellanic Gold Medal, by an award of the Society, in December, 1790.

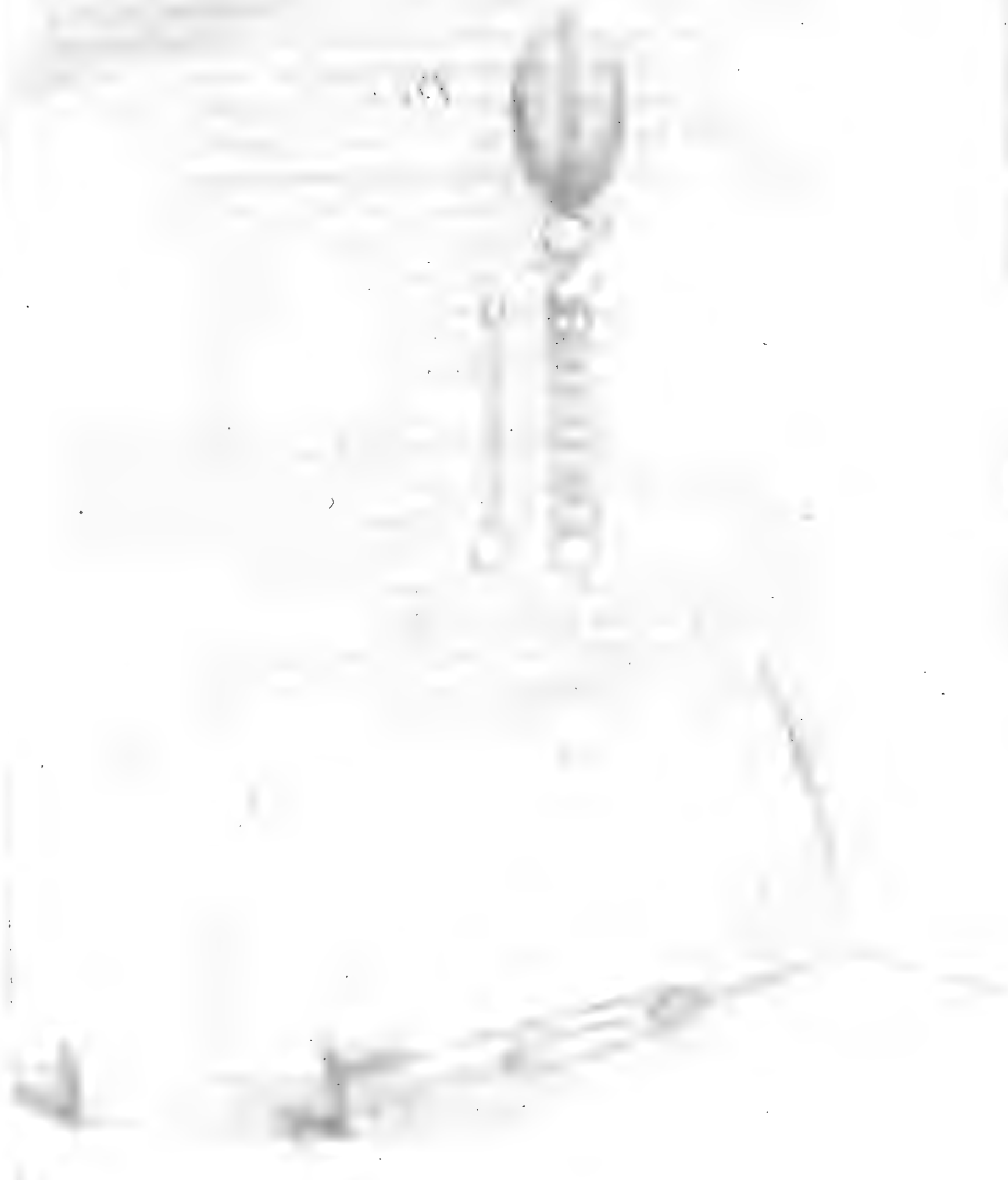
IT is an acknowledged fact, that when the ſhrouds of a veſſel are braced very tight, ſo as to prevent the maſts from having any play or ſpring, ſhe will not ſail as faſt as when her maſts are permitted to bend a little to the impulſes of the wind. The reaſon is, that the wind is ſeldom uniform in its force for any length of time; and it is impoſſible that a ſudden encreaſe of impulſe ſhould *inſtantaneouſly* communicate a proportionable velocity to ſo heavy a body, placed in a reſiſting medium of ſo great denſity.

In ſuch caſe the veſſel is forcibly preſſed into or againſt the water, and is obliged to heel from the blaſt, until a progreſſive motion, adequate to the force impreſſed can be communicated to the whole maſs. But theſe ſudden preſſures againſt the water and this heeling of the veſſel, are great obſtacles to faſt ſailing: in as much as they occafion an unprofitable expenditure of the force which fhould pufh her forward.

When a veffel firft hoifts her fails, although fhe may be in a fituation to receive the full impulfe of the wind, yet fhe will not *immediately* proceed with the velocity which fhe will afterwards acquire from the fame force: having not yet *got under way*, as the feamen exprefs it. Upon the fame principle, when a veffel is failing at the rate of five knots, if a fudden blaft of wind fhould come, which would enable her to make feven knots, fhe may be confidered as being perfectly ftationary with refpect to the two additional knots, and will require fome time to *get under way* as to them. Now the effect produced by relaxing the fhrouds is, that the maft, receiving the firft impreffion of the wind upon the fails, acts as a fpring, and yielding to the impulfe, gradually communicates motion to the whole veffel, giving her time to *get under way*, and occafioning an eafy tranfition from one degree of velocity to another: fo that her way is not checked by her being fuddenly urged againft the refifting medium on the acceffion of every new force impreffed.

But the misfortune is, that this advantageous ufe of the maft can be exercifed only to a fmall extent; for, if it is allowed too much play, it will be in danger of breaking. The object of the prefent propofal is to enjoy the fame benefit to a greater extent and with more fecurity.

The mafts, yards and rigging of a fhip receive the firft impulfes of the wind. All thefe are in fome degree elaftic. Every twifted rope is a fpiral fpring, and every fpar capable of being a little bent. But let us fuppofe that the ropes were all compofed of ftraight ftrands, that the mafts and yards were inflexible, and the fails made of thin light wood; in fuch cafe, I fuppofe, that the veffel in failing by the wind would make but little head-way, whatever the



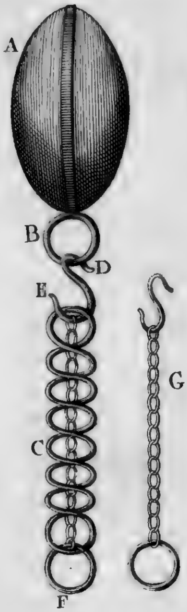


Fig: 1


Fig. 2

the ſhape of her bottom might be: but would expend the force of the wind in heeling and ſlipping to leeward. If this is true, her ſailing muſt be conſiderably aſſiſted by any means that ſhall encreaſe the active ſpring of her rigging. For this purpoſe I have contrived what I call a SPRING-BLOCK, to be applied to all ſuch parts of the rigging as will admit of it with ſafety and convenience, and where its operation will be moſt advantageous; but particularly to the ſheet-ropes, and, if practicable, to the dead eyes in lieu of what are called the chains.

Deſcription.

A, fig. 1, Is a block made in the uſual manner, having a ring or eye B at one end. C, is a ſpiral ſpring linked at one end to the hook D E and at the other to the ring F, which is to be annexed by a ſtaple to the timber-head, or by ſome other means, to the place where it is to be applied. The ſpring C, muſt be of well tempered ſteel, and proportioned in ſtrength to the ſervice it is to perform. Within the cavity or pipe formed by the ſpiral ſpring, there muſt be a *chain* of a ſuitable ſtrength called a *check-chain* (repreſented ſeperate at G) connected by links to the rings D and F. When the ſpring is not in action this chain is ſlack; but when the ſpiral ſpring is extended by the force of the wind as far as it can be without danger of injury; the cheek-chain muſt then begin to bear, to prevent its further extenſion; and, if ſtrong enough, will be an effectual ſecurity againſt failure.

Fig. 2. repreſents part of the gun-wale of a ſloop with the ſpring-blocks in action, one of them hooked to a ſtaple in the timber-head, and the other to the corner of the jib.

My expectation is that a veſſel thus furniſhed will be leſs liable to heel, that ſhe will receive the impulſes of the wind to better advantage, and ſail with a more lively and equable motion, than if rigged in the common way.

Vires acquiret cedendo. N°. XLI.

N°. XLI.

A Botanical deſcription of the PODOPHYLLUM DIPHYLLUM *of Linnæus, in a Letter to* CHARLES PETER THUNBERG, M. D. *Knight of the Order of Waſa, Profeſſor of Medicine and Botany in the Univerſity of Upſal, &c. &c.*

DEAR SIR,

Read May 18, 1792. IN the time of Tournefort, and for many years after his death, the *Anapodophyllon* of this great botaniſt was conſidered as a genus of which there was known but one ſpecies, viz. the *Anapodophyllon Canadenſe Morini.* When the name of this plant was afterwards altered, by Linnæus, to that of *Podophyllum*, he denominated the ſpecies, which had been previouſly deſcribed by Tournefort, by Cateſby, by Mentzelius, and by ſome other botaniſts, *peltatum*, from the target-ſhape of the leaves.

In the firſt edition of the *Species Plantarum*, this is the only ſpecies of *Podophyllum* which we find mentioned, or deſcribed. In the ſecond edition, which was publiſhed in 1762, we find another ſpecies, under the name of *diphyllum.* The two plants now ſtand oppoſed to each other, in the following conciſe characters: viz.

1. PODOPHYLLUM peltatum foliis peltatis palmatis, and

2. PODOPHYLLUM diphyllum foliis binatis ſemicordatis.

Theſe characters have been preſerved in all the ſubſequent editions of the *Species Plantarum* and *Syſtema Vegetabilium* that I have ſeen.

With

With the firſt of theſe ſpecies Linnæus could not but have been pretty well acquainted, as it had been figured and deſcribed by Tournefort, by Cateſby*, by Mentzelius, and other botaniſts, before him, and as he tells us he had an opportunity of examining the living plant. Of the other *ſuppoſed* ſpecies of *Podophyllum*, his knowledge was much leſs complete. In the *Species Plantarum*, he mentions it as a native of Virginia, on the authority of his friend Mr. Peter Collinſon, and gives the following deſcription of it. "Folia *radicalia, petiolata, binata ut in Hymenæa, glabra, integerrima, ſemicordata, abſque pedicellis.* Scapus *radicalis, uniflorus, fructu antecedentis*" (i. e. *Podophyllum peltatum*). "Flos *mihi non viſus.*"

In the thirteenth edition of the *Syſtema Naturæ*, printed at Vienna, in 1770, Linnæus ſtill retains the two ſpecies of *Podophyllum*, which I have mentioned: but, at this period, he ſeems to be uncertain whether his *diphyllum* is actually a ſpecies of the genus to which he originally referred it, as appears from the following words, ſubjoined to the ſpecifick character of the plant: viz. "*an Sanguinariæ ſpecies? cum Folium unicum binatum & Scapus aphyllus radicalis & Capſula oblonga.*" He then tells us that he has not ſeen the flowers, and that the plant was ſent to him (I preſume, either by Collinſon or by Gronovius) as a ſpecies of *Podophyllum*.

In the quarto-edition of the *Flora Virginica* of my induſtrious countryman Dr. John Clayton†, which was publiſhed

* Cateſby's figure is not very accurate.

† The fate of thoſe few perſons who have cultivated botanical knowledge in North-America, has been rather ſingular. The labours of Mr. John Baniſter were not inconſiderable, but they are ſwallowed up in the extenſive writings of Mr. Ray, and not one botaniſt in a thouſand knows any thing of them. The ſervices of Clayton were greater. In collecting, and in inveſtigating the hiſtory of plants, his enthuſiaſm and his induſtry were immenſe. He tranſmitted his ſpecimens and annotations to Gronovius, who could not have found it a difficult taſk to arrange the plants into a ſyſtematic form. The *Flora Virginica* is a reſpectable work, with which no botaniſt ſhould be unacquainted. In reading this work, it is a duty which we owe to merit to conſider the volume as the labour of Clayton and not of Gronovius, who kindly robbed the American botaniſt of the honour of his diſcoveries, whilſt he reapt the pecuniary profits of his toils.

liſhed by Gronovius, at Leyden, in 1762, I find that both the ſpecies of *Podophyllum* mentioned by Linnæus, are enumerated among the indigenous vegetables of Virginia. In this excellent work, after giving the Swediſh naturaliſt's ſhort ſpecifick character of the *Podophyllum diphyllum*, Dr. Clayton adds the following deſcription of his own: "Podophylli vel Nelumbonis ſpecies foliis reniformibus, in petiolis longiſſimis erectis e radice immediate "egreſſis, binatim diſpoſitis, ſubtus glaucis: fructu magno "coriaceo luteſcente uniloculari, per maturitatem ad apicem operculi inſtar horizontaliter dehiſcente: ſeminibus "oblongis lucidis ſpadiceis. Flores nondum videre licuit. "Maji initio ſolo ſubhumido & fertiliſſimo ſub arborum "excelſarum tegumine, convallibus & clivis montium "collegi*."

This is all the information that I have been able to collect, from the writings of botaniſts, concerning the *Podophyllum diphyllum* of Linnæus. In the *Hortus Kewenſis* of Mr. Aiton, a work which contains excellent deſcriptions of a conſiderable number of new, or hitherto imperfectly deſcribed, ſpecies of North-American plants, no mention is made of it. I preſume, it muſt have been unknown to Mr. Iuſſieu, when he publiſhed his *Genera Plantarum ſecundum Ordines Naturales diſpoſita*, in the year 1789, otherwiſe this able botaniſt would not have omitted the mention of it, in drawing the characters of the two genera *Podophyllum* and *Sanguinaria*, to both which our plant is nearly related. Neither do I find any mention made of this plant by Dr. Schoepf†, and ſome other late writers, who after *riding poſt-haſte* through the countries of the United-States, have publiſhed volumes of *Travels*, &c.

I have

* See page 81.

† This Gentleman is the author of a trifling work entitled *Materia Medica Americana potiſſimum regni vegetabilis.* Erlang: 1787; alſo of a work, in two volumes octavo, entitled *Reiſe durch einige der mittlern und ſudlichen vereinigten Nordamericaniſchen Staaten*, &c. printed, at the ſame place, in the following year, and of ſome other publications.

I have often ſought for this ſuppoſed ſpecies of *Podophyllum*, in the woods of Pennſylvania. Miſlead by Linnæus, who, at one time, deſcribes it as a ſpecies of this valuable genus, and at another time ſeems uncertain whether it is not a ſpecies of *Sanguinaria*, or *Puccoon*, I hoped to diſcover it in the neighbourhood of its relations, which are among the number of the moſt common vegetables of Pennſylvania, both on the eaſtern and on the weſtern ſide of the Alleghaney-Mountains. I ſought, however, without ſucceſs. Some of my botanical friends have been more fortunate. Mr. William Bartram has ſeen it, but not in flower, in the country of the Cheerake-Indians, where it grows abundantly. Another gentleman has obſerved it, growing on the ſide of a mountain, in a rich ſoil, near the river Monaungahela, in the county of Fayette, and ſtate of Pennſylvania. The ſame gentleman obſerved prodigious quantities of it on the Holſten, below the north-fork of this river, in the ſtate of North-Carolina. In neither of theſe ſituations, however, did he ſee it in flower.

About two years ſince, Mr. Andrew Michaux, an induſtrious French botaniſt, who has been travelling, for ſome time, through different parts of our States, diſcovered this vegetable on the Blue-Ridge, near the head of the Roanoke-River, in Virginia. It grew in a rich, loamy, humid ſoil, and generally under the ſhades of the large foreſt-trees of the mountains, ſituations correſponding to thoſe in which it had been diſcovered by the accurate and indefatigable Clayton, many years before him. Mr. Michaux ſays, the plant did not ſeem to have an extenſive ſpread, but that it was very common in two particular places. He did not ſee it in flower.

From a root of this vegetable, which was ſent to Mr. William Bartram, by Mr. Michaux, there was produced a fine ſpecimen, which flowered in the beginning of the ſpring of the year 1791, in the neighbourhood of Philadelphia. Mr. Bartram and myſelf carefully examined the plant, in the various ſtages of its growth, and, together, made the drawings which accompany this letter.

Before I proceed to the more immediate deſcription of this plant, I think proper to obſerve, that although it has already been diſcovered in ſeveral different parts of North-America, it is by no means ſo common a plant as the *Podophyllum peltatum* and *Sanguinaria canadenſis*. I have never ſeen an extenſive tract of our country in which theſe plants were not to be found. They extend from the top of Canada to the termination of the higher grounds of the two Floridas.—Hitherto, I have not learned that the *Podophyllum diphyllum* of Linnæus has been diſcovered to the eaſt of the great ranges of our mountains. No mention is made of it in the liſt of the plants growing in the vicinity of the town of Lancaſter, in this ſtate, by my friend the Reverend Dr. Muhlenberg, than whom no man has ſtudied the vegetables of a diſtrict with more elaborate attention, and happy ſucceſs*. Dr. James Greenway, a very reſpectable botaniſt, who reſides in Virginia, has never ſeen our vegetable in that ſtate.

I am far, however, from aſſerting that this plant is not a native of the Atlantic parts of North-America. The rich and happy countries of this great continent have, as yet, been very imperfectly explored. America has, indeed, produced ſome few men of talents, who knew nature, and who loved her. Clayton, and the two Bartrams † have done much. But an ocean of undiſcovered pearls remains to be inveſtigated. The electricity of your immortal Linnè

* See this gentleman's *Index Floræ Lancaſtrienſis*.

† John Bartram and his ſon William Bartram. The father has paid the debt of nature: the ſon ſtill lives, as a ſtrong proof that great natural genius will triumph over the difficulties ariſing out of the want of education, and that the ſtudy and contemplation of nature are favourable to the growth of extenſive benevolence and virtue.

ne has hardly been felt in this *Ultima Thule* of ſcience. Had a number of the pupils of that great man ſpread themſelves along, and ſettled in, the countries of North-America, the riches of this world of natural treaſures would have been better known. But alas! the one only pupil of your predeceſſor that has made choice of America as the place of his reſidence, has added *nothing* to the ſtock of natural knowledge. *Video meliora.*

But, I return to my plant.—ITS CLASS AND ORDER.

I had an opportunity of examining four flowers of this vegetable: they aroſe from one common root. Each of theſe flowers was furniſhed with eight ſtamina, and with one piſtillum. From this examination, I ventured to inform ſeveral of my friends, as well foreign as domeſtic, that the *Podophyllum diphyllum* of Linnæus belonged to the claſs and order *Octandria Monogynia* of the ſexual ſyſtem, and that it ſhould ſtand between *Mimuſops* and *Tropæolum.* More obſervations, however, are probably wanting to enable me to aſcertain, with certainty, this part of the hiſtory of the plant. Perhaps, the number of the ſtamina, in particular, is not definite*. But on this head, another ſummer will enable me to give you more certain information.

ITS NATURAL CLASS AND ORDER.

I think, it is a matter of much more conſequence to aſcertain the place of our genus in ſome *natural ſyſtem* of vegetables. I would not wiſh you to think, from this obſervation, that I undervalue the ſexual method of Linnæus. This is ſo far from being the caſe, that I am an implicit believer in the doctrine which aſſerts the exiſtence of ſexes in vegetables, and the neceſſity of an intercourſe

 between

* Since this letter was written, a number of flowers has been produced in the garden of Mr. John Bartram, near Philadelphia. In every inſtance, they were furniſhed with eight ſtamina, and one piſtillum. I preſume, therefore, the place of this plant in the ſyſtem of Linnæus is now well aſcertained.

between them for the purpoſe of perpetuating the ſpecies. I, moreover, greatly admire the ſyſtem of your countryman. In moſt reſpects, it is preferable to the method of Tournefort, or of any other botaniſt. But, ſtill, I cannot help wiſhing that the day may arrive, and, if the phyſicians of Europe continue to cultivate botany as ſome of them have done, it will arrive, when the ſexual arrangement ſhall give way to a more natural method, one in which the order, or aſſemblage, of nature will be purſued more rigorouſly than it has been by Linnæus. I would hardly venture to ſpeak with ſo much freedom to any other pupil of Linnæus. You, Sir, have ſhown, by the plan which you have purſued in your excellent *Flora Japonica*, that you do not implicitly follow the rules of your maſter. Your ſuppreſſion of the four claſſes *Gynandria*, *Monoecia*, *Dioecia*, and *Polygamia*, has always appeared to me to be a moſt judicious ſtep.

The plant under conſideration would be very well placed, between *Sanguinaria* and *Podophyllum*, in Linnæus's twenty-ſeventh natural order, called *Rhoeadeæ*. In the *Genera Plantarum ſecundum Ordines Naturales diſpoſita* of Mr. Juſſieu, a work of extenſive merit, it will have a very natural ſituation in the thirteenth claſs, denominated *Plantæ Dicotyledones Polypetalæ. Stamina Hypogyna;* and in the ſecond order, viz. *Papaveraceæ*. Its aſſociates, in this order, will be *Sanguinaria*, *Argemone*, *Papaver*, *Glaucium*, *Chelidonium*, &c.

THE GENERIC CHARACTER.

CALYX. A perianthium, conſiſting of three, four, or five (moſt generally of five), equal, concave, and lanceolate leaves, or pieces, rather ſhorter than the corolla, of a

pale

pale rose-colour, and falling off some time before the expansion of the flower.

Corolla. The corolla consists of eight, lanceolate, or narrow, ovate, pointed, somewhat concave, and spreading petals. In figure, they resemble the segments of the flower-cup, but are larger.

Stamina. The filaments, or threads, are eight in number, simple, slender, much shorter than the corolla*, and inserted into the receptacle. The *Antheræ* are flat, large, erect, oblong, and incurved.

Pistillum. The germen, or seed-bud, is superous, large, oblong, or ovate. The style is cylindrical, thick, and somewhat shorter than the filaments. The stigma is fleshy, radiated, or crisped.

Pericarpium. A large capsule, turban-shaped, pimpled, tapering towards the lower part, thin, unilocular, and divided, on the posterior part, by a longitudinal ridge. It splits, or opens, by a transverse suture, or lip, which is more than one half the circumference of the upper part.

Semina. The seeds are from twelve to twenty in number, lying loose. They are nearly ovate, and smooth.

The foregoing description is not, perhaps, in every respect, as accurate as I could wish. Future observations, however, will enable me to render it more worthy of your notice†.

Its name.

From the account which I have given of this plant, I have little doubt that you will agree with me in considering it as a genus, distinct from the *Sanguinaria* and the *Podophyllum*, to both which, however, it must be confessed, it bears considerable relation. As I have not found

* They are about one fifth of the length of the corolla.

† Since the letter was written, a greater number of flowers of this plant have been examined. In consequence of this examination, I do not find any necessity for altering, in the least, the description which I have given.

found it defcribed by any authors, except Linnæus and Clayton, neither of whom had feen the flowers, and as it is, certainly, a new family, I take the liberty of making it known to the botanifts by the name of

JEFFERSONIA,

in honour of Thomas Jefferfon, Efq. Secretary of State to the United-States.

I beg leave to obferve to you, in this place, that in impofing upon this genus the name of Mr. Jefferfon, I have had no reference to his political character, or to his reputation for general fcience, and for literature. My bufinefs was with his knowledge of natural hiftory. In the various departments of this fcience, but efpecially in botany and in zoology, the information of this gentleman is equalled by that of few perfons in the United-States.

Of the genus which I have been defcribing, we, as yet, know but one fpecies, which I call

JEFFERSONIA BINATA.

The *root* of this plant is fibrous, very branching, of a pale-brown, or dirty-yellowifh, colour, and confifting of a cortex, or bark, and a woody part. This ligneous portion is of a more lively yellow than the bark. The fibres, including both bark and wood, are not, in general, thicker than a common pin.

The *ftalks* are feveral: they do not branch out at all, but proceed immediately from the crown of the root, fupporting the leaves, and the flowers. Both thefe leaf and flower ftalks are naked, commonly about a line in thicknefs, fmooth, and of a dark green, fomewhat purplifh, colour. After the falling off of the flower, the ftalks, as well as the leaves, &c. encreafe, very confiderably, in fize.

The

The *leaves* are binate, or two-lobed, each lobe being ſomewhat of a ſemi-cordated form, very entire, ſmooth, and of a ſea-green colour on the under ſide. The principal nerves are five in number, in each lobe.

The *flower-cup* has been already deſcribed.

The *corolla*, or *flower*, is of a fine white colour, and ſtands erect, or horizontal, on the ſummit of the flower-ſtalk. There is never more than one flower on the ſame ſtalk.

The *filaments* have been ſufficiently deſcribed. The *antheræ*, or *ſummits*, are yellow.

The *piſtil* has been deſcribed, as has, likewiſe,

The *ſeed-veſſel*.

The *ſeeds* are nearly of a cheſnut-brown colour.

OBSERVATIONS.

The common height of the plant, whilſt in flower, is about ſix or eight inches: after the fall of the flower, it often grows a foot, or ſixteen inches high. The flower continues, for ſeveral days, in perfection and beauty, during which time the germen is viſibly enlarging. The petals now ſuddenly fall off, leaving the germen erect upon the ſummit of the ſtalk. This viſcus encreaſes in ſize very rapidly, changing its figure daily. When it is about three fourths of its mature ſize, it is nearly of an obovate, or turbinated, form, ſomewhat compreſſed on one ſide. During this ſtage of its growth, we plainly diſcern the tranſverſe ſuture, or lips of the inciſion, mentioned in the generic character. When it is completely ripened, the ſeed-veſſel opens, pretty ſuddenly, at this tranſverſe ſuture, upon which the ſuperior part riſes up, and now it appears like a cap, or helmet, diſcovering the naked ſeeds, lying

looſe.

loose. The seeds are to be dispersed. The stalk supporting their capsule becomes cernuous, or bends downwards, the bending being made a little below the protuberant part of the stalk, which I have represented in the different figures of the seed-vessel, &c.

The seed-vessel is, for some time, of a green-colour: as it advances in size, and age, it changes its colour, becoming, at length, of a yellowish-hue.

In the garden of Mr. Bartram, before mentioned, the *Jeffersonia binata* flowers early in the spring. The seeds ripen before mid-summer. Soon after this period, the plant withers and decays, but the root continues to live, at a small depth under the surface of the ground, encreasing, by offsets, on all sides.

As I have not had an opportunity of seeing the young plant arising from the seed, I can say nothing respecting its placentation.

I consider the science of botany as being so intimately connected with medicine, and with other useful arts, and I am so unfriendly to the *mere* nomenclatural part of the science, that I once resolved never to exhibit my description of a new plant, unless I could, at the same time, give some certain account of its properties in medicine, its use in diet, or in dying, &c. I have, however, been obliged to alter my determination; for of the *Jeffersonia binata* I know nothing that will serve to illustrate its history in either of these respects. It is, however, worthy of observation, that the root of this plant bears a very striking similarity, both in taste and in smell, to the root of our *May-Apple*, the *Podophyllum peltatum* of Linnæus. This taste is rather nauseous and bitter, and the smell powerful, and not agreeable.

The *Podophyllum peltatum* is a plant much esteemed by the Cheerake, and other tribes of North-American Indians;

ans. Its root is uſed as a purgative, emetic, and anthelmintic. I have made a number of experiments with this vegetable, an account of which, together with an engraving of the plant, I propoſe to publiſh, at a future period. Meanwhile, I beg leave to obſerve, that it generally proves purgative, though I have known it, in ſeveral caſes, to operate as an emetic*. The common doſe for an adult is from eighteen to twenty grains of the dried root, in powder. The advantages of this medicine over the Jalap I have often experienced in my practice. In the *firſt place*, being one of the moſt common vegetables in the United-States, it may always be had without the fear of adulteration, or of injury from worms, &c. *ſecondly:* it operates in a ſmaller doſe than either the Jalap or Rhubarb: *thirdly:* it does not ſo frequently as the Jalap prove emetic: *fourthly:* it is not ſo liable to gripe as this laſt-mentioned vegetable, and *laſtly*, it is not ſo nauſeous as either the Jalap or the Rhubarb. I think, it is poſſeſſed of ſome degree of an anodyne, or narcotick, quality.

I ſhall endeavour to procure a quantity of the root of the *Jefferſonia*, and ſhall inſtitute a ſeries of experiments, with the view to diſcover its chemical nature, and its effects upon animal bodies. Meanwhile, I am induced to believe, that I ſhall find it poſſeſſed of nearly the ſame properties as the *Podophyllum peltatum*.

* I do not well know how it has happined, that the root of the *Podophyllum peltatum* has ſo generally been conſidered merely as an emetic. It appears from Cateſby, that it is called *Ipecacuanha* in Carolina, and this author ſpeaks of it as an emetic. *The Natural Hiſtory of Carolina*, &c. vol. 1. p. 24. Dr. Schoepf, who ſeldom has any thing good of his own, follows Cateſby in attributing to this plant only an emetic property. Of its purgative quality, or of the doſe, he ſays nothing. See the *Materia Medica Americana potiſſimum regni vegetabilis*, p. 86. A more reſpectable philoſopher, the Count Caſtiglioni, has likewiſe fallen into the ſame error. See *Viaggio negli Stati Uniti dell' America Settentrionale fatto negli anni* 1785, 1786, e 1787. Tomo ſecondo, p. 329. Milano. 1790. As I had not an opportunity of ſeeing this gentleman's travels until after this paper was partly printed, I may be excuſed for mentioning here, what would have been more properly taken notice of at page 336, that the Count Caſtiglioni did not diſcover the *Podophyllum diphyllum*, in the courſe of his travels. "Il *Linneo*," ſays he, "ne annovera un' altra ſpecie ſotto il nome di *Podophyllum diphyllum* ſcoperta dal. Sig. "*Collinſon* nella *Virginia*, ma non avendola io veduta, nè eſſendo ſtata ben determinata dallo "ſteſſo *Linneo*, che pone in dubbio ſe poſſa eſſere una ſpecie di *Sanguinaria*, non ne farò altra "menzione." See *Viaggio negli Stati Uniti*, &c. tom. 2. p. 329.

I think, it was the genius of Linnæus which firſt ſuggeſted the idea that, with reſpect to vegetables, the buſineſs of creation is not *ſtationary*: or, in other words, that new plants are conſtantly creating from the admixture, or union, of two diſtinct ſpecies, either of the ſame, or of a different genus.

This idea of your illuſtrious countryman has received very powerful confirmation from the diſcoveries which have been made, of late years, in various parts of the globe. In America, I have obſerved a conſiderable number of theſe new, or *hybrid*, vegetables. Our woods, our fields, and our meadows, are full of them. It is among the *plantæ ſyngeneſiæ*, more eſpecially, that I have obſerved theſe hybrid plants, the offspring of promiſcuous cohabitation. The genera *Solidago* and *Aſter* are, with us, two families of baſtards. Several of the ſpecies of theſe genera, deſcribed by Mr. Aiton, in his excellent *Hortus Kewenſis*, evidently belong to this claſs.

I have ſometimes imagined, that the plant which is the more immediate ſubject of this letter is alſo an hybrid. It is, certainly, a beautiful example of a connecting medium between *Podophyllum* and *Sanguinaria*. Its calix is ſometimes three-leaved, which is the uniform number of the leaves of the calix of the *Podophyllum*. Theſe leaves, in both plants, are coloured, and concave. The root of both has the ſame ſmell, and taſte. To the *Sanguinaria*, our plant is related in the following characters. The calix, in both, is ſhorter than the corolla, and falls off before the expanſion of the flower: the petals are eight in number: the filaments are ſhorter than the corolla: the ſtigma is perſiſtent. But the relation of the *Jefferſonia* to the two genera, juſt mentioned, is, perhaps, ſtill greater than it appears to be, from the mere circumſtances which I have taken notice of. The *facies plantarum*, as Linnæus has

very

very well expreſſed the idea, the *phyſiognomy of plants*, as I call it, is a matter which it is not neceſſary a man ſhould be a very minute botaniſt to obſerve. Almoſt any perſon who ſhould ſee the *Jefferſonia*, the *Sanguinaria*, and the *Podophyllum*, growing together, either before, during, or after, the time of flowering, would immediately diſcover their family-relationſhip:

——————*facies non omnibus una*
Nec diverſa tamen, qualis decet eſſe ſororum.

I ſhall conclude this long letter with expreſſing a hope, that it will not prove altogether unentertaining to you; for I cannot but ſuppoſe, that every attempt (mine, I know, is an humble one) to encreaſe the maſs of that amiable ſcience which we both cultivate, will be acceptable to the ſucceſſor of LINNÆUS.

I have the honour to ſubſcribe

myſelf, Dear Sir, Your obliged

friend, &c.

BENJAMIN SMITH BARTON.

Philadelphia, April 29th, 1792.

EXPLANATION of the PLATE.

N°. 1. The plant, of its natural ſize, during the time of flowering.

N°. 2. 3. 4 and 5. Different views of the ſeed-veſſel. N°. 2 and 3 repreſent the horizontal lip, or ſuture, which afterwards opens, diſcovering the ſeeds, lying looſe, as in N°. 5. N°. 4. exhibits the ridge on the poſterior part of the ſeed-veſſel.

N°. 6. A leaf, of the common ſize, after the flower has fallen, and the ſeed-veſſel is ripe. Some of the principal nerves of the leaf are repreſented.

N°. 7. The germen, or ſeed-bud, with the ſtyle, and ſtigma, of the ſize they appear a few days after the falling off of the flower.

N°. 8. One of the leaves of the flower cup.

N°. 9. A ſeed, of its natural ſize, when ripe.

N°. 10. A filament and anthera, of the natural ſize.

N°. 11 and 12. The antheræ, at the time of their ſhedding the pollen, or fecundating duſt, burſting laterally.

N°. XLII.

Obſervations on the conſtruction of Hoſpitals, by Mr. Le Roy. *Member of the Royal Academy of Sciences—(Extracted from an Eſſay on the ſubject, which, with ſeveral elegant plans, was tranſmitted by the author to the Society, but could not be inſerted entire, as it contained many remarks of a local nature, reſpecting Paris—only.*

THE conſtruction of Hoſpitals is in general objectionable, either becauſe many of the wards do not admit of perfect ventilation, or becauſe the air paſſes from one patient over another, by which means contagious diſeaſes are often ſpread.

To avoid theſe inconveniences, a large Hoſpital ſhould conſiſt of diſtinct and ſeperate buildings, each forming one ward, erected upon arches or columns, at a conſiderable height

height from the ground, and ranged at a diſtance from each other, like the tents of an encampment.

The cieling or roof of each ward ſhould be formed into a number of ſpherical arches according to its ſize, the crown of each arch being in the middle of the breadth of the ward, and opening into a funnel like a common chimney, which ſhould be ſupplied with a vane, (reſembling that we call a cow) ſo that it may always open to leeward.

In each floor, midway as to breadth, ſhould be a row of holes at ſuitable diſtances from each other, to admit air from below, ſo conſtructed that the quantity of it may be regulated at pleaſure.

In conſequence of this ſtructure there muſt be a conſtant change of air, for that which is in the lower part of the ward, being warmed by the patients and nurſes, and the neceſſary fires, will aſcend, and in conſequence of the ſpherical conſtruction of the roof, will be directed to the openings in it, and flow through them, while the holes in the floor will afford a conſtant ſupply of freſh air, which will move rapidly as it enters the room ſo low.

A number of arches with openings is preferable to a ſingle arch in the center, becauſe the air in paſſing from the extremities of the room to the center flows, from one patient over another—and a plane or flat cieling, even with apertures, is improper, becauſe the upper air at a diſtance from the apertures cannot move to them.

The rooms may be warmed by placing grates or ſtoves over theſe holes in the floor, and no bad effect can be produced by the fire as the air and vapours will aſcend from it and go off by the holes in the cieling—If it be neceſſary to quicken the circulation of air, either on account of the ſluggiſhneſs of the atmoſphere, or of the contagious nature of any diſeaſes in the ward, ſmall fires may be fixed

in

in grates or ſtoves near the openings in the cieling, to increaſe the motion of the air.

To prevent the ſpreading of contagion, as well as to keep the ſick from beholding the ſufferings of each other, a ſcreen of ſuitable height ſhould be placed between each bed.

For contagious diſorders and ſurgical caſes, there ſhould be a number of wards, at a diſtance from the Hoſpital, and to leeward of it with reſpect to the prevailing winds.

PRESENTS

PRESENTS

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WITH THE

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June.	Specimens of Sal mirabile Glauberi, and Sal Ammoniac, prepared at an Elaboratory, in Philadelphia.	Meſſrs. Chriſtopher Jun. and Charles Marſhall, proprietors of the Elaboratory.
Nov.	Sundry publications by a Society at Cape Francois, called *Cercle des Philadelphes.*	Cercle des Philadelphes.
	Model of a machine for clearing wells, &c. of pernicious damps or fixed air.	Mr. Ebenezer Robertſon of Philadelphia, the inventor.
	Model of a bridge on an improved conſtruction.	Mr. John Jones, of Delaware State, the inventor.
Dec.	An extraordinary large tooth, of ſome unknown ſpecies of animal, (which appears to have been of the gramniverous kind) found at Tioga, on the banks of the Suſquehannah.	David Rittenhouſe, Eſq.
1787		
Jan.	An elegant copy of the *Medical Commentaries*; in 10 Vols. publiſhed by Andrew Duncan, D. D. of Edinburgh.	The Editor.
Feb.	Ten guineas towards compleating the Society's Hall.	Benjamin Vaughan Eſq. of London.

March.

1787.	Presents.	Donors.
March.	Two hundred guineas, for the purpose of eſtabliſhing an annual premium.	M. John Hyacinth de Magellan, of London.
April.	Specimens of *White glaſs*, made at a glaſs-houſe lately erected near Albany.	Mr. Daneufville, the proprietor of the glaſs-houſe.
May.	A Defence of the Conſtitutions of government of the United States of America, by John Adams, L.L.D.	The author.
	An enquiry into the original ſtate and Formation of the Earth, 2d edition—by Mr. John Whitehurſt.	The author.
	Tracts mathematical and philoſophical—by Mr. Charles Hutton.	The author.
	Catalogue of 1000 Nebulæ or cluſters of ſtars—by Mr. Herſchel.	Dr. Franklin.
Aug.	Fifty pounds ſter. towards completing the Society's Hall.	Hon. Henry Laurens, of South-Carolina.
	Ten guineas towards completing the Society's Hall.	Mr. Wm. Vaughan, of London.
Oct.	A treatiſe on ſome part of the theory of the planets. by Dr. Minto of Long-Iſland.	The author.
	A portrait print of Lord Napier, the famous inventor of Logarithms.	The Earl of Buchan.
	Experiences ſur les Vegetaux, par John Ingen-hauſz, M. D.	The author.
	Lettre de M. Benjamin Franklin, á M. David Le Roy of Paris.	M. David Le Roy.
	Lettre á M. Franklin ſur les navire des ancientes, &c. par M. Le Roy	The author.
	The Anatomy of the abſorbing veſſels of the human body; by William Cruckſhank. 4°.	Benjamin, Smith Barton, M. D.
	A number of Indian ſpear-ſtones lately found depoſited in the mud, near the river Wye, in Maryland.	Beale Boardley, Eſq.

Principles

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	Abhandlungen der Bœhmiſchen Geſellſchaft der Wiſſenchaften, auf das jahr 1785.	Dr. Franklin.
	Monatliche Beytræge, der bildung 3 copies.	Dr. Flanklin.
	Memoirs de l' Academie royale des Sciences de Turin, annees 1784—1785—2 vols. 4°	Dr. Franklin.
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	An attempt towards obtaining, invariable meaſures of length, capacity, and weight, by John Whithurſt of London.	The author.
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	Loix et conſtitutions des Colonies Francoiſes de l'Amerique, ſous le vent. 5 Vols. 4° par M. Moreau de M. Mery, Counſeiller au Counſeil ſuperieur du Cap Francois.	The Author.
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1788 *Jan.*	A drawing and deſcription of a marine Chevaux de Frize; by Mr. Robert Erſkine, F. R. S.	Ditto.
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	Experiences ſur la digeſtion de l'Homme, et de differentes eſpeces d' animaux; par M. L' Abbé Spallanzane.	Ditto.
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	Informe ſobre el Lugar de las ſepulturas. 8°	Academy of Hiſt. at Madrid.
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	Atti della Societa Patriotica di Milano, Vol. 1ſt. 4o.	Ditto.
	Diſſertazione ſulla Portatura de Gelſi. By Don Gerolamo Bruni.	Ditto.

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Aug.	Raccolta d'Opuſcali ſulla ſcienze é ſulla arti, 1 Vol. 40.	Patriotic Soçiety at Milan.
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Sept.	Fragmens de Politique et de Literature; par M. Mandrillon of Amſterdam.	The author.
	Richerches, memoires, et obſervations ſur les maladies epezootiques de St. Dominique; recueilles et publies par le Cercle des Philadelphes du Cap.	Cercle des Philadelphes.
	Dictionarie Eſpanol, Latino-Aribigo, 1ſt. Vol. folio—By M. Campomanes.	The author.
	Experiments and obſervations relating to various branches of Nat. Philoſ. Vol. 3d. by Dr. Prieſtly.	The author.
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	Eſſays; by Dr. Percival—1ſt. Vol.	The author.
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	Conſiderations on the relative ſituations of France and the United States; by J. P. Briſſot de Warville.	The author.
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	Histoire du Commerce, et de la Navigation des peuples anciens et modernes, 2 Vols.	Ditto.
		Ditto.
	Lockes Essay on Education; translated into the Russian language.	Ditto.
	The military ordinances of the king of Spain—in the Spanish language 4 Vols.	Ditto.
	Vida de Dom Joao de Castro, fourth Viceroy of the Indies—in the Portuguese language.	Ditto.
	Select extracts from Youngs Night-Thoughts—in the Portugues language.	Ditto.
	The proceedings on the restoration of the French parliaments in 1774; being a collection of original state papers.——in French.	Ditto.
	A collection of pamphlets on the late commotions in the Netherlands—in Low Dutch.	Ditto.
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April.	Model of a silk-reel,	Mr. Edward Pole of Philadelphia.
	Cases and observations by the Medical Society of New-Haven, in Connecticut.	The Medical Society, &c.
May.	A printed book the leaves of which are made of the roots and bark of different tress and plants, being	St. John Crevacoeur the inventor.

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	the first essay of this kind of manufacture.	
	A specimen of petrolium, found in considerable quantity on a branch of the Allegeney, called Oil Creek.	Mr. William Trumbull.
Oct.	First Vol. of the Transactions of the Royal Irish Academy.	Royal Irish Academy.
	Specimens of coal, white vitriol, slate, brick burnt slate, allum, nitre, freestone, and Indian pottery, lately found in a bank near Washington, in Pennsylvania.	David Reddick, Esq.
	An Essay on the powers and mechanisms of nature; by R. Young.	Mr. Samuel Mather of London.
	Specimens of the papyrus of Syracuse.	Dr. Franklin.
	Method of recovering persons apparently dead—in French; by Baronde Hupsch, of Cologne.	The author.
Dec.	An almanac of the island of St. Domingo, exhibiting a compleat view of the present state of the French Colony in that Island.	M. Samuel Vaughan jun.
	A specimen of West-India Cinchona.	Ditto.
	A specimen of Cinnamon, the growth of Jamaica.	Ditto.
	The shell and seeds of a species of the bread-fruit, lately obtained from the Isle of France, and known in the West-Indies by the name of *pain de singe*, or *Jack-bread fruit*.	Ditto.
1790 *Feb.*	Memoirs of the royal Academy of Sciences at Turin. for 1786 and 1787.	Royal Academy of Sciences Turin.
	Nouvelles experiences et observations sur divers objects de physique, by Dr. John Ingen-housz.	The Author.

Medical,

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	Directions for taking care of the cochineal insect while at sea; by ditto.	The Author.
	Letter to Sir Joseph Banks, on the subject of the cochincal insect, discovered at Madrass; by ditto.	The author.
June.	A volume of 200 elegant copper-plate engravings entitled Emblematica Rollenhagii, done at Ulrecht in the year 1613.	Mr. William Spotswood of Philadelphia.
	The Constitution of the Pennsylvania Society for promoting the abolition of slavery, &c.	William Barton, Esq.
	An address to an assembly of the friends of American manufactures, delivered Aug. 9th, 1787; by Tench Coxe, Esq.	Ditto.
July.	Ninety one volumes of the history of the Royal Academy of Sciences at Paris.	Left in legacy by Dr. Franklin, late President of the Society.
Sept.	A variation chart and magnetic atlas, by John Churchman.	The author.
October.	Model of a ramming block, for driving piles, on an improved construction, by Mr. Ludwig Conrod Kuhn.	The inventor.
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1791.		
Feb.	The Anatomical Inſtructor; by Mr. Thomas Pole Surgeon, of London.	The author.
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May.	A deſcriptive catalogue of ingraved gems, about 1500 in number.	Francis Hopkinſon, Eſq.
June.	Ninth volume of the Tranſactions of the Batavian Society of experimental Philoſophy, at Rotterdam.	Batavian Society Exper. Philos. at Rotterdam.
Auguſt.	Memoirs de l'Academie royale des Sciences de Turin, Vol. 4th.	M. De La Lande.
	A curious piece of Indian ſculpture, ſuppoſed to repreſent an Indian woman in labour, found near Cumberland river, Virginia.	Mr. Thomas Jefferſon.
	Principles ſur les meaſures en longeur et en capacité; par M. Bonne, of Paris.	The author.
Sept.	Syſteme des Lecons phyſiques par L' Abbe Nollet. 2 Vols. 8o.	Mr. John Vaughan.
	Muſſchenbrook's Philoſophy, 2 Vols. 4o.	Ditto.
	Tranſactions of the Society for promoting Arts and Manufactures, at London: for 1785.	Ditto.

Memoirs

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October.	An Eulogy on the Hon. James Bowdoin L. L. D. late Preſident of the American Academy of Arts and Sciences at Boſton, delivered before the Society, by John Lowell, one of the Counſellors of the Acad.	The American Academy of Arts and Sciences.
	Annimals of agriculture, &c. collected and publiſhed by Arthur Young, Eſq. from No. 72 to 77 incluſive.	Rodolph Valltravers, F R. S.
Nov.	Fundamenta Chymiæ; by George Erneſt Stahl, M. D.	Mr. Samuel Mitchell of Long-Iſland
	Maroſticenſis Philoſophi et medici in gimnaſio Patavino medicamentorum ſimplicium, &c.	Ditto
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Dec.	Hiſtoire et Memoires de la Societé royale.	Evan Edwards, Eſq.
	An Enquiry concerning Chettenham Water; by A. Fothergill, M D.	Judge Turner.
	An addreſs to the King and Parliment	Ditto.

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1792.		
June.	A great variety of specimens or samples of *French dies*, said to resist sea-water and all kinds of acids.	Peter Stephen Du Ponceau, Esq.
	A complete treatise on the mineral waters of Virginia; by John Rouell, M. D.	The author.
Feb.	The American Edition of the Encyclopædia, to be delivered in volumes to the Society, as published.	Mr. Thomas Dobson, of Philadelphia, the publisher.
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	Roman's account of East and West Florida.	Ditto.
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May.	An extraordinary case of extra uterine gestation; by William Turnbull of London.	Mr. Thomas Pole, Surgeon of London.
June.	History of New-Hampshire; by the Revd. Jeremy Belknap, Vol. 3d.	The Author.
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Wm. Temple Franklin, Eſq.	5	0	0
Dr. John Foulke.	5	0	0
Dr. Samuel P. Griffitts,	5	0	0
Iſaac Gray, Eſq.	5	0	0
Dr. George Glentworth,	5	0	0
Thomas Hutchins, Eſq. 10 maps of Pennſylvania.			
Wm. Hamilton, Eſq.	25	0	0
Daniel Heiſter, Jun. Eſq.	5	0	0
Henry Hill, Eſq.	13	15	0
Jacob Hiltzeimer, Eſq.	5	0	0
Mr. Levi Hollingſworth,	5	0	0
Rev. Dr. Henry Helmuth,	5	0	0
Jonathan Hoge, Eſq.	5	0	0
Francis Hopkinſon, Eſq.	5	0	0
Mr. Joſeph Hilburn,	5	0	0

Mr.

	£	s.	d.
Mr. Reuben Haines,	5	0	0
Ebenezer Hazard, Esq.	5	0	0
Mr. Joshua Howell,	5	0	0
Dr. James Hutchinson,	5	0	0
Mr. Pattison Hartshorn,	5	0	0
Jared Ingersoll, Esq.	8	0	0
Dr. John Jones,	5	0	0
Wm. Jackson, Esq.	5	0	0
Francis Johnson, Esq.	5	0	0
Mr. Wm. Johnson,	5	0	0
Mr. Joseph James,	3	0	0
Dr. Adam Kuhn,	5	0	0
John Lukins, Esq.	10	0	0
Mr. Thomas Lea.	5	0	0
Mr. John Lardner.	5	0	0
M. Peter Le Geaux.	5	16	8
Rev. Dr. Samuel Magaw.	10	0	0
John F. Mifflin, Esq.	5	0	0
Samuel Miles, Esq.	5	0	0
Robert Milligan, Esq.	5	0	0
Thomas M'Kean, Esq.	5	0	0
Thomas Mifflin, Esq.	5	0	0
Robert Morris, Esq.	23	5	0
Mr. Christopher Marshall.	10	0	0
Mr. Christopher Marshall, Jun.	5	0	0
Mr. Charles Marshall.	5	0	0
Joseph B. M'Kean, Esq.	5	0	0
Mr. Charles Moore.	5	0	0
Dr. John Morris.	7	10	0
Samuel Meredith, Esq.	5	0	0
Mr. Jonathan Mifflin.	5	0	0
John Nicholson, Esq.	17	7	10
Mr. Joseph Ogilby.	5	6	0
Mr. Robert Patterson.	5	0	0
John Penn, Jun. Esq.	25	0	0
Mr. Samuel Pleasants.	5	0	0
Charles Pettit, Esq.	5	0	0
Mr. James Pemberton.	5	0	0
Mr. Edward Pennington.	5	0	0
Samuel Powel, Esq.	5	0	0
Dr. Thomas Parke.	5	0	0
Mr. Joseph Pascall.	5	0	0
Mr. Charles W. Peale.	5	0	0
Mr. James Pearson.	5	0	0
Mr. William Payne.	5	0	0
David Rittenhouse, Esq.	10	0	0
John Ross, Esq.	5	0	0
Dr. John Redman.	5	0	0
William Rawle, Esq.	5	0	0
David Reddick, Esq.	5	0	0
Dr. Benjamin Rush.	5	0	0
Mr. William Roberts.	5	0	0
Jacob Rush, Esq.	5	0	0
Dr. Thomas Ruston.	5	0	0
Jonathan B. Smith, Esq.	8	0	0
Edward Shippen, Esq.	5	0	0
Jonathan D. Sergeant, Esq.	5	0	0
John Swanwick, Esq.	5	0	0
Dr. William Shippen.	5	0	0
Mr. John Sellers.	3	0	0
Mr. John Stille.	5	0	0
Messrs. Symington and Brown.	5	0	0
Mr. Thomas Siddon.	3	0	0
Mr. William Sykes.	5	0	0
Lawrence Seckel, Esq.	5	0	0
Mr. Robert Smith.	5	0	0
Mr. Eden Shotwell.	3	0	0
Charles Thompson, Esq.	15	0	0
Edward Tilghman, Esq.	5	0	0
Dr. William Thornton,	20	0	0
Mr. John Thompson.	5	0	0
Mr. John Vaughan.	26	2	10
Samuel Vaughan, Esq.	50	0	0
Mr. Benjamin Vaughan, London.	35	10	0
Mr. William Vaughan, London.	17	10	0
Mr. Charles Vaughan.	5	0	0
Mr. Samuel Vaughan, Jun.	5	0	0
Mr. Benjamin Wynkoop.	5	0	0
James Wilson, Esq.	5	0	0
Alexander Wilcocks, Esq.	5	0	0
Mr. John Wood.	5	0	0
Mr. Robert Waln.	5	0	0
Dr. Caspar Wistar.	10	0	0
Rev. Dr. William White.	10	0	0
Mr. Benjamin Workman.	3	0	0
Mr. Jonathan Williams.	18	15	0
Mr. Samuel Wilcox.	5	0	0

☞ At a meeting of the Society held on the 21st of December 1791.

On motion resolved—that the Society entertain a very high sense of the services rendered them by SAMUEL VAUGHAN, Esq. (in planning and superintending the building of their Hall) and that the *thanks* of this body be presented to that Gentleman for his disinterested and successful attention to their interests. And his Excellency the President (Dr. Franklin) did accordingly present the Society's thanks to Mr. Vaughan.

Extract from the minutes

R. PATTERSON, SECRETARY.

ADVERTISEMENT,

ADVERTISEMENT.

M. JOHN Hyacinth De Magellan, in London, having fometime ago offered, as a donation, to the American Philofophical Society, held at Philadelphia for promoting ufeful knowledge, the fum of two hundred guineas, to be by them vefted in a fecure and permanent fund, to the end that the intereft arifing therefrom fhould be annually difpofed of in premiums, to be adjudged by the fociety, to the author of the beft difcovery, or moft ufeful invention, relating to navigation, aftronomy, or natural philofophy (mere natural hiftory only excepted) and the fociety having accepted of the above donation, hereby publifh the conditions, prefcibed by the donor, and agreed to by the fociety, upon which the faid annual premiums will be awarded.

1. The candidate fhall fend his difcovery, invention or improvement, addreffed to the Prefident, or one of the Vice Prefidents of the fociety, free of poftage or other charges; and fhall diftinguifh his performance by fome motto, device or other fignature, at his pleafure. Together with his difcovery, invention or improvement, he fhall alfo fend a fealed letter, containing the fame motto, device or fignature, and fubfcribed with the real name, and place of refidence of the author.

2. Perfons of any nation, fect or denomination whatever, fhall be admitted as candidates for this premium.

3. No difcovery, invention or improvement fhall be entitled to this premium which hath been already publifhed, or for which the author hath been publicly rewarded elfe where.

4. The candidate fhall communicate his difcovery, invention or improvement, either in the Englifh, French, German or Latin language.

5. All fuch communications fhall be publicly read, or exhibited to the fociety, at fome ftated meeting, not lefs than one month previous to the day of adjudication, and fhall at all times be open to the infpection of fuch members as fhall defire it. But no member fhall carry home with him the communication, defcription or model, except the officer to whom it fhall be intrufted; nor fhall fuch officer part with the fame out of his cuftody, without a fpecial order of the fociety for that purpofe.

6. The

6. The ſociety having previouſly referred the ſeveral communications, from candidates for the premium then depending, to the conſideration of the twelve counſellors and other officers of the ſociety, and having received their report thereon, ſhall, at one of their ſtated meetings, in the month of December, annually, after the expiration of this current year (of the time and place, together with the particular occaſion of which meeting, due notice ſhall be previouſly given, by public advertiſement) proceed to the final adjudication of the ſaid premium: and after due conſideration had, a vote ſhall firſt be taken on this queſtion, viz. Whether any of the communications then under inſpection be worthy of the propoſed premium? If this queſtion be determined in the negative, the whole buſineſs ſhall be deferred till another year: but if in the affirmative, the ſociety ſhall proceed to determine by ballot, given by the members at large, the diſcovery, invention or improvement, moſt uſeful and worthy; and that diſcovery, invention or improvement, which ſhall be found to have a majority of concurring votes in its favour ſhall be ſucceſsful; and then, and not till then, the ſealed letter, accompanying the crowned performance, ſhall be opened, and the name of the author announced as the perſon entitled to the ſaid premium.

7. No member of the ſociety who is a candidate for the premium then depending or who hath not previouſly declared to the ſociety, either by word or writing, that he has conſidered and weighed, according to the beſt of his judgment, the comparative merits of the ſeveral claims then under conſideration, ſhall ſit in judgment or give his vote in awarding the ſaid premium.

8. A full account of the crowned ſubject ſhall be publiſhed by the ſociety as ſoon as may be, after the adjudication, either in a ſeparate publication, or in the next ſucceeding volume of their tranſactions, or in both.

9. The unſucceſsful performances ſhall remain under conſideration, and their authors be conſidered as candidates for the premium, for five years, next ſucceeding the time of their preſentment, except ſuch performances as their authors may, in the mean time, think fit to withdraw. And the ſociety ſhall, annually, publiſh an abſtract of the titles, object or ſubject matter of the communications ſo under conſideration; ſuch only excepted as the ſociety ſhall think not worthy of public notice.

10. The letters containing the names of authors whoſe performances

ſhall

ſhall be rejected, or which ſhall be found unſucceſsful, after a tryal of five years, ſhall be burnt before the ſociety, without breaking the ſeals.

11. In caſe there ſhould be a failure, in any year, of any communication worthy of the propoſed premium, there will then be two premiums to be awarded in the next year. But no accumulation of premiums ſhall entitle an author to more than one premium for any one diſcovery, invention or improvement.

12. The premium ſhall conſiſt of an oval plate of ſolid ſtandard gold, of the value of ten guineas, on one ſide thereof ſhall be neatly engraved a ſhort Latin motto, ſuited to the occaſion, together with the words——The premium of John Hyacinth De Magellan, of London, eſtabliſhed in the year 1786. And on the other ſide of the plate ſhall be engraved theſe words. Awarded by the A. P. S. ——— for the diſcovery of———A. D.

And the ſeal of the ſociety ſhall be annexed to the medal by a ribbon paſſing through a ſmall hole at the upper end of the plate.

The following communications from candidates for the Magellanic annual premium, remain under conſideration.

1. An eſſay on warming rooms. *Motto, Cuique eveniat ſemper prout meruit.* Read May 20, 1791.

The author propoſes, as an addition to the Franklinian fire-place, or open ſtove, that the freſh air neceſſary to feed the fire, be admitted from without, through tin pipes, placed under the floor, and riſing up through the hearth at one ſide of the ſtove, where they communicate with iron pipes paſſing thro' the fire as a grate. Theſe iron pipes again communicate with tin ones, extending up behind the wainſcot, nearly to the ceiling, where the air, now heated by paſſing through the fire, is ſuffered to eſcape into the room. By this contrivance, the inconvenience ariſing from the ruſhing in of cold air from without, through every crevice and aperture where it can find a paſſage, will, it is alledged, be effectually prevented, and the room keep warm with much leſs expence of fuel than in the common way.

2. An attempt to prove that the generally received opinion, that ſteel ſprings acquire an increaſe of ſtrength or power by cold weather, and loſe power by warm weather, is erroneous—Signature *Scrupulous*—Read November 4, 1791.

The

The writer endeavours to eſtabliſh this poſition, both from theory and experiment.— Heat expands and cold contracts a ſpring, or any other piece of metal proportionally, in all its dimenſions; and therefore, while cold makes a ſpring ſhorter, and on that account would increaſe its power, it alſo makes it both narrower and thinner, and on this account would diminiſh its power, in the ſame proportion; accordingly, by experiment, he found that a ſpring of twelve inches long, made faſt at one end, and having a weight ſuſpended from the other, did not ſuffer the weight viſibly to deſcend, upon being heated even to ſuch a degree as to evaporate a drop of water applied to it. If the above poſition be true, the *thermometer-curb*, applied to Harriſon's and other time-pieces, inſtead of being an advantage, muſt be directly the contrary.

3. A deſcription, accompanying a model of a machine, which the author calls an *Elevator*—Motto, *Nititur in ardua Virtus*—Read December 2, 1791.

The machine is a compound of perpendicular ſhafts, ſo connected by grooves, ropes and pullies, that each moves its inmate, and thus all riſe together.

" This machine," the author obſerves, " may be applied to many important uſes—A perſon of common weight may aſcend an hundred feet upon a frame of light conſtruction to gain a rocky precipice, to enjoy a fine proſpect, to reconnoitre the encampment of an enemy, and to diſcover land at ſea.—Diſpatch in loading and unloading, or any quick alternate motion, is well performed by the multiple motion of this elevator."

4. A deſcription with a model of a mechanical apparatus for regulating and governing the ſails of a veſſel at ſea—Signature I. S. S.—— Read November 2, 1792.

The author propoſes, that each ſail be placed within a large frame turning round on pivots at the top and bottom. At the extremity of the upper pivot or gudgeon is fixed a cog or ſpur wheel, which is turned by another wheel having half the number of teeth, and this ſupports a large vane, about one fifth of the ſize of the ſail, which is turned round with the wind. By this means the angular motion of the ſail will be but half that of the vane. Hence if the wind when directly a-ſtern, be at right angles with the plane of the ſail, a ſide wind would ſtrike the plane of the ſail at an angle of forty-five degrees, and a wind four points before the beam, would ſtrike the ſail at an angle of two points and an half; and thus, it is preſumed, that the mere action of the wind upon the

 vane,

vane, would always turn the ſails into their proper poſition, without any manual operation whatever. He alſo propoſes a method of furling the ſails by means of rollers, to be worked with cranks.

5. An improvement in the art of guaging. Signature W.—Read November 16, 1792.

The author points out various ſources of error in the preſent practice of guaging, particularly taking the dimenſions outſide of the caſk. He gives a drawing and deſcription of an inſtrument for taking the neceſſary dimenſions, viz. The length, head-diameter, bung-diameter, and a middle diameter between the head and bung, all inſide of the caſk; and by means of a table which he has ſubjoined, ſhews how to compute the contents of any caſk from theſe dimenſions, with the greateſt eaſe and accuracy.

Beſides the above communications, an eſſay on the cauſes of the tides has been received, but not being within the limited time, was not brought under conſideration at the laſt adjudication.

Several other pieces have been before the Society, but as their time of probation (five years) will expire before the next adjudication, in December 1793, they are of courſe deciſively unſucceſsful, and need not be noticed.

Publiſhed by order of the Society,

JAMES HUTCHINSON,
SAMUEL MAGAW, } Secretaries.
J. WILLIAMS, Jun.

END OF THE THIRD VOLUME.