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# I N T R O D U C T I O N

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 discriminati-

on 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 intellects, 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 furious *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 spongy; 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 compels 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 diffeminated 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.

may, 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

cover

\* 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 indispensable for breaking the force of a stormy tide. We want grasses that will flourish in dry and sandy soils: such f. e. 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 increase 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 increase most? what is the proper distance between them? what is the best mode of pruning, for  
 b promoting

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 sponginess of our timber, which defect so inimical to durability, strength, and preservation of a given form, is further increased by a too common ignorance or neglect of the proper season for felling 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 chestnut-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 resemble 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 four-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

§ Cræ's gally.

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



for five a seven months. Finally we may sincerely wish that the owners of venerable woodlands might regard them as principal ornaments of their country; and while they clear a part for the purposes of agriculture, leave these hills crowned with towering pines, and stately oaks; suffering likewise the groves of tulip-trees and magnólas to wave among yellow harvests and blooming meadows. In some of the old countries many gentlemen would purchase such rural charms at any expense, but must wait till the evening of life for the shade of their plantations; is it not then deplorable, that so many American farmers daily destroy what their offspring of better taste will deeply regret! this evil might in a great measure be lessened by a *treatise on ornamental planting* adapted to the present circumstances of this country.

Half a century ago, philosophers thought it beneath them to investigate the oeconomy of domestic animals. By this ridiculous pride European countries have suffered much. The Swedish naturalists were roused near thirty years ago, to a serious attention, by a pestilence among horses and horned cattle, which destroyed many thousands in some provinces. In America, this important science has been much neglected. Not to enlarge upon a subject which especially concerns agricultural societies, I shall only mention two or three particulars—This country is not unfavourable to horses; yet those of good quality are not very common, because the natural history of these noble animals is but little cultivated. They are often disabled by want of proper care; and perish by various disorders; especially by swelling in the throat, cholick, and the botts.\* Sheep thrive well in some parts, but in others I have seen them die by dozens, without the owners knowing or inquiring into the cause.

Horned cattle suffer much when exposed to the winter's cold, which destroys their hoofs even under the 39 degree. Both they and horses are affected by excess of heat in summer: which not seldom causes a fever, discernible by their want of appetite, dullness, and a yellow tinge of the mouth and eyes. The best European treatises on domestic animals will more or less apply to diverse parts of this country: a book written on sheep, in Swedish, by Hastfer, has great merit, and is applicable to the colder states.

Goats would be very valuable in the rocky woodlands of America, as they are in those of Europe. They are very hardy: their maintenance is cheap, as they browse summer and winter on most kinds of trees and

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shrubs;

\* 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 Ahlströmer.

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 promiscuous 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 gangrene 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 cultivated,

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

vated, with their variation from local causes; collect all the various names of the same fruit, and fix one as national, to prevent a confusion that often frustrates information both foreign and domestic.

Fish-ponds are useful decorations in places distant from lakes and rivers. I have often wondered why this advantage is not derived from ponds and streams which are so common: a useless and unwholesome swamp may thus be changed into an elegant improvement. A German author has wrote a valuable treatise on the fish-ponds of Bohemia. The subject has also been well treated by several æconomical writers of Sweden: in which country fish-ponds of all kinds are very common.

*ARTICLE. Physico Mathematica enquiries.*

Machines for abridging human labour are especially desired in America, as there can be no competition between them and the arms of industrious labour, while these have full employ on her extensive lands; which must be the case for ages. Agriculture has the first claim to the exertions of mechanical genius, as the principal source of national prosperity. Extent of territory, improved by artificial industry, must yield a great quantity of products at so cheap a rate, as to bear exportation to very distant markets. It is moreover a weighty consideration to the humane philosopher, that agricultural mechanism would in the Southern states supply the labour of slaves. Among important desiderata we may place these—A machine for sowing broad-cast, so as to spread the grain even and in proper quantity: another for cutting drains, and making banks on our extensive marsh-meadows: an apparatus for clearing new lands; which ought to be a compound of coulters, saws, axes, and screws; so that the trees may be pulled out of the ground, cut in convenient pieces, and heaped: a better instrument for reaping than the common sickle, such f. e. as the cradling scythe of Northern Europe: temporary sheds of easy and light construction for the preservation of the reaped grain in wet seasons.

The many shipwrecks that happen on the extensive, and often stormy coast of this country render diving bells very necessary; these machines are yet but little known.

A plenty of naval stores, and numerous ports render ship-building an important branch of national industry. This noble art, which has long been cultivated with success, would still be much improved by more expeditious modes of hauling timber, and of preparing the main pieces for the finishing workmanship.

An

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 increasing 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 increase 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 treatise on this subject, would be very valuable.

To form with speed and conveniency a tolerably accurate map of the United States, astronomical observations ought to determine the latitude and longitude of those places, which are most essential to the figure of the whole country, or to the situation of certain parts in a political, and economical view.

Exact surveys of private estates are indispenfible for the security of landed property: from a defect of such many law-suits have originated and will ensue for years. I omit what is the province of government in this matter; and only suggest a wish, that a small treatise on the survey of woodlands might be composed; as the best English guides, being calculated for an open country, do not particularly attend to this branch.

#### 4. *ARTICLE, Inquiries in Natural History.*

Natural history, like a faithful guide, leads us through the mysterious mazes of nature, and opens to our enraptured eye her sublime and beautiful wonders. How many precious plants are as despicable weeds trod under foot in every part of the world! How many new qualities are from time to time discovered in productions, which have been known for centuries in countries long ago perlufrated with this sacred lamp! what treasures may we not then expect in this new and vast division of the globe! in the forests of a thousand miles hitherto traversed only by savage tribes, and mercenary traders; in our lakes, some of which are inland-seas; and rivers that wander through several states before they meet the ocean! \* neglect of natural history under circumstances so alluring would indicate a want of rational taste. I often heard the great *Linnaeus* wish that he could have explored the continent of North America; may this wish animate American philofophers.

The vegetable realm claims our first attention. Let us begin with a research of the stores it offers for the preservation and recovery of health. The frequent appearance of trees, shrubs, and plants, whose taste and scent, or analogy with well known pharmaceutics, is very promising, would lead us to expect a very considerable stock of native *Materia-Medica*. But, although above an hundred of these species are, or have been, more or less in use among the inhabitants, † very few of them are

\* The United States extend from the Atlantic to Mississippi, 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 personal observation.

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, chilblains, 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

\* See *materia medica Americana potissimum regni vegetabilis*, by David Schoepf, printed in Geromey 1797. 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.

erity 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*, *Afarum*, 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; *Perisperm*; *Lonicera symphoricarpos*; by their barks: *Pyrola maculata*, with the Indian name *pipissewa*: *Sambucus canadensis*: *Laurus astivalis*, 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 *Perisperm* 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 *pipissewa*. § 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 astivalis*, 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,

c

that

\* Confer this book with Dr. Schoepf'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 Marshall*.

§ See ditto: a species of winter green.

¶ *Geschichte der Mission der Evangelischen Brüder unter den Indianern in Nord America*, by *Lesfel*, 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 fallads 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 *bifida, 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. Saraparilla, etc. want no mention: several cannot here find room.



ples, papaws, (*annona*) plumbs, grapes, perfumons, 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 Chestnut 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 dyes 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 chestnut*, and of *Jucca filamentosa*, *silk-grass*, are used for soap: § chestnuts 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 *Taupan*, 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 Perfimon 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 displayed only to those admirers, who have sought them, in fields and woods, from spring to autumn, in northern and southern climes, in the grand *Magniflora* and the humble lily of the valles. Many of the wild flowers would adorn gardens, and embellish groves and meadows: but a great part of these are known only in their native places, and some have not even obtained a vernacular name. Flowery shrubs are gradually coming into more notice; and some of the finest will endure the winter of Pennsylvania: 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 most agreeable by foliage, bloom or lofty growth, have a spontaneous wide range; and others will under a skillful hand pass their natural limits.†

My remarks on the Animal domains shall begin with the small tribes, because some of these do us remarkable mischief. The *Hessian fly* has for several years made great havock in the wheat fields through all the middle-states. † The canker worms, caterpillars, and other vermine lay waste our orchards: some remedies will hopefully result from the enquiries of late begun in several places. Hosts of locusts some years infest the woods, and cause considerable damage by devouring the leaves of trees over large districts, many of which decay when thus exposed to the burning sun: they lie in the ground for a period of years, not yet ascertained; appear in the latter part of the spring, when the oaks are in perfect foliage; and in a few weeks disappear.§

Venomous insects are rare, and obscurely known, as they seem confined to the woods. A species of these, called *mountain spider*, that haunts the inner parts of the southern states, is said to be large; strong enough to take small birds in his net; and by his sting to produce violent pains at the heart, inflammations with alternate cold sweats, tremors, frenzy, and death, if proper cure is not obtained. In the middle states there is a black spider, whose bite causes great pains and a transient blindness, but is not mortal. A large ant with a long sting, common in Maryland and further south, is also very noxious.

Among

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

† *Bignonia Catalpa* flourishes in and beyond Pennsylvania.

‡ Nettling in the joints of the stalk, they bite it off before the grain is ripe.

§ They seem to extend far, as many hundred acres upon the Ohio are said to be spoiled by them; yet is their depredation local and varying, so that different parts have their turn: they were in Pennsylvania eighty years ago, and with the same qualities, as I find by the old Swedish records, which also 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 venomous, 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 Museum. 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 question: 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 *Moose-deer* is yet undescribed, and known to few persons

\* Thunberg describes those of Japan in the same manner, under name of *Lampyrus 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, until 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 *Opeffum* 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.

Changes in the atmosphere have such important consequences on the affairs of human life ; that the art of prognosticating them is very beneficial. It has of late years been cultivated with great assiduity in various parts of Europe ; and the series of observations will gradually form a system, that may at least, unite probable conjectures with much certain knowledge. Several circumstances of the United States point out corresponding inquiries—We are subject to sudden gusts of wind, and some tornados that rapidly pass over a space of one or two hundred miles : from the beginning of Spring till the setting in of Winter, these occasion many unhappy accidents on our extensive coasts, and ample navigable rivers. Their transient strokes are, however, not comparable to those severe storms that generally visit us two or three times in that season : after these the gazettes announce numerous deplorable shipwrecks, and other disasters : coming from the East with heavy rains, they generally cause inundations, which overflow a vast extent of meadow grounds, on the lengthy rivers and winding creeks, and sometimes damage wharves and stores of commercial towns. A foresight of all these would enable us to elude their fury : vessels might stay in port, or seek a shelter : merchandize might be secured : the hay might be removed, and the cattle, which sometimes perishes by the sudden rise of the water. In summer the sudden gusts happen generally towards evening, after a sultry calm for some hours : when attended with thunder and rain, warning is given by the rising clouds : those with a clear sky are less frequent, and preceded only by light eddies in the air for some minutes\*. The tornados are probably announced by some remarkable symptoms, though their happily rare occurrence has prevented attention : the air is (I believe) very sultry for two or three preceding days, and on the last, somewhat hazy with tremulous light breezes from the West. The easterly storms are ushered in by the gradual thickening of the clouds, and encrease of the wind for many hours : †

The irregularity of our seasons, is a great impediment in the business of social life—The fallacious appearance of an early spring often invites the husbandman and gardener to planting and sowing, which will be injured by severe frosts and cold rains. The beginning of winter varies also by several weeks : after the first of December, mild weather is often changed into a cold, that within two or three days fills the rivers of the

d

northern

\* These are generally called whirlwinds from their versatile direction.

† When they continue for two or three days, they are not at their height 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: increasing 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-Flora*: 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* who 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.

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LIST OF THE OFFICERS

OF THE

*AMERICAN PHILOSOPHICAL SOCIETY,*

Held at PHILADELPHIA for promoting Useful Knowledge.

For the Year 1793.

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- Alexander Anderson.

Benjamin

*N. B. All those members whose places of abode are not specified are of Pennsylvania.*

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 William Bingham.  
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 Joshua Humphrys,  
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## I

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 Francis Johnston, Receiver General of the Land-Office, Pennsylvania.  
 Joseph

Joseph James.  
 John Jay, Chief Justice of the United States.  
 Dr. David Jackson.

## K

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## L

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 Benjamin Gloxin, M. D. of Colmar in Alsace.  
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H

- Dr. Thomas Henry, of Manchester in England.  
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XXXIV LIST OF MEMBERS.

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L

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M

Andrew Murray, M. D. Professor of Botany in the Univerfity of Gotten-  
tengen.

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M. Noel, M. D. of Paris.

Sir Edward Newenham, Bart. of Dublin.

O

Lewis William Otto, late Chargé des affaires of France, to the United  
States.

P

Thomas Purcival, M. D. of Manchester in England.

Thomas Pennant of Flintshire.

Peter Simon Pallas, M. D. Professor of Nat. Hift. at Petersburg.

R

The Duke of Richmond, of England.

M. Alphonfus le Roy, of the Academy of Arts and Sciences at Paris.

S

The Abbé de Soulavie of Paris.

George Spence, of Jamaica.

M. Stainsby, of Prague Prof. Nat. Philofophy.

Dr. Andrew Sparrman, Prof. Nat. History and Botany, at Stockholm.

Dugald Stewart, Prof. Moral Philofophy, at Edinburgh.

T

Charles Peter Thunburg, Prof. Nat. History, at Upfal.

Rev. Uno. von Troil, Arch Bishop of Sweden.

V

Samuel Vaughan, Jun. of Jamaica.

M. Le Veillard, of Paris.

Benjamin Vaughan, of London.

George Vaux, Surgeon of London.

Rodolph.

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Rodolph Valtravers, F. R. S.

Louis Valentin, M. D. Cape-Francois.

W

John Whithurst, F. R. S. London.

Thomas White, of Manchester England.

Caleb Whitford, of London.

John Walker, D. D. and M. D. Prof. Nat. History in the Univerfity of  
Edinburgh.

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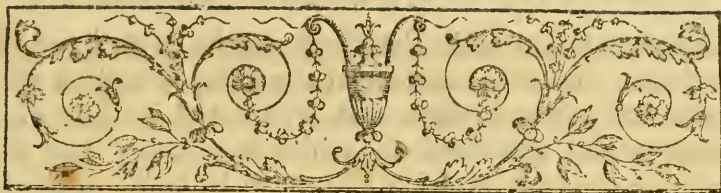
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- Page 86 line 1 for 600° read 60°.  
 88 at bottom for appendix N<sup>o</sup>. iv. read N<sup>o</sup>. v.  
 89 line 1        dele        for.
- Page 194. after the Title of the piece N<sup>o</sup>. 23. read To David Rittenhouse, L. I. D.  
 President 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.

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N<sup>o</sup>. I.

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

Passy, September 22, 1782.

S I R,

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

A

quainted

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 volcanos, 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 philosophizing, which proceeds upon actual observation, makes a collection of facts, and concludes no farther than those facts will warrant. In my present circumstances, that mode of studying the nature of this globe is out of my power, and therefore I have permitted myself to wander a little in the wilds of fancy. With greates esteem I have the honour to be, &c.

P. S. I have heard that chemists can by their art decompose stone and wood, extracting a considerable quantity of water from the one, and air from the other. It seems natural to conclude from this, that water and air were ingredients in their original composition. For men cannot make new matter of any kind. In the same manner may we not suppose, that when we consume combustibles of all kinds, and produce heat or light, we do not create that heat or light; but only decompose a substance which received it originally as a part of its composition? Heat may thus be considered as originally in a fluid state, but, attracted by organized bodies in their growth, becomes a part of the solid. Besides this, I can conceive that in the first assemblage of the particles of which this earth is composed each brought its portion of the loose heat that had been connected with it, and the whole when pressed together produced the internal fire which still subsists.

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N<sup>o</sup>. II.

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

Read June  
20, 1788.

**U**NIVERSAL space, as far as we know of it, seems to be filled with a subtil fluid, whose 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<sup>o</sup>. 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 23, 1788. **I**N 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 flucco 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 pulleys 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

face 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.

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N<sup>o</sup>. IV.

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

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 found 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.

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N<sup>o</sup>. 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.*

S I R

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 deficient, 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 consistence 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.

*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<sup>c</sup>CAUSLIN, M. D. Communicated by BENJAMIN SMITH BARTON, M. D.*

Read Oct.  
16, 1789.

**T**HIS 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. 1<sup>st</sup>.* 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. 2<sup>d</sup>.* When put into vinegar it did not produce the least effervescence. The vinegar having stood upon it some-

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 effervescence 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 ; 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 Fahrenheit'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  
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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.

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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  
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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<sup>o</sup>. 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

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\* “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 economy 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 cheerful leisure 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 plénitude 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

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† “ La population est un des plus sûrs moyens de juger de la prospérité d'un empire; et les variations qu'elle éprouve, comparées aux événemens qui les précèdent, sont la plus juste mesure de l'influence des causes physiques et morales, sur le bonheur ou 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 Acad. Sciences, for 1783.

“ La connoissance des probabilités de la durée de la vie, est une des choses les plus intéressantes dans l'histoire naturelle de l'homme.”—Sec 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 groundwork, 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  $4\frac{1}{2}$  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  $3\frac{9}{100}$  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  $4\frac{3}{100}$  births to a marriage. But M. Buffon supposes, that about one half the foundlings (*les enfans trouvés*) 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  $3\frac{8}{100}$  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  $3\frac{2}{100}$ . According to Dr. Price, the proportions of marriages to births are, at Berlin, 1 to  $3\frac{9}{100}$ —at Copenhagen, 1 to  $3\frac{5}{100}$ —and at Amsterdam, 1 to  $1\frac{2}{100}$ .—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

two thirds souls to a *family*, in that state---exclusive of Indians and Negroes---The proportion to a *house* is  $6\frac{5}{10}$ : For, the *families* are to the *houses*, in that state, as six to five. In Boston, there are to a *family*,  $5\frac{3}{10}$  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,  $5\frac{3}{10}$ , Marblehead,  $5\frac{1}{10}$  Newbury-Port,  $4\frac{8}{10}$ : At Ipswich, containing four thousand five hundred and sixty two inhabitants (and which will be mentioned hereafter,) the proportion is,  $5\frac{6}{10}$ . 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 is 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 Versailles, 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, consequently

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 Corfica, 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  $4\frac{2}{3}$  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  $4\frac{1}{3}$  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  $26\frac{6}{10}$  persons living, in proportion to each birth—Hence the number of annual births in that kingdom, multiplied by  $26\frac{6}{10}$ , will yield the number of its inhabitants.---It appears, also, by an enumeration of the inhabitants of the  
kingdom

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  $32\frac{7}{10}$ . 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  $30\frac{8}{10}$ : 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-

ty-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  $21\frac{6}{1000}$ , as the proportion out of which one dies annually:—and, in the second case, that proportion will be one out of  $23\frac{8}{1000}$ . 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 mentioned,

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  $47\frac{6}{100}$  to 100; and, in 1745, the proportion was, as  $49\frac{5}{100}$  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,\*  $41\frac{88}{100}$  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 Abbé 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  $100\frac{20}{100}$  deaths: and the Count de Buffon says, that, in fifty-eight years, the deaths in Paris exceeded the births only about  $\frac{1}{7}$  part. This is a favorable 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 completed, 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,  $50\frac{1}{2}$  deaths. The bills, for the white inhabitants in this city, for 1789 and 1790, give the proportion as only 100 births to  $49\frac{4}{100}$  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  $49\frac{1}{2}$  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  $13\frac{1}{4}$ . It is observed by Mr. Morfe, 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  
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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 twenty

ty-two; in Rome, one in twenty-three; in Amsterdam, one in twenty-four, &c. M. Sufmilch makes the proportion of those who die, annually, in *great* towns, to be from  $\frac{1}{24}$  to  $\frac{1}{38}$ ; 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  $\frac{1}{40}$  or  $\frac{1}{50}$ , to  $\frac{1}{23}$  or  $\frac{1}{24}$ ; moderate towns, from  $\frac{1}{23}$  to  $\frac{1}{33}$ ; 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. Sufmilch “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. Sufmilch 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 Brandenburg: 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 filed *the*

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*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  $27\frac{1}{4}$  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. Morfe 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 President, the illustrious Franklin, was of opinion, that the people of these states double their number in twenty years.\* Dr. Price seems to think---that, “in the back settlements, where the inhabitants apply themselves 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 instance of increase so rapid, as to have scarcely any parallel.”---Even in Madeira---where, according to Dr. Heberden, only  $\frac{1}{30}$  part of all the inhabitants die annually,---it is said they do not double their number in less than eighty-four years.

To assist us in forming a satisfactory judgment, respecting the probabilities of the duration of life, in this country---a consideration intimately connected, in the present enquiry, with the causes of the quick progress of its population,---it becomes necessary to examine into the † longevity of the inhabitants.---Having noticed, in the preceding part of these observations, that nearly one half of the people, in the Northern and middle states of the union, are under sixteen years of age---although Dr. Halley states, that, in Europe, the proportion of such is only one-third---the inference, necessarily resulting from these facts, is---either, that the probability of the continuance of life is greater here than in Europe, between the birth and sixteen years of age, out of equal numbers born; or, if the probabilities are equal, prior to that period of life, in the two countries respectively---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, subsequent to that period.

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From

\* Observations concerning the increase of mankind, peopling of countries, &c.

† “Those inhabitants of Pennsylvania, who have acquired the arts of conforming to the changes of our weather, in dress, diet, and manners, escape most of those acute diseases, which are occasioned by the sensible qualities of the air: and faithful enquiries and observations have proved, that they attain to as great ages, as the same number of people in any part of the world.”---Dr. Rush’s account of the climate of Pennsylvania, &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, Massachusetts, 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 Ponischang 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. Dowfett,—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.

▲ 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.*

S I R,

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 nevertheless 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 Apalachian 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 Apalachian 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 Halfon 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 Thermometer, 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° $\frac{1}{2}$  less than what Dr. Rush mentions to be the standard temperature of the air, in the city of Philadelphia, viz. 52° $\frac{1}{2}$ —"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 *Torun*, 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 thermometer 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°. II.) 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 83½ each:---three of the fifteen averaged 105½ 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, unhealthy: 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, *ceteris 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 completed.

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 routine 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

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extremes

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

† Dr. Ruff---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. Ruff'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  $98^{\circ}$  corresponding with  $29\frac{1}{2}$  of Reaumur---At the same place, in January 1780, it was at  $6^{\circ}$  corresponding with  $11\frac{1}{2}$  below 0, of Reaumur At Paris, in 1753, the mercury in Reaumur's thermometer was at  $30\frac{1}{2}$  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  $94^{\circ}$  of Fahrenheit's scale: but that, during the summer, the general height of the mercury was between  $84^{\circ}$ , and  $88^{\circ}$ , when the thermometer was placed in the shade, accessible to a free circulation of the air.---At the Norriton observatory (in lat.  $40^{\circ} 9', 31''$ , 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  $94\frac{1}{2}$ , 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 Massachusetts, 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 versa*—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 *Genl. 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 longè firmiorem, valentiorumque 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, than the medium of eighteen preceding years gives it.—The table for Salem, in Massachusetts, 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 completing 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 freest 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 <i>M. Buffon</i> .			N <sup>o</sup> . 1. PHILADELPHIA, for twenty-two Years.		
Periods of Life.	Persons living.	Decrease of Life.	Periods of Life.	Persons living.	Decrease of Life.
	1,000			1,000	
Between the Birth and 3	591	409	Between the Birth and 3	612	388
3 and 5	540	51	3 and 5	555	57
5 and 10	490	50	5 and 10	511	44
10 and 20	450	40	10 and 20	465	46
20 and 30	392	58	20 and 30	368	97
30 and 40	323	69	30 and 40	270	98
40 and 50	252	71	40 and 50	178	92
50 and 60	180	72	50 and 60	114	64
60 and 70	101	79	60 and 70	52	62
70 and 80	27.63	72.37	70 and 80	20	32
80 and 90	3.54	24.09	80 and 90	5.61	14.39
N <sup>o</sup> . 2. (a) PHILADELPHIA, for 1782, 1788, 1789 and 1790.			SALEM (in Massachusetts) for 1782, (b) 1783, 1789 and 1790.		
Periods of Life.	Persons living.	Decrease of Life.	Periods of Life.	Persons living.	Decrease of Life.
	1,000			1,000	
Between the Birth and 3	611	389	Between the Birth and 3	----	----
3 and 5	569	42	3 and 5	555	445
5 and 10	546	23	5 and 10	505	50
10 and 20	497	49	10 and 20	470	35
20 and 30	400	97	20 and 30	342	128
30 and 40	296	104	30 and 40	252	90
40 and 50	195	101	40 and 50	169	83
50 and 60	140	55	50 and 60	129	40
60 and 70	62	78	60 and 70	94	35
70 and 80	25	37	70 and 80	26	68
80 and 90	6	19	80 and 90	(c)	
SALEM (in Massachusetts,) for 1790. (d)			PARIS, From the Calculations of <i>M. Buffon</i> . (e)		
Periods of Life.	Persons living.	Decrease of Life.	Periods of Life.	Persons living.	Decrease of Life.
	1,000			1,000	
Between the Birth and 3	----	----	Between the Birth and 3	----	----
3 and 5	550	450	3 and 5	580	420
5 and 10	503	47	5 and 10	524	56
10 and 20	487	16	10 and 20	485	39
20 and 30	356	131	20 and 30	433	52
30 and 40	293	63	30 and 40	366	67
40 and 50	220	73	40 and 50	293	73
50 and 60	178	42	50 and 60	212	81
60 and 70	120	52	60 and 70	116	96
70 and 80	42	84	70 and 80	32	84
80 and 90	15.71	26.29	80 and 90	4.50	27.50

LONDON; from the calculations of M. Buffon, (e)			LONDON; from the calculations of Dr. Price.		
Periods of Life.	Persons living.	Decrease of Life.	Periods of Life.	Persons living.	Decrease of Life.
	1,000			1,000	
Between the Birth and 3	---	----	Between the Birth and 3	492	508
3 and 5	587	413	3 and 5	426	66
5 and 10	553	34	5 and 10	374	52
10 and 20	522	31	10 and 20	325	49
20 and 30	436	86	20 and 30	272	53
30 and 40	332	104	30 and 40	212	53
40 and 50	222	110	40 and 50	148	71
50 and 60	138	84	50 and 60	97	51
60 and 70	72	66	60 and 70	50	47
70 and 80	25	47	70 and 80	16	34
80 and 90	3.20	21.80	80 and 90	2	14
VIENNA.			BRESLAW in SILESIA, from the Calculations of Dr. Halley.		
Periods of Life.	Persons living.	Decrease of Life.	Periods of Life.	Persons living.	Decrease of Life.
	1,000			1,000	
Between the Birth and 3	431	569	Between the Birth and 3	760	240
3 and 5	379	52	3 and 5	710	50
5 and 10	327	52	5 and 10	653	57
10 and 20	288	39	10 and 20	592	61
20 and 30	247	41	20 and 30	523	69
30 and 40	199	48	30 and 40	436	87
40 and 50	147	52	40 and 50	335	101
50 and 60	96	51	50 and 60	232	103
60 and 70	47	49	60 and 70	131	101
70 and 80	15	32	70 and 80	34	97
80 and 90	2	13	80 and 90	1	33
NORWICH, G. BRITAIN.			NORTHAMPTON, G. BRITAIN.		
Periods of Life.	Persons living.	Decrease of Life.	Periods of Life.	Persons living.	Decrease of Life.
	1,000			1,000	
Between the Birth and 3	544	456	Between the Birth and 3	585	415
3 and 5	498	46	3 and 5	544	41
5 and 10	440	58	5 and 10	496	48
10 and 20	394	46	10 and 20	448	48
20 and 30	341	53	20 and 30	379	69
30 and 40	290	51	30 and 40	318	61
40 and 50	233	57	40 and 50	247	71
50 and 60	168	65	50 and 60	177	70
60 and 70	94	74	60 and 70	107	70
70 and 80	31	63	70 and 80	40	67
80 and 90	4.22	26 78	80 and 90	3.48	36.52

PARISH of Holy-Cross, Great-Britain.			PAIS DE VAUD, in Switzerland.			A Country parish in the Electorate of BRANDENBURGH.		
Periods of Life.	Perfons living.	Decrease of Life	Periods of Life.	Perfons living.	Decrease of Life.	Periods of Life.	Perfons living.	Decrease of Life.
Between the Birth and 3	1,000	—	Between the Birth and 3	1,000	-----	Between the Birth and 3	1,000	-----
3 and 5	717	283	3 and 5	735	265	3 and 5	687	313
5 and 10	659	58	5 and 10	701	34	5 and 10	642	45
10 and 20	589	70	10 and 20	653	48	10 and 20	577	65
20 and 30	545	44	20 and 30	610	43	20 and 30	527	50
30 and 40	486	59	30 and 40	563	47	30 and 40	486	41
40 and 50	426	60	40 and 50	506	57	40 and 50	432	54
50 and 60	353	73	50 and 60	431	75	50 and 60	374	58
60 and 70	273	80	60 and 70	314	117	60 and 70	282	92
70 and 80	171	102	70 and 80	168	146	70 and 80	166	116
80 and 90	90	81	80 and 90	46	142	80 and 90	44	122
	7	83		5	41		3	41

Number of the Deaths out of 1,000, under the ages of 3 and 5 years, respectively,--- for Ipswich Hamlet, in Massachusetts, Hingham, in the same State, and for the city of Berlin.---

<p>IPSWICH HAMLET, on a medium of 10 years</p> <p>HINGHAM, on a medium of 54 years,</p> <p>BERLIN, from the bills given by M. Sufmich,</p>	<p>under 3 years,</p> <p>under 5 do.</p> <p>under 3 do.</p> <p>under 5 do.</p> <p>under 3 do.</p> <p>under 5 do.</p>	<p>Deaths,</p> <p>-----</p> <p>181</p> <p>-----</p> <p>563</p> <p>-----</p> <p>516</p> <p>598</p>
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The numbers of those who die, after completing 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 <i>survive 80 years.</i>
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, <i>averag'd</i> , according to Mr. Kerseboom,	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 <i>general table</i> ,	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 Brandenburg,	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 53
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
{ Edinburgh--- (k)	{ 1 to 26
19. { 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 <sup>o</sup> . 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. Koningberg---1766, 1768,	do.	87. 47
16. Duchies of Holstein and Sleswic---1765, 1767,	do.	88. 23
17. Whitley, 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



(a) Out of 193 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 1783, 1789 and 1790---is only 145; and not quite 145. 7-8, during the 22 years, from which the table for Philadelphia N<sup>o</sup>. 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 unusually sickly in Philadelphia, as well as at Salem in Massachusetts. In the year 1782, also (viz. from Christmas 1783 to Christmas 1789,) out of 164 persons, who died in the congregations of Christ-church and St. Peter's, 29 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 both 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 completing their 60th year, at Paris; whereas, only 133, 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 completing 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. 43
Do.	90	3. 66
Do.	80	23. 66
Do.	70	76. 34
Do.	60	146. 46
Do.	50	227. 72
Do.	40	315. 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<sup>o</sup>. 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

**O**N 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 viewed 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.

N<sup>o</sup>. 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. **I**N 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 Saccharinum* 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 Ferruginæa*. (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 Mapletree 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

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I

which

\* Baron LaFontaine, in his voyage to North America gives the following account of the Mapletree 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 hoghead, 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.

I 2

The

\* 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 dried 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 hogheads 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 increased 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, four 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 7800lb 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  $\frac{2}{3}$  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 much greater than those of making maple sugar.

But the profit of the Mapletree 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.

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 disagreeable 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 labor

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 weakneses, 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 sugar,

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  
to

\* 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  $\frac{6}{10}$  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  $\frac{3}{10}$  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 unnecessary, 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. 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 committee of the British privy Council for trade on the subject of the Slave trade. I shall insert in this postscript 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.*

“**H**AVING 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<sup>o</sup>. 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 crowded 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 Halifax, and 4th, from Halifax 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 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  $58^{\circ}$  by Fahrenheit, and at sea it was  $69^{\circ}$ ; in October the water off Cape Cod was  $48^{\circ}$ , and at sea it was  $59^{\circ}$ . This difference was equally a guide in both cases, though the heat was different at different seasons.





A. Is the Track made in the America from Boston to Virginia  
 B. Is that made in the Norway from Virginia to England  
 C. Is that made in the Chesapeake from England to Halifax  
 D. Is that made in the Chesapeake from Halifax to New York  
 E. Is that made in the London Packet, W. L. Franklin from Europe to America

CANADA

UNITED STATES

AFRICA

SPAIN

BAY of BISCAY

ENGLAND

GULPH of ST. LAURENCE  
 NEWFOUNDLAND  
 Cape Breton  
 Bay of Fundy  
 Nova Scotia  
 Maine  
 Massachusetts  
 Rhode Island  
 Connecticut  
 Delaware  
 Maryland  
 Virginia

Boston  
 New York  
 Philadelphia  
 Charles Town  
 S. Augustine  
 Bahamas Islands  
 Bermuda  
 Center of the Gulf-Stream  
 Edge of the Gulf-Stream

Islands or Western Islands  
 Canary Islands  
 Madeira  
 Cape Verde

CANARY ISLANDS  
 C. Teneriffe  
 C. Palma  
 C. G. C. Hierro  
 C. B. C. Lanzarote  
 C. D. C. Fuerteventura  
 C. E. C. Gomera  
 C. F. C. Gran Canaria  
 C. G. C. Majorca  
 C. H. C. Minorca  
 C. I. C. Ibiza  
 C. J. C. Formentera  
 C. K. C. Mallorca  
 C. L. C. Menorca  
 C. M. C. Ibiza  
 C. N. C. Formentera  
 C. O. C. Mallorca  
 C. P. C. Menorca  
 C. Q. C. Ibiza  
 C. R. C. Formentera  
 C. S. C. Mallorca  
 C. T. C. Menorca  
 C. U. C. Ibiza  
 C. V. C. Formentera  
 C. W. C. Mallorca  
 C. X. C. Menorca  
 C. Y. C. Ibiza  
 C. Z. C. Formentera

Track of the Mercury  
 Track of the Chesapeake  
 Track of the London Packet

Track of the Chesapeake in June 1790  
 Track of the London Packet





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  $48^{\circ}$ ; at sea between that coast and the stream,  $59^{\circ}$ ; in the gulph stream at its edge,  $67^{\circ}$ ; between that, and the coast of Virginia farther southward  $64^{\circ}$ ; and in soundings on that coast,  $56^{\circ}$ . 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  $47^{\circ}$ ; between the coast and the stream,  $60^{\circ}$ ; and in the stream,  $70^{\circ}$ . 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  $600^{\circ}$ , and then continued a very gradual descent as we went to the Northward, 'till we struck soundings, when it was at  $48^{\circ}$ .

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 Halifax, 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 Halifax 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 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  $16^{\circ}$  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 than 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  $6^{\circ}$  in three hours run, and long before we  
were

\* Appendix N<sup>o</sup>. I.

† Appendix N<sup>o</sup>. II and III.

‡ Appendix, N<sup>o</sup>. 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.

VOL. III.

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These

# MARITIME OBSERVATIONS.

*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. Bracc, by JONATHAN WILLIAMS. Jun.

Dates. 1789.	Time.	Places at Noon.			Temperature of		NOTES.
		Lat. N.	Long. W.	Air.	Water.		
Oct. 11,	Sun fet.	42° 5'	69° 40'	58.	48.	October 11, sun fet. Sailed at 8 A. M. from Boston, and at sun fet, 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 symptom of the gulph stream in this longitude. We now probably approach the gulph stream, the water being 7° warmer than at noon. October 13, sun rife. 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 fet. We had a good observation at noon; we are probably still in the stream, the water continuing warm. October 14, sun rife. 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, sun fet. 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°.	
	Sun rife.			50.	54.		
12,	Noon.	40 23.	68 46.	50.	52.		
	Sun fet.			52.	59.		
13,	Sun rife.	38 40.	70 35.	57.	65.		
	Noon.			60.	67.		
14,	Sun fet.	38 46.	71 58.	64.	66.		
	Sun rife.			65.	62.		
15,	Sun fet.	38 25.	73 10.	69.	61.		
	Sun rife.			66.	64.		
16,	Sun rife.	37 45.	73 40.	70.	65.		
	Noon.			67.	64.		
17,	Sun fet.	37 36.	74 1.	59.	63.		
	Sun rife.			60.	64.		
18,	Sun fet.	37 34.	74 45.	61.	64.		
	Sun rife.			62.	64.		
19,	Sun fet.	37 4.	76 4.	66.	64.		
	Sun rife.			63.	64.		
	Sun fet.			60.	57.		
	Sun rife.			56.	60.		
	Noon.			58.	58.		

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 rife. By the sudden change in the heat of the water, I suspect we are drawing near foundings.  
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 Winghamly'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 foundings.



# MARITIME OBSERVATIONS. 91

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.		Temperature of		NOTES.
		Lat. N.	Lon. W.	Air.	Water.	
Nov. 30	noon	37° 0'	75° 43'	42°	47°	Nov. 30. Sailed this morning from Hampton Road; at noon
	sun set			42	50	
Dec. 1.	sun rise			42	54	Cape Henry bore West dist. 2 leagues.
	noon	36 30	71 2	44	60	
	10 P. M.			50	70	Dec. 1. Entered the Gulph Stream, at 10 P. M.
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 3	62 13	60	68	
	sun set			59	67	8 A. M.
5.	noon			56	66	
7.	sun set	38 7	54 4	66	68	
	noon	38 43	52 12	68	66	
8.	sun rise	39 56	48 52	66	62	
	sun rise			46	54	
10.	noon	40 10	46 12	54	60	I suppose this coldness to be owing to the Banks of Newfoundland, which are in this Longitude.
	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	
	sun rise			58	57	
15.	noon	44 58	32 27	60	55	Dec. 22. Since the 16th there has been little or no alteration till to-day.
	noon	45 58	29 00	56	53	
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

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C. A

## MARITIME OBSERVATIONS.

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 Chefterfield, Captain Schuyler, by J. W.

Dates. 1790.	Time	Places in at Noon.		Temp. of		Notes.	
		Lat. N.	Long. W.	Air	Wat.		
June	12 Noon.	49° 57'	5 <sup>R</sup> 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		
	Midnight			59	55	I suppose we are between Jacquet's and the Grand Bank of Newfoundland	
	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, foun. 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 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, 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.

lat. 44. 43. N. We tried with 160 fathoms but the lead was only about 12 pounds, and the line was a very  
lon. 46. 07. W. 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, 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 have 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, From the last found 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, 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 3 or 8 degrees colder than deep water; but on the banks of Newfoundland it is from 12 to 15 degrees colder.

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

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 foundings 73, 40 W. at noon, which turns out accurate, the land being in 74. 00 W.

*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. 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  $\frac{3}{4}$  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. 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 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 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 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.

26th.

27th.

July 27.

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

July 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

Lat. 40. 25.  
Long. 70. 30.

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.

## A P P E N D I X.

NOTES TO THE MARITIME OBSERVATIONS.

### N<sup>o</sup>. 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.*

**W**HEN 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 founded, 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<sup>o</sup>. II.

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

**I**N lat. 45. 43. N. long. 21. 20 W. from Greenwich, I 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<sup>o</sup>. III.

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

**O**N 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

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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.  $\frac{1}{2}$  W.  $1\frac{1}{2}$  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.

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No. IV.

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

**T**HE 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.

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No. V.

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

**T**HE 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 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 dropped from the hook, swam light on the surface  
N 2 till

\* 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.

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N<sup>o</sup>. 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.

**D**URING 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 skeptic

\* 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 properties the most opposite; and, consequently, that the effects of the poison of our venomous 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 venomous 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 Ceyede'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-

\* See Volume 2d, p. 58 and t. 58.

† See Volume 1st, p. 373. 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*, Lia.

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 uselefs.

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 venomous 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  
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\* 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-Mezereum*, 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-glands

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 *Mexceon* 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-lymphatics. 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 purpose, for the unhappy sufferer expired in a few minutes. This very sudden operation of the poison will not excite much wonder, when we consider the proximity of the wound in this case to the source of circulation. For although experiments are wanted to demonstrate the *precise* action of the poison of the RATTLE-SNAKE on the human and other animal systems, we are already in possession of facts which warrant us to conclude, that it exerts its principal effects on the sanguiferous system, and, as I believe, immediately on the blood itself. 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 poison of which I am speaking, we are certain that the introduction of the smallest portion of it into a blood-vessel is generally attended with the most serious consequences. Mr. Catesby says that, "where a Rattle-Snake  
 " with full force penetrates with his deadly fangs, and  
 " pricks a vein or artery, inevitable death ensues; and  
 " that, as I have often seen, in less than two minutes.  
 " The *Indians*," he continues, "know their destiny the  
 " minute they are bit; and, when they perceive it mortal,  
 " apply no remedy, concluding all efforts in vain\*." Mr. Catesby is frequently very accurate in relating facts, and in making observations. What he has here said respecting the fatal consequences of the *immediate* introduction of the poison into the blood-vessels perfectly corresponds with the information which I have received from a variety of sources. I am unwilling, however, to believe that, in every case, such an introduction is necessarily mortal. I cannot but suppose that of the many cases of the bites of  
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\* The Natural History of Carolina, &c. vol. 2, p. 61.

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 preventing 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 antiphlogistic 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.

Of

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 specifics 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 “snuns 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 *wigwam* 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 specifics are used *internally*, others are employed *externally*, whilst others, again,

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

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-Horchound*), *Scorzonera hispanica* (*Garden Vipers-grass*), *Solidago* (\*†*Golden-rod*. Different species are used.), *Aristolochia Serpentaria* (†*Virginian Snake-root*), *Juglans oblonga* (\**White-Walnut, Butter-nut*), *Cynoglossum virginicum* (†*Virginian Hounds-tongue*), *Convolvulus—arvensis?* (\**Leaf-Bindweed*) *Aëxa 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 sudorific. I have never heard that this bark has been employed for the bite of the RATTLE-SNAKE in man.



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(† *Common-Saffron*), *Fraxinus*—(† *White-Asb*) *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*), *Jussiaea?*—(\* † *Wood-Plantain*, *Rattle-Snake-Plantain*) *Hieracium Kalmii* (\* † *Rattle-Snake-Plantain*, *Poor-Robin's Plantain*).

## N<sup>o</sup>. XII.

### MAGNETIC OBSERVATIONS,

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

BY DR. S. WILLIAMS.

Months.	Days.	Great- est Va- riation.	Days.	Least Varia- tion.	Dif- fer- ence.	Mean	Mean	Mean
						Variation at 7 A. M.	Variation at 1½ P. M.	Variation at 9 P. M.
January	15 1½ P. M.	6° 50'	27 } 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 1½ 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<sup>o</sup>. XIII.

*Accurate determination of the right ascension and declination of  $\beta$  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  $\beta$  Bootes, and the Pole Star. The Declination of  $\beta$  Bootes was determined by comparing its zenith distance, with the zenith distances of  $\alpha$  Lyræ, Capella,  $\alpha$  Cygni,  $\gamma$  Andromedæ,  $\beta$  Medusæ, and  $\delta$  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

R. ASCENSION AND DECLINATION OF  $\beta$  BOOTES. 117

In applying the corrections contained in the tables of aberration and nutation, it is only necessary 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*.

Sun's place and place of the Moon's ascending node.		The Right Ascension and Declination of $\beta$ Bootes to the beginning of 1789.			
		S ° ' "		} Ann. Var. {	
		Right Ascension,	7 13 30 3.5	} + 34. 1	
		Declination,	41 13 47.94	} - 14. 53	
S. D. S.	Abrerration in R. Ascension.	Abrerration in Declination.	Nutation in R. Ascension.	Nutation in Declination:	
O. VI.	"	"	"	"	
o	+ 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. o 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. o 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. o 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. o 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. o 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

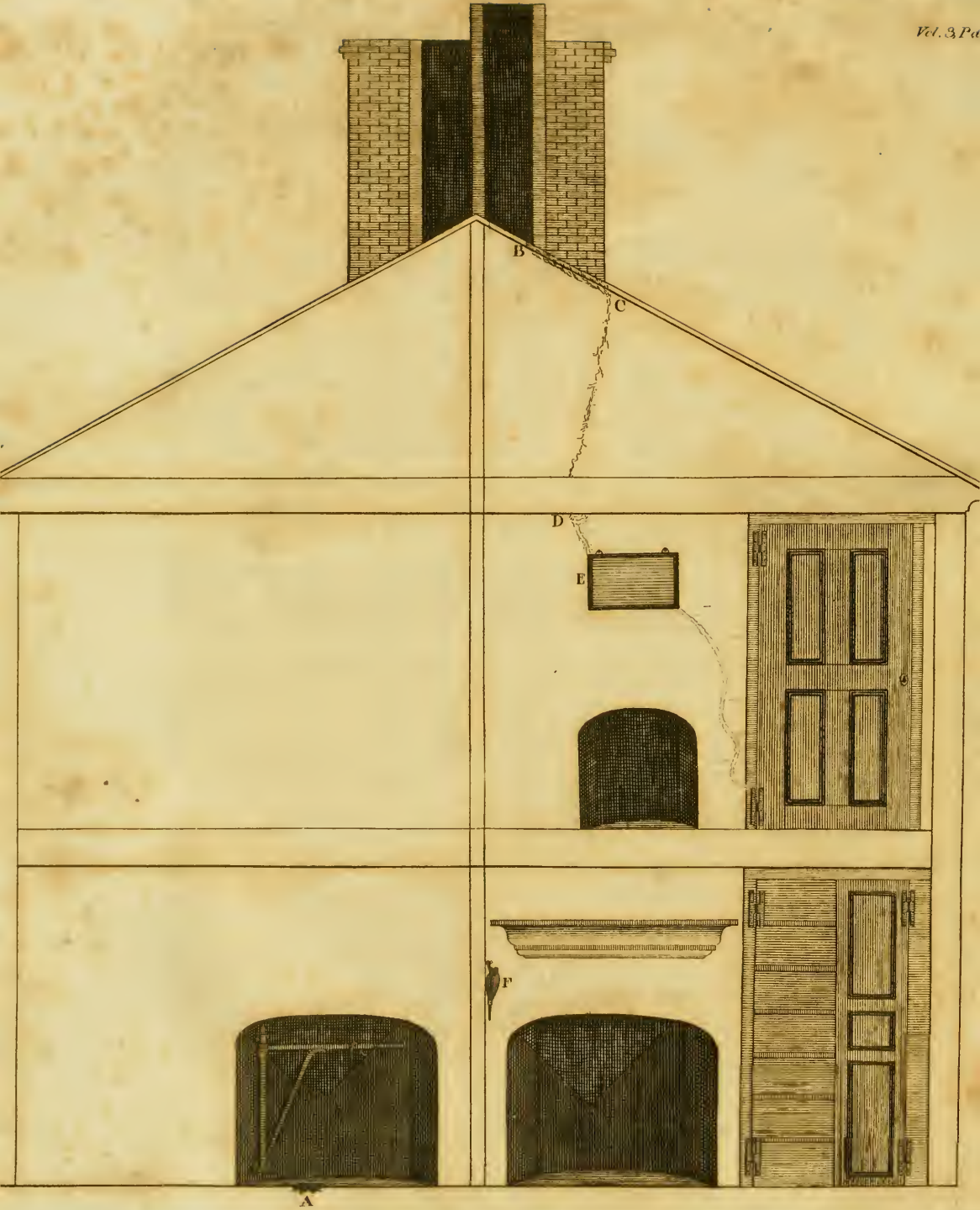
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Sun's place and place of the Moon's ascending Node.		The Right Ascension and Declination of the Pole Star to the beginning of the year 1789.			
		S ° ' "		} Ann. Var. {	
		Right Ascension, 0 12 32 7,06		} + 183,03*	
		Declination, 88 10 40,8		} + 19,4	
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 K.	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  $\frac{12".12}{2} \times 11 = 66".66$  which is the sum of the progression,—then the Annual Variation  $183".03 \times 11 = 2013".83 = 33".33$ , this added to 08. 12° 32' 7". 06. will give 08. 13° 5' 40". 39, and this sum increased by the sum of the progression 1' 6". 66 will give 08. 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





N<sup>o</sup>. 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.

**O**N 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 ceiling and plastering 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 ceiling 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, coruscations 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 light-

ning 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 westernmost 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.

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N<sup>o</sup>. 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. **O**N 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 stories at the East end. At each end there are two stacks of chimnies, which rise from the roof about half way between the eaves and the ridge. The pointed conductors, one at each end, are fastened to the two most Southerly chimnies, and are brought directly down the outside 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 screwed together and not connected by hooks.

The cloud which discharged the lightning came from the West, and the fluid appears to have proceeded down the Western conductor, at least in part, for the point is melted down to a considerable thickness. The next perceptible effect of it is on the South side of the same chimney, where it has torn up the shingles 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 West to East a foot above the eaves, and at the East end is connected with a copper spout which comes directly down along the wall, within four feet of the earth, where it discharges the rain water into a cedar tub, bound with iron hoops.

The lightning appears to have passed quietly along the copper, the whole length of the gutter and spout. About a hands breadth below the end of the spout it tore off and shivered in pieces an inch board, which passed down between the spout and the wall and had been lower down than the spout, partly passing into the tub, it made its way through to the outside, and thence into the earth, throwing off many small splinters from different sides of the tub.

Another part of the lightning appears to have proceeded along the Western rod until it came directly opposite to the copper gutter, from which it is distant 6 or 7 feet: it then ran along the cornish, 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 driest 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.

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## Nº. XVI.

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

Read Sept.  
21 1787:

**D**URING 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

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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  $0^{\circ}$  of Fahrenheit's scale.

In this situation, I suspended in it, a rag which had been dipped in water of the temperature of  $40^{\circ}$ —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  $98^{\circ}$  or near it, as it was my hand; by this experiment it appeared that a moist body of  $40^{\circ}$  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

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  $34^{\circ}$ , 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 congealation 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  $0^{\circ}$ , and then exposed to air of  $34^{\circ}$ , 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  $34^{\circ}$ —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  $34^{\circ}$ , 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  $0^{\circ}$ , were moistened with my breath, and in that situation exposed, one to the open air of  $34^{\circ}$ , 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  $32^{\circ}$ ; 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 atmosphere, 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 increased a certain degree above that of the air to which it is exposed, a visible vapour or smoke will arise from it, which will appear more or less in quantity in proportion to the heat.

3. If it be heated to  $212^{\circ}$ , while exposed to the pressure of the Atmosphere, or to  $98^{\circ}$  in vacuo, small transparent globules are formed suddenly, and with a crackling noise, in that part of it which first receives the heat; these globules, which are composed of elastic vapour, ascend through the water as quickly as air would do, if in the same circumstances: as soon as they escape from water into air, which is colder, they are converted from transparent elastic vapour, into visible inelastic vapour or smoke, which passes through the air as other visible vapour does: the formation and passage of these bubbles through the water, produces that motion in it which we call boiling.\* Any person may be convinced of this, by applying a candle to the bottom of a flask or thin glass vessel which has a small quantity of water in it.

The evaporation produced by immersing moist bodies or ice, in cold air, resembles the second kind which I have described (or that which produces smoke,) in several respects. In order to make water smoke, you need only render it warmer than the air to which it is exposed; thus, to give a very familiar example, a dish of tea, when first poured out, smokes at the fire side, when it has lost some  
of

\* I have stated that water will boil in vacuo, with a heat of  $98^{\circ}$  upon the authority of Mr. Watt; but an elastic vapour will arise from water in vacuo when the heat is much lower—Some Gentlemen have related in the Philosophical Transactions, that when they were making experiments with the Barometer in an exhausted receiver, an elastic vapour arose from the moist leathers, and compressed the mercury in the Barometer. They also refer to the experiments of Lord Cavendish, and from these they say it appears, that water of  $72^{\circ}$  yielded an elastic vapour when the receiver was so much exhausted, that the Barometer sunk to  $\frac{1}{4}$  of an inch, or when  $1-40$  of the common pressure of the Atmosphere remained; and that when the Barometer sunk to  $\frac{1}{4}$  of an inch, or that  $120$  only of the common pressure remained, the same kind of vapour arose from water of the temperature of  $41^{\circ}$ . This fluid therefore when its temperature is  $41^{\circ}$ , or upwards may be considered as in a constant nifus to assume the form of elastic vapour, which nifus is counteracted by the weight of the atmosphere. See Nairn's accounts of experiments with the air pump, in Phil. Transactions, 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 inseparably connected, the reason why ice smoked when first introduced into the cold vessel, is very clear, as its temperature was  $32^{\circ}$  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.

R 2

2. The

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 familiar 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

we

we have mentioned as one of the causes of evaporation. The process alluded to is that by which moisture is collected on the surfaces of cold bodies exposed to warm air—Dr. Franklin has explained this upon the principle that the water in the atmosphere is combined with heat, and that it is collected on the cold surface in consequence of the passage of this heat into the cold body. This explanation is the reverse of that which I have adopted, and as it explains to the satisfaction of every one, a process the reverse of evaporation, it strengthens that explanation.

When considering this theory of our great philosopher, and the pleasing application of it to many important processes of nature, it occurred to me to try the converse of the proposition; for if the collection of moisture on the surface of a body depends upon the abstraction of heat from the air by it, it follows, that when a body is not in a condition to receive heat from the atmosphere, no moisture can collect upon it.

As mirrors show the presence of moisture with so much accuracy I heated one of them, and found that although, when below  $98^{\circ}$ , they are covered with mist, if exposed but a moment to the breath, yet when heated but little above  $98^{\circ}$ , I could not impress any moisture upon it, although it was applied close to my mouth and breathed upon very frequently. Dr. Franklin's proposition requires nothing to confirm it, but if it were doubtful, this last experiment would furnish a strong argument in its favour.

N<sup>o</sup>. XVI.

*Postscript to Mr. BARTON'S \* Letter, to DR. RITTENHOUSE, of the 17th of March, 1791.*

Read Dec. 2d, 1791. **S**INCE 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<sup>o</sup>. 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<sup>o</sup>. 2 gives proportions, of the like kind, for four several sections of the state of Pennsylvania.

The

\* 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 acad. sciences*---read *hist. royal acad. sciences*.---Same page, line 3d from the bottom; for *probabilities*---read *probabilities*.---Page 30, last line; erase the words *in that state*.---Page 31, line 3d, from the bottom; for *Versailles*---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 *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 completed, 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<sup>o</sup>. 3, exhibits the ratio of free white males to free white females, in the several states, respectively, including the South-Western territory: And N<sup>o</sup>. 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 Kentucky, 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 Kentucky, 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.

The

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  $43\frac{7}{10}$ , of the living. But,

as



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.

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(TABLE

(T A B L E, N<sup>o</sup>. 1.)

States.	To 100 free white males } { Free white males, under 16 years of age.	
	To 100	
Kentucky,	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.		

(T A B L E, N<sup>o</sup>. 2.)

The state of Pennsylvania, divided into four sections.	To 100 free white males } { Free white males, under 16 years of age.	
	To 100	
The four westernmost counties,	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

(T A B L E, N<sup>o</sup>. 3.)

States.	To 100 free white males } { Free white females, of all ages.	
	To 100	
Rhode Island,	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
Kentucky,	100	89.78

(T A B L E, N<sup>o</sup>. 4.)

The state of Pennsylvania divided into four sections.	To 100 free white males } { Free white females, of all ages.	
	To 100	
The city and suburbs of Philadel.	100	106.29
The nine oldest counties, exclusive of the capital.	100	96.03
The eight counties settled next after the preceding nine.	100	91.62
The four westernmost and last settled counties.	100	89.09

New

N<sup>o</sup>. XVII.

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

Read Mar.  
7, 1788.

**T**HE 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 represented by lines and spaces, were denoted by the letters which denominate these, and their times by the common stops or marks of pause in reading, subjoined to the letters, this notation of music would certainly be as natural as the common one, and would moreover have this great advantage, that music might then be printed with the common alphabetical types; by which means all the inconvenience and expence attending the publication of music, according to the usual notation, would be avoided; a magazine or common news-paper, would then become a convenient vehicle for publishing the most celebrated airs or pieces of music (which any one might afterwards, if he should think it necessary, prick off for himself in the common form) and thus contribute to diffuse a more general knowledge of this ornamental and humanizing science.

To explain this matter more fully. Let the seven notes, a, b, c, d, e, f, g, on one of which the cliff is placed, be printed in small Roman letters; the seven notes next above these, in small Italics; the next seven, when any of them shall occur, in Italic capitals; and the seven notes below the cliff-octave, in Roman capitals. These 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 sufficient to express all the compass of tone on any particular cliff. The governing flats or sharps which are usually placed at the beginning of a tune, when transposed from its natural key; as also the cliff, time, mood or other circumstance, may be expressed in words at length after the title of the tune. Accidental flats, sharps and naturals, to deviate as little as possible from the common notation, I would express as follows: the flat by a small b, placed before the note affected, and set a little higher than the other letters in the line. This may be done either by using a letter of a smaller body and spacing 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

Rests will be very well expressed by the foregoing respective marks of time set alone, or not immediately preceded by a note.

A single bar may be intelligibly expressed by the m dash set side-wise accross 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 music may be very well expressed, or imitated, by the common printing types: thus a *trill*, by tr, set above the note; a *beat*, by the asterisk +, and a *turn*, by the letter S turned side-wise S, and set above their respective notes; a *slur*, by inclosing the flured notes in a parenthesis ( ) *staccato-notes* by a period or hyphen side-wise, set over, or under such notes; a *pause*, by a parenthesis and period together, set side-wise, over the note — *diminutives, or notes of transition*, as they are not counted in the time of the bar, will be very naturally expressed by enclosing such notes in a parathesis. [ ]

When three notes are reduced to the time of two, or six to the time of four, the figure 3 or 6 may be respectively set above such notes, as in the common notation.

All terms of execution or expression as, *adagio*, *andante*, *piano forte*, &c. and figures marking the chords in thorough bass, may be also expressed as in the common notation.

# Explanatory Examples.

Scale of Notes on the G Cliff.

ABCDEF G a b c d e f g a b c d e f g ABCDEF 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 ABCDEF G

Rests, and Marks of Time.

— , ; : . — · ; · : · —

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

<sup>s:</sup>  
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;:°f; | °f:e;f;d;  
(f;g,) | a.°b;g,([°b;]a;)e;e, | °f;e,f(°f gf) g°g; | a°g dg; a;  
;a; | f,d;a;b,a;a; | bagf;g; ;e; | (f,a;)d;f;(g,e;)c;d, | f:e;  
d,d; ;f; | <sup>Sym.</sup> gfga <sup>S:</sup> babc dAfd afda fdaf edef, d; ||

N<sup>o</sup>. XVIII.

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

Read June  
15, 1792.

**B** E I N G lately requested to make some calculations relative to mills; particularly Doct. Barker's construction, as improved by James Rumfey, 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 prin-  
 ciples may be, can afford much assistance to the practical  
 mechanic,” although indeed his theory, compared with  
 the above cited experiments, might suggest such an infer-  
 ence. 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, apper-  
 taining 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 overtakes 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 velocity. 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  $\left\{ \begin{array}{l} V = \text{the velocity, } M = \text{the momentum of the fluid} \\ v = \text{the velocity, } P = \text{the power of the wheel.} \end{array} \right.$

Then,  $V - v =$  their relative velocity, by definition 3d. and, as  $V : V - v :: M : \frac{M}{V} \times \overline{V - v} = P$  (*Prop. I.*) which  $\times v = P v = \frac{M}{V} \times v \overline{V - v^2} =$  a maximum; hence  $V - v^2 =$  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 determination, 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. between one third and one half; but in all the cases there related, in which the most work is performed in proportion to the water expended and which approach the nearest 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 scattering of the water carried up by the wheel, &c." Thus

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 velocity ( $V$ ) 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  $x = V \times 1 - \frac{\frac{rW}{R} + F}{M}$  = the true velocity required; or, if we reject the friction, then  $x = V \times 1 - \frac{rW}{MR}$  is the the-

orem

orem for the velocity of the wheel. This, by the common theory would be  $x = V \times \sqrt{1 - \frac{rW}{MR}}$ , 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  $\frac{1}{2}V = V \times \sqrt{1 - \frac{rW}{MR} - \frac{r}{M}}$ ; hence  $W = \frac{\frac{1}{2}M - r}{r} \times R$ ; or, if  $r = 0$ ,  $W = \frac{M}{2}$ ; but theorists make this  $\frac{MR}{9r}$ , where the error is  $\frac{MR}{16r}$ .

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

WM. WARING.

*Philadelphia, 7th, 9th mo. 1790.*

*Astronomical*

N<sup>o</sup>. XIX.*Astronomical-Observations, Communicated by DAVID RIT-  
TENHOUSE.*

*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  $9''\frac{1}{2}$  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. M. S.
Penumbra--thought to touch the ) at	6 8 46
Eclipse begins, - - - -	6 21 0
Tycho begins to immerge - -	6 38 45
wholly immersed - - - -	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 emergence 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 flow by each	}	17 56
		observations,		
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  $\frac{1}{2}$  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 flow,		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 $\frac{1}{2}$ interval, = +					9

Hence the clock was slow of the,  $\odot$  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  $18''\frac{1}{2}$  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  $\gamma$ , 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  $8^h. 3'. 10''$  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,  $12^h 55' 2''$ . 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	-	-	12 <sup>h</sup> 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.  $39^{\circ} 57' 10''$ . Long. west of Greenwich  $5^{\text{h}} 0' 35''$ .

November, 2d, 1789. Moon eclipsed

Beginning	6 <sup>h</sup> 12'	} P. M. mean time
End at	8 20	

Digits eclipsed,  $4\frac{1}{2}$

Transit of Mercury November 5th, 1789.

First external contact	7 <sup>h</sup> 51' 50"	} A. M. }	} Meantime
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	5 <sup>h</sup> 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	12 <sup>h</sup> . 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 separated  $8''$ , 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  $8^h. 3'. 50''$  } 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  $12^h. 55'. 10''$  } P. M.

Total egress  $12. 56. 35$  } Magnifying power 130.

☉'s diameter at 12. 15. =  $3 \frac{6}{10} = 32 \frac{14,5}{100}$

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

Beginning (sun just above the horizon) }

about - - -  $5^h. 45'. 30''$  }

Ring formed nearly, at  $6. 50. 30$  } A. M.

The ring broken  $6. 54. 47$  } Mean time.

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.

N<sup>o</sup>. XX.

*Dr. Rittenhouse, to Mr. Patterfon, 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  $90^\circ$ . The sum of all their cubes is =  $\frac{2}{7}$ , and the sum of their fourth powers =  $\frac{3}{8}$  multiplied by the arch of  $90^\circ$ . The sum of the fifth powers is =  $\frac{8}{3}$ , and the sum of the 6th powers =  $\frac{5}{16} \times$  by the arch of  $90^\circ$ .

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	}	By Demonstration.
is = $rr$ , or the square of the radius		
2d, sum of the 2d, power or squares is	}	By Infinite Series.
= $\frac{1}{2}rr \times$ by the arch of $90^\circ$ .		
3d, sum of the 3d, power or cubes is	}	By the Law of Continuation.
$\frac{2}{3}rr$ of the 1st, or = $\frac{2}{3}r^4$		
4th, sum of 4th powers is = $\frac{3}{4}rr$ of the 2d	}	By the Law of Continuation.
or = $\frac{3}{8}r^4 \times$ by the arch of $90^\circ$ .		
5th, sum of 5th. powers is = $\frac{4}{5}rr$ of the 3d,	}	By the Law of Continuation.
or = $\frac{8}{7}r^6$ .		
6th, sum of 6th. powers is = $\frac{5}{6}rr$ of the 4th	}	By the Law of Continuation.
or = $\frac{5}{17}r^6 \times$ by arch of $90^\circ$ .		
7th, sum of 7th. powers is = $\frac{6}{7}rr$ of the 5th,	}	By the Law of Continuation.
or = $\frac{1}{3}r^8$ .		
8th, sum of 8th. powers is = $\frac{7}{8}rr$ of the 6th,	}	By the Law of Continuation.
or = $\frac{3}{15}r^8 \times$ by the arch of $90^\circ$ .		
&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

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*Index Florae Lancastriensis, auctore* HENRICO MUHLEN-  
BERG, D. D.

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

GENTLEMEN,

Read Feb. 12th, 1791. I Did myself the honour to lay before the Philo-  
sophical 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. 2  
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. Linnaci 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, Stargrass.  
verna.
  2. †Blitum, Blite.  
capitatum,
  3. Cinna.  
arundinacea.
- CLASSIS 2.
- Diandria, Monogynia.*
4. †Ligustrum, Privet.  
vulgare.
  5. Chionanthus, Fringetree.  
virginica.
  6. †Syringa, Lilac.  
vulgaris.  
perfica.
  7. CIRCACA, Entchanters-  
wort.  
lutetiana.
  8. Veronica, Speedwell.  
virginica.  
officinalis.  
ferpyllifolia.  
Beccabunga.  
Anagallis.  
arvensis.  
marilandica.
  9. Diathera, Bastard Hedge-  
hyfop  
americana.
  10. Gratiola, Hedge-hyfop-  
virginica.

11. Utricularia, Water-mil-  
foil.  
gibba?
  12. Verbena, Vervain.  
nodiflora.  
hastata.  
urticifolia.  
carolina?
  13. Lycopus, Gypsiewort.  
europaeus.  
virginicus.
  14. Cunila, Pennyroyal.  
mariana, Dittany,  
pulegioides, Pennyroyal
  15. Monarda.  
fistulosa.  
didyma, Oswego-Tea.  
punctata.
  16. Salvia, Sage.  
lyrata.  
† officinalis.  
† Horminum.  
† Sclarea.
  17. Collinsonia, Horse-weed.  
canadensis.  
*Digynia.*
  18. Anthoxanthum, Spring-  
grass.  
odoratum.
- CLASSIS 3.
- Triandria, Monogynia.*
19. Valeriana, Valerian.  
Locusta.
  20. †Crocus, Saffron.  
fativus.

- |   |  |
|---|--|
| 21. <i>Ixia?</i><br><i>aquatica</i> . N. S.   | <i>oryzoides</i> .   |
| 22. <i>Iris</i> , Flag.<br><i>versicolor</i> .<br>† <i>pumila</i> .   | 29. <i>Paspalum</i> .<br><i>distichum</i> .  |
| 23. <i>Xyris</i> .<br><i>indica</i> .   | 30. <i>Panicum</i> , Panicgrafs.<br><i>glaucum</i> .<br><i>viride</i> .<br><i>italicum</i> .<br><i>crus galli</i> .<br><i>fanguinale</i> .<br><i>filiforme</i> .<br><i>dichotomum</i> .<br><i>capillare</i> .<br><i>latifolium</i> .<br><i>clandestinum</i> .<br><i>virgatum</i> .<br><i>heterophyllum</i> . N. S. |
| 24. <i>Schoenus</i> , Ruthgrafs.<br><i>fuscus</i> .<br><i>glomeratus</i> .<br><i>albus</i> .<br><i>lithospermus</i> . N. S.   | 31. <i>Phleum</i> , Timothy.<br><i>pratense</i> .  |
| 25. <i>Cyperus</i> Galingale.<br><i>mollis</i> . N. S.<br><i>strigosus</i> .<br><i>alternifolius</i> .<br><i>pumilus?</i><br><i>nutans</i> . N. S.  | 32. <i>Alopecurus</i> , Foxtail.<br>† <i>pratensis</i> .   |
| 26. <i>Scirpus</i> , Club-grafs.<br><i>palustris</i> .<br><i>capitatus</i> .<br><i>acicularis</i> .<br><i>lacustris</i> .<br><i>setaceus</i> .<br><i>capillaris</i> .<br><i>autumnalis</i> .<br><i>triqueter</i> .<br><i>mucronatus</i> .<br><i>echinatus?</i><br><i>sylvaticus</i> . | 33. <i>Muhlenbergia</i> , (Schre-<br>beri.)<br><i>diffusa</i> . N. S.<br><i>erecta</i> . N. S.   |
| 27. <i>Eriophorum</i> , Cotton-<br>grafs.<br><i>cyperinum</i> .<br><i>Digynia</i> .   | 34. <i>Milium</i> , Millet.<br><i>paradoxum</i> .  |
| 28. <i>Phalaris</i> , Canary.<br><i>arundinacea</i> .   | 35. <i>Agrostis</i> , Bentgrafs.<br><i>cylindrica</i> . N. S.<br><i>diffusa</i> . N. S.<br><i>capillaris</i> .<br><i>alba</i> .<br><i>virginica</i> .<br><i>mexicana</i> .   |
|   | 36. <i>Aira</i> , Hairgrafs.<br><i>cespitosa</i> .<br><i>flexuosa</i> .  |



- flexuosa.  
 navicularis, Schreberi. 44. N. S.  
 truncata. N. S.  
 pallens. N. S.  
 37. Melica, Melic-grafs.  
 speciosa. N. S.  
 38. Poa, Meadow-grafs.  
 alpina.  
 angustifolia.  
 pratensis.  
 annua.  
 flava.  
 pilosa.  
 capillaris.  
 compressa.  
 repens. N. S.  
 nutans. N. S.  
 distans.  
 39. Briza, Quaking-grafs.  
 media.  
 Eragrostis.  
 40. Uniola, Spike-grafs.  
 paniculata.  
 41. Dactylis, Cock's foot-  
 grafs.  
 glomerata.  
 42. Cynofurus, Dog's tail-  
 grafs.  
 indicus.  
 43. Festuca, Fescue.  
 elatior.  
 tenella, Schreberi.  
 N. S.  
 fluitans.
- obtusa. N. S.  
 Bromus, Brome-grafs.  
 fecalinus.  
 purgans.  
 ciliatus.  
 † tectorum.  
 45. Stipa, Feather-grafs.  
 avenacea.  
 46. Avena, Oats.  
 † elatior.  
 † fativa.  
 † nuda.  
 spicata.  
 fetacea, Schreberi. N. S.  
 47. Arundo, Reed.  
 epigeios.  
 48. Lolium, Darnel.  
 perenne.  
 49. Elymus, Lime-grafs:  
 canadensis.  
 striatus, Schreberi. N. S.  
 pilosus. N. S.  
 virginicus.  
 Hystrix.  
 50. Secale, Rye.  
 † cereale.  
 51. Hordeum, Barley.  
 † vulgare.  
 † distichum.  
 52. Triticum, Wheat.  
 † aestivum.  
 † hybernum.  
 † turgidum.  
 † polonicum.  
 † Spelta.

- Trigynia.*
53. *Holosteum*, Chick-weed.  
fucculentum.
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*.  
†fuccifa.  
†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. *Sanguiforba*, 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. 83. Menyanthes, Buck-  
 crispum? bean.  
 compressum. trifoliata.  
 CLASSIS 5. 84. Hydrophyllum, Wa-  
 Pentandria, Monogynia. terleaf.  
 72. Myosotis, Scorpion- virginicum.  
 grafs. 85. Lyfimachia, Loofeftrife.  
 fcorpoides. ciliata.  
 virginiana. punctata.  
 73. Lithospermum, Grom- 86. Anagallis, Red Pim-  
 well. pernel.  
 officinale. arvensis.  
 arvenfe. 87. Spigelia:  
 virginicum. † marilandica, Carolina  
 74. Anchusa, Alkanet. Pink-root.  
 virginica? 88. Azalea, Rosebay.  
 75. Cynogloffum, Hounds- nudiflora.  
 tongue. viscosa.  
 officinale. 89. Phlox.  
 virginicum. paniculata:  
 76. Pulmonaria, Lungwort. maculata.  
 virginica. pilofa.  
 77. Symphytum, Comfrey. divaricata.  
 † officinale. fubulata.  
 78. Borago, Borage. 90. Convolvulus, Bind-  
 † officinalis. weed.  
 79. Lycopfis. fepium.  
 virginica. panduratus:  
 80. Echium, Viper-grafs: purpureus.  
 vulgare. † Batatas.  
 81. Primula, Primrofe. fpithamaeus.  
 † veris. repens.  
 82. Dodecatheon. fibiricus?  
 Meadia. 91. Polemonium, Jacobs-  
 Ladder.  
 X 2 reptans.

- reptans.
92. Campanula, Bell-flow-  
er.  
rotundifolia.  
americana.  
perfoliata.  
aculeata. N. S.
93. Samolus, Brook-weed.  
valerandi.
94. Lonicera, Honeyfuckle.  
media?
95. Trioiteum, Fever-root.  
perfoliatum..
96. Mirabilis.  
† dichotoma.
97. Verbascum, Mullein.  
Thapsus.  
Blattaria.
98. Datura, Thorn-apple.  
Stramonium.
99. Hyoscyamus, Hen-  
bane.  
† niger.
100. Nicotiana, Tobacco.  
Tabacum.
101. Physalis, Winter-cher-  
ry.  
pubescens.  
viscosa.
102. Solanum, Nightshade.  
† tuberosum.  
† Lycopersicum.  
nigrum.
103. Capsicum, Spanish-  
Pepper.  
† annum.
104. Rhamnus, Buckthorn.  
alnifolius? Aitoni.
105. Ceanothus, New-Jer-  
sey 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.  
   *fyriaca*.  
   *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. *america-*  
   *na*, Marshalli.  
 122. *Heuchera*.  
   *americana*.  
 123. *Gentiana*, Gentian.  
   *Saponaria*.  
   *Centaureum*.  
   *phoenicea*. N. S.  
   *glandulosa*. N. S. *varie-*  
   *tas ciliatæ*?  
 124. *Hydrocotyle*, Penny-  
   wort.  
   *americana*.  
 125. *Sanicula*, Sanicle:  
   *canadensis*.  
   *marilandica*.  
 126. *Bupleurum*, Thoro-  
   wax.  
   † *rotundifolium*.  
 127. *Daucus*, Carot.  
   *Carota*.  
 128. *Conium*, Hemloc:  
   *maculatum*.  
 129. *Heracleum*:  
   *Sphondylium*, Cow-  
   parsnep.  
 130. *Ligusticum*, Lovage.  
   † *Levisticum*.  
 131. *Angelica*.  
   *atropurpurea*.  
   *lucida*.  
 132. *Sium*, Water-parsnep.  
   *rigidius*.  
   *suave*, *Walteri*?  
 133. *Sison*. Honewort.  
   *canadense*.  
 134. *Cicuta*, Cowbane  
   *maculata*.  
 135. *Coriandrum*, Coriander.  
   *fativum*.  
 136. *Scandix*, Shepherds-  
   needle.  
   † *cerefolium*.

- † cerefolium.  
procumbens?  
137. Chaerophyllum.  
138. Imperatoria, Master-  
wort.  
† Ostruthium.  
139. Thapsia.  
trifoliata.  
140. Pastinaca, Parsnep.  
fativa.  
141. Smyrnum, Alexanders  
aureum.  
integerrimum.  
luteum. N. S. aureum,  
Walteri.  
142. Anethum.  
† graveolens, Dill.  
† Foeniculum, Fennel.  
143 Carum, Caraway.  
Carvi.  
144. Apium.  
† Petroselinum, Parsley.  
† graveolens, Cellery.  
*Trigynia.*  
145. Rhus, Sumach.  
typhinum.  
glabrum.  
Vernix.  
copallinum.  
radicans.  
Toxicodendron.  
146 Viburnum, Mealy-tree.  
prunifolium.  
dentatum.  
Lantana.  
acerifolium.
- † Opulus.  
trilobum, Marshalli.  
Lentago.  
147 Sambucus, Elder,  
canadensis.  
nigra.  
148 Staphylea, Bladder-nut.  
trifoliata.  
149. Sarothra  
gentianoides, Ground-  
pine.  
150. Aralia.  
† spinosa, Angelica-  
Tree.  
racemosa, Pettymorrel.  
nudicaulis, Sassa-paril.  
151. Linum, Flax.  
† usitatissimum.  
virginianum.  
152. Drosera, Sundew.  
rotundifolia.  
*Polygynia.*  
153. Zanthorrhiza.  
† simplicissima. } Mar-  
apiifolia. } shalli.  
Aitoni.
- CLASSIS 6.  
*Hexandria, Monogynia.*  
154. Tradescantia.  
virginica.  
155. Pontederia.  
cordata.  
156. Narcissus.  
† poeticus.  
† Jonquilla.

- † Jonquilla.  
 157. Allium, Garlic.  
   † Porrum.  
   † sativum.  
   vineale.  
   canadense.  
   † Cepa.  
   montanum. N. S.?  
 158. Liliium, Lily.  
   † candidum.  
   † bulbiferum.  
   † pomponium.  
   canadense.  
   philadelphicum.  
 159. Fritillaria, Fritillary.  
   † imperialis.  
 160. Uvularia, Bell-wort.  
   perfoliata.  
   fessilifolia.  
 161. Erythronium, Dog-  
   tooth.  
   luteum. }  
   album. }  
 162. Tulipa.  
   † fylvestris.  
   † 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.  
   perficarioides.

- perficarioides.  
 obtusifolius.  
 alpinus.  
 Acetofella.  
 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:  
*Ostandria, Monogynia.*  
 183. Tropaeolum.  
 † minus.  
 † majus.  
 184. Rhexia, Soap-wood.  
 mariana.  
 185. Oenothera, Night-wil-  
 lowherb.  
 biennis.  
 fruticosa.  
 186. Gaura.  
 biennis.  
 187. Epilobium, Willow-  
 herb.  
 tetragonum.  
 palustre.
188. Vaccinium, Whortle.  
 flamineum.  
 corymbosum.  
 frondosum.  
 resinofum, Aitoni.  
 album.  
 189. Dirca, Leather-bark.  
 palustris.  
*Trigynia.*  
 190. Polygonum, Knotweed.  
 virginianum.  
 Lapathifolium.  
 Hydropiper.  
 perficaria.  
 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.*



*Trigynia.*

192. Rheum, Rhubarb.  
 † Rhaponticum.  
 † Rhabarbarum.  
 † hybridum.  
 CLASSIS 10.  
*Decandria, Monogynia.*  
 193. Sophora, Wild-Indigo.  
 tinctoria.  
 194. Cercis, Red-bud.  
 canadensis.  
 195. Cassia.  
 marilandica.  
 nictitans.  
 196. Ruta, Rue.  
 † graveolens.  
 197. Monotropa, Birds-nest.  
 Hypopithys.  
 uniflora.  
 198. Kalmia, Laurel.  
 latifolia.  
 angustifolia,  
 199. Andromeda, Moor-  
 wort.  
 paniculata, Aitoni.  
 200. Gaultheria, Mountain-  
 Tea.  
 procumbens.  
 201. Epigaea.  
 repens.  
 202. Pyrola, Winter-green.  
 rotundifolia.  
 minor.  
 umbellata.  
 maculata.

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*Digynia.*

203. Hydrangea.  
 arborefcens.  
 204. Saxifraga, Saxifrage.  
 pensilvanica.  
 nivalis.  
 205. Mitella.  
 diphylla.  
 206. Saponaria, Soapwort.  
 officinalis.  
 † Vaccaria.  
 207. Cucubalus, Campion.  
 stellatus.  
 208. Silene, Catchfly.  
 virginica.  
 antirrhina.  
 209. Arenaria, Sandwort.  
 serpyllifolia.  
 fetacea. N. S.  
 pensilvanica. N. S?  
*Pentagynia.*  
 210. Sedum.  
 † telephium, Ever-  
 green.  
 211. Penthorum.  
 fedoides.  
 212. Oxalis, Cuckow-bread.  
 violacea.  
 corniculata.  
 stricta.  
 213. Agrostemma, Cockle.  
 Githago.  
 214. Cerastium, Mouse-ear.  
 vulgatum.  
 femidecandrum.  
 hybridum. N. S?

Y

- hybridum, N. S? † coronarius.  
*Decagynia.* 223. Amygdalus.  
 215. Phytolacca, Poke. † Perfica, Peach.  
 decandra. 224. Prunus, Plumb.  
 virginiana.  
 CLASSIS II. pumila.  
*Dodecandria,* † Cerasus.  
*Monogynia.* americana, Marshalli.  
 216. Asarum. † domestica.  
 canadense. *Digynia.*  
 virginicum. 225. Crataegus, Hawthorn.  
 217. Portulaca, Purflane. coccinea.  
 oleracea. Crus galli.  
 218. Lythrum, Grafspoly. cordata, Aitoni.  
 petiolatum. pyrifolia, Aitoni.  
*Digynia.* flava, Aitoni?  
 219. Agrimonia, Agrimony. *Pentagynia.*  
 parviflora, Aitoni. 226. Mespilus, Medlar.  
 minor. N. S. arbutifolia.  
*Trigynia.* canadensis.  
 220. Euphorbia, Spurge. 227. Pyrus, Pear.  
 maculata. † communis.  
 Chamaesyce. † Malus.  
 Peplus. coronaria, Crab-apple.  
 † Lathyris. † Cydonia.  
 † helioscopia. 228. Spiraea, Meadowsweet.  
 corollata. opulifolia, Ninebark.  
*Dodecagynia:* trifoliata, Indian-phy-  
 221. Sempervivum, House- fic.  
 leek. *Polygynia.*  
 † tectorum. 229. Rosa, Rose.  
 CLASSIS 12. rubiginosa, Sweet-Bri-  
*Icosandria, Monogynia.* ar.  
 222. Philadelphus, Mock- carolina.  
 Orange. pendulina, Aitoni?  
 † centifolia.

- |                                  |                             |
|----------------------------------|-----------------------------|
| † centifolia.                    | † Rhoëas.                   |
| † gallica.                       | † somniferum.               |
| † alba.                          | 240. Argemone.              |
| 230. Rubus, Bramble.             | mexicana.                   |
| occidentalis.                    | 241. Nymphaea, Water-can.   |
| hispidus.                        | advena, Aitoni.             |
| fruticosus.                      | odorata, Aitoni.            |
| odoratus.                        | 242. Tilia, Lime-tree.      |
| † idaeus.                        | americana.                  |
| 231. Fragaria, Straw-berry.      | 243. Cistus, Cistus.        |
| vesca.                           | tomentosus.                 |
| 232. Potentilla, Cinquefoil.     | <i>Digynia.</i>             |
| pensilvanica.                    | 244. Paeonia.               |
| canadensis.                      | † officinalis.              |
| reptans.                         | <i>Trigynia.</i>            |
| 233. Geum, Bennet.               | 245. Delphinium, Lark-spur. |
| virginianum.                     | † Consolida,                |
| canadense?                       | <i>Pentagynia.</i>          |
| 234. Calycanthus.                | 246. Aquilegia, Columbine.  |
| † floridus, Sweet-scented Shrub. | † vulgaris.                 |
|                                  | canadensis.                 |
|                                  | 247. Nigella.               |
|                                  | † fativa.                   |
|                                  | 248. Liriodendron.          |
|                                  | tulipifera, Poplar.         |
|                                  | 249. Magnolia.              |
|                                  | glauca, Swamp-Saffras.      |
|                                  | acuminata, Cucumber-tree.   |
|                                  | tripetala, Umbrella-tree    |
|                                  | 250. Annona.                |
|                                  | triloba, Papaw.             |
|                                  | 251. Anemone.               |
|                                  | Hepatica.                   |
|                                  | virginiana.                 |
|                                  | quinquefolia.               |

CLASSIS 13:

*Polyandria, Monogynia.*

235. Actæa, Bane-berry.  
racemosa.
236. Sanguinaria, Blood-root.  
canadensis.
237. Podophyllum, May-apple.  
peltatum.
238. Chelidonium, Celandine.  
majus.
239. Papaver, Poppy.

- quinquefolia.  
 thalicteroides.  
 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*, Dra-  
 gons-head.  
 virginianum.  
 † Moldavica.  
 275. *Ocimum*.  
 † basilicum, Sweet-Basil.  
 276. *Trichostema*.  
 dichotoma.  
 277. *Scutellaria*, Skull-cap.  
 lateriflora.  
 integrifolia.  
 hypsipifolia.  
 elliptica, Claytoni. 92.  
 N. S.  
 pubescens. N. S.  
 278. *Prunella*, Self-heal.  
 vulgaris.  
 279. *Phryma*.  
*Leptostachya*.  
*Angiospermia*.  
 280. *Bartisia*.  
 coccinea. }  
 lutea. }  
 281. *Pedicularis*, Loufe-  
 wort.  
 asplenifolia. N. S.  
 canadensis.  
 282. *Gerardia*.  
 purpurea, Walteri.  
 erecta, Walteri.  
 flava.  
 pedicularia.  
 283. *Chelone*.  
 glabra.
- Pentstemon.  
 284. *Antirrhinum*, Snapdra-  
 gon.  
 † *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.  
 fativum.  
 294. *Draba*, Whitlow-grass.  
 verna.  
 bifolia. N. S.  
 295. *Lepidium*, Dittander.  
 † fativum.  
 virginicum.

- virginicum.  
 296. Thlaspi, Shepherds-  
 purse.  
 Bursa Pastoris.  
 297. Cochlearia.  
 † Armoracia, Horfe-ra-  
 dish.  
*Siliquosa.*  
 298. Dentaria, Coralwort.  
 enneaphylla.  
 299. Cardamine, Ladief-  
 mock.  
 virginica.  
 300. Sifymbrium, Water-  
 cress.  
 nasturtium.  
 amphibium.  
 301. Erysimum, Worm-feed.  
 officinale.  
 † Barbara.  
 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.  
 † fativus.  
 307. Cleome.  
 dodecandra.  
 CLASSIS 16.  
*Monadelpbia,*  
*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.

*Ostendria.*

*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.  
fylvatica.  
† 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.

† fativa.

## CLASSIS 18.

*Polyadelphia,**Polyandria.*

329. Hypericum, Johns-  
wort.

Kalmianum.

canadense.

perforatum.

quinquenervium, Wal-  
teri?

maculatum, Walteri?

## CLASSIS

## CLASSIS 19.

*Syngenesia,**Polygamia aequalis.*330. Tragopogon, Goats-  
beard.

† porrifolius.

331. Sonchus, Sow-thistle.  
oleraceus.

floridanus.

332. Lactuca, Lettuce.

canadensis.

† fativa.

333. Prenanthes, Wild-Let-  
tuce, Ivy-leaf.

altissima.

alba.

334. Leontodon, Dandelion.

Taraxacum.

335. Hieracium, Hawk-  
weed.

venosum.

Gronovii.

paniculatum.

Kalmii.

336. Hyoseris, Swine-fucco-  
ry.

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,



- |   |  |
|---|--|
| <p>† Abſinthium, Worm-wood.</p> <p>† vulgaris, Mug-wort.</p> <p>347. Gnaphalium, Cudweed.</p> <p style="padding-left: 2em;">obtusifolium.</p> <p style="padding-left: 2em;">margaritaceum.</p> <p style="padding-left: 2em;">plantagineum.</p> <p style="padding-left: 2em;">purpureum.</p> <p>348. Conyza, Plowmanswort.</p> <p style="padding-left: 2em;">asteroides.</p> <p>349. Erigeron, Fleabane.</p> <p style="padding-left: 2em;">canadense.</p> <p style="padding-left: 2em;">philadelphicum.</p> <p style="padding-left: 2em;">camphoratum ?</p> <p>350. Senecio, Groundſell.</p> <p style="padding-left: 2em;">hieracifolius ?</p> <p style="padding-left: 2em;">aureus, <i>et alii</i>.</p> <p>351. Aſter, Starwort.</p> <p style="padding-left: 2em;">hyſſopifolius.</p> <p style="padding-left: 2em;">rigidus.</p> <p style="padding-left: 2em;">novae angliæ.</p> <p style="padding-left: 2em;">undulatus.</p> <p style="padding-left: 2em;">grandiflorus.</p> <p style="padding-left: 2em;">cordifolius.</p> <p style="padding-left: 2em;">puniceus.</p> <p style="padding-left: 2em;">novi belgii.</p> <p style="padding-left: 2em;">mifer.</p> <p style="padding-left: 2em;">macrophyllus.</p> <p style="padding-left: 2em;">divaricatus.</p> <p style="padding-left: 2em;"><i>et aliae forſan hybridæ ſp.</i></p> <p>352. Solidago, Goldenrod.</p> | <p style="padding-left: 2em;">canadenſis.</p> <p style="padding-left: 2em;">altiffima.</p> <p style="padding-left: 2em;">lateriflora.</p> <p style="padding-left: 2em;">bicolor.</p> <p style="padding-left: 2em;">lanceolata.</p> <p style="padding-left: 2em;">caefia ?</p> <p style="padding-left: 2em;">flexicaulis. }<br/> padding-left: 2em;"&gt;latifolia. }<br/> padding-left: 2em;"&gt;rigida ?</p> <p style="padding-left: 2em;">odora, Aitoni.</p> <p style="padding-left: 2em;">aſpera, Aitoni ?</p> <p style="padding-left: 2em;"><i>et aliae forſan hybridæ.</i></p> <p>353. Inula, Elecampane.</p> <p style="padding-left: 2em;">† Helenium.</p> <p>354. Helenium.</p> <p style="padding-left: 2em;">autumnale.</p> <p>355. Zinnia.</p> <p style="padding-left: 2em;">† multiflora.</p> <p>356. Chryſanthemum, Goldins.</p> <p style="padding-left: 2em;">† Leucanthemum.</p> <p>357. Matricaria, Fever-few.</p> <p style="padding-left: 2em;">† Parthenium.</p> <p style="padding-left: 2em;">† Chamomilla.</p> <p>358. Anthemis, Chamomile.</p> <p style="padding-left: 2em;">Cotula.</p> <p style="padding-left: 2em;">† nobilis.</p> <p>359. Achillea, Yarrow.</p> <p style="padding-left: 2em;">Millefolium.</p> <p>360. Bupthalmum, Oxeye.</p> <p style="padding-left: 2em;">Helianthoides.</p> <p style="padding-left: 2em;"><i>Polygamia fruſtanea.</i></p> <p>361. Helianthus, Sun-flower.</p> |
|---|--|

- † 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-flow-  
   er.  
   Kalmii  
   pallida, Schreberi. N. S.  
   Cardinalis.  
   siphilitica.  
   inflata.  
 368. Viola, Violet:  
   palmata.  
   pedata.  
   primulifolia.  
   palustris?  
   fagittata, N. S. Aito-  
   ni.  
   † 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, Wal-  
   teri.  
   pallida. Clayton, 136.  
     n 200?  
 371. Ophrys, Tway-blade:  
   corallorhiza.  
   cernua.  
   maculata. N. S.  
   virginiana, Schreberi.  
   hyemalis. N. S.  
 372. Arethusa.  
   bulbosa.  
 373. Cypripedium, Ladie-  
   flipper.  
   Calceolus.  
   album, Aitoni.  
   acaule, Aitoni.  
     *Triandria.*  
 374. Sifyrinchium.  
   Bermudiana.  
     *Hexandria.*

*Hexandria.*

375. Aristolochia, Birthwort.  
ferpentaria.

*Polyandria.*

376. Arum, Cuckow-point.  
Dracontium.  
triphyllum.  
377. Dracontium.  
foetidum.

CLASSIS 21.

*Monoccia.*

*Diandria.*

378. Lemna, Duck-meat.  
minor.  
arhiza.

*Triandria.*

379. Typha, Cats-tail.  
latifolia.  
380. Sparganium, Burrweed.  
erectum.  
381. Zea, Indian-corn.  
† Mays.  
382. Tripfacum, Scamegrafs.  
dactyloides.  
383. Coix, Jobf-tears.  
† Lacryma.  
384. Carex, Seg.  
patula, Hudfoni?  
pulcaris.  
leporina.  
vulpina.

- muricata.  
loliacea.  
paniculata:  
varia, Schreberi. N. S.  
tomentosa.

- panicea.  
sylvatica, Hudfoni.  
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.*

- Pentandria.*
390. Xanthium, Clott-weed.  
strumarium.
391. Ambrosia.  
trifida.  
elatior.  
artemififolia.
392. Amaranthus.  
albus.  
hybridus.  
fanguineus.  
hypochondriacus.
393. Sagittaria, Arrow-head.  
fagittifolia.  
obtusifolia.  
lancifolia.
394. Quercus, Oak.  
Prinus.  
aquatica, Aitoni.  
nigra.  
rubra.  
discolor, Aitoni.  
alba.
395. Juglans, 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.  
Ofrya.
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, Arborvitae.
403. Acalypha.  
virginica.
404. Ricinus.  
† communis.  
*Syngenesias.*
405. Momordica.  
echinata. N. S.

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, Marshal-

li, Prickly-ash.

411. Spinacia, Spinach.

† oleracea.

412. Cannabis, Hemp.

† sativa.

413. Humulus, Hop.

Lupulus.

*Hoxandria.*

414. Smilax.

rotundifolia.

laurifolia.

Pseudochina.

415. Dioscorea.

villosa.

*Octandria.*

416. Populus, Poplar:

tremula.

balsamifera.

*Dodecandria.*

Menispermum, Moon-

seed.

virginicum.

carolinum.

*Monadelpbia.*

417. Juniperus, Juniper.

† Sabina

† communis.

virginiana? Red-Cedar.

CLASSIS. 23.

*Polygamia,**Monoecia.*

418. Veratrum, White-Hel-

lebore.

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.  
 odoratus.
421. Cenchrus, Hedge-hog-  
 grafs.  
 echinatus.
422. Atriplex, Orach.  
 † hortensis.
423. Acer, Maple.  
 rubrum.  
 sacharinum.  
 negundo.
424. Celtis. Nettle-tree.  
 occidentalis.
- Dioecia.*
425. Gleditsia, Honey-locust.  
 † triancanthos.
426. Fraxinus, Ash.  
 americana, Marshalli.  
 alba.  
 nigra.  
 pensilvanica.
427. Diospyros, Persimmon.  
 virginiana.
428. Nyssa, Tupelo-tree.  
 multiflora, Walteri, in-  
 tegrifolia Aitoni.
429. Panax.  
 quinquefolium, Gin-  
 feng.  
 trifolium.

## CLASSIS 24:

*Cryptogamia,**Filices.*

430. Equisetum, Horfe-tail.  
 arvense.  
 fluviatile.  
 hyemale.
431. Onoclea.  
 fenfibilis.
432. Ophioglossum.  
 vulgatum.
433. Osmunda, Flowering-  
 Fern.  
 virginica.  
 ternata.  
 regalis.  
 claytoniana.  
 cinnamomea.
434. Pteris, Brakes.  
 aquilina.  
 caudata.  
 talictroides, Schreberi.
434. Asplenium, Spleen-  
 wort.  
 rhizophyllum.  
 falicifolium.  
 Trichomanoides.  
 ebeneum, Aitoni.
436. Polypodium, Polypody.  
 virginianum.  
 Lonchitis.  
 cicutarium.  
 phegopteris.

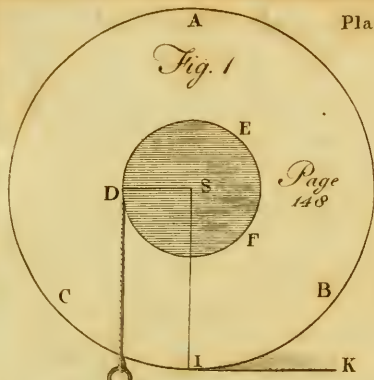
cristatum.

- cristatum.  
 marginale.  
 bulbiferum.  
 fragile.  
 437. Adiantum, Maiden-  
     hair.  
     pedatum.  
 438. Lycopodium, Club-  
     moss.  
     ferratum.  
     rupestre.  
     alopescuroides.  
     complanatum.  
     apodum.  
     obscurum.  
 439. Sphagnum, Bog-moss.  
     palustre.  
 440. Polytrichum, golden-  
     maiden-hair.  
     commune.  
     americanum, Dillen.  
         434. t. 55. f. 12.  
 441. Mnium.  
     palustre.  
     cuspidatum.  
     proliferum.  
     undulatum, et alia.  
 442. Bryum, Wall-moss.  
     striatum.  
     pomiforme.  
     pyriforme.  
     rurale.  
     scoparium.  
     undulatum.  
     glaucum.  
     pulvinatum.  
     pallidum, Schreberi.  
     Dillenii, Hiss. musc.  
         389. t. 49. f. 56.  
     *et alia.*  
 443. Hypnum.  
     adianthoides.  
     rutabulum.  
     filicinum.  
     delicatulum.  
     cristacastrensis.  
     abietinum.  
     cupressiforme.  
     dendroides.  
     Hypnum.  
     purum.  
     riparium.  
     sericeum.  
     velutinum.  
     serpens.  
     sciuroides.  
     julaceum.  
     Dillenii Hist. musc.  
         322. t. 41. f. 58.  
     *et alia.*  
         *Algae.*  
 444. Jungermannia:  
     viticulosa.  
     dilatata.  
     platyphylla.  
     et aliae.  
 445. Marchantia.  
     tenella.  
     conica.  
 446. Lichen, Liver-wort.  
     calcarius.

- calcarius.  
 ericetorum.  
 fagineus.  
 saxatilis.  
 parietinus.  
 granosus, Schreberi.  
 phyfodes.  
 ciliaris.  
 pulmonarius.  
 calicaris.  
 caperatus.  
 crinitus, Schreberi.  
 apthofus.  
 caninus.  
 fylvaticus.  
 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.  
 fuberofus:  
 fanguineus.  
 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.

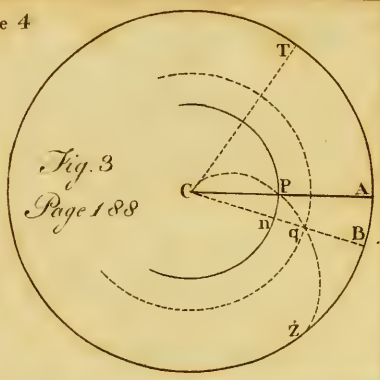






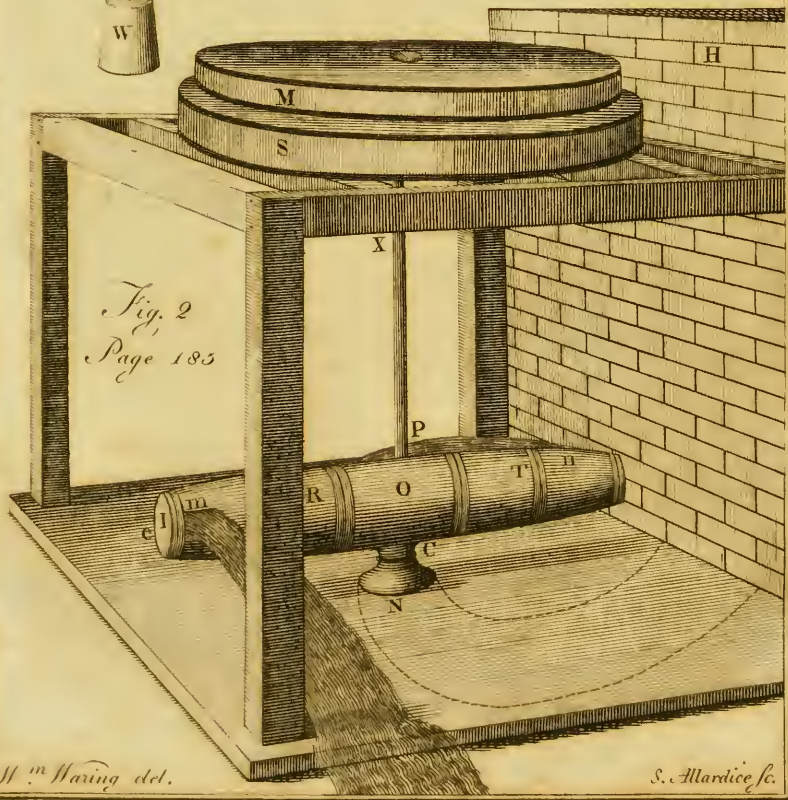
*Fig. 1*

*Page 148*



*Fig. 3*

*Page 188*



*Fig. 2*  
*Page 185*

N<sup>o</sup>. 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.

**R**T. 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  
VOL. III. A a bottom

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  $= e\sqrt{h}$ , it will be, as  $ch : ue \sqrt{h} : : p : p\sqrt{h}$ ,  $=$  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,  $\left\{ \begin{array}{l} a = \text{area of either aperture} \\ h = \text{height of the water above the centres of the apertures} \\ w = 62,5 \text{ lb. avoirdupois} = \text{the Wt. of a cubic foot of water,} \end{array} \right\} \text{ in feet.}$

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 reaction thereof ceases, and the equal impulse remaining on the contrary side  $e$ , will be the force required. Viz.  $ahw$  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 as 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,  
 $a$  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  $t^2$ :

$$1.228ax :: aw \dot{x} : \frac{1.228awx \dot{x}}{t^2} = \text{the centrifugal force thereof at}$$

$x$  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

$$x=r, \text{ being doubled, is } \frac{76.75ar^2}{t^2} = \text{the central force of the}$$

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

A a 2 different

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  $x = CP$ , 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 CA.

$c = 3.1416$ ;  $a, r, t$  and  $w$ , as before.

Then the moving plane or particle P will be  $\frac{ax}{2cx}$ , and its weight  $wax$  lbs. as before, also its velocity  $= \frac{v}{t}$  and the time

\* The velocity must be uniform if the tube be prismatic; 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 com-

municate a velocity of  $\frac{2cx}{t}$  feet per second, to a body weigh-  
ing  $\frac{awx}{16t}$  lb. in  $\frac{x}{v}$  seconds will be  $\frac{cwavx}{16t}$  lb.=the fluxion of

the inertia, and the fluent, when  $x$  becomes =  $r$ , will be  $12.272avr$

$\frac{12.272avr}{t}$  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, QEF.

This may be obtained independently of fluxions; by considering, that the whole quantity of water ( $rwa$ ) in

the time  $\frac{r}{2crv}$  of its passing through the rotatory, acquires a

velocity  $\frac{2crv}{t}$  equal to, and in the direction of, the aper-

tures, 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  $2wa h : 8\sqrt{h}^2 = 64h : : 2awh$

$+\frac{76.75ar^2}{t^2} : 64h + \frac{39,296r^2}{t^2} =$ the square of the augment-

ed 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 substituting  $8\sqrt{h + \frac{.614r^2}{ht^2}}$  for  $v$ , in  $\frac{12.272avr}{t}$  it becomes  $\frac{98.176ar^2}{t^2} \times \sqrt{\left(\frac{---}{r^2} + .614\right)}$  = the inertia; and, as the central force  $\frac{76,75ar^2}{t^2} : \frac{98.176ar^2}{t^2} \times \sqrt{\left(\frac{ht^2}{r^2} + .614\right)} :: 1 :$   
 $1,28\sqrt{\frac{ht^2}{r^2} + .614} = \sqrt{1 + \left(\frac{1.638ht^2}{r^2}\right)}$ ; that is, the power gained by centrifugal force is to the obstruction occasioned by the inertia, in the proportion of 1 to  $\sqrt{1 + \frac{1.638ht^2}{r^2}}$ ); by which it appears that the latter is the great-

ter, except when  $t$  or  $h = 0$ , or  $r$  infinite; cases never occurring in practice; and that the longer the brachia, the less the fall of water, and the greater the velocity of rotation are, the nearer these forces approach the ratio of equality; but as we always find something in practical mechanics to prevent our "running into infinitesimals," so here we are particularly limited; for in the

*Adjustment of the parts and motion.*

The centrifugal force should not exceed the gravity of the rotating water, or this water would be drawn into the tube faster than the natural supply at its entrance, by the velocity proper to that depth; consequently must lose the pressure of the column above it: nor should the velocity of the apertures, be greater than half that of the water through them; for the apertures being still adapted to the velocity, the effluent quantity or number of acting particles is as the time; consequently the momentum is in the simple



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,  $\frac{76.75r^2}{t^2} = 2war$ ; and,  $\frac{2cr}{t} = 4\sqrt{h+r}$ . from which equations we have the following.

Viz.  $\left\{ \begin{array}{l} h = 3r = 5t^2 \\ r = 1.63t^2 = \frac{1}{2} h \\ t = \sqrt{.614r} = \sqrt{\frac{1}{3} h} \end{array} \right\}$  nearly, where we find, h, r, & t<sup>2</sup>, 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 apertures 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  $62,5(ah+r) - 125ar = 62,5a \times h - r$  (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,  $AV = .614r^2$   
 $8a\sqrt{h} \frac{AV}{t^2}$  - 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,  $\frac{2^{wah}}{2} = 41\frac{2}{3}ah$ , 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

*Eafy*

*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 velocity at the apertures may be easily reduced to any part of the machinery by the common rules of mechanics.

N<sup>o</sup>. 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..

S I R,

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  $47^{\circ}$ . and in the gulph stream at,  $70^{\circ}$ . viz.

By Capt. Billings,		By my experiments	diff. between
1791, June, coast,	61	1789 Nov. coast, 47	June and Nov.
do. Stream,	<u>77</u>	do. stream, 70	$14^{\circ}$ .
do. stream warmer,	<u>16</u>	do. stream warmer 23	<u>7</u>

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  $10^{\circ}$ . 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 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 eastward. 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 soundings, 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 latitude on the 30th ( $37^{\circ} 47'$  N.) that he was on the 17th of August. ( $37^{\circ} 53'$  N.) but during the intermediate time he was driven, as winds prevailed, in a zig zag course, as far North as  $39^{\circ} 04'$  N. and as far south as  $36^{\circ} 26'$  N. It appears also during this time that his thermometer varied from  $1^{\circ}$  to  $5^{\circ}$ ; but it is to be remarked that there is a medium in his thermometrical variations answering to the medium of his latitude. When he was in  $39^{\circ} 04'$ . the thermometer marked  $75^{\circ}$  and when in  $36^{\circ} 26'$ . it also marked  $75^{\circ}$  but when in  $38^{\circ} 12'$ . it marked  $70^{\circ}$ . 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 southward the thermometer marked 77.

Returning towards the coast of America, Captain Billings discovered his passage across the gulph stream by a sudden fall in the mercury of  $5^{\circ}$  from noon to night, and about  $5^{\circ}$  farther West, by a further fall in the space of 8 hours run, he discovered the coast, where he got soundings, before he saw the land.

The usefulness of the thermometer as a nautical instrument is not confined to the discovery of an approach towards objects of danger *known to exist*; but it, may if attended to, discover others *not at present supposed to exist*, against 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; some are said to be uncertain, others have been seen but once, and preserve the names of their supposed discoverers. These facts are generally doubted, and by some mariners have been ridiculed; but it should be considered that in every instance where the discovery of these hidden dangers have been fatal, no one could escape to tell the melancholy tale, and surely the number of missing ships justifies a conjecture that such misfortunes have happened, and ought to influence every navigator to make accurate observations on the temperature of the sea during the *whole* of his voyage.

A gentleman of undoubted veracity related to me some time since, the following fact, which I mention on account of its aptitude to this subject.

On a voyage from the West-Indies to England, the small vessel he was in, touched at Bermuda. On leaving that island, having fine weather and a smooth sea, they sailed along a ridge of rocks, seeing the bottom very plain-



ly 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 set. 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 founding, 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

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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	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 a rois, 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. Land in sight, but frequently obscured by fog. Land distant about 6 leagues. Land distant about 2 leagues being the high land of Braganca nova
	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 de- } { grees, 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	
	8 A. M.				57	
	Noon.				55	

*A Thermometrical*

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*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 ESE dist. 7 leagues.
	Noon.	41 07	9 04		60	
5	Noon.	40 39	13 06	69	61	} But about half of degree difference of latitude during 5 days, and little or no change in the temperature of the sea.  N. B. I and $\frac{1}{2}$ degree southing water 3° warmer. At 4 P M made the island St. Michael Island dist. 4 leagues, tack'd and stood off, at 5 A M. tack'd and stood to the southward. Made the island Tercera. at 4 P. M. Near Tercera, St. Georges and Pico in sight: Close in with St. Georges. Land out of sight:
6	8 A. M.			69	65	
	Noon.	40 35	17 06	69	67	
7	10 P. M.	40 29	20 24	68	68	
8	No on.	40 24	22 01	69	68	
9	No on.	41 00	22 49	68	68	
10	No on.	40 13	22 39	68	68	
11	No on.	38 42	24 02	69	71	
	10 P. M.				70	
	Midnight				69	
12	Noon.	37 57	24 55	72	70	
14	Noon.	38 45	27 07	73	71	
15	2 P. M.			72	70	
	Sunfet.			72	69	
	Sunrise.				68	
16	2 P. M.	38 24	27 51	73	70	
	Sunfet.				69	
	10 P. M.				68	
	Midnight				69	
	Noon.	37 53	27 20	73	71	
17	10 P. M.				72	
	No on.	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.	28 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.

## N°. XXIV.

First Memoir of Observations on the Plants denominated  
*Cryptogamick.*

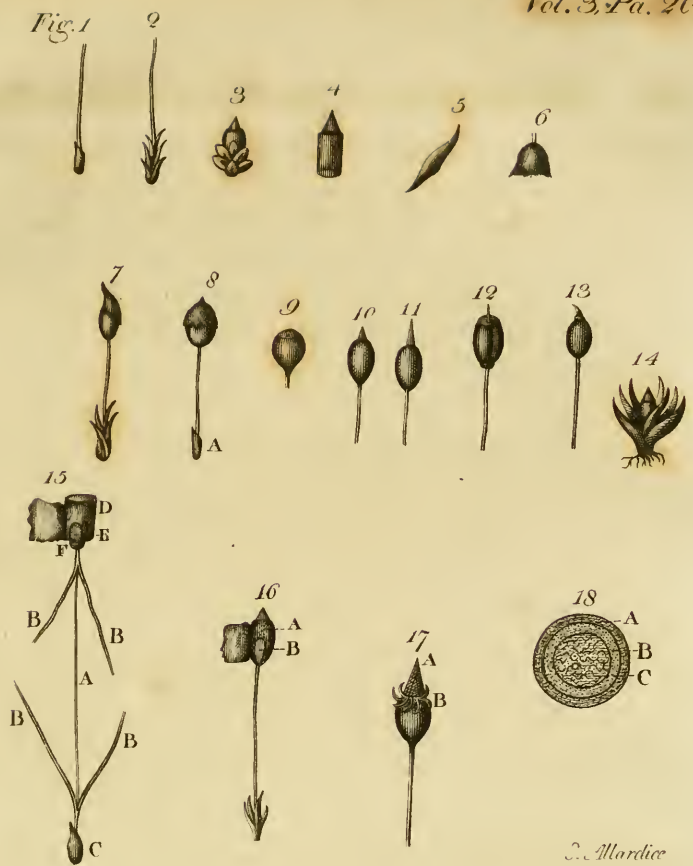
*Nusquam natura major quam in minimis.*

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.



S. Allardie

- 1. The calyx (perichæstium) 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 calyxine 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 Polytrichoides* (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 chapter, flattened at the base. *Polytrichum.*
  - 13. A corolla the opercule of which is in the form of a chapter, rounded at the base. *Bryum.*
  - 14. The corolla, stalk, leaves and root of the *Pboscum*.
  - 15. The corolla of the *Polytrichum commune*, opened after its explosion.
  - 16. The corolla of the *Hypnum velutinum* (Linn.) opened after the escape of the pollen.
  - 17. The corolla of the *Hypnum* at the moment of fecundation.
  - 18. An horizontal portion of the urne, seen with the microscope.
- 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.
  - A. The pollen, or fecundating powder.
  - B. The capsule, surrounded with the fecundating powder.
  - C. The calyx.
  - A. The interior cills.
  - B. The exterior cills.
  - A. The epidermis.
  - B. The fecundating powder.
  - C. The capsule and seeds.



Stage	Input	Output
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

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 asperision 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

fection of their parts, have induced some naturalists to believe, that these little animals were not subject to the general law by which all the others are governed. Thence, they concluded that the principle of regeneration by means of the sexual organs was not exclusively necessary for the multiplication and reproduction of every individual.

This system, however opposed to what comes under our daily observation, has, nevertheless, found, and still continues to find, many warm supporters, and has been much strengthened by the analogy which has been discovered between the mosses and the mushrooms, the sexual organs of which were not determined till I made my observations on the subject, so that these plants were thought to be to the vegetable, what worms † and polypi are to the animal, world.

I shall not, in this place, undertake to refute this opinion with regard to the polypi, which do not come within the limits of these observations, but until more accurate experiments shall have brought us to the certain discovery of the manner by which these little animals are reproduced, I shall remain satisfied with the observation of Bernard de Jussieu on the polypus, and shall reject every system which tends to favour an opinion, that nature, who in all other things, and in those which are most within the reach of our observation, ever acts by constant and by uniform laws, could have become so different from herself and have adopted partial rules in favour of a very small number of individuals. Here I shall confine myself to some of those plants denominated *Cryptogamick*, which I have observed with great care and attention, and which (as I shall endeavour.

† I might have dispensed with mentioning the Polypi in particular, as they are comprehended under the general appellation of worms; but I thought it best to make special mention of them, as of all animals they are those of which the most fabulous accounts have been given, and which have afforded the greatest scope 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 *supervegetation*; “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 genus *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 *Nesloe*, &c. the Capsule which is formed at the extremity of the point of a non descript species of *Hydnium*; and lastly, I have shewn the duplicity of the blades of the *Agaricus* of Linnaeus, which, in the manner of pods or siliques, 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.

¶ Linnaeus and his followers have adopted the opinion of Dillenius,

lists, the cilia are the male organs, and the pollen contained in the urn is the seed. Others, again, adopt an opinion entirely different, and pretend that the urn is a capsule which contains the seed, and that the glandular parts situated under the foliola, or little leaves, of the stellated branches (as in the *Polytricum* and *Mnium*) are the antheræ, or organs which contain the prolific liquor. The questions which now divide the naturalists on this subject are the following :

1st, Whether the parts of which we are speaking are in fact the sexual organs of the mosses.

2dly, To determine the use and the nature of each separately in regard to the functions which are attributed to them.

These two questions being solved, there can remain no doubt as to the mode of regeneration of these plants, and every contrary system must fall to the ground. Of this I have become fully convinced by means of some very simple and very easy observations, which may be made by others, with the greatest facility.

I shall not here attempt to refute the several opinions which I have thus slightly mentioned. Men of information, and those devoid of prejudice, will easily determine how far these opinions are worthy of confidence, particularly after they shall have read the following detail of my observations on the subject.

OF

§ Hill and Meese. Their system, the most ingenious of all, is extremely plausible, but it cannot be admitted, 1st. because the Pollen, which they consider as seeds, has all the characteristics of a fecundating pollen, such as its convulsive and impetuous emission, its inflammability, and its great difficulty of incorporating with water. 2d. Because the Cilia not being uniform or constant in all the mosses, and being sometimes found of two different species in the same individual, cannot be direct organs of generation, but only (as I shall presently demonstrate) accessory and secondary organs, intended to protect and facilitate the act of fecundation.

The other systems are still less admissible, because they cannot be applied to all the species of mosses, and are liable to exceptions which are sufficient to demonstrate 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 *Perichæti-um*. { 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 *Opercul*: { more or less subulated in almost every one (Fig. 9. 13.); and in the form of a chapter 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 Lille 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 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 accessory 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 prolific 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 authorized 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 Mem-  
ber of the Academy of Sciences of Paris.

N<sup>o</sup>. 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.

S I R,

Read Feb.  
3, 1792.

**A** GREENABLE 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 mound 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 those remarks.

The works at Grave-Creek I have carefully viewed, but never traced the lines with such accuracy as to enable me to give you a plan. They are very extensive, commencing about four miles below Grave-Creek, and continuing, at intermediate distances, 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 same distance north of the mouth of Grave-Creek. The works are very similar to those at the mouth of Muskingum. The continuation of works each way consists of square and circular redoubts, ditches, walls, and mounts, scattered, at unequal distances, in every direction, over extensive flats. The big-grave, so called, has been opened, and human bones found in it; but not of an extraordinary size; neither have I ever heard of bones of an extraordinary size being found in any of those graves, many of which have been opened, and generally found to contain human bones.

These are the only considerable remains which I have myself examined. The common mounts, or Indian graves, or monuments (for they are not always found to contain bones), are scattered over the whole country, particularly along the Ohio, and its main branches: indeed, I have scarcely ever seen an handsome situation on an high flat, adjoining any large stream, where there were not some of the above mentioned vestiges of antiquity.

Travellers, whose authority I depend on, inform me that on a branch of the Scioto, called Paint-Creek, are works much more considerable than those at Grave-Creek, or Muskingum, a mount much larger, a greater variety of walls, ditches and enclosures, and covering a much greater extent of country; that they continue for nearly sixty miles along the Scioto to its junction with the Ohio, opposite

site

sites 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 gentleman 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 middle 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 water, the great spirit raised this wall above water, to set the Chactaws 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, PETREFACTIIONS, 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 petrefactions, 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 Mississipp, 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 Mississipp, 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 Wylls 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 Mississipp 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.

7 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 Chactaw 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 characteristics: 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 customs, their languages, &c. such as that there are Indians who speak the Welsh language; that there are others who live in works similar to the ancient remains, already described; that there are Indians who live a shepherd-life, and others who entirely cultivate the soil. But I have not such full assurance of the truth of these things as to authorise me in reporting them.

I have, thus, according to the best 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 subjects: but such as they are, please to accept them as my earnest endeavours to serve you.

With every sentiment of respect,

I am, Sir,

Your most Obedient and

Humble Servant,

JONATHAN HEART.

N<sup>o</sup>. XXVI.

*An Account of some of the principal Dies employed by the North-American Indians. Extracted from a paper, by the late Mr. Hugh Martin.*

Read Oct.  
4th, 1782.

**T**HE Indians die their *red* with a slender root, which is called in the language of the Shawanoes *Hau ta the caught*. Upon my showing a specimen

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 *Hau ta the caught* 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 off, 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 caught* 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 intestines of various species of animals, as bears, &c.

N<sup>o</sup>. 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. **I**N 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 feed 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 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 fusquipedalis, 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, specioso 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 back-seam of the bean; these seeds are nearly flat, four-cornered,

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<sup>o</sup>. 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.

**A** GREENABLE 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. **T**HE 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. **T**HE 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<sup>o</sup>. 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.

**T**O 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-Parfnep, 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 parfnep, in the stalks, leaves, or flowers; though the root has some resemblance to a parfnep, 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 these 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-caniculatus, purpureus, superne tomentosus.—Folia petiolata, petiolis semi-amplexicaulibus, membranaceis, sulcatis, triternata, bipinnata, cum impari terminatrice, sæpe bilobo; foliis sessilibus, oblongo-lanceolatis, serratis.—Folia ima longissime petiolata, triternata, foliolis ovalibus serratis, serraturis denticulatis.

Flores albi, in umbellis compositis subrotundis, sine involucrio 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 involucre; containing many smaller or partial umbels, each with an involucre 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 tasting it, the two elder of the boys perceived it was not the root, they wanted. They, therefore, threw it down and left it. The youngest boy took it up, said it was Eel-Root, and he would eat some of it. They went on searching and digging for some time: at length their young companion was missing; they turned back the way they came, and found him lying on the ground, speechless and senseless. They took him up, to carry him home: a neighbour met them, on the way, to whom the boys related the story, as above. This gentleman upon whose veracity I relate this fact, being a man of reputation and character, and in whose integrity I place the greatest confidence, told me the story, a few days after it happened. He says, he ordered the boy to be laid down, under a tree; poured down some milk and oil, and sent him home to his owner, who lives within a mile. He was utterly deprived of sense; there was no convulsion, or spasm; nor any degree of tension, or stiffness: his limbs were perfectly limber and loose; he appeared to be in a deep sleep, deprived of all motion, except that of respiration. The boys shewed this gentleman the plant, that the diseased one had eaten of. Some of the leaves were shewn to me, which I immediately discovered to be the species of Hemlock, here mentioned. The boy was carried home; and, after a day or two, came to his senses again; but they think he has never perfectly recovered: a small degree of dullness and stupidity still remains on his brain.

The Cicuta, or Hemlock of the ancients, used for putting malefactors to death, particularly at Athens, is unknown to us at this day. The celebrated Dr. Mead, in his Essay on Poisons, thinks it was not a simple, but a compound of anodyne juices, with others of a corrosive nature.

Throphrastus.

Throphraftus fays that Thrafyas, a great phyfician, had invented a compofition, which would caufe death, without any pain; and that this was prepared with the juice of Hemlock, and Poppy together; and did the bufinefs, in a fmall dofe. Plato relates the noble death of his mafter Socrates, fo as to evince it was brought on by a compound of this nature; viz. the fymptoms were eyes fixt, heavinefs and infenfibility of the legs, great coldnefs, which, by degrees, feized the vital parts.

The famous poifon, kept by the public of Marfeilles had Hemlock, or Cicuta, as an ingredient in it; a dofe of which, was allowed by the magiftrates, to any one, who could fhew a reafon why he fhould defire death.

The Cicuta, or Hemlock, here mentioned, and of which, this boy had eaten but a very fmall quantity of the root, feems to be of fufficient ftrength, without any addition. We are told that, vegetable poifons, fuch as Hemlock and Monkfhood, occafion convulfions, and bring on a painful death; and that, this deadly quality confifts in juices of a corrofive nature, affecting the ftomack and firft paffages with a violent pain and inflammation: that this active, acrimonious, ftimulating, or corrofive property was corrected in the celebrated poifons above mentioned, by the admixture of anodynes and narcoticks, that fhould weaken the vellicating, and painful part of their operation, and blunt the fenfibility of the nervous fyftem; fo as to render their effects infenfible until they brought on an eafy death.

The plant, here defcribed, feems to be poffeffed of all the powers above mentioned. A very fmall quantity of the root was eaten: It operated upon the nervous fyftem, fo as to deprive the boy of all fenfe and motion, except refpiration; and had he taken a larger dofe, death would

have

have been the consequence. This is a plain indication of its narcotick quality, and stupefactive powers.

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N<sup>o</sup>. XXX.

*Description of a Machine for measuring a ship's way: in a letter from FRANCIS HOPKINSON, Esq. to Mr. JOHN VAUGHAN.*

Read Dec. 17, 1790. **I**N the 2d. volume of our Philosophical Transactions, I published a description of an instrument for measuring a ship's way through the sea. I have not heard of any objection to the principles on which such a machine may be constructed, but it may, probably, have been thought too complex for general use.

As this object, should it be accomplished, would be of great importance, I have made another attempt to the same purpose; in which, if there should be no other objection, the want of simplicity cannot reasonably be complained of.

Close along the ship'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 vessel is loaded. This pipe must be so bent at the bottom as that its orifice may be directly opposed to the line of the ship's progress, and project but a little way beyond the keel or cut-water. The upper part of this pipe must also be so bent as that it may enter into the fore-castle, through a hole made for the purpose, above the water line. The pipe should be secured in its place by staples or clamps.

On the top of this copper pipe should be a cover to be screwed on, and through the cover a hole must 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.

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N<sup>o</sup>. XXXI.

*An Inquiry into the Question, whether the APIS MELLIFICA, or TRUE HONEY-BEE, is a native of America.*

Read Feb.  
1, 1792.

**S**O 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

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"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 authorized 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\*.” 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  
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\* Purchas. Vol. iv.

† See the Dissertation, p. 128.

‡ See book vii. p. 331.

§ Book I. p. 63.

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 combs 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.

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\* 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 favour of their having been first brought from Europe.

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§ The History of Louisiana, &c. page 284. English Translation. London: 1774. 2.

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 "extending 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  
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\* 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 they 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

\* 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 enticing 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 Hufewife 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



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-bags*: 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 *Nabantics*. I find mention made of the Nabantics, 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 'bre*, 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 warw*, honey *aum warw web socat*, and bees-wax *aum warw web 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.

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\* They call the *Honey-Locust-Tree* (*Gleditsia triacanthos* of Linnæus) *pi te la we min se bi*.

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 warw web 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 *web* 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 warw web 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 *positive* kind.

The *positive* 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,

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that

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 Kentucky, 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 Kentucky 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 Kentucky 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 Kentucky. 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 origin. 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†."

K k 2

It

\* 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 embryonic 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 257.

† He means sterling.

‡ An historical and geographical account of the province and country of Pennsylvania, &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.*

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N<sup>o</sup>. XXXII.

*An Account of a Comet.*

DEAR SIR,

Read Feb. 15th, 1793. **O**N 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<sup>o</sup>. XXXIII.

N<sup>o</sup>. 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 Orthocopy.*

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 Malinhot, &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  $\beth$  *beth*,  $\gimel$  *gimel*,  $\daleth$  and *dalet*, without the point, have the powers of  $\beta\gamma^*$ ,

$\delta\zeta$

\*  $\beth$  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  $\theta$ , &c.

Shew a sentence in the Roman alphabet to an individual 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 represented 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 complex, adopting one that might be reduced to such simplicity, 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 possible, to the frequency of the sound in the different languages. 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 representing

representing 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 Morfan, 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 sag through a few references.

Many urge the utility of the old orthography to prevent obscurity in writing, but 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— *‘If you speak like moderns, why would ye write like ante-christians?’* pronounced, ante not anti, 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 Monboddó, 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 accommodate*

“modate orthography better to the pronunciation, without  
 “considering that this is to measure by a shadow, to take  
 “that for a model or standard which is changing while they  
 “apply it.” If language change, the orthography ought  
 also to change; but if orthography were once properly ac-  
 commodated to language, even this would not be liable to  
 change, consequently that : and it would then be consider-  
 ed, by all but Johnsonians, as great an impropriety to *mis-*  
*call* a written word, as now to pronounce it *properly*.  
 “Others,” he says “less absurdly indeed, but with equal  
 “unlikelihood of success, have endeavoured to proportion the  
 “number of letters to that of sounds, that every sound may  
 “have its own character, and every character a single sound.  
 “Such would be the orthography of a new language to be  
 “formed by a synod of Grammarians upon principles of science.  
 “But who can hope to prevail on nations to change their  
 “practice, and make all their old books useless? or what ad-  
 “vantage would a new orthography procure, equivalent to  
 “the confusion and perplexity of such an alteration?” In an-  
 swering the above I will first ask the simple question *what*  
*is the use of writing?* It is to exhibit to the eye the same  
 words that are spoken to the ear: and it is impossible to  
 do this without giving a distinct mark for every distinct  
 sound: to deviate from this rule is to run into error. A  
 synod of grammarians would not require a new language  
 to accommodate true spelling to, it may be so easily accom-  
 modated to \* all languages; and if false orthography does  
 not

\* In a tour through Scotland, I visited the Hebrides, and met with many old men who  
 neither spoke a word of English, nor could they read a word in any language; these men  
 repeated many of the poems ascribed to Ossian, and other ancient bards. One of these Poems  
 I wrote with such orthography and characters, as I thought might answer to the sounds which  
 were repeated by an old man. I afterwards read it slowly to a sensible old woman, who un-  
 derstood it, and the English, well enough to give me a translation; this was as regular a poem  
 as any I have seen translated, possessing also much genius, but she often lamented the poverty  
 of the English language, which she said was incapable of expressing the sublimity of many of  
 the passages. It might be so, but I conceived there was another, and a more forcible reason,  
 viz. her being more extensively acquainted with the gaelic than the English. I will here di-  
 gress

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: 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 imperfect 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 1<sup>st</sup> of his prosodial grammar.

‡ Page 1X. 1d.

“*however, are mutes:*” *b* 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 *b* be rejected as a letter, merely because it is a mark of aspiration, the *k, p, t* and *o* ought as well to be omitted, because they are only marks of aspiration: *r, f, o, s* 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 *beating* 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 *bate*, and his first *e* as in *bet*, except in length; for, substitute the last for the first, and the word *bet* will make by prolongation *heet*, written at present *bate*.—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, bior; 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 lan-

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  $\alpha$  begins the name of the ox, which is *alpha* in the Phenician (and  $\aleph$  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.

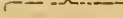





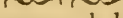


*The*

\* 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—ayt/b—ai—foe—ayt/b*, 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 sound whatever, *voice*, as to call by that name the particular sounds uttered by the human organs of speech.——



*The Characters.*

Common	nasal	stopt	fibilant	short
 Π Π Δ Ε Ι Ο Υ Ζ Υ Ρ Λ J V Ø W	 M N D	 G B D	 F Ø S	 K P T Ø H
Vowels			Aspirates	
 π π Δ ε ι ο υ ζ υ ρ λ j v ø w				
 † m n d				
 g b d				
 f f s k p t ø h				

*The following characters are particularly recommended.*

Π Π Δ Ε Ι Ο Υ Ζ Υ Ρ Λ J V Ø W M N D G B D F Ø S K P T Ø H

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.

‡ Pronounced

	Pronounced like,	e	as in herd,
<i>o</i>	- - -	a	law
<i>u</i>	- - -	a	rat
<i>a</i>	- - -	e	red
<i>e</i>	- - -	i	fit
<i>i</i>	- - -	o	fog
<i>o</i>	- - -	o	fool
<i>u</i>	- - -	y	ye
<i>y</i>	- - -	z	zeal
<i>z</i>	- - -	r	red
<i>r</i>	- - -	l	let
<i>l</i>	- - -	g	judge
<i>j</i>	- - -	v	vast
<i>j</i>	- - -	th	that
<i>v</i>	- - -	w	wolf
<i>th</i>	- - -	m	met
<i>w</i>	- - -	n	nap
<i>m</i>	- - -	ng	king
<i>n</i>	- - -	g	get
<i>ng</i>	- - -	b	bat
<i>g</i>	- - -	d	dim
<i>b</i>	- - -	sh	ship
<i>d</i>	- - -	f	fit
<i>sh</i>	- - -	th	thin
<i>f</i>	- - -	f	set
<i>th</i>	- - -	k	kiss
<i>f</i>	- - -	p	pen
<i>s</i>	- - -	t	ten
<i>o</i>	- - -	wh	when
<i>k</i>	- - -	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 vowels 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.

### Pronunciation

\* Though it is said Pronunciation is such *quæ nec scribitur, nec pingitur, nec laurire cam fas est, nisi viva 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 f are the A and J inverted, the T is the E reversed. The long S (ſ) should be totally omitted, it has so much the appearance of f. The Ð 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. UWMN are made like the small letters, u being the inverse only of n, and w of m, filling the line with great beauty, and avoiding disagreeable angles.

*Pronunciation of the Letters*

## I

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*, SŪN; *ruff*, RŪF; &c.

## II

To pronounce the second common vowel, the mouth must be more open than for I, 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 I, 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  $\square$  may be found in the second perpendicular column of the table of sounds, in *yawn*,  $\text{Y}\square\text{N}$ ;—*saw*,  $\text{S}\square\text{W}$ ;—*raw*,  $\text{R}\square\text{W}$ ; &c.—

## a

The third common vowel: the mouth must be still more open than for  $\square$  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, *yell*,  $\text{YEL}$ ;—*zephyr*,  $\text{ZEFIR}$ ;—*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*,  $\text{YI}$ ;—*zeal*,  $\text{ZHIL}$ ;—*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  $\square$ , but

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, yoke, *ΥΟΚ*;---zone, *ΖΩΟΝ*;---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 *υ*. Its power may be found in the seventh perpendicular column of the table of sounds, in the words, yew, *ΥΟΥ*;---zeugma, *ΖΟΥΓΜΑ*;—soup, *ΣΟΥΠ*;—root, *ΡΟΥΤ*; &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 *ŷ*, 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, yawn, *ΥΕΩΝ*;—yarn, *ΥΑΡΝ*;—yell, *ΥΕΛ*; &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, ZAG;---zephyr, ZEPHYR;---zeal, ZILL; &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, ruff, RUF;—raw, REE;—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, lump, LIMP;—law, LEE;—lals, 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 */b* (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, majesty, MADJUSTI;—treasure, TREJER;—zeizure, SIIJER; &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, very, VORI;—vaunt VEENT;—vast;—vain, 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 acerbus for acervus, and veneficiam for beneficium.—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.

## D

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 *o*, it is not  
thus



this used among the Saxons; for *ðorn* is pronounced *thorn* with two aspirates; thus also they pronounce *ÐAU* (dew)—*ÐUN* (to do)—*ÐEIL* (a part), &c. I however adopt it as the vocal of *o*, and exhibit its power in the tenth horizontal line of the table of sounds, in the words, *the*, *ÐA*;--*that*, *ÐAT*;--*them* *ÐEM*; &c. People who lisp make use of this sound in all cases instead of *z*.

## w

Fifteenth vocal—The organs the same as in pronouncing the *u* except that the lips are a little more protruded and contracted; the air is also forced into the mouth with more strength, and not being permitted to escape with such facility, a hollower sound is produced, and if pronounced very full, the cheeks are a little expanded, and the voice becomes somewhat tremulous. This is the true vocal of the Gothic aspirate *o* (p. 291.) represented in modern English by *wb*, but more properly in ancient English by *hw*. *W* is so seldom used in the English language, that I had doubts whether I should admit it, or substitute the *u*, as it is only necessary in cases where the *sound* of the *u* follows. It is not however what Mr. Sheridan supposed—*viz.* the French \**ou* as in *oui*; for these make the simple *u* as in *blue*, *blu*;—Its power will be found in the twelfth horizontal line of the table of sounds, in the words, *wolf*, *WULF*;--*wool*, *WUL*;--*would*, *WUULD*.

## m

Sixteenth vocal---The lips are shut---the sound consequently passes through the nose, and this is therefore called a nasal vowel---by some *mugitus*, from its resembling 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, *muff*,  $m\text{UF}$ ;--*maw*,  $m\text{UH}$ ;---*mas*,  $m\text{AS}$ ; &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 *nut*,  $n\text{UT}$ ;--*naught*,  $n\text{UH}\text{T}$ ;--*nape*,  $n\text{AP}$ ;--*neck*,  $n\text{EK}$ ; &c.

## D

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 *longing*, or by *n* as in *longer*. Its true power may be found in the sixteenth horizontal line of the table of sounds, in the words, *tongues*,  $t\text{ANZ}$ ;--*hang*,  $h\text{AD}$ ;--*length*,  $l\text{AN}\theta$ , &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 ΑΡΡΥΗΤΟΣ the modern ΑΚΡΥΗΤΟΣ.---The power of the *g* may be found in the seventeenth horizontal line of the table of sounds, in the words, *gun*, ΓΥΝ;---*gall*, ΓΑΛ;---*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, *but*, ΒΥΤ;---*ball*, ΒΑΛ;---*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, *dull*, ΔΥΛ;---*daub*, ΔΑΥΒ;---*DARK*;---*debt*, ΔΕΤ;---&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 *shell*,  $\text{ſEL}$ ; --- by *ss*, as in *assurance*,  $\text{AſſURANS}$ ; by *s*, as in *Asia*,  $\text{AſIA}$ ; by *\*ti*, as in *nation*,  $\text{NEETIEN}$ ; by *ch*, as in *pinch*,  $\text{PINTſ}$ ; --- by *ci*, as in *suspicion*  $\text{ſUSPICIEN}$ ; --- by *ce*, as in *Ocean*,  $\text{OCEEN}$ ; --- and its vocal *j* is also absurdly represented by *s*, as in *treasure*; *z* as in *seizure*; *g* as in *lodge*; (table of sounds) *ſi*, as in *conclusion*, *persuasion*; 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 *r* is very common in the Russian, and is thus made  $\text{Ѡ}$ : 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  $\text{𐤃}$  (shin) of the Phenicians and Hebrews; and is the aspirate of *jaddi*. --- It is also the *sjin* of the Arabians. The power of *r* may be found in the seventh horizontal line of the table of sounds, in the words, *shut*,  $\text{ſET}$ ; --- *shawl*,  $\text{ſEEL}$ ; --- *shell*,  $\text{ſAL}$ ; --- *shell*,  $\text{ſEL}$ ; &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 ( $\text{Ϝ}$ ) which now forms the (*F*); and, being inverted in the time of Claudius to signify the *v*, which is its vocal, (as in  $\text{DIſAI}$ ,  $\text{AMPLIAſIT}$ ) 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, *fun*,  $\text{F}\text{UN}$ ;—*fall*,  $\text{F}\text{E}\text{LL}$ ;—*FAT*;—*fame*  $\text{F}\text{E}\text{EM}$ ; &c. in the ninth horizontal line of the table of powers.

o

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  $\text{D}$ ; 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  $\Theta\text{E}\text{DS}$  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  $\text{D}$ ). The power of  $\theta$  may be found in the eleventh horizontal line of the table of sounds in the words *thbird*,  $\Theta\text{IRD}$ ;—*thaw*,  $\Theta\text{IT}$ ; *thank*,  $\Theta\text{ANK}$ ;—*thane*,  $\Theta\text{EN}$ ; &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, *sun*,  $\text{S}\text{UN}$ ;—*saw*,  $\text{S}\text{E}\text{E}$ ;—*SAT*; &c.

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O o

Twenty-

## k

Twenty-sixth letter, and fifth 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 *κ*, 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 *peace*, ΠΙΙS; *canker*, ΚΑΝ-ΚΑΙΡ, besides having the sound of *r* as in, *special*, SPEFAL. It was also used by the Latins for, *g*, as in, *neglecta*, for *neglecta*; and for *q* when short, as, *cotidie* for *quotidie*, 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, *come*, ΚΙΜ;—*call*, ΚΕΙΛ;—*calm*, ΚΑΑΜ;—*came*, ΚΕΕΜ; &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, *puff*, ΠΙΠ;—*pull*, ΠΕΠΛ;—*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, *set*, for *sed*; and *aput* for *apud*, which are common in Terence. The power of *t* may be found in the twenty-second horizontal line of the table of sounds, in, *tun*, TUN;—*talk*, TALK;—*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 *wb*.—Its power may be found in the thirteenth horizontal line of the table of sounds, in the words, *what*, WHT;—*while*, WAIL;—*when*, WEN;—*which*, WIT;—

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 *a* 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 *but*, HAT;—*ball*, HALL;---*HAT*, &c.

O O 2

*Affinities*

*Affinities of Letters.*

Vowels	{	I	-	-	<i>b</i>	}	Aspirates	Vowels		Aspirates		}	of the Germans.*	
		Z	-	-	<i>s</i>			I	Y	çj	The Russians have this aspirate but no appropriated letter.			
		J	-	-	<i>f</i>			{	L	R				*
		V	-	-	<i>f</i>				Nafal	stopt				<i>t</i>
		D	-	-	<i>s</i>			n	D	<i>t</i>				
		W	-	-	o			m	B	<i>p</i>				
		G	-	-	<i>k</i>			D	G	<i>k</i>				
		B	-	-	<i>p</i>									
		D	-	-	<i>t</i>									

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 *D*, 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 272.)

Of all the distinct sounds contained in the English Language.

	ɪ	ɪ	a	e	i	o	u	
y		<small>yawa</small> yɪɪn	yarn	<small>yell</small> yel	<small>ye</small> yi	<small>yole</small> yook	<small>yew</small> yuu	1
z			zag	<small>zephyr</small> zefar	<small>ziil</small> ziil	<small>zoon</small> zoon	<small>zuugma</small> zuugma	2
s	<small>san</small>	<small>sa</small> sɪn	sat	set	sit	sot	<small>suup</small> suup	3
r	<small>ruff</small>	<small>rau</small> rɪf	rat	red	rip	rot	<small>root</small> ruut	4
l	<small>lump</small>	<small>law</small> lɪp	<small>las</small> las	let	lip	log	<small>loop</small> luup	5
j	<small>madjasti</small>			<small>treasure</small> trejar	<small>sijare</small> sijar	<small>lodje</small> lodj	<small>jury</small> djuri	6
r	<small>faat</small>	<small>faat</small> fɪt	ral	<small>faat</small> fel	<small>faat</small> fip	<small>faat</small> fort	<small>faat</small> ruut	7
v	<small>very</small>	<small>vunt</small> vɪnt	vast	<small>vain</small> veen	<small>victor</small> viktim	<small>vote</small> voot	uvula	8
f	<small>fan</small>	<small>faat</small> fɪt	fast	<small>fame</small> feem	fit	fog	<small>faat</small> fuul	9
ð	<small>the</small>		<small>that</small> ðat	<small>them</small> ðɪm	<small>this</small> ðis	<small>those</small> ðooz		10
θ	<small>third</small>	<small>thru</small> θɪrð	<small>thank</small> θaŋk	<small>there</small> θeen	<small>thin</small> θin	<small>thoral</small> θooral	<small>there</small> θu	11
w	—wolf, wulf; —wool, wul; —would, wuuld; —							12
o		<small>oat</small> oɪt	<small>oak</small> oail	<small>oan</small> oen	<small>oitr</small> oitr			13
m	<small>maif</small>	<small>mau</small> mɪf	mas	met	mis	moor	<small>moon</small> muun	14
n	<small>nut</small>	<small>naught</small> nɪt	nap	<small>neck</small> nek	nip	no	<small>noon</small> nuun	15
ɒ	<small>longer</small>		<small>long</small> hɒŋ	<small>length</small> lɛŋθ	<small>ink</small> ɪŋk	<small>longer</small> lɒŋgɪr		16
g	<small>gun</small>	<small>gall</small> gɒl	gap	get	gift	go	<small>groom</small> gruun	17
k	<small>come</small>	<small>call</small> kɒl	kaam	<small>came</small> keem	<small>kiss</small> kis	kost	<small>kuul</small> kuul	18
b	<small>bat</small>	<small>ball</small> bɒl	bat	bet	bit	bot	<small>blue</small> bluu	19
p	<small>pass</small>	<small>pat</small> pɒt	pan	peg	<small>pill</small> pil	pot	<small>puul</small> puul	20
d	<small>dull</small>	<small>daub</small> dɒb	dark	<small>debt</small> det	dim	dot	<small>doom</small> duun	21
t	<small>tan</small>	<small>talk</small> tɒk	tan	ten	tin	<small>toon</small> toon	<small>took</small> tuuk	22
h	<small>but</small>	<small>hall</small> hɒt	hat	<small>heat</small> heet	hit	hot	<small>huuk</small> huuk	23
	1	2	3	4	5	6	7	



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, ðat Djenkin iz a uizzard.
3. Ai fou, pai K-t, ðat senkin ifs a uifart.

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, s, l, 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 briu boø Peelz tu ða pond,  
 (would say,) Poi priu poth Beels tu dæ 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, v*, we hear daily among cattle and domestic beasts; the *y, z, j, v, v*, are like the buzzing of beetles; *l, f, s, 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 *σ* 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—*kun*, 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? or 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

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their

\* Mr. Sheridan hath not only rejected the *c*, *q*, & *x*, but likewiſe the *j*, which he ought to have retained inſtead of the *exb* 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*, *okceſſion* (*occazhun Sher*;)—*adheſion*, *adhiſſion* (*adhezhun*) *deciſion*, *exploſion*, *confuſion*—Prefed: gram: xlviiii.—

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 vowel should be founded 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*, *st*: 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.

P p 2

*Properly*

\* Page xliv. Profod: Gram: (prefixed to his dictionary.)

*Properly written thus.*

A uaild, oeer uiidz and flourz promiskas suut,  
 Or gardn temtin uie forbiddn fruut.  
 Togedur let us biit dis ampl fild,  
 Trai ont bi opm ont da kovart yiid;  
 Da lectant trakts da gididi haits eksploor, &c.

It is to be observed that the word *the* changes its termination  $\alpha$  or  $\rho$  into *i* before words that begin with  $\alpha$ ,  $\beta$ , *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 stop 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 474)—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 cadence, to the most ordinary phrases: with regard to clearness, let fact decide. The Chinese 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'	akfnt	akfent
	Cem' ent	cement'	femant	fiment
	Con' cert	concert'	konsart	kansart
	Con' test	contest'	kontest	kantest

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 *ETEA PTEPOENTA* 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

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moments

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

Q q 2

which

\* As letters denote the component parts of words, the *AGOPHISIS* 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 Græca*, 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 Profepopeia.

Erotesis— <i>Erootesis</i> —Note of interrogation	!—?
Ecphonesis, <i>Ekphonesis</i> ---note of admiration or exclamation,	!—!
Parenthesis—Parenœsis,	(—)
Crotchet--- <i>Krotchet</i> or Parathesis-- <i>Parathesis</i> ,	[—]
Quotation-- <i>Kuoteesis</i> an,	"—"

Profepopeia

Prosepopoia--action of making a speech for another,	- - - - -	'—'
Accent-- <i>Aksnt</i> ,	- - - - -	'
Hyphen-- <i>Haifən</i> ,	- - - - -	-
Synthesis-- <i>Sinsesifis</i>	- - - - -	=
Comma-- <i>Komma</i> ,	- - - - -	,
Semicolon-- <i>Semikolon</i> ,	- - - - -	;
Colon-- <i>Kolon</i> ,	- - - - -	:
Period-- <i>Piiriod</i> --full stop or punctum,	- - - - -	.
Apostrophe-- <i>Apostrofe</i> or mark of elision,	- - - - -	'
Caret - - wanting,	- - - - -	^
Asterisks,	- - - - - * * *	*
Hiatus,	- - - - -	_____
Zugoma--BRACE or tie,	- - - - -	{—}
Irony-- <i>Aironi</i> ,	- - - - -	+—+
Kaluptophasis-- <i>Kaluptofafis</i> --to be spoken aside,	- - - - -	{--}
Emphasis, <i>Emfasis</i> . 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 teaching the SURD, or DEAF and consequently DUMB,  
to Speak.*

**T**HE 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 mal-conformation of the organs of speech. If the latter there  
is

\* “Ciascheduno sa, che, come, non v'è cosa, che più dispiaccia a Dio, che l'ingratitude, 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.

*Tsiascheduno sa, ke come, non v'è cosa, ke piu dispiaccia a Dio, ke l'ingratitude ed inosservanza de' suoi precetti; essi non v'è niente ke cagioni maggiormente la desolazione dell' universo, ke la pazzia, e la superbia de' i omni, la pazzia de' Dgentili, l'ignoranza, e l'ostinazione de' Djudei, e scismatici.*

† 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; ð—s; 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 man's conversing with himself before it, but in presence of his teacher, to prevent his making mistakes, in the formation of the true sounds: and there are more guides in acquiring what words are spoken by others, than people in general imagine; for so many of the letters which make a visible effect upon the organs, in their formation, enter into the composition 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 short-hand; and is almost as easily caught by the watchful eye of the attentive deaf, as short-hand without vowels is read by the experienced stenographer. Both arts require long practice, but both are very attainable.

When he has learned the true \*sounds of the thirty letters, in the English language, he will be capable of reading as well as of speaking, and he ought to have a catalogue of objects, designed or represented, that he may affix proper ideas to proper terms.—Thus a child may be taught to read, to speak, to understand others, to write, and obtain a knowledge of things at the same time.

The greatest difficulty that the deaf have to surmount, in making a quick progress, in general conversation, 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, so as to read words as they are now written, it would be unintelligible.—The dictionaries of Dr. Kenrick and Mr. Sheridan, would very much assist at present, for the deaf should have an opportunity of acquiring the sounds of words, whenever they were disposed to learn, without being obliged to have recourse to others: but there are many defects, as well as mistakes, in Mr. Sheridan's, and though I have not seen Dr. Kenrick's, I know the manner, and it must also be defective,

\* See the preceding dissertation Page 280 et seq:—also the table of sounds.



fective, because in neither work, have letters been invented for the sounds not before represented.---If the dumb had the advantage of learning a language properly spelled, every time they read in a book, the sounds would be impressed upon the mind, and reading would offer an eternal source of improvement, both in correct speaking, and in matter; and thus might a person, 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 sounds only would be required, and he would have no idea of the possibility of substituting a wrong letter in writing, for one which he could properly pronounce; thus, spelling would not be a study in writing. I speak now, not only in favour of the deaf and consequently dumb, but of all others, who have not yet learned to read. Some of these ideas I have often repeated, but repetition is admissible, when we consider with how much difficulty truth is made to grow in a soil 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 shutting them separately, by laying various numbers of fingers upon the other hand, first on one side, then on the other, and by different signs, passing through the whole scale of sounds---and composing words by visible motions, which are agreed upon by a friend. They also write, and learn the meaning of things, by referring to the representatives of words instead of the words themselves, and the meaning of things would be as easily taught by this mode as by the ear, provided there were as much repetition in one case as in the other.

It is necessary, that the dumb have each a book, in which should be written under proper heads, the names of familiar objects, and under them those things which have a connection, beginning with genera, and descending to species.

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 Tyger, &c.  
Horse  
Horse, Mare  
Foal

Granivorous

Horned Cattle

Birds

Birds of Sea, fresh water  
water fowl prey, &c.

Fishes

Rept: Insects, Amph:

Bull, Cow, Sheep, &c.  
Ran, Ewe  
Lamb

VEGETABLES

Trees

Shrubs

Plants

MINERALS

Platina

Gold

Silver

Copper

Tin

Lead

&c.

STONES

Diamond

Sapphire

Ruby,

Topaz

Emerald &c.

Flint

Calcareous, &c.

EARTHS

Vegetable

Ogres or Calces

Clays

Marbles

&c.

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 philosophy, including chemistry, by which they will see the extensive variety that even artificial mixtures and combinations of bodies will produce. The names, the processes, and results should be written, that nothing be lost. Space and time should be measured, and all the parts of discourse made familiar by examples, as a sensible man would see occasion.

The utility of attempting to teach the dumb to speak, has indeed been disputed by many, not only on account of the difficulties which are judged insurmountable, the imperfect manner in which the pupils articulate, and the disagreeable noise they make in endeavouring to pronounce, but also on account of the difficulty with which they understand what others say, and more especially when they can be comprehended so well by writing, and made useful members of society by drawing.—The imperfect manner in which they speak depends not upon the pupil, if of common capacity, but upon the teacher; and I am confident, from short trials I have made, that the art is to be perfectly obtained by the foregoing method. The difficulty of understanding what others say I have already considered (page 313 art. 3d) and though writing is a very necessary qualification, yet pen and paper are not always at hand. Drawing I approve of, as useful to every one, and perhaps more particularly so to a person whose want of natural faculties deprives him of many sources of amusement. But speech is so useful upon every occasion, that to attain it is to facilitate the very means of existence: for if a deaf man was even always provided with a book and pencil he would often meet with persons who could not read, and one sentence if only imperfectly spoken would convey more meaning than all the gestures and signs 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.

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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<sup>o</sup>. XXXV.

*An Improvement on metallic Conductors or Lightning-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.*

S I R,

Read Nov. 5, 1790. FROM the instances which now and then occur of houses being struck with lightning, that are furnished with metallic conductors, and the frequent

quent instances of these conductors having their tops melted off by a stroke of lightning, 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 lightning, 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 metallic 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 metallic 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 familiar

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 lightning 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 manufactory 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<sup>o</sup>. 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.

**A**FTER 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 completing 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.

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N<sup>o</sup>. XXXVII.

*A method of draining Ponds in level Grounds, by* JESSE HIGGINS, of Delaware.

Read July  
15, 1791.

**A**T 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

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N<sup>o</sup>. XXXVII.

*Observations on the severity of the winter 1779, 1780, by the Rev. MATHEW WILSON of Lewis, dated 22d June 1780.*

Read June 1781. **T**H E 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, musketoos, &c. &c. have generally died.

6. The grafshoppers 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 leisure, 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 *pin*es have suffered in the general calamity; and what is still more remarkable

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 bound*, 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.

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N<sup>o</sup>. 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 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 bases, 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 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.*

**I**T 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 oc-

caſion an unprofitable expenditure of the force which ſhould puſh her forward.

When a veſſel firſt hoifts her fails, although ſhe may be in a ſituation to receive the full impuſe of the wind, yet ſhe will not *immediately* proceed with the velocity which ſhe will afterwards acquire from the ſame force: having not yet *got under way*, as the ſeamen expreſs it. Upon the ſame principle, when a veſſel is ſailing at the rate of five knots, if a ſudden blaſt of wind ſhould come, which would enable her to make ſeven knots, ſhe may be conſidered as being perfectly ſtationary with reſpect to the two additional knots, and will require ſome time to *get under way* as to them. Now the effect produced by relaxing the ſhrouds is, that the maſt, receiving the firſt impreſſion of the wind upon the fails, acts as a ſpring, and yielding to the impuſe, gradually communicates motion to the whole veſſel, giving her time to *get under way*, and occaſioning an eaſy transition from one degree of velocity to another: ſo that her way is not checked by her being ſuddenly urged againſt the reſiſting medium on the acceſſion of every new force impreſſed.

But the miſfortune is, that this advantageous uſe of the maſt can be exerciſed only to a ſmall extent; for, if it is allowed too much play, it will be in danger of breaking. The object of the preſent propoſal is to enjoy the ſame benefit to a greater extent and with more ſecurity.

The maſts, yards and rigging of a ſhip receive the firſt impuſes of the wind. All theſe are in ſome degree elastic. Every twiſted rope is a ſpiral ſpring, and every ſpar capable of being a little bent. But let us ſuppoſe that the ropes were all compoſed of ſtraight ſtrands, that the maſts and yards were inflexible, and the fails made of thin light wood; in ſuch caſe, I ſuppoſe, that the veſſel in ſailing by the wind would make but little head-way, whatever  
the



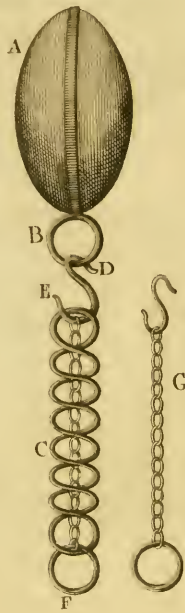
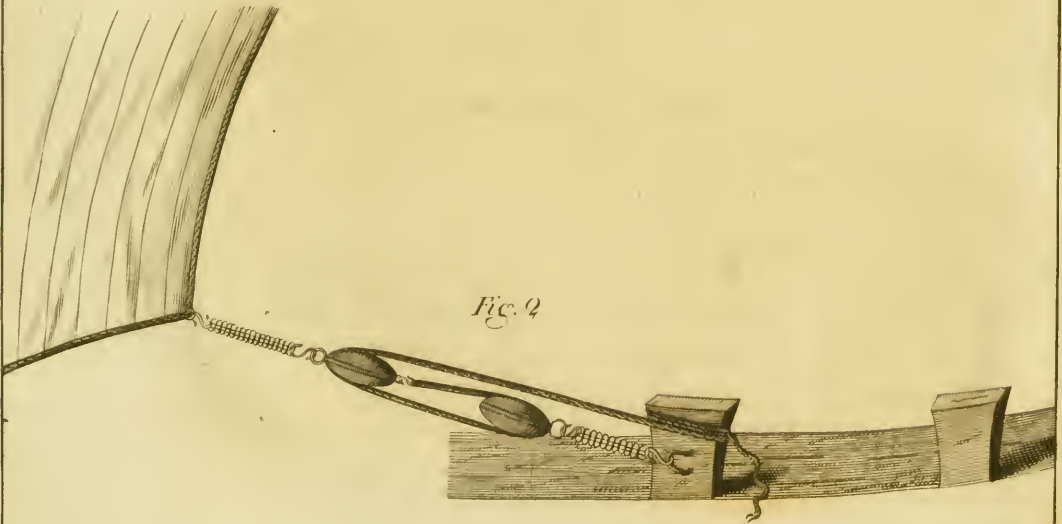


Fig. 2



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 check-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. acquirit cedendo.*

Nº. XLI.

N<sup>o</sup>. 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. **I**N the time of Tournefort, and for many years after his death, the *Anapodophyllum* of this great botanist was considered as a genus of which there was known but one species, viz. the *Anapodophyllum 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 specific character of the plant: viz. “*an Sanguinarie 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. Jussieu, 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 südlichen vereinigten Nordamerikanischen 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 Lin-  
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\* See this gentleman's *Index Floræ Lancastrænsis*.

† 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.

nè 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 *Oëlandria Monogynia* of the sexual system, and that it should stand between *Mimusops* and *Tropeolum*. 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

U t 2

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*, *Diocia*, 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, pimp-  
led, tapering towards the lower part, thin, unilocular, and divided, on the posterior part, by a longitudinal ridge. It splits, or opens, by a transverse future, 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 described by any authors, except Linnæus and Clayton, neither of whom had seen the flowers, and as it is, certainly, a new family, I take the liberty of making it known to the botanists by the name of

### JEFFERSONIA,

in honour of Thomas Jefferson, Esq. Secretary of State to the United-States.

I beg leave to observe to you, in this place, that in imposing upon this genus the name of Mr. Jefferson, I have had no reference to his political character, or to his reputation for general science, and for literature. My business was with his knowledge of natural history. In the various departments of this science, but especially in botany and in zoology, the information of this gentleman is equalled by that of few persons in the United-States.

Of the genus which I have been describing, we, as yet, know but one species, which I call

### JEFFERSONIA BINATA.

The *root* of this plant is fibrous, very branching, of a pale-brown, or dirty-yellowish, colour, and consisting 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 *stalks* are several: they do not branch out at all, but proceed immediately from the crown of the root, supporting the leaves, and the flowers. Both these leaf and flower stalks are naked, commonly about a line in thickness, smooth, and of a dark green, somewhat purplish, colour. After the falling off of the flower, the stalks, as well as the leaves, &c. encrease, very considerably, in size.

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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 chestnut-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 future, or lips of the incision, mentioned in the generic character. When it is completely ripened, the seed-vessel opens, pretty suddenly, at this transverse future, 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.

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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 Checrake, 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*.

X x

I think,

\* I do not well know how it has happened, that the root of the *Podophyllum peltatum* has so generally been considered merely as an emetic. It appears from Catesby, that it is called *Ipecacuanba* 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 356, 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  
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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<sup>o</sup>. 1. The plant, of its natural size, during the time of flowering.  
 N<sup>o</sup>. 2. 3. 4 and 5. Different views of the seed-vessel. N<sup>o</sup>. 2 and 3 represent the horizontal lip, or future, which afterwards opens, discovering the seeds, lying loose, as in N<sup>o</sup>. 5. N<sup>o</sup>. 4. exhibits the ridge on the posterior part of the seed-vessel.

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N<sup>o</sup>. 6.

- N<sup>o</sup>. 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<sup>o</sup>. 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<sup>o</sup>. 8. One of the leaves of the flower cup.
- N<sup>o</sup>. 9. A seed, of its natural size, when ripe.
- N<sup>o</sup>. 10. A filament and anthera, of the natural size.
- N<sup>o</sup>. 11 and 12. The antheræ, at the time of their shedding the pollen, or fecundating dust, bursting laterally.

N<sup>o</sup>. 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.*

**T**HE 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 separate 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



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1787		
<i>Jan.</i>	An elegant copy of the <i>Medical Commentaries</i> ; in 10 Vols. published by Andrew Duncan, D. D. of Edinburgh.	The Editor.
<i>Feb.</i>	Ten guineas towards compleating the Society's Hall.	Benjamin Vaughan Esq. of London.
		<i>March.</i>

	PRESENTS.	DONORS.
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	Lettre de M. Benjamin Franklin, à M. David Le Roy of Paris.	M. David Le Roy.
	Lettre à M. Franklin sur les navire des ancienes, &c. par M. Le Roy	The author.
	The Anatomy of the absorbing vessels of the human body; by William Cruickshank. 4 <sup>o</sup> .	Benjamin, Smith Barton, M. D.
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1787.

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1788.

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- Differtazione sulla Portatura de Gelfi. By Don Gerolamo Bruni.

- Patriotic Society at Milan.
- Ditto.
- Ditto.
- Ditto.
- M. Campomanes of Madrid.
- Academy of Hist. at Madrid.
- Ditto.
- Ditto.
- Patriotic Society at Milan.
- Ditto.
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- Ditto.

	PRESENTS.	DONORS.
1789.		
<i>Aug.</i>	Raccolta d'Opuscoli sulla scienze é sulla arti, 1 Vol. 40.	Patriotic Society at Mi- lan.
	Institutes of Physics; by John An- derson, Prof. Nat. Phil. in the University of Glasgow, 80.	The author.
<i>Sept.</i>	Fragmens de Politique et de Litera- ture; par M. Mandrillon of Am- sterdam.	The author.
	Richerches, memoires, et observati- ons sur les maladies epezootiques de St. Dominique; recueilles et publies par le Cercle des Philadel- phes du Cap.	Cercle des Philadelphes.
	Diçtionarie Espanol, Latino-Aribi- go, 1st. Vol. folio—By M. Cam- pomanes.	The author.
	Experiments and observations relat- ing to various branches of Nat. Philos. Vol. 3d. by Dr. Priestly.	The author.
<i>Oct.</i>	Etat des Finances de St. Dominique par M. de Marbois.	The author.
	An account of the life writings and inventions of John Napier of Mer- chiston.	Earl of Buchan.
	Essays; by Dr. Percival—1st. Vol.	The author.
<i>Nov.</i>	Swediaur's observations on venereal complaints.	The author.
	A pamphlet in French on the subject of the influence of atmospheric electricity on vegetation. By Dr. Ingen-haufz.	Dr. Franklin.
	Considerations on the relative situa- tions of France and the United States; by J. P. Briffot de War- ville.	The author.
<i>March.</i>	The History of France; by Velly, Villaret, and Garnier,—in French 22 Vols.	Mr. P. S. Du Ponceau, of Philadelphia.

	PRESENTS.	DONORS.
1789.		
<i>March.</i>	Popes Essay on Man, in five languages —all poetical translations.	Mr. P. S. Du Ponceau.
	Histoire du Commerce, et de la Na- vigation des peuples anciens et modernes, 2 Vols.	Ditto.
	Lockes Essay on Education; translat- ed 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 lan- guage.	Ditto.
	The proceedings on the restoration of the French parliaments in 1774; being a collection of ori- ginal state papers.—in French.	Ditto.
	A collection of pamphlets on the late commotions in the Nether- lands—in Low Dutch.	Ditto.
	A dictionary of the French and Por- tugues languages.	Ditto.
<i>April.</i>	Oeuvres de M. Thomas, de l'Acade- mie Francoise, 2 Vols.	Ditto.
	Dissertation sur le Moyen de confer- vir le papier de la <i>piquere</i> des in- fects.	M. Arthaud.
<i>April.</i>	Model of a silk-reel,	Mr. Edward Pole of Phi- ladelphia.
	Cases and observations by the Me- dical Society of New-Haven, in Connecticut.	The Medical Society, &c.
<i>May.</i>	A printed book the leaves of which are made of the roots and bark of different trees and plants, being	St. John Crevaecour the inventor.

1789.

## PRESENTS.

DONORS.

- the first essay of this kind of manufacture.
- A specimen of petrolium, found in considerable quantity on a branch of the Allegeny, called Oil Creek.
07. First Vol. of the Transactions of the 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.
- An Essay on the powers and mechanisms of nature; by R. Young.
- Specimens of the papyrus of Syracuse.
- Method of recovering persons apparently dead—in French; by Baronde Hupfch, of Cologne.
- Dec. An almanac of the island of St. Domingo, exhibiting a compleat view of the present state of the French Colony in that Island.
- A specimen of West-India Cinchona.
- A specimen of Cinnamon, the growth of Jamaica.
- 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 *painde singe*, or *Jack-bread fruit*.
- 1790  
Feb. Memoirs of the royal Academy of Sciences at Turin. for 1786 and 1787.
- Nouvelles experiences et observations sur divers objects de physique, by Dr. John Ingen-houfz.
- Mr. William Trumbull.
- Royal Irish Academy.
- David Reddick, Esq.
- Mr. Samuel Mather of London.
- Dr. Franklin.
- The author.
- M. Samuel Vaughan jun.
- Ditto.
- Ditto.
- Ditto.
- Royal Academy of Sciences Turin.
- The Author.

Medical,



	PRESENTS.	DONORS.
1790.		
<i>April.</i>	Medical, philosophical, and experimental essays; by Thomas Percival M. D. Vol. 2.	The Author.
<i>May.</i>	Letters on Cochineal, continued, by James Anderfon M. D. of Madrafs.	The Author.
	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 cochineal insect, discovered at Madrafs; by ditto.	The author.
<i>June.</i>	A volume of 200 elegant copper-plate engravings entitled Emblematica Rollenhagii, done at Ulrecht in the year 1613.	Mr. William Spottwood 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.
<i>July.</i>	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.
<i>Sept.</i>	A variation chart and magnetic atlas, by John Churchman.	The author.
<i>October.</i>	Model of a ramming block, for driving piles, on an improved construction, by Mr. Ludwig Conrod Kuhn.	The inventor.
	Model of a convenient <i>sick-bed</i> ; by ditto.	The inventor.
<i>Novem.</i>	A copper-plate print of two remarkable <i>Lufus Naturæ</i> .	Thomas Pole Surgeon of London.
	An attempt to explain a difficulty in	The author.

the

	PRESENTS.	DONORS.
1790.	the theory of vision, depending on the different refrangibility of light; by Nevil Maskelyne, astronomer royal.	
Nov.	Some account of the discovery made by the late Mr. John Dolland, which led to the grand improvement of refracting telescopes; by Peter Dolland.	Nevil Maskelyne, astron. royal.
	Account of a new instrument for measuring small angles, called the <i>prismatic micrometer</i> , by the Revd. Dr. Maskelyne.	The author.
1791.		
Feb.	The Anatomical Instructor; by Mr. Thomas Pole Surgeon, of London.	The author.
April.	A Synopsis of a course of lectures on the theory and practice of medicine, by B. Waterhouse, M. D.	The author.
May.	A descriptive catalogue of ingrated 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 mesures en longueur et en capacité; par M. Bonne, of Paris.	The author.
Sept.	Systeme des Lecons physiques par L' Abbe Nollet. 2 Vols. 80.	Mr. John Vaughan.
	Musschenbrook's Philosophy, 2 Vols. 40.	Ditto.
	Transactions of the Society for promoting Arts and Manufactures, at London: for 1785.	Ditto.
		Memoirs

	PRESENTS.	DONORS.
1791. Sept.	Memoirs relative to the History and Sciences of the Chinese; by the French missionaries at Poken; 12 Vols. 40.	Mr. John Vaughan.
	A profile in plaster of Paris of Dr. Priestly—particularly valuable for the strong resemblance to the original.	Ditto.
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.
	Animals of agriculture, &c. collected and published by Arthur Young, Esq. from No. 72 to 77 inclusive.	Rodolph Valltravers, F R. S.
Nov.	Fundamenta Chymix; by George Ernest Stahl, M. D.	Mr. Samuel Mitchell of Long-Island
	Marosticensis Philosophi et medici in gimnasio Patavino medicamentorum simplicium, &c.	Ditto
	Nouveau voyage dans les Etas-unis 1st and 3d Vols.	M. Peter Briffot de Warville.
	Model of a machine, for saving persons from the upper stories of a house on fire.	Rev. Nicholas Collin, D. D. the inventor
	Three hundred and eight pounds, for the purpose of discharging a debt, due by the Society, to the estate of the late Francis Hopkinson, Esq.	David Rittenhouse, L. L. D. President of the Society.
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 Parliament	Ditto.

1791.

## PRESENTS.

DONORS.

- of G. B. on preserving the lives of the inhabitants, &c. by W. Hawes M. D.
- Dec.* A piece of stone, containing several petrified shells, &c. found beyond the Blue mountains. Mr. John Arndt of Easton.
- 1792.
- June.* A great variety of specimens or samples of *French dyes*, 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 ENCYCLOPEDIA, to be delivered in volumes to the Society, as published. Mr. Thomas Dobson, of Philadelphia, the publisher.
- A curious library-chair belonging to the late Dr. Franklin. Mr. Richard Bache.
- Newton's Principia. Mr. Robert Aitken of Philadelphia.
- Roman's account of East and West Florida. Ditto.
- March.* Two specimens of lime-stone bearing impressions of the Echinus, or sea-nettle, found in Washington county, Georgia. Mr. Peter Boyle.
- History of New-Hampshire, by the Revd. Jeremy Belknap Vol. 2d. The Author.
- April.* The three Georgics, and some books of the Æneid of Virgil, translated into Greek. The Princess of Dashkew,
- 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.
- Historical collections; consisting of State papers, &c. by Ebenezer Hazard, A. M. The Author.
- Travels

	PRESENTS.	DONORS.
1792. <i>July.</i>	Travels through North and South Carolina, Georgia, &c. containing an account of the soil and natural production of those regions. By Mr. William Bartram.	William Barton, Esq.
	Catalogus secundus Librorum omnis ordinis, Latino aliisq. doctioribus linguis conscriptum, in Bibliopolio B. Wild and J. Althier, 1792 á Utricht.	B. Wild and J. Althier, Utricht.
	Supplementum Catalogi secundi Librorum, omnis ordinis, &c.	Ditto.
	Catalogue de livres Francois, &c.	Ditto.
<i>Aug.</i>	A medical dissertation on Inoculation, by M. Valentius.	The Author.
	History of the Province of New-York, by William Smith, A. M.	William Barton, Esq.
<i>Sept.</i>	Essai historique sur la Colonie de Surinam.	M. Peter Le Geaux.
	A stone of black slate, in form of a regular dodecahedron, the side of each pentagon about one inch and an half, found on the shore of the Ohio.	Dr. Charles Brown.
<i>Oct.</i>	A thesis (in French) on the diseases of the inhabitants of St. Domingo, and of other hot climates in general: by Chev. de St. George Chirurgien major des Hospitiaux de la marine royale a Portau Prince.	The Author.
<i>Nov.</i>	Time an apparition of eternity; by John William Gerarde de Brahm, of Philadelphia.	The Author.
1793. <i>Jan.</i>	A discourse intended to commemorate the discovery of America, by Christopher Columbus, by the Revd. Jeremy Belknap.	The Author.
<i>Feb.</i>	An elegant and correct map of Penn-	The Author.

1793.

PRESENTS.

DONORS.

- sylvania; by Mr. Reading Howell of Philadelphia.
- March.* Le vrai Calendrier perpetuel et general, suivant le stile Julien et la correction Gregorienne; by M. Rodolph Valtravers, of Rotterdam. The Author.
- June.* Viaggio negli Stati Uniti dell' America Settentrionale; da Luigi Castiglioni—of Milan 2 Vols. 8<sup>o</sup>. The Author.
- Regnerus de Graaf de Virorum organigenerationis, &c. Dr. John Morris of Philadelphia.

*Donations towards the erection of a building, for the accommodation of the Society, not mentioned in the foregoing list.*

JOHN Ambley, Esq. London,	20	0	0	Dr. John Carfan,	5	0	0
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Mr. Charles Marshall.	5	0	0	Dr. William Thornton,	20	0	0
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Mr. Charles Moore.	5	0	0	Mr. John Vaughan.	26	2	10
Dr. John Morris.	7	10	0	Samuel Vaughan, Esq.	50	0	0
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Mr. Jonathan Mifflin.	5	0	0	Mr. William Vaughan, London.	17	10	0
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Mr. James Pearson.	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.

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## A D V E R T I S E M E N T.

**M.** JOHN Hyacinth De Magellan, in London, having sometime ago offered, as a donation, to the American Philosophical Society, held at Philadelphia for promoting useful knowledge, the sum of two hundred guineas, to be by them vested in a secure and permanent fund, to the end that the interest arising therefrom should be annually disposed of in premiums, to be adjudged by the Society, to the author of the best discovery, or most useful invention, relating to navigation, astronomy, or natural philosophy (mere natural history only excepted) and the Society having accepted of the above donation, hereby publish the conditions, prescribed by the donor, and agreed to by the Society, upon which the said annual premiums will be awarded.

1. The candidate shall send his discovery, invention or improvement, addressed to the President, or one of the Vice Presidents of the Society, free of postage or other charges; and shall distinguish his performance by some motto, device or other signature, at his pleasure. Together with his discovery, invention or improvement, he shall also send a sealed letter, containing the same motto, device or signature, and subscribed with the real name, and place of residence of the author.

2. Persons of any nation, sect or denomination whatever, shall be admitted as candidates for this premium.

3. No discovery, invention or improvement shall be entitled to this premium which hath been already published, or for which the author hath been publicly rewarded else where.

4. The candidate shall communicate his discovery, invention or improvement, either in the English, French, German or Latin language.

5. All such communications shall be publicly read, or exhibited to the Society, at some stated meeting, not less than one month previous to the day of adjudication, and shall at all times be open to the inspection of such members as shall desire it. But no member shall carry home with him the communication, description or model, except the officer to whom it shall be intrusted; nor shall such officer part with the same out of his custody, without a special order of the Society for that purpose.

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

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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 gauging. Signature W.—Read November 16, 1792.

The author points out various sources of error in the present practice of gauging, 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.

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JAMES HUTCHINSON,	}	Secretaries.
SAMUEL MAGAW,		
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*END OF THE THIRD VOLUME.*













