An essay on the method of studying natural history, being an oration delivered to the Societas Naturae Studiosorum, at Edinburgh, in the year 1782 / [Richard Kentish].

Contributors

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AN ESSAY ON THE METHOD OF Studying Natural History;

BEING

AN ORATION

Delivered to the SOCIETAS NATURÆ STUDIOSORUM, at EDINBURGH, in the Year 1782.

By RICHARD KENTISH,

M. D. F. A. S. Ed. President of the Society, and Member of several Literary Societies, &c. &c.

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MDCCLXXXVII.

" Look thro' Nature, up to Nature's God."

POPE.

TO THE RIGHT HONORABLE

Lord Viſcount Mandeville.

MY LORD,

I FEEL myſelf happy in the permiſſion of dedicating this little work to your Lordſhip; and I flatter myſelf that its object will not appear unworthy that attention which Natural Hiſtory deſerves, as a part of polite education. The ſtudy of Nature forms one of the moſt pleaſing and inſtructive amuſements of youth;—it is become the favored topic of Princes, and the great delight of ſcientific men.——It has opened to our view, in its varied purſuits, a wide and extenſive field of obſervation and improvement.——It has aided the arts, and proved the baſis of ſcience.——Its utility has recommended it to all ranks of ſociety; and I hope

that the obſervations which are here preſented to your Lordſhip will ſerve to facilitate an acquiſition, which will prove a ſource of rational entertainment, and important information, throughout the various periods of that elevated ſtation which your Lordſhip is deſtined to fulfil. And that you may imitate the engaging example of your illuſtrious parents, and emulate their noble virtues, is the earneſt wiſh of

My Lord,

Your Lordſhip's moſt obedient,

Humble Servant,

RICHARD KENTISH.

Gower-Street, Bedford-Square,
June 7, 1787.

PREFACE.

WHEN *the profeſſed intention of an Author is mere utility, the acquirement of much fame is precluded, and he ought to feel himſelf happy if he eſcapes without cenſure.—Such, in the preſent inſtance, is my own caſe.——I do not in this performance ſtand forth as the Champion of Diſcovery, or the Inventor of Theory.—An unexpected occurrence laid the foundation of this Diſcourſe, and a peculiarity of events has induced its publication. In the courſe of my ſtudies at the Univerſity of* Edinburgh, *I neceſſarily became engaged in the purſuits of Natural Hiſtory, and I ſoon perceived that a connected view*

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of the ſcience, in our own language, was wanting. An occaſion offered for my exertions, and I ventured to arrange my ideas in a ſummary view of the ſubject before a Society of Naturaliſts in the Univerſity.

It was the wiſh of ſeveral learned friends that I ſhould preſent my arrangement to the public; but I rejected ſuch ſolicitation, in hopes of perfecting my views:—profeſſional engagements, and an almoſt total abſtraction from literary purſuits during an annihilation of a triennial ruſtication, prevented me from ſuch an undertaking. At length, however, I was tempted to review my theme, and I have only now to regret that it was not longer delayed. The additions which a country life afforded me to make were ſo trivial, that

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my work may ſtill appear imperfect. But I am not without hopes that it may, notwithſtanding, poſſeſs ſufficient merit for the purpoſe to which it is deſigned.—By preſenting to the young Student a ſyſtematic view of the moſt approved methods of ſtudying the three kingdoms, or grand arrangements of Nature, with the beſt authors on each, my Work will be found to comprize a totality which is not (as far as I can learn) to be met with in our own language.—I truſt, therefore, as a General Introduction, it may have its uſe; and I have reaſons for its preſent publication ſtill more urgent. Having engaged in a Courſe of Lectures on Chemiſtry and the Materia Medica, I am induced to preſent my pupils with this view of the Method of Studying Natural Hiſtory, *being fully convinced that no real pro-*

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greſs in either of theſe ſciences can be made without ſuch ſtudy.—It is on theſe arguments alone that I venture to preſent my Eſſay to the peruſal of the candid reader.

GENTLEMEN,

GENTLEMEN,

I Cannot enter on the exerciſe of that office to which you have elected me, without thanking you for the honor which ſuch a choice has conferred upon me. I now feel the want of thoſe talents which I have ſo often admired in others. Oratory is an acquiſition, which I now would wiſh to poſſeſs. But the art of ſpeaking is not to be acquired in a moment. Nature has not been alike bountiful in her gifts of ſpeech. To ſpeak well in public aſſemblies is an accompliſhment not dependant on the natural Powers alone. Cuſtom and Habit give confidence to the ſpeaker, and thoughts and words, like mechanical operations, are facilitated by uſe, and improved by culture. Eloquence, is not however the diſtinguiſhing mark of a philoſopher; to think accurately,

to ſpeak juſtly and reaſon rightly, are objects of his attention. The flowers of rhetorick and the ornaments of ſpeech he ſtudies not. Though he admires them in others, he is apt to diſregard them as uſeleſs and often prejudicial to philoſophy. To improve the heart and inſtruct the head, are objects of his attention. You, Gentlemen, as a Society of Philoſophers, will therefore, I truſt, excuſe the want of eloquence in your Preſident; you will hearken to what he may ſay with readineſs, and liſten to the matter, regardleſs of the manner.

To thank you for the honor I have received is not ſufficient; unprovided therefore as I am with a rich "wardrobe of words," unadorned as my argument may appear, I ſhall attempt to compenſate for this defect by calling your attention for a few moments to objects worthy of your conſideration. As an original Member of this Society,

you

you will pardon me, if I preſume to lay before you the Hiſtory of this now reſpectable Inſtitution. Your Society, Gentlemen, dates its Origin from the year 1782. A year diſtinguiſhed for the number of ingenious and learned men in this Univerſity. The Students were indeed not ſo numerous as at preſent, but the names of men, who that year adorned the Liſt, and particularly aſſiſted in the formation of this Society, will long be remembered with pleaſure, and mentioned with reſpect.

A ſet of Gentlemen from various parts of the world, whoſe parental climes differed more than their Opinions, united for the purpoſe of mutual improvement in the different branches of Natural Hiſtory. Botany, and Mineralogy were their chief purſuits, and to procure ſpecimens of the different Plants, and Minerals, their intention. For this purpoſe they met, and unanimouſly went in queſt of their reſpective

objects. Having for ſometime continued to amuſe themſelves in this manner, ſome circumſtances occurred which made them deſirous of meeting for the purpoſe of imparting their diſcoveries: accordingly they met at each others rooms, and each in his turn entertained the reſt with his ſucceſs in collecting. The moſt curious ſpecimens were produced and the general opinions received. We did not long continue this mode of meeting before we attracted the notice of the moſt eminent Naturaliſts in Edinburgh. The Profeſſors of the Univerſity, with that Liberality which marks their character, offered every aſſiſtance to our enquiries. The College Muſeum was tendered to our uſe, the Profeſſor of Natural Hiſtory entertained us with the choiceſt ſpecimens of his cabinets, entered his name upon our liſt of ordinary members, and became a conſtant attendant on our debates: How great the improvement

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we now receive from ſuch attention, you all know. After this Acquiſition to our number, our fame went abroad, Gentlemen of the moſt diſtinguiſhed Talents aſſociated with us, our illuſtrious Profeſſors of Chemiſtry and Botany took their ſeats in this Society, its attendant members increaſed, regulations were found neceſſary, and a Code of Laws, ſimple but efficient, were eſtabliſhed. Every Member in his turn gave in papers for diſcuſſion, a *Calendarium Floræ* was kept, obſervations from different quarters were received, we were no longer a Society of young uninformed ſtudents, Gentlemen of the firſt abilities and diſtinction honored us with their remarks, and Nobility itſelf added dignity to our liſt of members. Such is the Hiſtory of our firſt Seſſion. In the year 1783 our meetings were faſhioned into a regular Society, Officers were appointed, Preſidents were elected, and our numbers

increaſed.

increaſed. The preſent Seſſion has confirmed the Utility of ſuch an Inſtitution; and I truſt, Gentlemen, your foundation is now too firm ever to fall. When I reflect on the ſmall beginning and rapid improvement of this Society, I cannot help congratulating its Members on the proſpects before them. The hiſtories of few ſocieties riſe with ſuch rapidity towards perfection; the ſtate you have now attained, and the number of illuſtrious Characters that adorn your Liſt of Members augurs proſperity. Your Society, I preſume to hope, will flouriſh, and its name go abroad. At this ſeat of ſcience it will prove a fruitful ſeminary of natural knowledge, and as its Members diſſeminate they will ſpread its Fame. To attempt an eulogy on the objects of your meetings will appear ſuperfluous, I muſt content myſelf therefore with ſaying a few words on the ſtudy of Natural Hiſtory. Such

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of my hearers as are already advanced far on the ſcale of ſcience, will I truſt pardon the liberty I take in addreſſing myſelf to the younger Members of this Society. To them I would obſerve that Natural Hiſtory now makes a part of polite education, and the man who is ignorant of it will frequently be deprived of one of the greateſt ſources of ſelf-amuſement.

It would be no difficult matter to ſhew the utility, ſublimity and importance of that ſcience which "vindicates the ways of God to man," but I truſt that none of my hearers will ſtand in need of arguments or logical reaſoning, to convince them of the rank which the ſtudy of nature holds amongſt the ſciences. Every branch of natural Hiſtory is now become an important part of literature, it is cultivated by the higheſt orders of ſociety, even Princes themſelves have laboured in the extenſive field

which

which it opens to their view, and their reſearches have been attended with ſucceſs. The encouragement given to this ſtudy is of very ancient date.

Alexander the Great allowed Ariſtotle a conſiderable ſum, to enable him to purſue this knowledge, and large ſums of mony have been expended in our own and other countries of Europe, in the formation of thoſe collections which do honour to the taſte of a refined people, and mark the munificence of an enlightened age. The attention of foreigners has been conſtantly attracted by theſe repoſitories of curioſities, and though the greater part of travellers are admitted but to gaze with wonder on the ſtrange appearances preſented to their view, yet to a philoſophical enquirer, the effect is widely different. When he beholds the productions of different climates, and ſees the varied form of nature; when he finds himſelf ſurrounded

with

with the inhabitants of different elements, and divers countries; when he traces the variety of ſpecies, and infinitude of products; when he examines the contraſt in ſize and ſhape of animals, the wonderful œconomy of Vegetables, and the properties of the Mineral kingdom, he is led into a thouſand ſpeculations on the appearances of life, the methods made uſe of to ſuſtain the living principle, and the wonderful extent. and diverſity of organized and unorganized matter. The arranged collection of art is not however the ſource from which the greateſt knowledge is derived. The whole ſyſtem of nature is to the Philoſopher a grand Muſeum, and the properties of its contents the fit ſubject of his contemplation.

It is by ſuch purſuits that the human intellect aſſerts its native dignity, and claims the aſcendancy which it poſſeſſes. Every ſubordinate ſpecies

of the animal creation acts contented in a leſſer ſphere, and performs the part aſſigned it with inſtinctive quietude, but man contemplates on the things around him, ſurveys, examines, and admires; his capacity is adapted to complex enquiries, he is not ſatisfied with the bare inſpection of facts, he marks effects, and dares to aſk the cauſe. The aptitude of his mind is ſuch, that the moſt complicated inveſtigation is within the compaſs of his intelligence, and ideas the moſt abſtract, are comprehended with ſimple facility. He taſtes the pleaſures of an imagination too fine for the groſs conception of other animals, and pervades the ſecret paths of Nature.

To every order of ſociety the ſtudy of nature cannot fail of being intereſting; it is in a peculiar manner connected with the avocations of ſome men; it is the pedeſtal of philoſophy, and the ſole foundation of all her

her diſcoveries. The practical profeſſions of mankind are frequently inſeparable from the ſtudy of nature. The ſcience of Medicine is a ſtriking inſtance of this kind; the connection is ſo intimate, that we find the names of phyſicians conſtantly enrolled amongſt the moſt eminent naturaliſts. The ſciences of Chemiſtry, Botany, and Anatomy, which form the moſt material branches of medical education, cannot be attained without a partial knowledge of Natural Hiſtory; and although a minute acquaintance with the multiplied objects of each department is tediouſly laborious, yet a general one is eaſy, uſeful, and neceſſary to the character of a polite ſcholar. Without pretending to a minute knowledge of the ſubject, or wiſhing to arrogate more information than you are ready to admit, I will venture to beg your indulgence whilſt I ſay a few words to thoſe who may be entering on this pleaſing ſtudy.

The whole diverſity of organized and unorganized matter, which preſents itſelf to our view in the external or internal parts of the Earth, has been comprehended by the Naturaliſts under three grand claſſes or diviſions, which have been called the Three Kingdoms of Nature, viz. The Mineral, 2. Vegetable, 3. and Animal.

By the aid of theſe general, and ſome ſubordinate diſtinctions, which will fall under our conſideration, the ſtudy of Nature is facilitated, the various appearances of bodies, which at firſt ſight ſeem innumerable, are brought under our review, and we are enabled to characterize them by peculiar marks. It is to this claſſification that we are indebted for that comprehenſive knowledge which we are able to attain, and that acquaintance which we poſſeſs with the animate and inanimate parts of the Creation. The methods which have been uſed for this purpoſe, are the

preſent

preſent objects of our attention. By detailing the principal ſyſtems which have appeared, I ſhall have an opportunity of remarking on the excellencies and defects of each, and be enabled to point out the proper guide for the conduct of beginners.

Mineralogy is that branch of Natural Hiſtory, which falls firſt under our conſideration. We ſhall view it in its moſt extenſive ſenſe, and by Minerals denote, not only ſuch ſubſtances as are found in mines, as Metals, Semi-metals, Sulphur and Salts, but likewiſe all foſſils that do not belong either to the Vegetable or Animal Kingdom. This ſtudy appears to be very ancient. The Jews and Egyptians in the time of Moſes were acquainted with precious ſtones, and even the moſt rude and barbarous nations have been found to poſſeſs ſome knowledge of the ores of different metals. But it is only in modern times, amongſt civilized and

learned

learned nations, that Mineralogy has aſſumed the form of a regular ſcience. It is a branch of learning, whoſe cultivation and improvement requires both ſpeculation and practice. Many nations in Europe have found it an object of political attention. In Sweden and Germany there are colleges in which it is regularly taught; it forms a diſtinct and honorable profeſſion, like that of the divine, the phyſician, or the barriſter, and its ſuperior officers, form a part of the adminiſtration of the ſtate. * The ſtudents are ſent to foreign climates for the purpoſe of collecting rare and curious ſpecimens. The Ruſſians and Spaniards have lately adopted this plan, and the French have erected a Mineralogical School at Paris, to which a conſiderable ſtipend is annexed. Perſons are employed in tracing ſubterraneous maps of the whole

* Kirwan's Elem. of Min. p. 28.

whole kingdom of France, and Mineralogical Voyages have been taken at the public expence. In our own country, which is allowed to be richer than France in mineral productions, the ſcience of Mineralogy has received no encouragement from the public, and the ſtudy has been chiefly confined to a few Gentlemen of the Medical profeſſion. Even Chemiſtry, which we ſhall attempt to ſhew, is the parent of Mineralogy, has been ſcarce attended to in England, whilſt neighbouring nations have purſued it with enthuſiaſtic ardour; it forms the favourite occupation, and even the moſt faſhionable object of attention, not only of the middling, but even of ſome in the higheſt ranks of ſociety. *

Before

* Among theſe ſays Mr. Kirwan, we may reckon in Ruſſia, Prince Gallitzen: in Germany, Count Sickengen; in Italy, the Counts de Saluces, de Morozzo, and the Marquis de Gironi, Governor of Leghorn;

Before we detail the ſyſtems which have been profeſſedly offered to the public, we ſhould premiſe, that it has long been matter of controverſy among the Naturaliſts, "Whether the characters of minerals ſhould be taken from external appearances only, or from their internal properties as diſcovered by chemical agents? If it be granted that every art and ſcience ſhould be founded on permanent principles, there can be no doubt but the latter opinion is founded in truth, and that the internal properties of minerals are

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Leghorn; in Geneva, Mr. de Sauſſure; in France, the Dukes de Chaulnes, Rochefoucault, and D'Ayen; the Counts de Lauraguais, la Garay, Milly, Treſſan, and de la Tour d'Auvergne; the Marquiſſes de Courtenvaux, and de Courtivron; the Barons d'Olbach and de Servieres; Meſſieurs Trudaine, Lavoiſier, Montigny, de Morveau; and among the Ladies, Madame la Preſidente d'Arconville. To this Liſt we may add the Earl Dondonald in Scotland, and Mr. Kirwan himſelf in England.

Kirwan's Elem. Min. Pref. iii. note.

are the only durable marks on which we can depend, in our reſearches on the unorganized, inanimate parts of matter. The ſtudy of Mineralogy therefore, neceſſarily requires the knowledge of the general principles of Chemiſtry, for which purpoſe I recommend to your attention, the Dictionary of Chemiſtry by M. Macquer, tranſlated by Mr. Keir, whoſe notes are a valuable addition. The Chemical Eſſays of the Biſhop of Llandaff, are valuable on account of their application to the arts; whilſt the Elements of Chemiſtry by M. Fourcroy, contain all that is neceſſary for a beginner to ſtudy as the rudiments of the ſcience. The works of many eminent chemical philoſophers, as Bergman, Scheele, Lavoiſier, Morveau and others who have written ſingly, or publiſhed papers in the different Periodical Tranſactions or Memoirs of learned Societies, as thoſe of the Royal Society of Lon-

don, Academie de Science of Paris, Stockholm and Peterſburgh, &c. will give him great information. But the Dictionaire de Chymie, now publiſhing by M. Morveau, in the Encyclopedie, is juſtly eſteemed the firſt chymical work that ever appeared.

When a tolerable knowledge of Chemiſtry is once acquired, the ſtudy of Mineralogy will be eaſy; for we aſſume it as an eſtabliſhed fact, that no real progreſs can be made in this Science independant of ſuch a foundation. The early Syſtems were in this repſect defective. We ſhall take a ſhort view of them.

The earlieſt ſyſtem of which I have any account, was that of Magn. Bergarter Bromel, publiſhed in 1730. He arranges all Mineral ſubſtances under the following claſſes. 1. Terræ. 2. Salia. 3. Sulphura. 4. Lapides. 1 Igne perſiſtentes. 5. 2 Calcinabiles. 6. 3 Igne Vitreſcentes. 7. Figurati.

8.

8. Petrifacta. 9. Calculi. 10. Semi-Metalla. 11. Metalla.

There are many miſtakes in this work, and its fundamental error is the want of Chemical knowledge in the author.

In 1736, the celebrated Linnæus, Profeſſor of Natural Hiſtory at Upſal in Sweden, publiſhed a Syſtem, in which he comprehends all Minerals under three claſſes. 1. Petræ. 2. Mineræ. 3. Foſſilia.

The work is defective in many particulars, but from the minute attention paid to ſpecies, may be uſeful for ſome purpoſes.

In 1747 J. G. Wallerius publiſhed a work which is in high eſteem even at this day by many Naturaliſts. It is certainly uſeful for the ſtudy of ſpecies, but he has not availed himſelf of the aid of Chemiſtry. His diviſions are, 1. Terræ. 2. Lapides. 3. Mineræ. 4. Concretæ.

In 1748, J. L. Wolterſdorf ſent into the world a ſyſtem comprized under the following claſſes. 1. Terræ. 2. Lapides. 3. Salia. 4. Bitumina. 5. Semimetalla. 6. Metalla. 7. Petrifacta. The laſt claſs is treated very fully, and as the branch is curious, it may afford inſtruction to thoſe who particularly wiſh to purſue this part of Natural Hiſtory.

In 1755, F. A. Cartheuſer publiſhed a Syſtem of Mineralogy with the following diviſions. 1. Terræ. 2. Lapides. 3. Salia. 4. Inflammabilia. 5. Semimetalla 6. Metalla. 7. Heteromorpha. Under the laſt claſs he includes the Petrifacta.

The Syſtem of J. H. G. Juſtus appeared in 1757, his diviſions are, 1. Metalla. 2. Semi-Metalla. 3. Phlogiſtica. 4. Salia. 5. Petrificata. 6. Terrena. The work is ſaid to treat copiouſly of the gems, but I have not been able to meet with it.

In

In 1758 an anonymous publication appeared, of which Linnæus ſays "Vox Swabii, manus Cronſtedti." He was right in ſuppoſing the work to be Cronſtedt's. Whatever aid Swab afforded is unknown. The ſyſtem has been uniformly attributed to Cronſtedt, and ſince publiſhed in his name. It is this work which laid the foundation of the preſent improved ſtate of Mineralogy. But it is highly probable that the writings of ſome diſtinguiſhed philoſophers, as Mr. Margraaf of Berlin, and Mr. Pott, who about this time publiſhed his Lithogeneſis, were in ſome degree the cauſe of the improvement which took place. This ſyſtem was the firſt which introduced Chemiſtry as the baſis of the ſcience. His claſſes, and genera and ſpecies, are drawn from the compoſition and internal nature of minerals, but the varieties from external appearance only. By this means the advantages of both ſyſtems are combined.

The

The claſſes are 1. Terræ. 2. Salia. 3. Phlogiſtica. 4. Metalla. The work has been in general eſteem with the chemical ſect, and the ſtudent will find it of great uſe previous to his entering upon a minute inveſtigation of ſpecies in the ſyſtem delivered by Mr. Kirwan, whoſe reſearches place him far above the ſcale of ordinary writers. A ſyſtem of ſix claſſes was publiſhed by Vogel, and a copious work on Engliſh foſſils by Sir John Hill, but they do not appear to be worthy much attention. We ought however to remark, that not long ago ſome ſtrenuous advocates have written in defence of the opinions which found the ſcience on the external appearances of minerals only. Mr. Werner has written in the German language a Treatiſe on the external characters of Foſſils, which is in high eſteem. Mr. Romè de Liſle has likewiſe publiſhed a voluminous Treatiſe on the external forms of Chryſtals, under

which

which title he comprehends all thoſe Foſſils that are ſuſceptible of a regular figure, which he imagines may be diſtinguiſhed by the angles their plane make with each other, if there be no *heterogeneous matter* contained in them. The objections to this latter opinion are very obvious. There are many minerals which have no appearance of chryſtallizations. There are likewiſe chryſtallizations of no determinate figure, and the very form of chryſtals often depends upon accident. Mr. Werner attempts to claſs minerals by the joint conſideration of all their external properties; but that this combination of character is inadequate to the purpoſe will be apparent, by conſidering the miſtakes which have happened in ſuch a claſſification. So far from becoming acquainted with the nature of a mineral by ſuch a ſuperficial examination, we deceive ourſelves, and may commit miſtakes of ſerious conſequence. We

may

may reject foſſils of high value, or remain unacquainted with minerals which contain the moſt precious ſubſtances. The ores of metals are often only to be known by chemical teſts. Mr. Werner has placed among the *Micas* a green foliated ſubſtance;* which being ſent to Mr. Bergman, proved to be a compound of marine ſalt of copper, and argillaceous earth. So much ſuperior is chemical experiment to bare enquiry, that this miſtake was detected in ſo ſmall a quantity as a ſingle grain. Mr. Kirwan has placed the excellency of chemiſtry in a ſtriking point of view, by examining the mutability of thoſe external properties which minerals poſſeſs. And as it is impoſſible to ſet the matter in a clearer light than he has done, we ſhall take the liberty of adding an abſtract of his obſervations, which will corroborate

* Kirwan p. vii Pref.

corroborate the opinion we have labored to eſtabliſh. That *colour* is a very deceitful appearance, is manifeſt to every one who knows that white quartz, white lead ore, and white calcareous iron ore, have exactly the ſame ſnow white colour. There are likewiſe ſome ſpecies of the ores of iron, manganeſe, cobalt and copper, of the ſame iron-grey colour, whilſt wolfram and blende are of the ſame browniſh black, &c: a change of texture frequently produces a change of colour, thus a lump of cinnabar, which is *dark red*, will become of a beautiful *florid red*, by ſimply reducing it into powder.

Tranſparency and *opacity* are common to a great variety of very different ſubſtances.

Coherence and *hardneſs* are properties equally ambiguous. When a body is ſo hard as to ſtrike fire with ſteel, it has been ſuppoſed to be pure flint

or ſiliceous earth, and this has been eſteemed the moſt certain infallible teſt; but it is now known that well baked clay, and other ſubſtances, will exhibit this appearance.

Texture, in all its varieties, is common to ſubſtances widely different. Thus the fibrous is found in aſbeſtos, ſhoerl, ſome varieties of gypſum, pyrites, pumice, antimony, hæmatites, malachite, cobalt, and arſenical ores; the ſcaly in mica, lead and iron ores &c. &c.

The varieties of *ſhape*, even when regular and determinate, are innumerable. Mr. de Liſle finds nine varieties in that of fluor, thirty-two in the ſhape of calcareous ſpar, fourteen in that of gypſum, ſixteen in that of quartz, beſides its monſtrous forms, equally regular as the reſt; nineteen in that of felt, ſpar, &c. The ſame ſpecific ſubſtance is not only ſuſceptible of various ſhapes, but various ſub-

ſtances

ſtances ſpecifically different, aſſume the ſame ſhape. The native calx of arſenic, blende, cinnabar and grey copper ore, appear often in a tetrahædal form; zeolyte, fluor, common ſalt, galæna, in a cubic, &c.

The form of ſaline ſubſtances has been thought moſt permanent, but Mr. Pott aſſures us, that microcoſmic ſalt aſſumes the figure of almoſt all other ſalts, viz. nitre, vitriol, ſal ammoniac, allum, Glauber's ſalts, &c.* Mr. Macquer diſcovered that corroſive ſublimate chryſtallized by cooling forms needles, but by mere evaporation cubes or lozenges.‡

Many other inſtances might be given of the inſufficiency of figure or ſhape for the perfect delineation of permanent mineral characters.

* Vid. IV. Pott, 49.

‡ Mem. Par. 1755, p. 540.

Specific Gravity is allowed to be one of the beſt external teſts; but it frequently varies, by reaſon either of the different texture of the ſame ſpecies of mineral into whoſe interſtices water cannot equally penetrate, or by reaſon of the greater proportion of ſome or other of the conſtituent parts, as is particularly obſervable in zeolytes, ſparry or calcareous iron ore, and other foſſils. Alſo, various ſubſtances ſpecifically different, poſſeſs very nearly the ſame ſpecific gravity.*

It now remains that we give an Account of the true method of ſtudying Mineralogy, in doing which we are lead to ſpeak of ſome excellent performances which have appeared in our own time; the Sciagraphia Regni Mineralis of Sir Torbern Bergman, Profeſſor of Chemiſtry at Upſal, tended very much to the improvement of Mineralogy,

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* Vid. Kirwan's Elem. of Min. Pref. viii. ix. x. xi.

Mineralogy. It may be conſidered as a maſter-piece of the kind. His claſſes are four. 1. Sales. 2. Terræ. 3. Bitumina. 4. Metalla. Theſe, he obſerves, are the moſt natural diviſions. "Foſſilia," ſays he, "generatim quadruplicis ſunt differentiæ vel enim ſalina, vel terrena, vel phlogiſtica, vel denique metallica indole gaudere reperiuntur. Hinc quatuor enaſcuntur Claſſes.*"

He has introduced ſome new terms into the ſcience which ſeem very expreſſive, and which have given riſe to a happy choice of names affixed to ſpecies. Thus among the Sales Neutrales, their nature is deſigned by their appellation.

What was commonly called vitriolated tartar, is named alkali vegetabile vitriolatum, which ſhews at once the component parts of the compound.

The

* Bergm. Sciagr. Regn. Min. p. 20

The Glauber's ſalt is named alkali minerale vitriolatum. The uſe of ſuch names is obvious to a Chemiſt. We immediately ſee that in the firſt example, the mineral is compoſed of the vegetable alkali united to the vitriolic acid; in the latter, it is the mineral alkali combined with the ſame acid. Amongſt the ſaline ſubſtances with an earthy baſis, we likewiſe find the nature of the foſſil expreſſed by its name. Epſom ſalt is named magneſia vitriolata, and alum, argilla vitriola. Amongſt thoſe with a metallic baſis, the union is equally clear: blue vitriol is named cuprum vitriolatum; white vitriol, zincum vitriolatum, &c. We are at firſt ſight rather ſurpriſed to find the diamond arranged amongſt the bitumina, or inflammable ſubſtances. Mr. Bergman proceeds on a fact publiſhed by M. Lavoiſier in the Mem. de l'Acad. de Paris, and which has ſince been fully eſtabliſhed. This precious

ſtone,

ſtone, which has by the common conſent of all mankind been held in general eſteem, is now found to poſſeſs properties peculiar to itſelf. When expoſed to the focus of a ſtrong burning lens, it is entirely evaporated under the form of vapor.

The great genius of Newton never ſhone more conſpicuous, than in the minute obſervations which he made on this ſingular gem. In the ſecond book of Optics, part iii. prop. x. we have a curious inveſtigation of the properties, which unctuous and ſulphureous bodies have in reflecting and refracting the rays of light, the words of the propoſition are: "If light be ſwifter in bodies than in vacuo, in proportion of the ſines which meaſure the refraction of the bodies, the forces of the bodies to reflect and refract light, are very nearly proportional to the denſities of the ſame bodies, excepting that unctuous and ſulphu-

reous

reous bodies refract more than others of the ſame denſity.

In the proof of this propoſition, we are preſented with a table, which is worthy the attention of every chemical philoſopher, and as I do not know that it has ever been noticed in the works of Chemiſtry, I ſhall here take the liberty of offering it to the inſpection of the reader. In doing this, it is but fair that I acknowledge my obligations to an ingenious friend, the Reverend Mr. *Stephenſon*, Fellow of Clare Hall, who firſt pointed out to me the following paſſages.

TABLE

TABLE.

The refracting Bodies.	The proportion of the Signs of Incidence and Refraction of yellow Light.	The Square of B. R. to which the refracting force of the Body is proportionate.	The denſity and ſpecific Gravity of the Body.	The refractive flower of the Body in reſpect of its denſity.
A Pſeudo Topazius, being a natural pellucid brittle hairy Stone, of a Yellow Colour - -	23 to 14	1,699	4,27	3979
Air - -	3851 to 3850	0,00052	0,00125	4160
Glaſs of Antimony	17 to 9	2,568	5,28	4864
A Selenitis -	61 to 41	1,213	2,252	5386
Glaſs Vulgar -	31 to 20	1,4025	2,58	5436
Chryſtal of the Rock	25 to 16	1,445	2,65	5450
Iſland Chryſtal -	5 to 3	1,778	2,72	6536
Sal Gemmæ -	17 to 11	1,388	2,143	6477
Alume - - -	35 to 24	1,1267	1,714	6570
Borax - - -	22 to 15	1,1511	1,714	6716
Niter - - - -	32 to 21	1,345	1,9	7079
Dantzick Vitriol	103 to 200	1,295	1,715	7551
Oil of Vitriol -	10 to 7	1,041	1,7	6124
Rain Water - -	529 to 396	0,7845	1,	7845
Gumm Arabic -	31 to 21	1,179	1,375	8574
Spirit of Wine well rectified -	100 to 73	0,8765	0,866	10121
Camphire - -	3 to 2	1,25	0,996	12551
Oil Olive - - -	22 to 15	1,1511	0,913	12607
Lintſeed Oil - -	40 to 27	1,1948	0,932	12819
Spirit of Turpentine.	25 to 17	1,1626	0,874	13222
Amber - - -	14 to 9	1,42	1,04	13654
A Diamond - -	100 to 41	4,949	3,4	14556

" The refraction of the air in this table, is determined by that of the atmoſphere, obſerved by aſtronomers, for if light paſs through many refracting ſubſtances or mediums, gra-

dually denſer and denſer, and terminated with parallel ſurfaces, the ſum of all the refractions will be equal to the ſingle refraction, which it would have ſuffered in paſſing immediately out of the firſt medium into the laſt. And this holds true, though the number of the refracting ſubſtances be increaſed to infinity, and the diſtances from one another as much decreaſed, ſo that the light may be refracted into every point of its paſſage, and by continual refractions, bent into a curve line. And therefore the whole refraction of light, in paſſing through the atmoſphere, from the higheſt and rareſt part thereof, down to the loweſt and denſeſt part, muſt be equal to the refraction, which it would ſuffer in paſſing at like obliquity out of a vacuum, immediately into air of equal denſity, with that in the loweſt part of the atmoſphere.

Now

Now by this table, the refractions of a Pſeudo Topaz, a Selenitis, Rock Chryſtal, Iſland Chryſtal, Vulgar Glaſs, (that is, ſand melted together) and Glaſs of Antimony, which are terreſtrial ſtoney alcalizate Concretes, and *air, which probably ariſes from ſuch ſubſtances by fermentation*, though theſe be ſubſtances very different from one another in denſity, yet they have their refractive powers almoſt in the ſame proportion to one another, as their denſities are, excepting, that the refraction of that ſtrange ſubſtance, Iſland Chryſtal, is a little bigger than the reſt: And particularly Air, which is 3,400 times rarer than the Pſeudo-Topaz, and 4,200 times rarer than Glaſs of antimony, has, notwithſtanding its rarity, the ſame refractive power in reſpect of its denſity, which thoſe two very denſe ſubſtances have in reſpect of theirs, excepting ſo far, as thoſe two differ from one another.

Again, refraction of the Camphire, Oil Olive, Lintſeed Oil, Spirit of Turpentine and Amber, which are *fat and ſuphureous unctuous bodies, and a diamond, which probably is an unctuous ſubſtance coagulated*, have their refractive powers, in proportion to one another as their denſities, without any conſiderable variation. But the refractive powers of theſe unctuous ſubſtances, is two or three times greater in reſpect of their denſities, than the refractive powers of the former ſubſtances in reſpect of theirs."

For the remaining part of the obſervations, which are well worthy the attention of a Chemiſt, we muſt refer to the work itſelf, without which, the whole of the table here given, cannot be underſtood

The work of Mr. Kirwan has no rival. It poſſeſſes the ſingular advantage of combining the excellence of preceding writers with many new diſcoveries.

coveries. The author has availed himſelf of the labors of others, and labored much himſelf.

The Sciagraphia Mineralis of Mr. Bergman has been of great uſe to him, and Mr. Kirwan acknowledges that it was, " by the ſolidity of his judgment, the ingenuity and accuracy of his methods, and the multiplicity of his experiments, that Mineralogy was brought to that degree of perfection at which we at preſent behold it." The writings of Margraaf of Berlin, and the diſcoveries of Brandt, Swab, Gahn, and Scheele are all made ſubſervient to this ſyſtem. The claſſes of our author are the ſame as thoſe of M. Bergman. 1. Earths and Stones. 2. Salts. 3. Inflammable Subſtances. 4. Metallic Subſtances. He takes the character of his Claſſes, Genera and Species, from the nature of their internal compoſition; but the varieties are deſcribed from their external appearance

pearance only. Thus among the Earths

CALCAREOUS GENUS,

Species I.

Calcareous earth, uncombined with any acid.

Species II.

Combined With the aerial acid.

Series I.

Tranſparent ſpars.

Series II.

Opake.

In this inſtance we ſee the Genus is firſt mentioned according to its chemical nature. The Species is likewiſe chemically deſcribed, together with ſuch a deſcription of the external qualities as can be of ſervice to aſſiſt the Naturaliſt. Thus the firſt ſpecies is

ſaid

ſaid to be " a ſtone of a grey colour, moderately hard, or rather ſoft, found near Bath ; it is mixed with calcareous earth combined with fixed air ; and hence it effervesces with acids, but at the ſame time it is ſoluble in water, to which it communicates the taſte of lime ; and if this ſolution be mixed with ſulphur it diſſolves it, and forms a calcareous liver of ſulphur, with the aſſiſtance of heat, whence it is plain that part of the calcareous earth is in an uncombined ſtate." Here we have a deſcription of the appearance as it moſt commonly occurs, but a certain knowledge of the matter can only be gained by Chymical experiment. In the two ſpecies again we know, that they " all effervesce with acids ; none give fire with ſteel ; and the chryſtallized decrepitate when heated." The moſt remarkable varieties of external appearances are comprehended under the two ſeries of, 1. Tranſparent.

rent, 2. Opake. In the firſt ſeries they are called Spars, and theſe are mentioned to be found in various forms, as rhombodial, hexangular, triangular, polyangular. Their ſpecific gravity is likewiſe commonly noticed, and Mr. Kirwan is particularly minute in giving an exact chymical analyſis of the mineral, wherever it can be done.

The ſcience of Chymiſtry is indeed eminently conſpicuous in this particular analyſis, and has been carried to great extent: not only the common minerals, but even the precious ſtones have been analyſized by the indefatigable Mr. Bergman. We ſhall here ſubjoin an abridged view of one of the tables given by Mr. Kirwan, with ſome amendments from the ſecond vol. of Bergm. Opuſc, Chen.

TABLE

TABLE III.

Of the proportion of ingredients in Earths and Stones.

Calcareous Genus.

100 Parts.	Calcar.	Argill.	Silex.	Magn.	Water	Iron.
Calcareous Spar	53	—	—	—	11	a
Gypsum -	32	—	—	—	38	b
Fluor -	57	—	—	—	—	c

a. And 34 Fixed Air. b. and 30 Vitriolic Acid. c. 43 Acid and Water.

Siliceous Genus.

100 Parts.	Silex.	Argill.	Calcar.	Magn.	Iron.
Chrystal - -	93	6	1	—	—
Flint - . -	80	18	2	—	—
Jasper - -	75	20	—	—	5
Ruby - -	39	40	mild 9	—	10
Hyacinth -	25	40	Dº 20	—	13
Topaz - -	39	46	Dº 8	—	6
Emerald -	24	60	8	—	6
Sapphire -	35	58	5	—	2
Garnet - -	48	30	12	—	10

What has been said will give a tolerable idea of the present improved state of Mineralogy, and it must ap-

pear ſufficiently obvious, that there can be no compariſon in the methods to be adopted for its attainment. A ſuperficial dabler in the ſtudy of Nature, may amuſe himſelf by collecting and arranging multitudes of Minerals, which may in reality be mere varieties of a few Species, whilſt the more enquiring Naturaliſt will labour to attain real knowledge, and wiſh to poſſeſs thoſe facts which lead him to an exact diſcrimination of the objects of his purſuit.

When a tolerable knowledge of Mineralogy is acquired, the philoſophic Naturaliſt will receive great amuſement from a variety of geological obſervations on the antiquity and origin of Mountains, their height, and the means of determining it by means of the Barometer; — their internal ſtructure; — the nature of Volcanos and their productions, &c.

Thoſe

Thoſe who wiſh to make themſelves more particularly acquainted with the Theories that have been publiſhed reſpecting the formation and ſtructure of the World, will find great information and amuſement from the "Lettres Phyſiques et Morales," par M. de Luc, where the Theories of Burnett, Whiſton, Woodward, Leibnitz, Scheuchzer, l'Abbè Pluche, Le Catt, Telliamed, Lazzaro Moro and Buffon are detailed. Mr. Forſter's Obſervations, the Amænitates Academicæ of Linnæus, and ſeveral other Works, will likewiſe be found exceedingly uſeful on this and other branches of Natural Hiſtory. We ſhall here ceaſe our account of the method to be preferred in ſtudying the inanimate parts of Matter, and proceed to treat of organized bodies, as they appear under the forms of Vegetable, or Animal Life.

PART II.

The Vegetable Kingdom.

IN ſtudying the appearances of matter under the organiſed form of vegetables, many curious obſervations preſent themſelves to the eye of a philoſopher. Their ſtructure, habit, propagation, and ſeveral other phyſiological queſtions, equally intereſting and important, occur to the naturaliſt; whilſt their number, diverſity, and other peculiar circumſtances, attract his attention. It is not our buſineſs in this place to indulge the ſpeculations of enquiry, or deſcant on the beauties of this field of nature. We muſt content ourſelves with ſuch obſervations as may yield inſtruction to the uninformed,

formed, and teach them how to tread the ſplendid path of flowers. From the earlieſt period of time ſome attention ſeems to have been paid to the vegetable kingdom. The food of the rude inhabitants of every country is commonly derived from plants. The moſt barbarous nations are found to poſſeſs ſome knowledge of the uſe of vegetables. It is therefore to be preſumed, that, long before hiſtory conveys intelligence, the ſtudy of mankind was particularly turned towards this part of the beauties of nature. We learn from Holy Writ, that Solomon was far advanced in the ſcience of Botany. He is ſaid to have written on the ſubject; but neither his writings, nor thoſe of Anaxagoras, nor Pythagoras, have been handed down to us. Theophraſtus, the diſciple of Ariſtotle, in the third century before the Chriſtian æra, publiſhed a work, entitled, "The Hiſtory of Plants," which,

which, I believe, is the earlieſt legend that this ſubject boaſts of. In it he treats of the origin, propagation, anatomy, and conſtruction of vegetables, of vegetable life, and of vegetation. It was near four hundred years after this publication, that Dioſcorides diſtinguiſhed himſelf as an eminent botaniſt. Pliny, in the amplitude of his natural purſuits, glanced at the vegetable creation; but he does not appear to have entered deeply into the ſubject, and many ages elapſed before this branch of knowledge aſſumed the regular form of a ſcience. At length the time arrived when the neceſſity of ſyſtem became apparent. A ſerious attention convinced the botaniſts that the kinds and ſpecies, even of locality, were too numerous for the memory to retain without arrangement. The methods which were choſen are very different; and the young ſtudent will be ſurprized to find, that even at the pre-

ſent

ſent day, philoſophers are unacquainted with a ſyſtem wholly unexceptionable. The method of arranging plants alphabetically was much followed, eſpecially in local catalogues. Pauli, in his Quadripartitum Botanicum, publiſhed in 1639, has diſpoſed them according to the *time of flowering*. Beſler, in the Hortus Eyſtettenſis, 1640; and Dillenius, in the Catalogus Giſſenſis, 1719, have followed this method. Others have arranged them according to the *different places of their growth*, as the authors of the Hiſtoria Lugdunenſis, in 1587; and ſome according to their virtues in medicine. Others who obſerved that many vegetables agreed with each other in certain particulars, have endeavoured to take theſe peculiarities as the leading character of their ſyſtems. Thus the harmony or proportion in the form and diſpoſition of their roots, leaves, flowers, or fruit; the particular mode of growing, flowering,

ering, or foliation; has given riſe to claſſes agreeable to ſuch diſtinctions. Hence the diviſion of trees into pomiferæ, nuciferæ, bacciferæ, pruniferæ, glandiferæ, &c.: of herbs into bulboſæ, ſiliquoſæ, umbelliferæ, verticillatæ, papilionacæ, &c. Theſe are claſſes or orders which Nature herſelf has inſtituted, and it is the grand deſideratum of botany to reduce, and connect all vegetables according to ſuch a *natural method*. In this point, however, the moſt ſanguine endeavors of the naturaliſts have hitherto proved ineffectual. John and Caſpar Bauchine, in the laſt century, purſued this plan. Gerard and Parkinſon followed their example, but as they eſtabliſhed no preciſe definitions to their claſſes, and were not accurate in the minuter parts of their ſyſtem, their claſſification proved exceedingly imperfect.

Conrade Geſner, a diſtinguiſhed naturaliſt, who died in 1565, ſeems to have

have been the firſt who pointed out the method of claſſing plants from the flower, or fruit; but he did not purſue the idea ſo as to faſhion it into a ſyſtem. Cæſalpinus, phyſician to Pope Clement VIII. was the firſt author who arranged vegetables in a true ſyſtematic manner. In his *Libri de Plantis*, publiſhed in 1583, he endeavors to eſtabliſh the character principally *from the fruit*, but a great length of time elapſed before his plan was wrought into a ſyſtem. Morriſon and Ray publiſhed their ſeparate ſyſtems nearly together, in which their characters are principally taken from the fruit. Several authors of eminence have attempted to perfect their labors, as Knaut in Germany, Paul Herman and Boerhaave in Holland, and Dillenius, profeſſor at Oxford. The flower was firſt taken as the foundation of the claſſical character by Rivini, at Leipſic, in 1690. The regularity and irregularity, as

well as the number of the *petals*, have been made the principal diſtinction. Tournefort, in 1694, carried this method to very great perfection. He forms the character of his claſſes from the figure of the flower, and eſtabliſhes his orders or ſubdiviſions on the different ſituation of the fruit, whether above or below the empalement or receptacle. Ruppius, in 1718, likewiſe took the flower as the foundation of his method. Several attempts have been made to arrange vegetables according to what are called natural claſſes; the foundations of which comprehend a variety of characters ariſing from a combination and agreement in the *habit* of plants, and their *harmony* in the eſſential parts of fructification, as we have before noticed. Van Royen, late profeſſor at Leyden, is author of the moſt elegant ſyſtem hitherto publiſhed on this plan. It is exhibited in the Prodromus Floræ Leydenenſis,

ſis, 1740, and together with that of Cæſalpinus, Tournefort, and Ray, compriſes the whole of the Syſtematiſts with which my late worthy friend and præceptor, Dr. Hope, thought it neceſſary for his ſtudents to be acquainted, previous to their entering upon the Linnæan ſyſtem.*

Haller has given a method reſembling that of Van Royen, which is brought to great perfection in his Enumeratio Stirpium Helvetiæ, 1742. Hortus Gottingenſis, 1753, and Hiſtoria Stirpium Helvetiæ, 3 tom. fol. 1768. Gmelin, in the Flora Sibirica, 1747, followed nearly the ſame plan; and L. Gerard, in his Flora Gallo-Provincialis, Paris, 1761, preſerves very nearly the natural generical characters of Linnæus, taking the orders of a *natu-*

* Vide Dr. Hope's uſeful little work, entitled, Genera Plantarum in Uſus Academicos. *Edinb.* 1780.

ral method, conſtructed by B. Juſſieu, for his claſſes.

Among the ſyſtematic writers, Linnæus has enumerated no leſs than twenty-eight; but as it would be tedious to purſue this part of our ſubject any farther, we ſhall proceed to detail that ſyſtem which is now the moſt univerſally received and admired.

Charles Von Linnè, or (as he was commonly called) Linnæus, was the ſon of a Swediſh Divine, and born at Roeſhult, in the province of Smaland, in Sweden. There is ſomething botanic in the very name of Linnæus; for the anceſtors of this family are ſaid to have taken the ſirnames of Linnæus, Lindelius, and Tiliander, from a large lime-tree, or linden-tree, yet ſtanding on the farm where this naturaliſt was born. Such an origin of ſirnames is not uncommon in Sweden. After ſtruggling with the difficulties of adverſe fortune, this great

great man arrived at honor and independence. He was made Profeſſor of Phyſic and Botany in the Univerſity of Upſal, Phyſician to his Sovereign, and Knight of the Order of the Polar Star. In 1757, he was ennobled, and on the reſignation of his office had his penſion doubled, and a liberal donation of landed property ſettled on him and his family. He died January 11, 1778, aged ſeventy years and eight months. It is, however, foreign to our purpoſe to purſue the biography of any naturaliſt. The diſtinguiſhed eminence of Linnæus can alone excuſe the preſent digreſſion.* We ſhall therefore return to

* On the death of Linnæus a general mourning took place at Upſal, and his funeral proceſſion was attended by the whole Univerſity, as well profeſſors as ſtudents; and the pall ſupported by ſixteen Doctors of Phyſic, all of whom had been his pupils. The King of Sweden paid the higheſt honors to his memory, He ordered a medal to be ſtruck, of which one ſide exhibits Linnæus buſt and name, and the other Cybele, in

to give a ſketch of the botanic ſyſtem of this great man.

Linnæus

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in a dejected attitude, holding in her left hand a key, and ſurrounded with animals and growing plants, with this legend—Deam luctus angit amiſſi ,—and beneath—Poſt Obitum Upſaliæ, die x Jan. MDCCLXXVII, Rege jubente.——The King likewiſe was preſent at the meeting of the Royal Academy of Sciences at Stockholm, when Linnæus's commemoration was held; and in his Speech from the Throne to the Aſſembly of States, he paid a tribute to this great man's memory, by lamenting the loſs of Sweden in his death. The benevolent and diſtinguiſhed Profeſſor of Botany at Edinburgh, at the opening of his Lectures in 1778, pronounced an eulogium in honor of Linnæus, and perpetuated, by an elegant compliment, the fame of this naturaliſt, together with his own name. He laid the foundation ſtone of a monument in the Botanic Garden, conſiſting of a vaſe ſupported on a pedeſtal, with this inſcription,

Linnæo
poſuit
J. Hope.

This very worthy man, whoſe death is ſincerely lamented by all who knew him, has left behind him another inſtance of his peculiar attention to merit, in whatever rank of ſociety he found

Linnæus very early attempted a natural method of arrangement; but he ſoon found that too many links are wanting in the chain to render it the readieſt guide to botanical ſcience. He only reduced the genera into orders, but did not venture to form the claſſical part of a ſyſtem on that plan. He made an attempt to fix the *calyx*, or *cup* of the flower in plants, as a ſource of arrangement, in which he ſeems to have followed Profeſſor Magnol, of Mont-

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found it. In a ſhady and retired part of the ſame garden is raiſed a monument to the memory of a faithful ſervant, who diſcharged the duties of his office as a Gardener with fidelity and credit. The man, who, in the midſt of various occupations which ſcience and medical practice occaſion, could give attention to the perpetuity of merit, will not, it is hoped, himſelf ſoon ſink into oblivion. A ſelect publication of ſuch manuſcripts as the Profeſſor has left behind, could not fail of being a valuable acquiſition to the botanic world. The progreſs which he had made in a natural method will prove to him "Monumentum ære perennius."

Montpelier, who publiſhed in 1720.* But he ſoon rejected all theſe methods, and was the firſt who conſtituted the ſtamina and piſtils, as the baſis of an artificial method of arranging plants. He was led to this by conſidering the great importance of theſe parts in vegetation. He maintained, that they alone are eſſential to fructification, ſince all other parts, except the *anthera* and *ſtigma*, are wanting in ſome flowers. The preſent philoſophy of botany regards the former as the male, and the latter as the female organs of generation in plants. From this diſtinction of the ſexes of vegetables, the arrangement of Linnæus is known by the name of the Sexual Syſtem. It conſiſts of twenty-four claſſes, and their characters are eſtabliſhed upon the number, ſituation, or arrangement of the ſtamina, or male organs. The orders

* Vide Pulteney's View of Linnæus's Writings, p. 116.

ders or ſubdiviſions of theſe claſſes are, as far as poſſible, drawn from a ſimilar number, ſituation, or arrangement of the piſtils, or female organs. In the firſt twenty claſſes are contained ſuch flowers as have the ſtamina and piſtils both within the ſame cup or petals, or ſtanding on the ſame receptacle where theſe are wanting. The author calls them hermaprodite: as according to his doctrine there are both male and female parts in the ſame flower.

The firſt ten claſſes proceed in an uninterrupted ſeries, from Monandria to Decandria; the plants of each having as many ſtamina as the title expreſſes; thus, 1. Monandria, Stamen unicum in flore hermaphrodito. 2. Diandria, Stamina duo in flore hermaphrodito. 3. Triandria, Stamina tria in flore hermaphrodito, &c.

The eleventh claſs is Dodecandria, Stamina duodecim in flore hermapro-

dito. For it is very remarkable, that no plants yet diſcovered have exactly eleven ſtamina.

The twelfth, Icoſandria, containing ſuch plants as have about twenty ſtamina, or more, ariſing from the *calyx*, or *corolla*, and not from the receptacle.

The thirteenth, Polyandria, may have the ſame number of ſtamina as the former, but they ariſe from the *receptacle*, and are commonly very numerous.

The fourteenth claſs, Didynamia, comprehends ſuch plants as have four ſtamina, two long, and two ſhort. This includes vegetables of a very particular deſcription, the eſſential character of which does not conſiſt in the number, but ſize and peculiar form of the ſtamina, two of which are uniformly ſhorter than the other. The corolla is irregularly ſhaped, and there is only one piſtil.

The fifteenth, Tetradynamia, includes plants with ſix ſtamina, four of which are longer than the other two.

The ſixteenth, Monadelphia. In this the ſtamina are not diſtinct at the baſe, but united into one body.

The ſeventeenth, Diadelphia, in which the ſtamina are united at the baſe into two bodies.

The eighteenth, Polyadelphia. In this the ſtamina are united at the baſe into ſeveral bodies.

The nineteenth, Syngeneſia, in which the antheræ unite together ſo as to form a tube or cylinder, through which the piſtil commonly aſcends.

The twentieth, Gynandria, in which the ſtamina proceed from the piſtil, and not the receptacle.

The twenty-firſt, Monoecia; ſuch as have ſeparate male and female flowers on the ſame plant.

The twenty-ſecond, Dioecia ſuch as have ſeparate male and female flowers on ſeparate plants.

The twenty-third, Polygamia. In this claſs, beſides the hermaphrodite flowers, there are others, either male or female, in the ſame plant.

The twenty-fourth, Cryptogamia. In which are contained thoſe plants, the mode and organs of whoſe fructification are not yet ſufficiently aſcertained. They have been called imperfect plants, and it may juſtly be ſaid of them, "Parvitate oculos noſtros ſubterfugiunt."*

The

* It was rather from conjecture than proofs, that Linnæus inſtituted the claſs of Cryptogamia. He reaſoned from analogy, and late writers have given proof of the truth of his ſuppoſition. Some time ago Micheli aſſerted, that he had obſerved the real ſtamina and piſtilla in Moſſes; but his obſervations were neglected, and ſcarcely credited, 'till the accurate Dr. Hedwig, of Leipſic, publiſhed his hiſtory of Moſſes in 1782, in which he has demonſtrated the parts of fructification of ſeveral Moſſes, and illuſtrated the ſtructure and œconomy

of

The orders of the ſyſtem are for the moſt part taken from the number of the piſtils, or female parts. Thus in the firſt thirteen claſſes, in which the claſſical character depends uninterruptedly on the number of ſtamina, the orders depend likewiſe on the number of piſtils; but when ſituation or different arrangement takes place, they are moſt commonly founded on other diſtinctions. Thus the Didynamia has the two

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of theſe minute plants in a very complete manner. He proves that the capſula of Dillenius, (the anthera of Linnæus) which both thoſe authors conſidered as producing the impregnated pollen, is in fact the fruit, and the powder which it contains the ſeed; and that the male flowers are what Linnæus and others took for the female. This was ſuſpected by the celebrated Schreber, and the opinion is now adopted by all ſcientific botaniſts. Dr. Hedwig has proſecuted his enquiries in other orders of the Cryptogamia; and in a prize diſſertation, publiſhed at Peterſburgh, which has not yet reached this kingdom, he has illuſtrated the fructification of the Filices, Algæ, Muſci, and Fungi, in thirty-ſeven plates. For an Abſtract of his Diſcoveries, vide Smith's Tranſlation of Linnæus's Diſſertation on the Sexes of Plants, p. 59, 60, 61, 62.

two orders of Gymnoſpermia and Angioſpermia: the former having four naked ſeeds, and the latter having the ſeeds incloſed in a ſeed veſſel. In the Tetradynamia, the two orders of Siliculoſa and Siliquoſa are taken from the ſize and ſhape of the pod or ſhale; in the former of which it is ſhort, and in the latter long. In the claſſes of Monadelphia, Diadelphia, and Polyadelphia, the orders are formed from the number of the ſtamina. In the Syngeneſia claſs there are two general ſubdiviſions or orders, Polygamia and Monogamia; the firſt of which is divided into five leſſer diviſions, as Polygamia, Æqualis, Superflua, Fruſtranea, Neceſſaria, Segregata. The differences here ariſe from the different ſtructure or ſex of the Floſcules, conſtituting the whole flower.

In the Gynandria, the orders are taken from the number of the ſtamina,

as

as in the ſixteenth, ſeventeenth, and eighteenth claſſes.

In the Monoecia and Dioecia claſſes, the characters of the orders are drawn from the characters of the foregoing parts of the ſyſtem as far as to the Monoecia claſs itſelf; the firſt order of which contains Monandrous, and the laſt order of the *Diocoeia* Gynandrous plants.

The orders of the Polygamia contain the Monoecious, Dioecious, or Trioecious plants. The orders of the Cryptogamia claſs are Filices, Muſci, Algæ, and Fungi.

It will be unneceſſary to purſue this ſyſtem any farther. From what has been ſaid, a general idea may be formed of its principle; and as it is now almoſt univerſally received, we may venture to recommend it to the ſerious attention of thoſe who wiſh to make any progreſs in the ſcience of Botany. The great difficulty of this ſtudy conſiſts in acquiring the various terms

which

which ſerve for the deſcription of the different parts of plants. It is therefore neceſſary that the young ſtudent be furniſhed with ſome guide on this ſubject. The moſt uſeful works with which I am acquainted are Lee's Botany, and the Elements of Botany, by Mr. Roſe, an ingenious Apothecary, who has given a tranſlation of Linnæus's principal Obſervations in ſupport of the Sexual Syſtem. From theſe books alone, conſiderable progreſs may be made in Botany; but it is from the writings of Linnæus only that we can derive a full and complete knowledge of the vegetable creation. His Genera and Species Plantarum, together with the Supplement publiſhed by Young Linnæus, are indiſpenſably neceſſary to the Botaniſt.* The Philoſophia Botanica is a work

* Theſe works are lately tranſlated into Engliſh by a Society at Litchfield; but the performance (however laudable the attempt) falls ſhort of the original, and ſerves to convince us,

work of great utility, and together with a little Eſſay, entitled, " A Diſſertation on the Sexes of Plants," tranſlated from the Latin of Linnæus by my worthy friend Mr. Smith, one of the original members of this Society, forms a very happy illuſtration of the doctrine on which our author founds his ſyſtem. The Botanic Letters of Rouſſeau, lately tranſlated, with additions, by Profeſſor Martin, of Cambridge, will afford amuſement and inſtruction to the young Botaniſt, whilſt the plates which have been publiſhed by a variety of authors, and executed by many eminent artiſts, will have the happy effect of conveying entertainment and improvement. The firſt botanic plates of which I have received any account are thoſe of Geſner, which, though on

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us, that no real progreſs can be made in Botany, or, perhaps any of the ſciences, without a tolerable knowledge of the Latin Tongue.

wood, were very uſeful in their day, as well as thoſe of Rudbeck, Ferrarius, Dodartius, and Rhædius. The firſt copper-plates of plants were publiſhed by Columna, which, together with thoſe of Rivinus, Dillenius, Sir Hans Sloane, and Sir John Hill, form very uſeful additions to the Botanic library. The latter has confined his delineations to the Engliſh plants; but his work is far ſurpaſſed by the very elegant and ſplendid plates of Mr. Curtis, an apothecary in London, whoſe performance is an honor to the age which produced it. The learned Preſident of the Royal Society, Sir Joſeph Banks, who is juſtly eſteemed and diſtinguiſhed as the moſt eminent naturaliſt in this or any other country, is completing a ſet of plates, which for utility and elegance ſurpaſs every thing of the kind. They preſent to the Botaniſt well-finiſhed repreſentations of ſuch plants as he may never have an opportunity of beholding.

ing. The elegant engravings in Mr. Forſter's Obſervations, a work which we have already recommended, ought likewiſe to be mentioned as worthy the attention of thoſe naturaliſts who are deſirous of being acquainted with the curious productions of the vegetable world in the South Seas.

In ſuch an extenſive field as that of Botany, it often happens that the genius or particular views of one man incline him to cultivate with peculiar ardor a particular part. In ſuch caſe it may be of uſe to know, that ſeveral authors have diſtinguiſhed themſelves in reſpective departments. Thus Moriſon and Artedi excel in their accounts of the Umbelliferous plants. Ray, Montius, Scheuchzer, and Michelius, are the eſteemed writers on the Gramina; Dillenius on the Moſſes; and both the latter likewiſe on the Fungi.

The anatomy and phyſiology of plants have been accurately treated by

Malpighi, Grew, Hales, Geſner, Feldman, and Ludwigius. The virtues of plants have been copiouſly treated by many writers on the Materia Medica. No ſubject, indeed, has been more diſcuſſed, and worſe treated. The wildeſt conjectures have been aſſumed as facts, and qualities the moſt imaginary have been attributed to vegetables, and their various parts. It has been the buſineſs of medicine in the preſent age to conſign to oblivion many plants formerly ſuppoſed to have ſpecific powers. To thoſe who may occaſionally deſire to turn their attention to this matter, I would recommend Dr. Alſton's Lectures on the Materia Medica, publiſhed by Dr. Hope, which, with Lewis's Diſpenſatory, form a ſyſtem of vegetable medicine, ſufficiently accurate for the purpoſes of common enquiry. The work of Geoffroy was formerly in great repute, and does ſtill deſerve attention, for the chemical analyſis which he

gives

gives (however imperfect) of ſeveral plants. In the ſyſtems of Materia Medica by Murray, and Bergius, Profeſſor at Stockholm, we have arrangements according to the Linnæan method, highly uſeful to medical men. And the Materia Medica of Dr. Cullen is perhaps the moſt philoſophical view that was ever given of this ſubject. The Amœnitates Academicæ, which conſiſt of a Collection of Theſes in 7 volumes, in 8vo. publiſhed under the inſpection of Linnæus, contain many valuable obſervations on every branch of Natural Hiſtory. Dr. Lewis's Commerc. Technic. or Philoſophical View of the Arts, is a work which deſerves to be mentioned in this place, as highly uſeful to the Naturaliſt and Philoſopher. The plants of particular countries have likewiſe their particular hiſtorians. Thoſe of Lapland have been explored by Linnæus; of Pruſſia, by Læſilius;

of

of Paris, by Vaillant; England, by Ray, Sir John Hill, Hudſon, Curtis, &c. and of Scotland, by Lightfoot.*

We ſhall here cloſe our account of the method of ſtudying the vegetable kingdom; and we truſt, that what has been ſaid will be ſufficient to excite the attention of the young ſtudent, as well as to afford him ſome inſtruction.

We have endeavoured to give the outlines of this branch of ſtudy: for as general information muſt neceſſarily be premiſed before particular knowledge can be attained, we truſt, that it will appear no ſmall progreſs to have acquired, at one view, ſome acquaintance with the various authors of an enlarged and comprehenſive ſubject.

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* Vide Linn. Phil. Botan.

PART III.

The Animal Kingdom.

WHEN we take a view of the number of animals which exiſt in every part of our earth, we ſhall be ready to acknowledge, that it muſt be matter of real difficulty to attain a tolerable acquaintance with them. The appearances of nature are not immutable. Many of her external forms are fugitive, and it is only by ſerious attention, and minute inveſtigation, that we can fix upon points which ſhe has characterized indelible.

When ſuch characteriſtic marks are once diſcovered, we may proceed to ſyſtem, and attempt the claſſification even of infinitude. Multiplicity will no longer conſtitute difficulty. It is by method

that we facilitate ſtudy, and in matters of natural ſcience, we are at liberty to borrow artificial aid. I ſhall therefore mention ſome of the principal methods which have been offered to the public, and conclude with an enumeration of the principal authors in each branch of the ſcience.

Ariſtotle was probably the firſt whoever thought of arrangement in this ſubject. He eſtabliſhed only general and ſimple diviſions; but his excellent reflections on the external and internal organs of animals, laid a foundation upon which the claſſifications of the firſt methodical naturaliſts, as Geſner, Aldrovandus, Johnſton, Charleton, Ray, &c. have been founded.* A great number of other naturaliſts, whom

* In 1693, Mr. Ray publiſhed his Synopſis Method. Animalium, Quadrupedium, & Serpentini Generis. His two general diviſions are into Quadrup. ungulata, or hooſed; and Quadrup. unguilata, clawed or digitated.

whom we ſhall have occaſion to mention hereafter, have enriched Natural Hiſtory by their obſervations: but it was left to the ſagacity and penetration of Linnæus to fix upon a method of characterizing all living bodies. His ſyſtem is undoubtedly liable to many exceptions; but it is eaſier to find fault than to amend. In the year 1735, Linnæus firſt publiſhed the ſyſtem, of which we ſhall attempt ſome account. After taking a philoſophical view of the ſubject in general, he proceeds, in Vol. I. of the Syſtema Naturæ, to the eſtabliſhment of the claſſical characters, from the different internal ſtructure of animals. By this natural diviſion all the animal kingdom naturally divides itſelf into ſix claſſes, as follow:

Animals with the heart furniſhed with

Two ventricles and auricles:	Viviparous.	Mammalia.
Blood warm and red	Oviparous.	Birds.

One ventricle and auricle:	Reſpiration voluntary.	Amphibia.
Blood cold and red.	Breathing by gills.	Fiſhes.
One ventricle without auricle: -	Antennated.	Inſects.
Sanies, cold and colourleſs.	Tentaculated.	Worms.

To this account of the internal ſtructure the author adds all the differences ariſing from the lungs or other organs of reſpiration, from the maxillæ, jaws or mandibles, organs of generation or ſenſation; the teguments, or outward covering, and the fulcra, or legs, wings, &c. At the head of each claſs is given a conciſe deſcription of the claſſical character, including an explanation of the terms belonging to the claſs. We have likewiſe a general enumeration of the beſt authors on each; a part of the work exceedingly uſeful to ſtudents, and from which we ſhall occaſionally borrow, in our view of the method of ſtudying this part of the creation.

CLASS

CLASS I. MAMMALIA.

Comprehends all thoſe animals which we call quadrupeds, (except the lizard genus, or reptiles pedati, as they are called) and likewiſe the cetaceous order, or whales, cachalots, and porpeſſes. Several authors have diſſented from this arrangement of whales with quadrupeds, and the author had ſeparated them in the firſt edition of his Syſtema Naturæ; but upon reflection he thought himſelf juſtified in ſuch a claſſification. The ſtriking particulars in which they differ from fiſhes, as the ſtructure of the heart, having lungs for reſpiration, moveable eyelids, being viviparous, and furniſhed with teats, all incline him to refer them to this claſs. The ſingle circumſtance of living in the ſame element is therefore overlooked.

The mammalia are divided into ſeven orders, which are principally taken from the difference in the number, ſituation, and form of the three kinds of teeth with which animals are endued, viz. the *primores* or *inciſores*, called the fore-teeth or cutting-teeth; the *laniarii* or *canini*, dog teeth, canine, or lacerating teeth; and the *molares*, grinders, or double teeth. Our author likewiſe takes into conſideration the feet, as will appear from the following view of the orders.

I. Digitated.

Fore teeth, four. Canine ſingle, - -	Primates.	1.
Fore teeth, none -	Bruta.	2.
Fore teeth, 6, 2, 10 conical. Canine ſingle -	Feræ.	3.
Fore teeth, two. Canine none -	Glires.	4.

II. Hoofed.

No fore teeth above	Pecora.	5.
Fore teeth above and below	Belluæ.	6.

III. De-

III. Deſtitute of Hoofs or Claws.

Teeth, various in the diffe-
rent genera - Cete. 7.

We ſhall here detail the characters as they ſtand at the head of each order.

I. Primates. Animals furniſhed with fore teeth, or cutting teeth: four above; parallel. Two pectoral teats.

II. Bruta. No fore teeth.

III. Feræ. Six ſharp fore teeth in the upper jaw. One canine tooth on each ſide.*

IV. Glires. Two fore teeth in each jaw, cloſe together; but remote from the grinders. No canine teeth.

V. Pecora. No fore teeth in the upper jaw; ſix or eight in the lower jaw very remote from the grinders. Hoofed feet; inguinal teats.

VI. Bel-

* There are exceptions to this order, ſome of the genera have above ſix teeth. The Didelphis has 17, the Sorex 19, and the Erinaceous 20.

VI. Bellua. Fore teeth truncated. Hoofed feet.

VII. Cete. Breathing apertures on the head. Pectoral fins. Tail placed horizontally. No claws.

Many objections have been made to this ſyſtem of claſſification. It is ſaid to be arbitrary and unnatural. Animals are claſſed together whoſe figure and habits are diſtinctly different. It is therefore alledged that the method is imperfect; and the fact may be admitted without any detraction of its real merits. For although the pride and aſſumed conſequence of man may be offended when he beholds himſelf ranked with the brute creation, and finds that even the internal ſtructure of ſuch a hideous monſter as the bat reſembles the real formation of his frame; yet on minute enquiry he will have cauſe to admire the ſimplicity and magnitude of that ſyſtem which ſhews him his real ſtation, and makes

him

him acquainted with the wondrous extent of his own empire. Linnæus has placed man at the head of the Primates, and given him the Grecian dictate, " Know thyſelf," as his motto. By a conciſe and elegant comment he endeavors to ſhew, that however near his alliance to the mere animal, yet by the culture of his faculties, it is in his power to prove himſelf an *intelligent and moral being*.

The nature of our plan will not allow us to enter into a detail of the genera or ſpecies; we ſhall therefore continue our view of the ſyſtem, by an examination of the orders of the remaining claſſes.

CLASS II. Aves. Birds.

Linnæus has divided theſe into ſix orders, the diſtinction of which are chiefly taken from the beak; but it has

has been neceſſary in ſome genera to take in the tongue, nares, or noſtrils, and likewiſe the feet, and other parts.

I. Accipitres. Rapacious. Birds having the upper mandible of the beak furniſhed on each ſide with an angular proceſs.

II. Picæ. Pies. Birds having the beak rather compreſſed on the ſides, and convex on the upper part.

III. Anſeres. Web-footed. Theſe have a beak ſomewhat obtuſe, and covered with a thin ſkin; at the baſe underneath gibbous, and wide at the end; the *faux*, or edges of the baſe, denticulated; the feet palmated, or webbed, and formed for ſwimming.

IV. Grallæ. Waders. Theſe have the beak ſubcylindrical, and ſomewhat obtuſe; the tongue entire, and fleſhy; the thighs naked for ſome ſpace above the knees.

V. Gal-

V. Gallinæ. Gallinacious. Birds having the upper mandible convex, or arched, and receiving the edges of the lower noſtrils, half covered by means of a convex membrane, rather cartilaginous; the rectrices, or tail feathers, more than twelve; the feet cloven, but the toes connected by a membrane as far as the firſt joint.

VI. Paſſeres. Paſſerine. Theſe have a conical acuminated beak; the noſtrils ovated, open, and naked.

CLASS III. Amphibia.

All the animals of this claſs have not the power of living either in air or water; but they have the ſingular property of ſuſpending the function of reſpiration, and can perform it in a more arbitrary manner than other animals.

This claſs is divided into four orders:

I. Reptiles pedati. Reptiles. Amphibious animals, which breathe through the mouth by lungs only; they are furniſhed with four feet.

II. Serpentes apodes. Serpents. Amphibious animals, breathing through the mouth by means of lungs only. They are deſtitute of feet, fins, and ears.*

III. Meantes. Gliders. Theſe animals breathe by means of gills and lungs,

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* Perhaps this laſt aſſertion is not fully proved.—Fiſhes were formerly ſuppoſed to be deſtitute of the organs of hearing; but ſeveral years ago Placentini found ſome bones in the head of a pike which had the appearance of thoſe organs. Klein improved upon this hint in his Hiſtory of Fiſh, &c. Vide Phil. Tranſ. vol. ix. p. 114. The learned Profeſſor Camper deſcribed the organs very fully in the Memoir. de Mathem. & Phy. Roy. Acad. Sc. Paris. Since which time Mr. John Hunter and Dr. Monro have demonſtrated them in a great variety of ſpecies. The probability, therefore, ſeems to be, that ſerpents may have the organs of hearing, though hitherto undiſcovered.

lungs, and are furniſhed with arms and claws.

IV. Nantes pinnati. Breathing fiſhes. Theſe reſpire arbitrarily by means of gills and lungs. The rays of the fins are cartilaginous.

CLASS IV. Pisces. Fishes.

In the firſt edition of the Syſtema Naturæ, Linnæus followed the method of his friend Artedi, whoſe Ichthyology was publiſhed in 1738, in Holland. This method was eſtabliſhed on the ſtructure or ſituation of the tails in the cetaceous order, and on the difference in the gills, and rays of the fins in the other orders, whether cartilaginous or bony; but (as we have already ſeen) the cetaceous order is now placed among the Mammalia, and the Nantes Pinnati referred to the Amphibia. In the two laſt editions our au-

thor forms four orders of the bony fiſhes, (which reſpire by means of gills only) and theſe he has taken from the ſituation or abſence of the *ventral* fins. He compares theſe to the feet of other animals, and their ſituation is denoted with reference to the pectoral fins. The orders are,

I. Apodes. Fiſhes deſtitute of ventral fins.

II. Jugulares. Thoſe which have the ventral fins placed before the pectoral.

III. Thoracici. Fiſhes having the ventral fins placed underneath the pectoral fins.

IV. Abdominales. Theſe have the ventral fins placed behind the pectoral, on the abdomen. Some authors, as Artedi and Gronovius have attempted to diſtinguiſh the ſpecies by the number of the rays in the fins; but the variation is too great to eſtabliſh a ſufficient character. The ſpecific characters

ters are therefore, at preſent, taken from a variety of particulars, as the number of rays in the fins, the form of the tail, the cirrhi, or beard at the mouth, the length of the jaw, and the ſpots and lines on the body, &c.

CLASS V. INSECTA. INSECTS.

A great number of authors appeared before Linnæus on this ſubject; but he was confeſſedly the firſt who determined the genera of inſects, and aſſigned them their proper characters. He has arranged them under ſeven orders:

I. Coleoptera. Inſects having the wings covered with two cruſtaceous caſes, divided by a longitudinal ſuture.

II. Hemiptera. Half-winged inſects, which have the ſhells or caſes ſemi-cruſtaceous, not divided by a ſtraight

ſtraight ſuture, but incumbent on each other in the margin. The beak is curved inwards.

III. Lepidoptera. Theſe have four wings, imbricated, or cloathed with fine ſcales, or feathers; tongue ſpiral, and coiled up; body hairy.

IV. Neuroptera. Inſects with four naked tranſparent, or reticulated wings; the tail in moſt kinds without a ſting.

V. Hymenoptera. Theſe have four membranaceous wings, except ſome few ſpecies, which are deſtitute of wings. The females have the tail armed with a ſting.

VI. Diptera. Inſects with two wings, having alſo a balance or club behind each wing.

VII. Aptera. Inſects without wings in either ſex.

In ſtudying this, as in every other part of Zoology, it is neceſſary to acquire a certain number of terms, without

without which no real proficiency can be made in the ſcience. The genera of this claſs are characterized from certain parts of the animals, ſome of which have technical names, as the antennæ, or feelers; elytra, or outward caſes; roſtra, or mouth, &c. The head, thorax, tail, and other parts, are likewiſe occaſionally uſed to aſſiſt in forming the character The ſpecies of each of the orders are very numerous.

CLASS VI. VERMES.

We are now arrived at the laſt claſs in the Syſtem of Nature, which we are to conſider as divided by our author into five orders. Linnæus has followed the method of Peyſonel, Juſſieu, and others, by introducing the coral and corallines into the animal kingdom, under the names of Lithopyta and

Zoophyta. We ſhall likewiſe find the ſtudy of a very ſplendid part of Natural Hiſtory preſenting itſelf to our view, in the examination of the orders of this claſs. Conchology, or the ſtudy of ſhells, has long attracted the attention of Naturaliſts; and diſputes have ariſen reſpecting the proper method of ſtudying the ſubject. The ſhells themſelves, as mere coverings, or parts of living animals, cannot certainly demand our primary attention in a ſyſtem of Zoology. The animals as one whole fall under our conſideration, and accordingly Linnæus has made Conchology a branch of Zoology, and not of Mineralogy.

The characters of the orders of this claſs are very various.

I. Inteſtina. Animals ſimple, naked, deſtitute of limbs.

II. Molluſca. Animals ſimple, naked, not included in a ſhell, but furniſhed with limbs.

III. Te-

III. Teſtacea. Theſe are generally of the foregoing order, but included in a ſhell.

This order comprehends the whole tribe of ſhells, conſiſting of thirty-ſix genera, and above eight hundred ſpecies, diſpoſed according to a new method. The three firſt genera are called Multivalves; the next fourteen Bivalves; and the remainder Univalves.

IV. Lithophyta. Theſe animals are compoſite. They are affixed to, and fabricate a fixed calcareous baſe, known by the name of coral.

V. Zoophyta. Theſe are likewiſe called compoſite animals, and ſaid to reſemble a flower, and to ſpring from a vegetating ſtem.

Obſervations are yet wanting to aſcertain the two laſt orders with preciſion. It is confeſſedly a matter of the greateſt difficulty to draw the line of ſeparation between the three kingdoms. The gradations of organized

bodies are ſuch as obſtruct preciſe definition. Animals may exiſt whoſe principle of life reſides in a ſtructure of parts reſembling the organization of vegetables, as is ſaid to happen in the order Zoophyta; and it is not impoſſible to conceive that the real living parts of an animal may preſent themſelves to our view in a form reſembling that of a vegetable; but it is hardly poſſible to imagine, nay, it is diſſonant to reaſon, to affirm, that the principle of life can exiſt in unorganized matter.

The Polype is evidently an animal bearing no reſemblance to a plant; and probably future attention and experience to this order may inform us, that all the animals hitherto known under the name of Zoophytes, are properly referable to ſome other claſs or order. The whole order conſiſts, according to Linnæus, of fourteen genera, of which nine are fixed, and the

reſt

reſt locomotive; amongſt the former are reckoned the Iſis, or Red Coral, Sea Fan, Alcyonium, Sponge, Coral-lines, &c. Among the latter the Polype, Sea Pens, Tænia, Furia, and the Microſcopical Animalcula. This view of the genera will be ſufficient to ſhew the great defect of the order itſelf. For the greater part of the microſcopical animalcula, or Animalcules des Infuſions, as they are called, have been ſhewn by the Abbé Spallanzani, and others, to be diſtinct animals, not always of the claſs of Vermes. Some, indeed, have a very ſingular appearance; but I believe none of them are Zoophytes. In the ſame manner objections may be made to the order of Lithophyta. Theſe animals have been ſuppoſed to connect the animal and mineral kingdoms; and it muſt be confeſſed, that they appear the laſt link in the chain of organized matter: but it appears to

me, that Naturaliſts have taken a ſuperficial view of the matter of fact, and deſcribed as Lithophytes, ſubſtances which are in reality nothing more than the neſts of real animals.

The genera of this order are four: the Tubiporæ, or red tubular coral; Madrepores, or brain ſtones; Millepores, and Cellepores. In each of theſe kinds we obſerve certain pores or cells, apparently the receptacles or habitations of diſtinct animals. The aſſemblage which we view is not therefore to be conſidered as an animal, but rather as the fabrication of many animals, in the ſame manner as a ſhell is the work of a ſingle animal. The coral, in my opinion, properly ſpeaking, is no more a Lithophyte than any of the ſpecies in the order Teſtacea. It muſt, however, be confeſſed, that this ſubject is at preſent involved in great obſcurity.

But to return: the generical diſtinctions of the claſs of Vermes are taken from a variety of particulars which deſerve our attention. In the Inteſtina the genera are characterized almoſt ſolely from the diverſity of the body of the animal. In the Molluſca, from the body and feelers, called Tentacula, and from other parts.

In the Teſtacea, the included animal, the general differences among the ſhells themſelves, and principally the *cardo*, or hinge in the bivalves, together with the *aperture* in the univalves, furniſh the general character.

In the Lithophyta the inhabitant animal is conſidered with the form of the coral itſelf: a proof of Linnæus's opinion of the real nature of theſe animals. He conſiders the whole as the fabrications of different animals, and not as one whole animal itſelf. Have ſubſequent naturaliſts entertained the ſame ideas?

In

In the Zoophyta again the animal and the different forms of its fabrications lay a foundation for the generic notes.

The authors in Zoology are numerous and valuable. Geſner, Aldrovandus, and Johnſton, are reckoned amongſt the early writers on the Mammalia; and we have already mentioned our own countryman, Mr. Ray, as the predeceſſor of Linnæus. Many objections (we likewiſe obſerved) have been made to the general ſyſtem of the latter: we ſhall, therefore, in this place take a view of the authors who have diſtinguiſhed themſelves in the various departments of this combined ſubject. In 1731, Mr. Klein publiſhed his Quadrup. Diſpoſitio Breviſque Hiſt. Nat.—In his firſt order he has improved upon Ray's method; but in the ſecond, the idea of a natural method ſeems to have

forſaken

forſaken him; as he has combined animals which Nature ſeems to have referred to diſtinct claſſes: the camel is placed with the ſloth, the mole with the bat, and the glutton with apes. In 1756, M. Briſſon propoſed a method of claſſing quadrupeds according to the number or defect of their teeth, beginning with the toothleſs, as the ant-eater, and ending with thoſe that have the moſt, as the opoſſum.

On the ſubject of quadrupeds, we muſt not omit to mention the Count de Buffon, whoſe writings in various branches of Natural Hiſtory and Philoſophy deſerve the attention of the naturaliſt. It is not, however, with a view to eſtabliſh the utility of ſyſtem that we mention this author; he has attempted to reject all ſyſtem, particularly in the ſtudy of quadrupeds, whoſe numbers are ſo few as to give ſome countenance to his opinion; but

but although we are unable to ſubſcribe to his ſentiments in this, and many other particulars, yet the elegance of his diction, and boldneſs of his thoughts, give ſuch an air of novelty and genius to his works, as is rarely to be met with in ſubjects of Natural Hiſtory, and muſt always recommend them to the peruſal of the curious. His deſcription of animals is generally beautifully juſt, and truly philoſophic. In ſome inſtances we have the appearance of prejudice, but it is the prejudice of a philoſopher.

Mr. Pennant, the Engliſh Linnæus, has given a ſyſtem of quadrupeds, which is held in high eſteem, and by many preferred to that of Linnæus. He follows Ray's method of hoofed or digitated; and, like M. Klein, makes ſeparate genera of the rhinoceros, hippotamus, tapiir, and muſk. The apes are placed according to Ray,

and

and followed by the maucaucos. In the arrangement of carnivorous animals he follows Linnæus, omitting the ſeal, mole, ſhrew, and hedgehog. The three laſt are joined to the herbivorous or frugivorous of Mr. Ray. The fourth ſection of digitated quadrupeds comprehends thoſe which are entirely deſtitute of cutting teeth, as the ſloth and armadillo. The fifth ſection comprizes thoſe which have no teeth, as the manis and ant-eater. Our author has likewiſe added the diviſions of pinnated and winged quadrupeds. Under the firſt are comprehended the walrus, ſeals, and the manati. Theſe, he obſerves, appear the links between the quadrupeds and cetaceous animals. The bats are the winged quadrupeds, and ſeem to connect the claſs of birds.

The claſs of aves has attracted the attention of many diſtinguiſhed naturaliſts. In 1755, Geſner, and 1557,

Bellonius, publiſhed upon this ſubject. Linnæus ſtiles them " Patres " Artis."

In 1599, Aldrovandus, and 1648, Margraave, made additions to the ſcience. In 1676, Mr. Willughby, an Engliſhman, publiſhed his Ornithology; which continues to hold a place in every naturaliſt's library. He was ſucceeded by Mr. Ray, in 1713; and in 1726, the ſtudy of this claſs was enriched with tolerable plates by Marſiglius. But theſe were excelled by Friſchius, in 1734. In 1731, Albinus and Cateſby employed themſelves on this ſubject. And in 1745, Mr. Edwards publiſhed his Ornithology, embelliſhed with very elegant plates, In 1746, Linnæus firſt gave the outlines of his claſſification of the aves, in the Fauna Suecica; and in 1758, it was publiſhed in the Syſtema Naturæ. In 1760, appeared the work of M. Briſſon, which is held in high eſti-

eſtimation by ſome of the continental writers. Since which time we have the valuable work of Mr. Pennant, which deſervedly makes a part of every Engliſh naturaliſt's library. The Comte de Buffon has alſo publiſhed a ſplendid Ornithology, but the plates are inferior to thoſe of Edwards.

The authors on the Amphibia are very few: Seba, Cateſby, Gronovius, and Garden, comprize the liſt. The laſt order of this claſs has been referred to the Piſces, and treated upon by the writers under that diviſion.

The authors of the fourth claſs are more numerous than the preceding. The firſt that we ſhall mention is Bellonius, whoſe work appeared in 1552. In 1554, Rondeletius and Silvianus both publiſhed upon this ſubject; and in 1558, the indefatigable Geſner was employed in this branch of Natural Hiſtory. In 1605, Aldrovandus, in

1685, Mr. Willughby, and in 1710, Mr. Ray, made additions to Icthyology by the publication of their reſpective obſervations. In 1760, Seba publiſhed his work. He was ſucceeded by Artedi, the friend of Linnæus, who is univerſally allowed to have treated the ſubject in a maſterly, ſcientific manner. He was ſucceeded by Gronovius, Haſſelquiſt, Cateſby, and Garden. To this liſt we muſt add M. Brouſſonet, Profeſſor of Natural Hiſtory at Montpelier, and honorary member of this Society, who has publiſhed one decade of Ichthyologia, in which he has deſcribed ten rare and curious fiſhes, now in the collection of Sir Joſeph Banks, Bart. He offers a new method of diſtinguiſhing the ſpecies according to the proportional length of parts, meaſuring from certain fixed points, as from the apex of the ſuperior maxilla to the tail fin, ventral fin, dorſal or pectoral fin, &c. This

diſtinction

diſtinction is founded upon the idea that the increment of all the fixed points in the growing animal is equal, or proportionate.

The authors on inſects are very numerous. Linnæus was the firſt who undertook to determine the genera of inſects, and aſſign them their proper characters. Swammerdam informs us, that no leſs than four hundred writers preceded him on this ſubject; and we find, that the ſtudy of butterflies was at one time ſo faſhionable, that the Lady Merian actually ſailed from Holland to Jamaica in purſuit of this ſplendid tribe of inſects. Moſt of the authors have invented ſyſtems for themſelves, and there is now publiſhing in France a work, entitled, Papillons de l'Europe, in which we have ſome very good plates finely coloured, and a ſort of new arrangement. Poda, Sultze, Geoffroy, Scopoli, and Gronovius, are the chief ſyſtematic writers.

writers. Sir John Hill divides them into three claſſes: 1. Apteria, having no wings. 2. Pteraria, including all winged inſects. 3. Gymnarthridia, including all inſects which have ſoft and naked bodies, furniſhed with limbs. Mr. Ray has two principal diviſions; and Dr. Hook has preſented us with a Micrography in Folio. Fr. Redi, a phyſician at Florence, has publiſhed ſeveral figures, with ſome new and curious experiments of his own. Malpighi and Bartholine have ſome fine obſervations, and we have likewiſe ſeveral intereſting experiments on inſects in the Philoſophical Tranſactions of London, Paris, and Leipſic. Hoeffnagel, painter to the Emperor Rudolphus, has given plates of above four hundred ſpecies. Mr. Albin has likewiſe given a new hiſtory of the Engliſh inſects, with very beautiful figures. We have alſo a work on Engliſh moths and butterflies,

flies, by Mr. Wilks, Lond. 1747, 1760. But the Memoires pour ſervir à l'Hiſtoire des Inſectes, par M. de Reaumur, à Paris, 1734, 1742, is eſteemed the beſt and moſt philoſophical account of the ſubject which ever appeared. Bonnet de Geers, Schæffers, Jungius, and Scopoli, with a whole troop of Germans, have been employed as auxiliaries in this purſuit; but to the young ſtudent we recommend a little work by Mr. Curtis, as the moſt uſeful introduction.

The writers on the claſs of vermes are only numerous on the order of Teſtacea. We have no authors of note on the Inteſtina. On the Molluſca Bohadſchius is the principal; and on the Teſtacea we find Bonannus in 1684;* and Liſter, in 1685, publiſhed his

* His work is entitled Recreatio Mentis & Oculi in Obſervatione Animalium teſtacearum a P. Phil. Bonnano S. J. Rom. 1684.

his Synopſis Methodica Conchyliorum, Libr. III. Append. 2. Lond.—Ibid. 1692, Fol.

In 1702, and 1705, Rumphius publiſhed on this ſubject. After whom appeared the following works:

Car. Nic. Langii Methodus Nova & Facilis Teſtacea Marina in ſuas Claſſes, Genera, & Species diſtribuendi. Lucern. 1722.

Jac. Theod. Klein Sciagraphia Tubulorum Marinorum Muſei Kleiniani. Ged. 1731—4.

Jan Planci Arminienſis de Conchis minus Notis Liber. Venet. 1739. Romæ, 1760—4.

Nic. Gualteri Index Teſtarum Conchyliorum Muſæi ſui. Flor. 1742, Fol.

L'Hiſtoire Naturelle eclaircie dans une de ſes Parties Principales de la Lithologie, & la Conchyliologie, par M***, à Paris, 1742.

The plates of Argenville, which appeared in 1758, with thoſe of Regenfuſius,

fuſius, executed at the expence of the King of Denmark, are ſplendid illuſtrations of Conchology. A copy of the latter is now in the Univerſity Library, Cambridge.

Columna, Barrelierus, Plancus, Klein, Ginannus, and Adanſon, have likewiſe written on this ſubject; but to a beginner Da Coſta's Introduction to Conchology is the moſt uſeful, and, with Liſter and Argenville, will give as much information as moſt men wiſh to acquire on this very beautiful and pleaſing topic.

On the Lithophytes we have "Al. Fred. Marſigli Hiſtoire de la Mer, à Amſterdam, 1725, Fol. Obſervations ſur la Formation du Corail, & des autres Productions appellées Plantes Pierreuſes, par M. de Reaumur, 1727. And a work by Donatus.

On the Zoophyta we have "Examen de quelques Productions Marines, qui ont été puiſes au Nombre de

Plantes, & qui ſont l'Ouvrage d'une Sorte d'Inſectes de Mer, par M. Bern. de Juſſieu, 1742.

Eſſays on the Natural Hiſtory of Polypes, by Henry Baker. Lond. 1743-8.

Memoires pour ſervir à l'Hiſtoire d'une Eſpece de Polypes d'Eau douce, par M. Trembley. Leyd. 1744.

Lettres d'Eugene à Clarence au Sujet des Animaux appellées Polypes. A Straſb. 1745--8.

Car. Linnæi Diſſ. Corallia Balthica, Reſp. Henry Fougt. Upſ. 1745.—— Amæn. Acad. p. 177.

Ejuſd. Diſſ. Tœnia Reſp. Godof. Dubois. Upſ. 1748.---Amæn Acad. p. 53.

Della Storia Naturale Marina dell Adriatico Saggio del S. D. Vitaliano Vonati. Venez. 1750.

An Eſſay towars a Natural Hiſtory of the Corallines, by John Ellis. Lond. 1755.

Jobi Baſteri Opuſcula Subſeciva Obſervationes Miſcellaneas de Animalculis,

lis, & Plantis Quibuſdum Marines Eorumque Ovariis & Seminibus Continentia. Tom. I. L. i. 3. Tom. II. L. i. 3. Haerlem, I. 759. 1765.

Henr. Aug. Wriſberg Obſervationum de Animalculorum infuſoriorum Geneſi & indole Satura. Goetting. 1765.

Lettre de M. Derome de Liſle à M. Bertrand ſur. les Polypes d'Eau douce, 1766.

Pet. Sim. Pallas Elenchus Zoophytorum. Hag. com. 1768.

Aquatilium & Terreſtrium aliquot Animalium Obſervationes, Fabio Columna Auctore. Rom. 1606.

Ul. Aldrovandi de Animalibus exſanguibus, mollibus, & cruſtaceis. L. Bonon. 1606, Fol.

Jo. Jonſtoni Hiſt. Naturalis de exſanguibus Aquaticis, Lib. III. Francof. 1650, Fol.

Having gone through the plan propoſed, it will be unneceſſary for me to detain you any longer; I ſhall there-

fore conclude with obſerving, that in the ſtudy of Zoology the ſubject of Comparative Anatomy deſerves particular attention; and as it is intimately connected with general Phyſiology, it becomes the more immediate object of medical men. The little work of Dr. Monro, as an elementary ſyſtem, is the beſt with which I am acquainted. It is, however, to be regretted, that we have no tranſlations of ſeveral uſeful works in the German language. There is one author in particular which I would recommend to the ſtudy of thoſe who are able to peruſe it: It is the work of Profeſſor J. C. P. Erxleben, publiſhed at Gottingen in 1768, and contains the moſt ſcientific view of the three kingdoms of Nature with which I am acquainted. It is matter of no ſmall regret to me that I did not meet with it ſooner. But I am ready to acknowledge my obligations for the information which I have

borrowed

borrowed from it in ſome parts of this work; and I am ſorry that my ignorance of the German language did not enable me to ſtudy ſome other works, to which I have had acceſs in the library of the learned Preſident of the Royal Society, whoſe liberality and ardor in the purſuits of ſcience do honor to the nation.

The hints which I have given will, I truſt, be ſufficient to recommend and facilitate this pleaſing ſcience to all ranks of men whom it may concern; and there are few indeed whom it does not affect. Any farther eulogy or inſtruction to the young ſtudent muſt appear unneceſſary on the preſent occaſion; I ſhall therefore conclude with one more phyſiological plagiariſm:

" Here then we reſt: " The Univerſal Cauſe
Acts to one end, but acts by various laws."
In all the madneſs of ſuperfluous health,
The trim of pride, the impudence of wealth,

Let

Let this great truth be preſent night and day,
But moſt be preſent if we preach or pray.
Look round our world, behold the chain of love
Combining all below, and all above;
See plaſtic Nature working to this end,
The ſingle atoms each to other tend,
Attract, attracted to, the next in place,
Form'd and impell'd its neighbour to embrace.
See matter next, with various life endu'd,
Preſs to one centre ſtill, the General Good.
See dying vegetables life ſuſtain;
See life diſſolving vegetate again.
All forms that periſh other forms ſupply,
By turns we catch the vital breath and die:
Like bubbles on the ſea of matter born,
They riſe, they break, and to that ſea return.
Nothing is foreign; parts relate to whole;
One all-extending, all-preſerving ſoul
Connects each being, greateſt with the leaſt;
Made beaſt in aid of man, and man of beaſt.
The chain holds on, and where it ends unknown.

POPE'S ESSAY on MAN, Ep. III. Begin.

FINIS.