acid soon made its appearance, and then the gas became capable of impregnating chalk with nitrous acid as at first *."

These experiments of Thouvenel, and particularly the last observation, point out carbonic acid as the important agent in nitrification, at least as distinctly as could be expected of experiments of this nature.

It has all along been observed in the management of artificial nitre-beds, that although free exposure to the atmosphere be indispensable to the progress of nitrification, yet a strong current of air is exceedingly prejudicial. The rapid circulation of the atmosphere would be attended with the quick dissipation of the carbonic acid gas, upon which we have supposed the superiority of these nitre-beds to depend.

The atmosphere at all times and places abounds in carbonic acid gas, as the exposure of lime-water would quickly indicate. In those chalks and calcareous soils, in which the spontaneous production of nitrous salts is observed, the activity of the carbonate of lime may, therefore, equally depend upon its *dissolution*, effected by the absorption of moisture and carbonic acid from the atmosphere. It would still, however, be a curious subject of inquiry—whether these soils and chalks do not, in some cases, contain within themselves the carbonic acid necessary in conjunction with water to effect their partial solution, and be thus enabled to act to a greater extent upon the absorbed oxygen and azote—the elements of nitric acid?

Should this theory of the instrumentality of carbonic acid, in nitrification, be eventually substantiated, several improvements, in the artificial production of nitre, might evidently be deduced from it.

XXXVIII. *A Sketch of the Natural Affinities of the Lepidoptera Diurna of Latreille.* By WILLIAM SWAINSON, Esq. F.R.S. F.L.S. &c.†

TO those who have traced the progress of human knowledge, or are themselves engaged in its pursuit, it must appear evident that its extent would have been much greater than it really is, were we not so frequently withheld from communicating that which *we know*, from a sense of the importance of that which we do *not know*. Hence it is, that undertakings long meditated upon, and even carried beyond the point to which others have reached, are frequently laid aside on the appearance of some unexpected difficulty or temporary em-

* Aikins' Chemical Dictionary, vol. ii. 160. From *Mém. Etrang. de l'Acad. des Sciences*, tom. xi. 503.

† Communicated by the Author.
barrassment.

barrassment. This, it is true, in progress of time may frequently be overcome; but no sooner do we begin to make a little progress, than other doubts arise, which can only be solved by information which we again wait for. Thus months and years pass away, and that knowledge which, if properly used, might have advanced others one step nearer to the Temple of Truth, is suffered to lie useless and unemployed.

I have been led to these reflections, by having lately had occasion to bring together all I can find hitherto written on the *Lepidoptera*, and to revise what I had myself done on the same subject, some years ago. In the winter of 1823 I attentively studied these insects, with a view to discover their natural affinities; and I communicated the result to several of my entomological friends in the following spring. I deferred however the publication of these views, at the time, from a desire of procuring further information upon several points, then involved in obscurity. These have long since been cleared up; but other difficulties presented themselves; and it is probable that but for the necessity I am now under of introducing this subject in a larger work, the essay of which the following is a sketch would still have remained neglected.

Before entering upon this subject, it may be as well for me to express my firm conviction that the Almighty Author of the universe has created all things that have life upon one plan; and "that this plan is founded on the principle of series of affinities returning into themselves*;" which can only be represented by circles. This sublime discovery, sufficient of itself to immortalize a name, was first made known to the world by our illustrious countryman. It was soon after confirmed by two other eminent philosophers †, unknown to each other, and finally has been proved to demonstration. Yet the right application of these principles to the race of beings *now existing* upon our globe, is another consideration; on which there is, and always must be, great diversity of opinion. The temple has been shaken, and in part destroyed; and although a sufficient portion remains to give us some faint idea of the original beauty and perfect harmony it once exhibited, the restoration of the fragments will long continue to engage the speculations and inquiries of the beholder. One fact, however, is certain, That where we find the series of any particular group unbroken by sudden or abrupt transitions, it will always be found to contain five others of an inferior description, two of which will exhibit a perfection superior to the other three. And it is no less certain, that this law of Nature is most con-

* MacLeay, *Horæ Entomolog.* Part ii. p. 459.

† MM. Fries and Decandolle. See Linn. Trans. vol. xiv. p. 62.

spicuous in those groups where the series of affinities is so perfect, and the change so gradual, as to set at defiance all possibility of separating the minor divisions by absolute and exclusive characters.

Now, upon looking to the *Lepidoptera*, it does not require any prejudice in favour of the foregoing principles, to discover five prominent groups of nearly equal magnitude, which may be represented by the genera *Papilio*, *Sphinx*, *Bombyx*, *Geometra*, and *Noctua* of the Linnæan school. And further, that while the two former are typical, the first represents the greatest perfection, and the second contains not only types of the other four divisions, but nearly so of all the subordinate groups.

In selecting the *Lepidoptera Diurna* of M. Latreille as a subject for the present sketch, I shall avoid entering into details of those reasons which have induced me to abandon the different arrangements proposed by others. Those of Linnæus and Fabricius were confessedly artificial; although the minor groups of the latter deserve to have been better known, and more generally adopted. The first attempt that I can discover towards a natural method, is that published by Geoffroy in 1764*, which in all probability furnished the basis of the classification adopted by the celebrated Latreille. Both, in fact, are founded upon characters drawn from the larva and pupa, and the partial or full development of the anterior feet in the perfect insect. The former are so much diversified, as to lead us to imagine that by attentively studying and judiciously combining their forms, we may obtain some certain clue to thread the labyrinth of affinities; or, at least, that we shall make a nearer approach to the truth, than if we looked only to the shape of the wings, or the nails of the tarsi. Yet it must be confessed that difficulties are opposed to this line of inquiry, which, in the present state of entomological knowledge, seem to me insurmountable. The larvæ of many considerable groups inhabiting distant regions are to this day utterly unknown: and even among those contained in the valuable works of Stoll and Abbot, there exists such a striking diversity in the forms of larvæ belonging to insects of the same natural group, that no certain conclusions can, at present, be made upon the subject.

The pupa state likewise presents many remarkable variations. Yet as, upon the whole, it is confined to much fewer forms, and these forms are better understood, there seems no

* Was this borrowed from the illustrious DeGeer? His invaluable "*Mémoires*," now of very rare occurrence, I unfortunately do not possess.

reason to doubt, that in our present difficulties, more accurate results will be derived by an attention to this state of the insect, than can be expected from a paramount regard to the larva. Entomologists have long ago remarked the following variations in the form and suspension of diurnal pupæ.

1. Pupa suspended by the posterior extremity.
2. Pupa attached by the posterior extremity, but braced or supported in a horizontal or vertical direction by a transverse thread.
3. Pupa attached like the last, but foliculated, or inclosed within a leaf. Among these, two forms are conspicuous:—
 1. Pupæ elongated and angular.
 2. Pupæ obtuse and smooth.

Geoffroy and Latreille have not failed to draw a marked distinction between such of the diurnal *Lepidoptera* as have the anterior feet perfect, that is, distinctly furnished with claws, and those which have the same feet imperfect, or not furnished with claws.

It is clear that in any attempt towards a natural arrangement, all these variations must have their due weight, yet without being used as circumscribing bounds. There is presumptive evidence to prove the truth of the assertion, “that the variation of metamorphosis (or of any particular set of organs) is only an index of the series of affinity, and not a principle by which groups have been strictly circumscribed*.”

On searching for that group which presents the most perfect development of organs, and at the same time is eminently distinct from the other primary divisions of the *Lepidoptera*, our attention is immediately fixed upon the genus *Papilio* of modern authors. In these the larva is eruciform, the pupa angulated and braced, and the perfect insect furnished in both sexes with distinct nails on their anterior feet. These characters, strikingly exemplified in the typical groups (*Papilio*, *Pieris*, L.) are softened down, and in part exchanged for others in the aberrant examples. In the genus *Colias* for instance, the anterior feet are short, and the *ungues* small and weak: in *Thais* the club of the antennæ is elongated and arched like that of many *Hesperidæ*; and in *Parnassus* the pupa is smooth and subfoliculated†. To this last genus we shall subsequently have to call the reader’s attention.

By the short and weak feet of *Colias*, we are conducted to a large and very important division, comprising many forms defined by Fabricius, but classed by Latreille as the genus *Nymphalis*. If strength of body, rapidity of flight, superiority of size, or brilliancy of colouring, were sufficient to constitute the typical

* *Horæ Ent.* part ii. p. 456.

† Latreille, *Gen. Inst.* See also *Esper.* vol. i. tab. 2. f. 1.

perfections of the diurnal *Lepidoptera*, the superiority would undoubtedly be conferred upon this group, did they not show a decided inferiority to the last in their imperfect construction. The anterior legs are destitute of claws, and are so short, as to appear at first sight perfectly useless. The angular form of the pupa is still fully preserved; yet, instead of being braced, it is suspended only by the posterior extremity. The lower wings of the perfect insect are dilated, so as to form a groove for the defence and support of the short conic body. It is obvious that this particular construction is admirably adapted for giving to these insects that superiority of flight for which they are remarkable. Yet in this power there are gradations: it is most developed in the genus *Paphia*, F., but is diminished in *Morpho*; the former is conspicuous for strength, the latter for size and beauty. Tracing this gradation further, we find in the genus *Hipparchia* a feeble and irregular flight, and a considerable falling off, in other respects, from the typical characters.

The following observation of the celebrated Latreille deserves particular attention, in this part of our inquiry. "*Papil. Cramerii*: *Phlegia*, *Eugenia*, *Calliope*, *Euterpe*, *Diaphana*, *Lenea*, *Nise*, *Melanida*, etc.; *Heliconiorum habitus*; horum lepidopterorum sedes naturalis incerta; an genus proprium?" No better authority can be brought forward to show that we have now arrived on the confines of another and a very extensive group, typically represented by the genera *Mechanitis* and *Idea* of Fabricius: these, with *Euplæa*, and probably *Acræa* of the same author, are marked by the same debility in their anterior feet, and the same mode of suspension in their pupa state, as the last: the pupa, however, is obtuse, and quite smooth; while the perfect insect, from its delicate construction, betrays a weakness of flight unexampled among the diurnal *Lepidoptera*. This I have myself witnessed. The feeble texture, and horizontally lengthened wings of *Mechanitis* seem, during flight, scarcely sufficient to support its long and clavate body. As we recede from these, the anterior feet in one or two groups, not hitherto characterized, begin to assume a more decided form, as if Nature was about to quit this type for another. Unfortunately, the slight information we possess on the metamorphosis of these insects, leaves me in much ignorance in this part of my inquiry; and I must content myself with noticing the generally weak construction, and striking similitude between several of the *Heliconi* and *Erycinæ* of Latreille, as circumstances strongly in favour of a natural affinity.

The next division comprises groups of the most singular
and

and apparently unconnected, forms; yet all agreeing, so far as we yet know, in the following characters. Larva somewhat onisciform. Pupa short, contracted, smooth, and braced. The anterior legs, in some genera approaching to the insects we have just quitted, are very short; in succeeding groups they become progressively longer, and finally, in *Polyommatus*, Latr. the six feet, in both sexes, are alike furnished with nails. These nails are, indeed, scarcely perceptible in *Thecla*, but in *Lycena* they become perfectly developed. The forms and habits of this interesting group are no less varied. They are mostly of a small size; some are remarkable for their sombre, others for their brilliant, colouring. Some are feeble, and when at rest extend their wings horizontally; others, of a more robust make, fly with swiftmess, and repose with their wings erect. Like the *Acrita* of MacLeay, this group appears, on a hasty glance, to want that symmetry of conformation so observable in the preceding divisions. Yet this impression soon vanishes, and we discover, in this apparently heterogeneous assemblage, that Nature has given symbolical representations of every form which she afterwards adopts to characterize the leading divisions of the whole tribe. The *Papilionidæ*, *Nymphalidæ*, *Heliconidæ*, and *Hesperidæ*, are not only represented, but every minor group and nearly every principal genus, will find its prototype among the *Erycinidæ*.

To lay any particular stress on the close affinity between the aberrant groups of the *Erycinidæ* and the *Hesperidæ* is quite unnecessary. By Fabricius they were at first united in the same genus, and M. Latreille has placed one almost immediately after the other. The only difficulty is, in ascertaining to what family the *Hesperidæ* are united by affinity at the opposite extremity of their own circle. The characters exhibited by the perfect insects have been sufficiently detailed by others, although the minor groups remain, for the most part, undefined. The larva, in every instance we know of, is eruciform; but the pupa, unlike that of any other division, is foli-culated, or hid within a leaf, to which it is additionally attached by a transverse thread or brace. Now on looking to all the groups we have here noticed, we find no approximation to this metamorphosis, unless it be among the *Papilionidæ*. The pupæ of most *Hesperidæ*, it is true, are smooth; and so far the affinity between them and the *Erycinidæ* is preserved; yet even here the form is elongated; while there are not wanting instances of Hesperian pupæ assuming something the angulated form seen in *Papilio*. On a due consideration, therefore, of all these affinities, coupled with the fact of the pupa of *Parnassus* having been described by all writers as foli-cu-

lated, I can come to no other conclusion than that we have at length returned, by a different route, to the point from which we first commenced our inquiry. And that notwithstanding the apparent dissimilarity between *Papilio* and *Hesperia*, they are, in fact, closely united by certain characters, which, under various modifications, preserve an unbroken thread through the whole circle of the diurnal *Lepidoptera*.

Nevertheless it must be observed, that there is an apparent hiatus between the points of these two groups, so far as regards the forms of the perfect insect: or at least, that the transition is not so gradual and progressive as that which can be traced in the other divisions. But this, I apprehend, may originate either from ignorance of the metamorphos of certain insects already known, or of others which still remain undiscovered. I venture to express this opinion, because, so far from discovering any particular fallacy in the mode of investigation here adopted, I find it has conducted me through difficulties, which, but for this guide, appeared at first insurmountable. I see, therefore, no reasonable cause to doubt it will fail, or become no longer of value, in the present instance. The true metamorphos of *Urania Leilus**, when discovered, may probably confirm the views of M. Latreille; and by assigning to this insect an intermediate station between the two groups, render their connexion perfect. Of the metamorphos of *Castnia* we are equally ignorant: but I am more inclined to consider that on this point also, the views of that celebrated entomologist will be found correct; and that *Castnia* will form an aberrant group among the *Sphingides* connecting them with the *Hesperidæ*, by means of *Hesp. Amycus* of Cramer.

It will be easily seen, that in this faint attempt to thread the labyrinth of Nature, many inferior groups have been passed over. To have enumerated all which have been defined by Fabricius and Latreille, and to have characterized many others now before me, would have swelled this paper to a volume. These I shall examine more in detail at a subsequent period. At present, my chief aim has been to fix the reader's attention to the typical or more prominent forms, and to the affinities by which they appear connected. If these are tolerably correct, the minor divisions will easily arrange themselves on one side or the other. It is the perfection of a natural group, that, however extensive, it cannot be broken up, and arbitrary characters assigned to the different portions. On the contrary, each will be dependent and interwoven with the next; and the

* I have so frequently had occasion to notice, when in South America, the inaccuracy of M. Merian's plates, that I am fearful of citing them as an absolute authority.

whole will present that order, beauty, and harmony, which belongs alone to the works of Omnipotence.

Whether in this feeble effort to illustrate such truths I have made some approach to a correct view of Nature, or whether, deceived by the little knowledge we yet possess, I have used it to construct an artificial system, and thereby given another instance of the misapplication of the Quinary principles, is not for me to judge. Mr. Macleay has justly said, "It is easy, indeed, to imagine the prevalence of a number; the difficulty is to prove it. The naturalist, therefore, requires something more than the statement of a number, before he allows either a preconceived opinion, or any analogy not founded on organic structure, to have an influence on his favourite science." (Linn. Trans. vol. xiv. p. 57.) To bring the foregoing observations to this test, I shall endeavour to exhibit, in the following synopsis, the leading characters of the groups at one view.

LEPIDOPTERA DIURNA, Latr.

		Families.
1.		
Typical Group.	{ Pupa suspended. Anterior legs imperfect.	1. <i>Nymphalidæ</i> .
Pupa angulated.	{ Pupa braced and naked.... } Anterior	2. <i>Papilionidæ</i> .
	{ Pupa braced & foliculated. } legsp perfect.	3. <i>Hesperiidæ</i> , Leach.
2.		
Aberrant Group.	{ Pupa braced. Larva onisciform. Anterior legs semi-perfect.	4. <i>Polyommataidæ</i> .
Pupa smooth.	{ Pupa suspended. Anterior legs imperfect.	5. <i>Heliconidæ</i> .

By bringing the *Heliconidæ* back to the *Nymphalidæ*, the five groups (which I shall denominate families) will be united every way, and form a circle. The result will be, that all the most perfectly formed insects will be brought together; at the same time that their several distinctions, in other respects, are preserved. The power of flight (which is the distinguishing character of the *Lepidoptera*) is seen to be developed, diminished, and again increased, in a very remarkable manner.—With regard to analogical relations, the following are among the most striking.

		Hexapod or sub-Hexapod.
Tetrapod.	{ Body short, thick, conic, reposing in a groove formed by the posterior wings. Club of the antennæ, seldom compressed. Thorax very thick. Flight strong, rapid.	<i>Hesperiidæ</i> .
<i>Nymphalidæ</i> .		
	{ Body lengthened, slender, clavate, free. Club of the antennæ compressed, generally spatulate. Thorax small. Flight feeble, slow.	<i>Polyommataidæ</i> .
<i>Heliconidæ</i> .		

Many other analogies may be noticed among the perfect insects; and many, doubtless, from the larvæ of such as are at present known;—but enough has been said on this point.

In conclusion, I should suggest that the secondary groups,

or sub-families, be distinguished by the termination *ina* or *ana*, as *Papilionina*, *Coliana*, *Paphiana*, &c. This rule, so generally adopted in other departments of natural history by modern writers, will at once explain the station occupied by these groups, in relation to those throughout nature.

Tittenhanger Green, near St. Albans,
Feb. 1st, 1827.

XXXVIII. *On the Crystalline Form of the Hyalosiderite.*
By WILLIAM PHILLIPS, Esq. F.G.S. &c.*

DR. WALCHNER of Freiburg not long since described a new mineral, under the name of Hyalosiderite, in Schweigger's *Neues Journal*; and a translation of his communication has appeared in the 63rd vol. of the *Philosophical Magazine*, and also in the first vol. of the *Edinburgh Journal of Science*.

Having lately obtained a specimen of that extremely curious mineral, affording several nearly perfect crystals, well adapted for the use of the reflective goniometer, I was induced to measure them by means of it, both because the inspection of them raised some doubts of the correctness of Dr. Walchner's determination in attributing to this substance an octohedron as the primary form of its crystals, and also because he has himself observed, that his own determinations of the measurements he has given, "cannot boast of very great accuracy." But it is somewhat singular that Dr. Walchner should believe his determinations will nevertheless "contribute to adjust in some measure the determinations published in Hausmann's *Spec. Cryst. Metall.* relative to the crystals of iron slags formed in various metallurgical processes;" "for," says Dr. W., "we find a corresponding similarity not only in the forms in general, but also in the angles of inclination of the planes:" and he then observes, that the angles given by Hausmann "could not but be very imperfect, on account of the small size" of the crystals.

Dr. Walchner has not said by what means he obtained the two measurements on which he has relied for the calculation of all the others given by him: he says, "the inclination of the planes d and d' (a^1 on c or c' of the following figure) may be determined most exactly, although on account of the smallness of these crystals, even these measurements remain imperfect;" and immediately adds, "the inclination on d on d' was determined to be 141° , and the inclination on d' on a (c or c'

* Communicated by the Author.