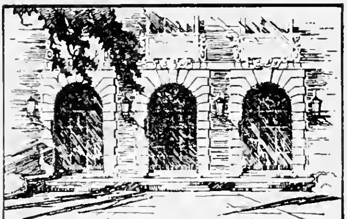

Horæ Entomologicæ:

OR

Frederic Moore

ESSAYS

from the

ON

THE ANNULOSE ANIMALS:

Executors

BY

of the late

W. S. MACLEAY, Esq. A.M.

OF TRINITY COLLEGE, CAMBRIDGE.

Thos Horsfield

VOL. I. PART I.

Augt 1859

CONTAINING

ervations on the Geography, Manners, and Natural A..nities of the Insects which compose the Genus *Scarabæus* of Linnæus;

TO WHICH ARE ADDED

A few incidental Remarks on the Genera *Lucanus* and *Hister* of the same Author.

WITH AN APPENDIX AND PLATES.

" *Les Entomologistes multipliaient à l'envi les observations; mais ils se* " *dispensaient de les générau...*" SAVIGNY, Mem. sur les Animaux sans Vertèbres. *Part* I. *Pref.*

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MDCCCXIX.

PREFACE.

In offering to the public this, his first essay in Entomology, the author thinks it by no means unlikely that he shall incur the charge of aiming at innovations in the science. The following remarks are, however, as he conceives, entirely practical, and the examination of their accuracy is within the reach of every entomological student. By such persons at least, therefore, he trusts that they will be considered as proceeding from a wish to connect and to reconcile with each other the observations of his predecessors, rather than from an absurd ambition to controvert or obliterate the result of their labours.

The author has for the present confined his attention to one branch of the science; principally, indeed, because he coincided with Fabricius in imagining that on *Monographs* has been founded almost every thing in the general systems now in use that can strictly be called natural. But the vast number also of animated beings which has been added to our lists since Linnæus first published his *Systema Naturæ*, and the still increasing numbers which daily arrive from the most remote quarters of the globe, or which swell our indigenous catalogues in proportion as our Fauna is explored, render it almost impossible for the naturalist to study in detail, more than one department of that which may be his favourite science. Of entomology in particular there are no bounds to the stores, and it may truly be said of insects,

> " *Sed neque quam multæ species nec nomina quæ sint*
> " *Est numerus.*"

Amidst these countless multitudes, the animals which compose the Linnæan genus *Scarabæus* appear in all ages to have attracted the notice of the admirers of nature. This may have been partly owing to their size, and partly to their splendour; but still more likely to the celebrity of the Ἡλιοκάνθαρος, or *Scarabæus pilularius* of the ancients,—an insect which from the singularity of its form and manners, became even an object of veneration and worship with the ancient Egyptians.

Indeed it was the peculiar interest which the *Scarabæus sacer* of Linnæus excited, as being a principal among the many objects " *qualia demens Ægyptus coluit*," that first led the author to investigate its natural history with the intention of drawing up a monograph[a] of the several species composing the genus *Ateuchus*, to which this insect had been referred by Weber and Fabricius. But he soon found that the unsettled and hitherto ill-defined state of the science had not only rendered this celebrated species, by means of repeated changes in nomenclature, unknown to any but entomologists; but that several other very distinct species were confounded together with it, under the trivial name of *sacer*. To this difficulty was added the unaccountable circumstance, that none of the great systematic authors, except Fabricius and Latreille, had properly distinguished it from other Coleopterous insects with lamellate antennæ, although the habits of these are often totally different. It thus was evident, that to review the whole of the Lamellicorn insects, properly so called, became necessary for any one who might wish to have correct ideas of the true place held in nature by the most interesting of the tribe. And as his father possessed a cabinet containing nearly 1800 species of the Linnæan genus *Scarabæus*, the author was led to imagine that few could be placed in a situation more favourable for the investigation, than himself; and, therefore, that it

[a] This intention has since been abandoned, in consequence of a work "*sur les Insectes Sacrés d'Egypte*" being now in the hands of the person in Europe the best able to treat the subject—M. Latreille de l'Academie Royale des Sciences.

would be in some measure inexcusable, did he not make the attempt. But in undertaking this task— as he has been obliged to search for an arrangement which when adopted should coincide with nature, and as after some time and labour bestowed on the research, he is still unable to lay down any distinct principle or rule by means of which such a classification may be arrived at—it seems necessary that he should here make a few remarks on systems in general, as well as on that plan which it has been judged proper to pursue in the following pages.

If it be true, as has been said, that there are few persons who form an accurate idea of what is meant by a System in natural history, it is equally just that there are still fewer persons who comprehend the exact difference between the Natural and an Artificial System, although the whole science now depends on this distinction being thoroughly understood. A celebrated French naturalist[a] has indeed defined a *System* to be an arrangement of bodies according to the distinctions taken from the consideration of one only of their external parts and properties; whereas he considers a *Method* to be an arrangement founded upon distinctions drawn from the form and structure of several of these parts. But so far as relates to their effects on natural history, the author of the following work has had rea-

[a] Cuvier, *Dict. des Sciences Naturelles. Pref.*

son to remark, that a system and method, in the above acceptation of the words, may be made to amount to the very same thing; and he has even been led to believe that a system or method entirely founded on *distinctions* must be artificial, whether such distinctions be drawn from the consideration of one or of one hundred parts. The chances, perhaps, are in favour of our being the least distant from truth in the latter of these two cases:—but after all, if any certain or positive difference can exist between them, it seems to be, that the greater the number of parts on which the distinctions are founded, the less convenient for use will be that particular method.

A system has also been said to act precisely towards enabling mankind to derive advantage from discoveries in natural science, as a dictionary in a particular language enables the world to participate in the discoveries that may have been made in that language. Now this observation is perfectly just, provided the system alluded to be an artificial one, and the discoveries it elucidates be supposed to refer entirely to nomenclature; for names in an artificial system are exactly what words are in a dictionary. But all knowledge in natural history beyond this of nomenclature is not (speaking properly) to be inculcated by a system, but is collectively itself no other than the *Natural System*. If, therefore, this natural system be said to be a medium for teaching the properties of natural objects, the definition is equally unhappy as if it were said that the system of the universe enables mankind to acquire a knowledge of itself, that is, of the various properties of the heavenly bodies. In natural philosophy a system has usually indeed been considered as synonymous with an hypothesis; but the two ideas expressed by these words have of late been very properly distinguished by observing that though a mere fiction or hypothesis may explain phænomena, yet a system is a certainty that must be deduced from these. The existence of particular phænomena can therefore never be legitimately proved or explained by a system, though they are virtually included in it, much in the same manner as in the statement of a proposition all those facts are assumed upon which its demonstration may depend.

When it is considered that in proportion to the number of data used in any investigation, the greater is the accuracy of the result, there seems little difficulty in allowing that the perfect knowledge of the natural system must consist in that of *all* the phænomena of natural history. This is moreover in no small degree rendered probable, though not absolutely confirmed, by the well known circumstance that the observations, whether of distinction or affinity, which are taken from the consideration of any single organ, of themselves alone invariably produce an artificial system. Nor ought it indeed to excite surprise, that a definite truth can rarely be obtained by reasoning on solitary data; because we are usually in such cases forced to call in some hypothesis to our aid in order to arrive at a conclusion. Yet thus it is that the habit of reasoning on single facts has been the bane of the study of nature, that it has led many of us totally away from the true path, and created such a delusion that we often imagine the most to be known when in reality we know nothing.

Were the planets to be arranged in a table according to any one of their properties,—as for instance, the period of rotation on their several axes,—such a system would be artificial, and only useful in that, having observed the length of a rotation, a reference to the table would be a convenient mode of determining the name of the planet. But no one would ever think of confounding this artificial table or system with the system of the universe; although an error exactly similar is every day committed in natural history, when a person who may by the mere exercise of his memory have become acquainted with an artificial table, fancies that he must therefore be a profound naturalist.

If it should be asked what is here meant by an artificial table in natural history, the author would reply, that such in his opinion is that rather oddly termed *Système de la Nature*, which has been defined by Cuvier to be a great catalogue in which all organized beings have suitable names, can be recognised by suitable characters, and may be distributed into divisions and subdivisions which are themselves also named and characterized. If then such a system as this be termed a dictionary, the true natural system may be reputed the language to which it refers; and as a dictionary is nothing but an useless assemblage of words, without some grammar or rules of syntax by means of which a knowledge of the structure of the language may be acquired, so an artificial system is a dry unmeaning collection of names, unless it be made subservient to the discovery of the natural one. An artificial system, according to what has been said, must always be more or less a violation of natural order; since it has no higher pretensions, no other merit, than the readiness and facility with which it may enable an object to be named; and again, because this facility seems principally to depend on the assumption of arbitrary distinctions with which nature is altogether unacquainted. But it is different with respect to the natural system; since an injury to the order of creation in this ought to be as offensive and as readily perceptible to the naturalist, as an error of syntax is to the grammarian. An artificial system depends solely on observation, and may even be said to require the exercise of no other faculty than that of vision. The discovery of the natural one, on the contrary, is only to be hoped for from a cautious process of inductive and analogical reasoning, applied to facts gathered from observation. Thus it requires neither talent nor ingenuity to invent an artificial system, and there may be as many hundreds of such as there are heads to devise them; but of natural systems there is and can be only one. Finally, the former is the miserable resource of the feeble mind of man, unable to comprehend in one view the innumerable works of the creation; whereas the natural system is the plan of the creation itself, the work of an all-wise, all-powerful Deity.

It will then scarcely be believed, that while the scientific world is inundated with artificial systems, the imperfections of which are daily discovered and daily criticized, not one in a hundred naturalists takes a more exalted view of the creation than to become acquainted with that farrago of names which so many confound with the natural system. And it will still less be credited, that some of those even who can properly distinguish them, either covertly insinuate or openly assert that we ought to rest contented in our ignorance, and to cease our inquiries after those affinities, from the study of which, says a learned writer, " the science acquires new dignity; and instead of being conversant merely with exterior forms and nominal distinctions, becomes acquainted with the laws and operations of nature[a]."

Though Linnæus first distinguished the natural from all artificial systems; yet with true philosophic caution he was satisfied, at the early period when he wrote, that the first step towards ascertaining the plan on which organized beings were constructed, was to acquire some general knowledge of the beings themselves. He therefore cultivated his artificial systems and his specific differences, to the comparative neglect of the higher branches of the science; and imagined that his time was thus more rationally employed, in collecting materials for himself and others to work upon at some future period, than if he commenced at once the investigation of natural affinities.

This methodical order in the study of the science on which he threw so much light, is one of the best proofs of his excellent sense: nay, a deviation from it by an ordinary individual at that time would have argued as much presumption as ignorance. But there are exceptions to every rule, and Linnæus was so gifted by nature, and undoubtedly possessed such an intuitive knowledge of her arrangement, that we cannot but regret that his time

[a] Roscoe, *Linn. Trans.* vol. xi.

should have been employed more conformably to the dictates of his modesty than to the advantage of science. It was this modesty which probably induced him to make the unfortunate remark, that they who used an imperfect natural method, rejecting the artificial system, seemed to him like persons overturning a commodious and well covered house in order to build another in its place, the roof of which they are incompetent to complete. But if such an opinion was unfortunate for the celebrated man with whom it originated, it was more peculiarly so for those disciples who have always adhered to the principles and sworn by the words of their master, even when they may have differed from him in their application. Relying on authority of such weight, they thought that, because they were secure from present blame, they must also be secure of future glory in following his example. They forgot that in the above remark Linnæus takes a circumstance for granted, which surely it is not for any human being to decide upon; namely, the incompetence of mankind to arrive at the natural method. They failed to observe that it is as impossible as hopeless, that we should ever be able to bring our knowledge of the natural system to perfection, unless we make use of the imperfect fragments of it which we already possess. Surely, at least, it was not by leaving every thing to hazard, and by losing sight of the natural system altogether, that they ought to have expected its discovery. The simile of Linnæus would indeed have been more accurate had he said, that to imagine that the natural method can be discovered without a previous acquaintance with an artificial one, is to fancy that it is possible to erect a building without having collected the materials necessary for the undertaking. But then he ought to have added, that he who contents himself with an artificial method without a wish to attain the natural one, is a man who lives quietly and indolently amid a confused mass of materials, that might with industry enable him to construct that fabric of which the architect in the true sense of the word, is no other than the great Creator himself.

Setting aside their convenience for use as catalogues, it may, however, be fairly asked, what good purpose hitherto have these artificial systems, these commodious and well-covered houses answered? The ichthyologist may, for instance, pride himself on his knowledge of the "finny race;" but unless he possess some nobler ambition than a perfect acquaintance with an artificial system, he must not be surprised that all his vaunted science is to be surpassed by that of many a poor fisherman. Both may with equal ease be able to give a name to the objects of their search, and both of them are equally ignorant of their natural affinities. Wherein, it may be asked, does the *practical* botanist (to use a modern expression) differ from the village herbalist or culler of simples; unless it be that the latter cannot give so learned a name as the former, to what it may have cost them equal trouble to find? The advocate of artificial methods will answer, perhaps, that the difference between the above two collectors is, that the one refers species to their genera, whereas the practical skill of the other is confined to species alone. But in reply to this, a question at first arises, namely—whether the notion of genera, as commonly understood by naturalists, be altogether accurate? And then, even though this doubt should be decided in the affirmative, it ought to be recollected that the notion of genera is not peculiar to naturalists; but that, on the contrary, the rudest and most uncultivated mind readily perceives it; and indeed, that it must have existed in man ever since he exercised so common a faculty as comparison. When the ancients divided the vegetable kingdom into plants alimentary, medicinal, poisonous, tinctorial, and so forth, the classification was not perhaps very scientific; but a division into genera was thereby as strictly implied, as if the stamens and pistils had been taken into consideration. Linnæus, therefore, in his definition of genera, has done nothing more than expressed with precision an idea, which, whether it be correct or not is another question, but which must certainly have been coexistent with the first use of human reason.

But it is said that every naturalist who has hitherto proposed a natural system, has thereby only deceived himself and others with an illusive structure, which, like the castle in a fairy tale, falls to pieces on being tried by the talisman of truth. The fact is perhaps indisputable;—but what after all does it prove? not certainly that the existence of the natural system is chimerical, or that the discovery of it is impracticable. Yet, according to Linnæus, the false naturalist is he who flatters himself with the idea of having attained the natural method, "*qui methodum naturalem sibi notam crepat*." There can indeed be no doubt that the natural method is often in the mouths of the very persons who have the least notion of what it means. This, however, is not exactly the question at issue. We have in truth to learn, whether the investigation of the order of nature ought altogether to be abandoned; for it is idle to assert that any man in his senses will waste his time in seeking that which, if the opinion of Linnæus be adopted, he must be convinced that it is ridiculous in him to fancy that he can ever find. Before, therefore, we can admit the above definition to be correct, it is surely requisite for its defenders to prove, either the truth of the

Epicurean doctrine, and show that every form of matter takes its source solely from the casual concurrence of atoms; or, if a regular order and arrangement be by them allowed to exist—in short, if there has been a creation,—that it is impossible for man to discover the plan on which it has been conducted. When the truth of either of these hypotheses—the first of which Linnæus was certainly the last man ever to have entertained—shall rest on a foundation more solid than bare assertion, then, and not till then, we may adopt the above celebrated definition. But in the mean time, were it said that the mere ability to assign an arbitrary name, without any further object in view, however it may argue that our time has been employed, can never show that any substantial knowledge has been acquired, we should therein assert nothing that requires demonstration, nothing that is not self-evident and equally true, whether the natural system be hypothetical or not.

The author is aware that for the decided nature of these reflections he is likely to be judged severely by some of those persons whose opinions in general he would always regard with deference. But truth is the sole object at which he aims; and though he venerates the name of Linnæus, he has always endeavoured that it should not be so blindly as to render this his object unattainable. He repeats, that he honours the memory of this great man; but not on account of his precision of description; for this, except in the case of species and genera, Linnæus has himself acknowledged to be prejudicial to an acquaintance with the natural method; nor on account of his learning in synonyms; for this, though a very useful, is also but a very humble species of compilation; and finally, not on account of his having been a happy inventor of words, since this is the excellence of a grammarian rather than of the naturalist. The glory of Linnæus is built, as the author conceives, on much more stable foundations; for the man who first pointed out the distinction between the natural method and an artificial system, who first perceived the impossibility of giving either accurate definitions or characters to natural groups, and who first remarked the existence of intermediate genera between natural orders, must always be considered as one of the principal founders of our knowledge with respect to the natural system, whensoever this shall appear.

A French botanist[a] has indeed wittily styled Linnæus the Aristotle of the North: but this is to be accounted a reflection on certain disciples of the celebrated Swede, and not on himself. The merits of Linnæus and Aristotle must both be judged, not

[a] Mirbel, *Elem. de Botanique.*

by the discoveries made since they flourished, but by the comparison of what they made known with that which was known before them. Neither of these great men can be blamed because servile schools of followers may have risen up, and boldly preached their infallibility; or because with a superstitious intolerance their disciples may have denounced as a species of heresy, the praiseworthy ambition of those who wished to penetrate further than themselves into the secrets of nature. The nation which has borne the brunt of these absurd charges in natural history is at last triumphant; it can now appeal to facts, and leave the world to judge between its original discoveries on the one hand, and the monotonous chiming on the ideas of Linnæus, which its adversaries have contented themselves with, on the other. Who indeed, without the imputation of prejudice, can now assert that the Northern schools have done as much within the last thirty years for natural history, as some of their more southern opponents? The truth is, that, like the religion of Mahomet, the Linnæan system has given rise in some parts of Europe to an unfortunate species of self-content, a barbarous state of semi-civilization, which is so far worse than absolute ignorance, that the existence of it seems to preclude every attempt at further improvement.

In England, the country where above all others the spirit of emulation produces the noblest effects, it was truly unfortunate that no previous system or method of natural history was in vogue at the period of the Linnæan discoveries. We shall have ever perhaps to regret that no English name, not even that of Ray, was sufficiently known or admired at the time to be put in competition with the gigantic authority of Linnæus. All minor luminaries, indeed, were lost in the blaze of light, which thus at once succeeded almost utter darkness. To widen the field of inquiry, is of itself no small service rendered to science; and this praise, at least, both Adanson in Botany, and Fabricius in Entomology, have a right to claim. Yet the dazzling power of the Linnæan name has detracted even from the merits of these men, who have secured immortality were it only because they dared think for themselves. It was however this last circumstance, in fact, which in the eyes of some of our countrymen constituted their crime,—an unfortunate prejudice, since, through it, some future historian of the progress of human knowledge will have to state that England, till within the few last years, stood still at the bottom of the steps where Linnæus had left her, while her neighbours were advancing rapidly towards the entrance of the temple. To France is the same glory due for having resisted this *vis inertiæ*, that we have seen England obtain for the dispersion of the Aristotelian clouds which once obscured natural philosophy. Tournefort was a mighty name, which, though infinitely inferior in true value to that of Linnæus, was nevertheless, fortunately for them, of sufficient importance with his countrymen to make them call in question the infallibility of any other. When therefore the majestic eloquence of Buffon and the profound observations of Bernard Jussieu were publicly known, a few French naturalists became satisfied that natural history had higher objects in view, than either to name the contents of a museum, to describe new species, institute new genera, or even to unravel the intricacy of synonyms.

This country also has at last, under the auspices of a few justly celebrated men, spurned the fetters so long imposed on her, and proclaimed to the world, that whatever degree of respect may be due to the name of Linnæus, (and none has paid a greater,) yet nature, and nature only, is infallible. It was thus only that England could ever have taken her proper place in the annals of natural science—that pre-eminent place to which her discoveries in philosophy proved that she was entitled, even at the moment when her naturalists were lost in prejudice, if not in error. But this prejudice is, in truth, to be imputed to some only of our countrymen, since the whole of Europe acknowledges and admires, among a few exceptions from it, that venerable one where splendid talents, a long life, and princely fortune have been invariably devoted to patronize science, without regarding either the garb, the language, or the peculiar opinions of the person by whom it may have been cultivated.

In the following pages, the author, sincerely convinced that the object he had in view would have been otherwise unattainable, has endeavoured to pursue the example set by the new school of naturalists; for he happens indeed to be one of those who prefer an imperfect transitory glimpse of nature, pure and unveiled, to a full view of the most commodious and ostentatious mantle that can be employed to conceal her beauties from the gaze. With such sentiments, it cannot be a matter of surprise that he should have distrusted names still more celebrated in entomology than that of Linnæus, when their authority was used to confirm a system. His confidence, however, in the OBSERVATIONS of these much respected persons has been always implicit, and if he has ventured to criticize their theory, it would be truly ungenerous in him not to state that his present opinions have been founded on the accuracy of the facts to which they first drew his attention. To observe, to compare, and from these observations and comparisons to attempt to draw conclusions, has been the common plan pursued both by them and by himself. The conclusions thus arrived at, it is true, have been very different; but the author would by no means be understood to offer his own to the public as rigidly correct. He wishes, on the contrary, that they may be subjected to the same criticism, that with the same doubt and constant reference to nature for their accuracy, they may be examined by those entomologists who would explore the same path. And if when assayed by this last only legitimate test, an error in the following remarks shall be detected, he trusts that he shall at least experience as much pleasure as vexation on being brought to a knowledge of the truth.

It may now be well to conclude this long preface with a few words on the manner in which the following investigation has been conducted. The author's first endeavour, after discovering the principal affinities, was to ascertain the connexion that might exist between the general structure of the animal and its manner of living. This in many cases, from our ignorance of physiological entomology, was impossible; but in the organs of manducation the author conceived himself in no danger of violating the order of nature, by examining whether the texture and form of these bore any regular relation to their uses, and more particularly to the quality of their food. Such a plan, it was true, came in direct opposition to that of the celebrated naturalist[a], who has laid it down as a rule, that we ought to take the character from the conformation alone, and not from any property or habits the exercise of which is momentary. But the mere authority of a name, however distinguished, could never shake the author's belief in a truth so apparent, as that the conformation of an organized being was originally ordained by nature subservient to and dependent upon its habits and manner of living; and that therefore to study for purposes of arrangement the structure of an organ, without considering its use to the animal, is as if we were, on comparing the merits of different pieces of mechanism, to examine the form and count the number of teeth in a wheel, without bestowing a thought on the functions which this may perform in the whole machine. Besides, that such a plan in Entomology is contrary to that of nature, was evident, by the best work in the science having been pursued on a totally different system.

And here the author cannot refrain from expressing the extraordinary obligations which he owes to the works of the Baron DeGeer, a man whom he must ever consider as the first entomologist that has hitherto lived, and whose *Mémoires,* modestly entitled *pour servir à l'Histoire des Insectes,* comprise a fund of observation and acute

[a] Cuvier, *Regne Animal,* vol. i. p. 8.

reasoning, which they who cultivate this engaging science must hope rather to develope than to augment. An independent spirit, which prompted De-Geer to refuse obsequious submission to the authority even of Linnæus, and an utter absence of any partiality for nomenclature, seem, with a strong natural feeling for the observation and arrangement of facts, to have been the principal causes of the excellence of that work, to which the author must refer those who may wish to enter perfectly into the spirit of the following remarks.

For the better understanding of any anatomical terms that may be used, he would also recommend the perusal of the article *Bouche*, in the *Dictionnaire d'Histoire Naturelle*, now in the course of publication at Paris, in which the reader will find the structure of the mouths of insects explained with great skill by M. Latreille. And by the study of this article, with the further assistance of the plates with which the Horæ Entomologicæ have been adorned by the most able entomological artist in existence, the author hopes that his ideas may be followed sufficiently to prevent him from being subject to misconstruction.

EXPLANATION OF PLATES.

A. *Antenna.*

B. *Labrum.*

b. *Hinder margin.*

c. *An excrescence, which I suspect to be the consequence of disease in the specimen examined.*

D. *Mandibula.*

d. *Outer side.*

E. *Maxilla.*

e. *Maxillary feeler.*

F. *Mentum.*

f. *Stipes.*

*g. *Labial feeler.*

h. *Labium.*

i. *An excrescence, which I suspect to be the consequence of disease in the individual examined.*

N. *Clypeus.*

n. *Fore margin.*

o. *Eye.*

Fig. 1. *Hister maximus.*

2. *Lamprima aurata.*

3. *Paxillus crenatus.*

4. *Passalus interruptus.*

5. *Chiron digitatus.*

6. *Nigidius cornutus.*

* This is imperfect in fig. 17.

Fig. 7. *Ægus chelifer.*
8. *Sinodendron cylindricum.*
9. *Hybosorus Arator.*
10. *Elephastomus proboscideus.*
11. *Athyreus bifurcatus.*
12. *Acanthocerus æneus.*
13. *Phoberus horridus.*
14. *Cryptodus paradoxus.*
15. *Mæchidius spurius.*
16. *Chalepus geminatus.*
17. *Dasygnathus Dejeanii.*
18. *Amblyterus geminatus.*
19. *Pelidnota 6-punctata.*
20. *Rutela Lineola.*
21. *Macraspis 4-vittata.*
22. *Chasmodia viridis.*
23. *Platygenia Zairica.*
24. *Gymnetis nitida.*
25. *Serica brunnea.*
26. *Euchlora viridis.*
27. *Areoda Leachii.*
28. *Oplognathus Kirbii.*
29. *Anoplognathus viridi-æneus.*
30. *Anoplognathus dytiscoides.*
31. *Leucothyreus Kirbyanus.*

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CORRIGENDA.

Page 32, line 14, for *circles* read *circle*.

—— *ib.* —— 19, for *Recticera* read *Rectocera*.

—— 40, —— 4, for *tarsi* read *tibiæ*.

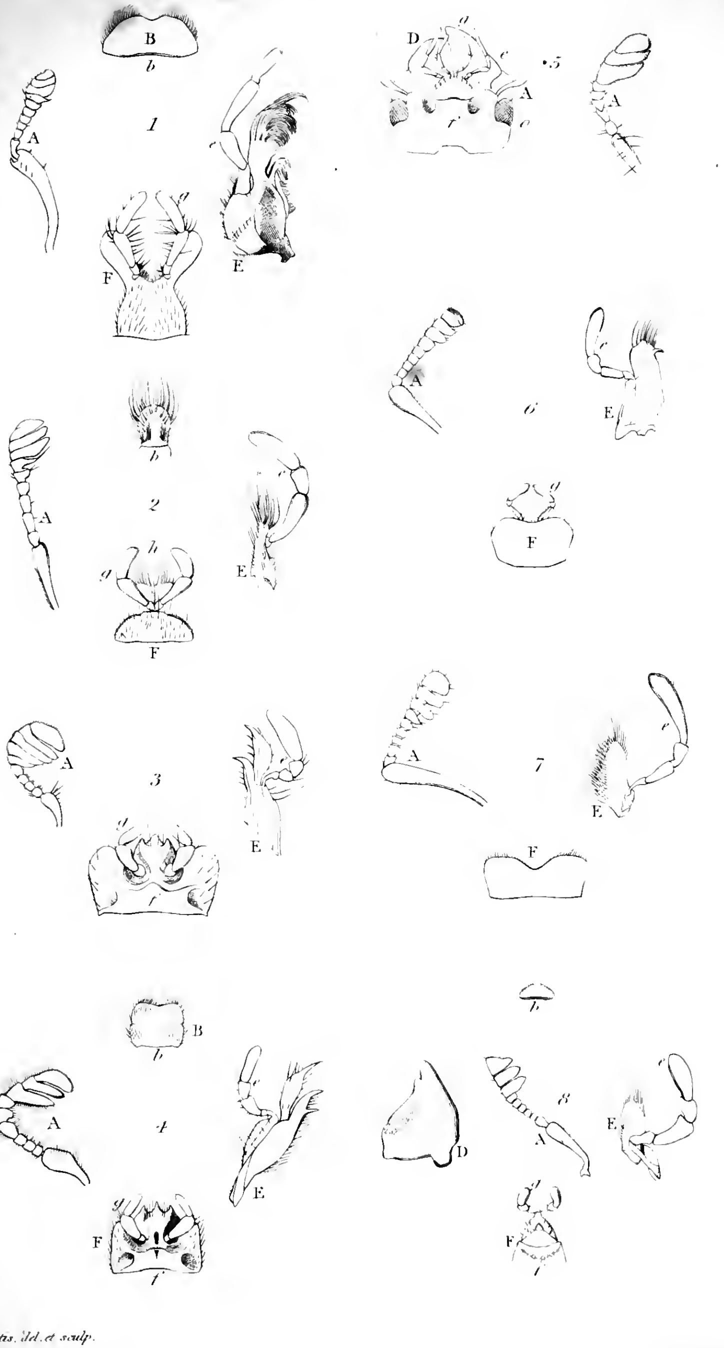
—— 59, —— 8, for *replace* read *supply*.

—— 61, —— 9, after *which* add *with the exception of Lethrus*.

—— 69. Erase note *b* at the bottom of page, because a late examination of the genus *Hexodon* has proved that it cannot with propriety be inserted among the Rutelidæ.

—— 102, line 5, for *exponendum* read *exponendam*.

—— 113, —— 14, for *ad generi Dorco* read *ad genus Dorci*.



J. Curtis. del. et sculp.

J. Curtis, del. et sculp.

J. Curtis, del et sculp

HORÆ ENTOMOLOGICÆ. *

CHAPTER I.

INTRODUCTION.

It has long since been stated that those organs, whether in the Animal or Vegetable Kingdom, which tend to the reproduction of the species [a], in reality compose the essence of its being; or, in other words, that the chief object of the existence of the individual is to bring these to maturity. The truth of this assertion has been supported by the remark, that the vital principle begins to decay throughout organized matter, as soon as the abovementioned organs cease to be able to perform their functions. It has also been urged, that as Fructification forms the great basis of arrangement in Botany, so considerations founded on the reproduction of the species ought to afford the most natural method of classifying the Animal Kingdom. But without discussing the accuracy of this mode of argument, it were useless to enter into the various objections—the various difficulties that such a system would be exposed to; objections and difficulties that render it absolutely necessary to inquire after some other principles of arrangement. Now, if we lay aside the reproduction of the species, undoubtedly the chief remaining function of life is its preservation in the individual [b]; for indeed it has been questioned by

[a] *Monog. Apum Angliæ*, vol. i. page 39.

[b] " Dass den Mundtheilen unter den übrigen Theilen des Insekts eine vorzügliche Aufmerksamkeit gebührt, bedarf wohl keines ausführlichen

* marginal Notes by Dr Horsfield. (T.H.)

some naturalists, which of the two ought to be considered the more important. The organs, therefore, tending to the preservation and nutrition of the individual, are those to which we must, in preference to all others, apply ourselves, when searching for the path Nature may have pursued in the distribution of animal life. These are not only, as will hereafter be shown, less liable to variation, when viewed in a general manner; but, on the other hand, are subject in detail to all those endless changes of form, which must depend on the variety of methods which beings endowed with animal life are obliged to use for the purpose of prolonging their existence. Thus Savigny has most ingeniously shown that one general plan of construction is visible throughout the mouths of Insects, while the parts of which they are composed put on an infinite diversity of form.

But there is another reason why we should prefer the study of these organs to that of others which have been used by entomologists in the formation of their numerous Systems, namely, that they are, with the exception of the organs of sight and locomotion, the only parts of an insect of which we absolutely comprehend the use. The func-

beweises. Sie sind die Werkzeuge, auf denen die Erhaltung des Thiers beruht. Nach den verschiednen Arten der Nahrung, die dem Thiere bestimmt ist, sind sie verschieden eingerichtet; sie enthalten gewöhnlich alle Werkzeuge zum Habhaftwerden der Speise, und zu der stufenweisen Vorbereitung derselben, bis zum Uebergange in den Schlund beieinander, und die Arten dieser Vorbereitung sind so mannichfach wie die nahrungstoffe, auf die sie angewandt werden, und wie die Bestimmung des Insekts selbst, in dem grossen Haushalte der Natur. * * * Welche Menge von Zurüstungen fordert diess alles! Selbst Sinneswerkzeuge sind unter die Mundtheile gesetzt; und bei diesen verschiednen Bestimmungen, bei der oft grossen Zahl von Theilen gewähren sie einen Reichthum von Merkmalen, der für die Unterscheidung höchst willkommen sein muss." *Ueber das Fabricische System. Mag. für Insekt.* von Illiger. i. 261.

tions of the antennæ even to this day are unknown[a]; and possibly may continue so, as there is no reason why an animal, whose general construction is so different from our own, should not possess sensations with which we must for ever remain unacquainted. The same may in some measure be said of the Elytra, Wings, Sternum, Scutellum and Tarsi, organs which are either not to be found, or if found, are by no means analogously constructed in the *Vertebrata*, the only animals to which with propriety we can refer our own sensations. Nevertheless, all these parts of an insect have been made use of in their turn for purposes of general arrangement; and it is undoubtedly true, that no divisions, or rather no *affinities*[b], can be more natural than such as are often pointed out by some of these organs; as for instance, the antennæ. Of the truth of this remark it will be seen that the Lamellicorn Insects afford a very striking example. But an implicit confidence for purposes of classification in any solitary anatomical part, or even in the organs of manducation themselves, must be objected to. We ought to proceed with care, assuming no principle of arrangement as fixed, and nothing as fixed in arrangement itself, except so far as we may

[a] It is probably on some account like this that Fabricius passes such a sweeping condemnation on the use of the antennæ in the formation of genera: "Antennæ ad characteres generum vix usurpandæ." *Phil. Ent.* p. 130.—"Antennæ ad generum characteres minus valent quam plurimi estimant." *Ibid.* p. 94.

[b] The French naturalists make use of the expression *coupes naturelles* as we are accustomed to speak of sections and natural genera. But however correct all this may be in practice, it has certainly given rise to many erroneous ideas; as it is difficult to conceive why genera should have been imagined to exist in nature, until we had previously familiarized ourselves with the term *natural divisions*. As matters now stand, in endeavouring to discover divisions instead of affinities, we make use of an artificial method instead of a natural one to arrive at—Nature.

be sure that our conclusions agree with what may be observed in nature.

It appears to me, however, as a principle unobjectionable in itself, that the adoption of any organ, not immediately connected with the sexual difference, for purposes of generic arrangement, ought to be in an inverse proportion to the difference of that organ in the sexes. So that when we find the form of the mandibles, for instance, to differ in the sexes of the genus *Lucanus*, we ought to choose some other test by which we may distribute these insects into natural groups.

I shall perhaps be more clearly understood from the inspection of the following table, in which I have attempted to class, according to their degree of variation as to form or number, first in the sexes, and secondly in the species, all the various organs which have been the *keystones* of different systems. This table, however, is to be considered with reference to the Coleopterous insects only.

	In the Sexes.		In the Species.	
	As to Number.	As to Form.	As to Number.	As to Form.
Capitis Thoracisque Cornua vel Gibberes	variable	variable	variable	variable
Alæ.............	variable	....	variable	variable
Tarsorum Articuli	variable	variable	variable	variable
Pedum Ungues	invariable?	invariable?	variable	variable
Scutellum distinctum..	invariable	invariable	variable	variable
Sternum productum ..	invariable	invariable	variable	variable
Palpi	invariable	variable?	variable	variable
Antennæ	invariable	variable	invariable	variable
Pedes...............	invariable	variable	invariable	variable
Mandibulæ	invariable	variable	invariable	variable
Mentum	invariable	invariable?[a]	invariable	variable
Oculi...............	invariable	invariable	invariable	variable
Maxillæ.............	invariable	invariable	invariable	variable

[a] It is possible that the form of the mentum may be found to differ in the sexes of some of the Linnæan *Lucani* .

It may be seen from this table, that there are four modes at least in which the parts of an insect may vary; and as the great difficulty of making use of an organ in arrangement must depend on the irregularity and confusion which arise from the interference with each other of these several modes of variation, it follows that those parts are the best calculated to serve as the basis of classification which vary in the least number of different ways. Hence we are led to conclude, that the *mentum, oculi,* and *maxillæ* are the parts of an insect which are the most to be attended to in our endeavours to arrive at a natural system. But the first and last of these are very much preferable, for the attainment of our object, to the eye; inasmuch as the variation of the form of this organ in different species is by no means so easily seized.

If however I have laid peculiar stress on the modifications of the maxillæ[a], I wish to be understood as by no means undervaluing those characters which may be drawn from the more obvious parts of an insect. Such characters, indeed, once that the chain or order of nature is discovered and established, are the most useful, because the ordinary observer can by their means arrive at the same conclusions with the anatomist, without giving up the time and attention requisite for the dissection of the parts of the mouth. At the same time we ought to be very careful in the use of artificial characters; and to recollect, that in natural history we have always good reason for suspecting *methods*. Indeed, the interests of science and that love of truth which every scientific

[a] "Maxillam constantissimam invenimus, vix in congeneribus aberrat." *Phil. Ent.* p. 93.—"Maxillæ et labium ejusdem speciei tunc constantissima semper simillima." *Ibid.* p. 94.

man ought to possess, require that we should not allow ourselves to be dazzled by the seeming simplicity of rules, so far as to overlook the cases where these rules interfere with the evident order of nature. I am induced the rather to make this observation, because I have long felt that the system adopted by Geoffroy, Dumeril and Latreille, of arranging insects according to the number of joints in their tarsi—a system now in very general use, owing to the unrivalled reputation of the last-mentioned entomologist—is by no means natural[a]. By the inspection of the foregoing table it will appear, that few characters are so variable as those drawn from the tarsi, and consequently few so objectionable for general use; though it must be granted, that in particular tribes these organs may safely be used for generic distribution. The consequence, however, of making primary divisions after the number of joints in the tarsi, has been, that many genera have been separated and thrown at an immense distance from the true place assigned them in nature. Among numberless general instances of which evil it will only be necessary to note the affinity between the *Psephalidæ*, Leach, and *Staphylinidæ*, Kirby, the genera *Cis*, Lat. and *Anobium*, F.,

[a] "Ce n'est pas assez pour pallier les fréquentes anomalies qui se rencontrent, de dire que tel insecte a cinq articles aux tarses quoiqu'on n'en découvre que quatre. Il devroit en effet en avoir cinq d'après la règle qu'on a établie. Cependant ces explications, toutes ingénieuses qu'elles sont, ne peuvent me convaincre, et je ne puis me déterminer à supposer plus d'articles aux tarses qu'on ne peut réellement en découvrir, en y mettant toute l'attention possible. Le nombre des articles doit être clair, positif et uniforme, sans quoi le caractère est vacillant. Au reste, je ne disconviendrai pas que sans être rigoureusement propres à diviser les ordres, ils ne puissent très-bien servir pour un tableau dans lequel les genres seroient ordonnés selon le nombre des articles des tarses."—*Ent. Helvetique*, p. 30.

Nilio, Lat. and *Coccinella*, L. &c., and to observe their respective places in the latest systematic works on Entomology. But two cases which affect the natural arrangement of the Lamellicorn insects, though in different ways, must particularly be mentioned. We have the genus *Trachyscelis*, Lat. inserted among other heteromerous insects, and separated from *Ægialia*, Lat. to which it is so nearly allied both in anatomy and habits. Again: it seems difficult to conceive why the genus *Sinodrendron*, F. should be so much further removed from the *Bostrichidæ* than a *Curculio*, L. to which these have evidently much less resemblance.

In several cases also the number of articulations in the tarsi varies even in the sexes, which peculiarity Gyllenhall on the indication of Müller observed in several species of the genus *Cryptophagus*, as for instance, in his *C. fumatus* (*Corticaria fumata*, Ent. Brit.); and I have myself observed this curious and interesting difference of the sexes in *Cryptophagus pallens* (*Tenebrio pallens*, Ent. Brit.), an insect by no means uncommon in England[a]. I state these cir-

[a] "Detexit acutissimus Müller pastor Odenbachensis in genere Cryptophagorum, sexui uni esse sæpe quatuor, sexui alteri semper quinque articulos tarsuum in pedibus posticis; et jam observarunt, tum entomologus consummatissimus Dom. Doct. Illiger, tum laudatus Müller, plurimas parvorum Dytiscorum species, quas cum nominatis auctoribus ad genus Hyphydrum referimus, solummodo anteriorum pedum habere articulos tarsuum quatuor, postici vero pedum paris quinque, unde Cel. Illiger ex hoc genere peculiarem subdivisionem jure formavit; (vid. Illig. Mag. tom. i. p. 299.) quum vero in ceteris proximâ affinitate Dytiscis jungatur illud genus, proxime ab eis id inserui notatâ tantum hac diversitate." Gyllen. *Ins. Suec.* (Præf.) Vol. i. p. v.

Again: " Singularis valde et inexspectata est observatio a Dom. Müller in Illig. Mag. iv. p. 214, allata quod tarsi postici in altero sexu plurium specierum hujus generis tantum 4-articulati sunt; *hoc tamen verum esse in hac specie et nonnullis insequentibus observavi.*"—Gyllen. *Ins. Suec.* p. 168.

cumstances not as reasons for rejecting the tarsi altogether in arrangement, but as proving how little they are to be depended on as the ground-work of primary divisions or families.

In discussing the use of particular parts of an insect for purposes of classification, the *sternum* deserves some degree of consideration, as we find it often assuming, in the *Lamellicornes*, Lat. a very peculiar character, which appears in some measure to correspond with their manner of living; but the use of this part of the insect has hitherto been undiscovered. We may, however, arrive near the object of our wishes on this subject, by considering the construction of this organ, and the manners of the various insects which possess it. On dissecting a lamellicorn insect it will be found, that on the inside and from the lower extremity of that ring of the abdomen which is known to entomologists by the name of *pectus*, there rises upwards obliquely a long crustaceous triangular pyramid, the apex of which is fixed to the abovementioned extremity. This pyramid has the lateral angles of its base very acute, and is the proper sternum of the *Lamellicornes*, Lat. composing indeed the whole of it in nearly all the *Scarabées de terre* of De Geer: but in many of the other division, composed of insects which feed on living plants, and which I have therefore called *Thalerophaga*, we find that the lower acute edge of the pyramid is joined to the breast by a thin crustaceous plate, the extremity of which appears produced externally between the first pair of legs into what is commonly called the *sternum productum*[a]. If we examine a longitudinal section of it under this

[a] Fabricius appears to have been acquainted with this external process of the sternum only. "Sternum linea pectoris longitudinalis, sæpe antice posticeque mucronatum, differt quoad proportionem, apicem."

form, as in the genus *Anoplognathus*, Leach, a construction is to be discovered which may be compared to the keel of a ship, or still better to the sternum of a bird; and the organ, no doubt, serves for some analogous purpose to all insects whose flight in the air or progress in the water Nature intended should be rapid. This *keel* must be a great advantage to every Coleopterous insect possessing it, and particularly to the bulky *Lamellicornes*, as materially contributing to balance the inconveniences that may arise from the obstruction of their wings by the superincumbent elytra, their greater specific gravity, and the blunt broad surface which they expose to the resistance of the air in flying—inconveniences that insects of the other orders, with the exception of the *Orthoptera*, are in no degree subjected to. The forked base of the pyramid which I have described is supported by strong muscles attached to the sides of the body, and thus appears to serve for another use, namely, the support of the intestine. This organ, which in the *Petalocera*, Dum. is long and cylindrical, passes close to the back of the insect, directly over the forked base of the prism. But whatever the use of the sternum may be, the above table will sufficiently show that it is not well adapted to be a principle of classification.

The next organ which demands our attention is the *scutellum*; not as being in itself of importance, but because Geoffroy's arrangement of the Linnæan genus *Scarabæus* has been founded on it. It is sufficient to state, in order to prove the absurdity of using this character for great divisions, that the accurate distinction is not, as has been supposed, whether the scutellum does or does not exist in a lamellicorn insect, but whether it is or is not distinct.

There are several other parts of an insect which, like those I have just considered, might be made use of to prove how erroneous is the idea of assuming any particular organ as the sole source of the *Essential Character*[a]: but I trust the above will be sufficient. Natural History is the science of comparison;—to trace affinities, to weigh distinctions, and to compare characters, are the three principles upon which the whole knowledge of a naturalist hinges; and so true is this position, that the earliest authors who have made Nature the object of their study have been obliged to use a classification rude indeed, as might have been expected, but not the less satisfactorily proving that Natural History is of all the branches of human knowledge, that which the most requires the arrangement of our ideas. The very naturalists—such as Buffon, Reaumur, and Bonnet—who despised scientific nomenclature, were obliged to attend to classification; and the reason was evident. Nomenclature, it must always be understood, is artificial; and once that a natural group was indicated, it mattered little whether this group had a name, unless it was for the purpose of assisting the memory[b] and connecting the chain of reasoning. Entomologists therefore, who never studied Nature in books, but

[a] It is not to the Essential Character itself, as defined by Fabricius, (*Phil. Ent.* p. 96,) that I object; but to the impossibility of finding such. "Character essentialis optimus facillimus at vix possibilis." Why then trouble ourselves with hunting after a chimæra?

[b] The almost exclusive attention which has of late years been unfortunately lavished on *Nomenclature* and *Systematic Arrangement*—on the means in short, and not on the end of the science—has with ignorant persons diminished the importance of the study of Natural History itself. Let us hope that the slur will be soon entirely obliterated by those naturalists who have already shown that they are not to be deterred from the investigation of affinities by great names, because, forsooth, these may have preceded them in the annals of science.

compared her with herself, and that in a few objects which could easily be comprehended without resorting to subdivision, would naturally set little value on names, while on the other hand the very object of their pursuit was the investigation of affinities. No distinct ideas of an organized being could indeed be formed in one's own mind, much less communicated to that of others, except by first comparing the several parts with those in some other and well known organized being; and secondly, by the comparison of the two wholes. This process, so necessarily and so unconsciously adopted by persons the most ignorant of natural history, is nevertheless a rude species of classification. The disposition to classify is then natural to the human mind; and that organized beings have in some manner been arranged in nature, this disposition, if allowed to act freely, will soon discover. But, unfortunately, it is not so easy to agree upon the method in which organized matter was disposed at the creation; and every naturalist, in attempting to find the natural system, has only added an artificial one to the hundreds that had already been proposed. In Botany indeed Linnæus most happily founded his artificial system on the parts of fructification—organs which are perhaps the most important in the natural system. The consequence was, that the Linnæan groups in botany were not so wholly different from the more modern ones, which had their origin in a multitude of other though less essential characters combined with the former. It has not, however, been so with Entomology[a]. Linnæus commenced with a system entirely

[a] "Examinavi tantam scientiarum tam affinium diversitatem; et in illa omnia firma, certa, in hac vero omnia vaga inveni.—Certitudinem hanc Botanices regulis fixis bene stabilitis niti observavi, quum e contrario in Entomologiâ omnino nullæ sancitæ."—*Phil. Ent.* (Præf.)

artificial; and almost every author previous to Latreille, while he altered the principle, followed Linnæus in the details of arrangement. Hence arose the abuse of the *Essential Character*; a term excellent and useful in the abstract idea given of it by Linnæus and Fabricius, but which, being founded on one or two favourite parts only of the insect, soon became little else than a magical name for each principle of classification, whatever this might have been, and from which the entomologist fancied Nature could make no appeal. One author accordingly made use of the antennæ alone for his system; another of the tarsi; and a third of the *instrumenta cibaria:* and each, according to his own plan, took his essential character solely from the modifications of the favourite organ which he had chosen to be the keystone of his system. It will therefore cease to excite surprise that Entomology, generally speaking, should be still in its infancy. The French entomologists have, it is true, made use of a system founded upon and combined of all the parts of an insect. Yet, by supposing Nature to have been absolutely governed by a set of rules which they themselves laid down, and by scarcely allowing the possibility of her making exceptions to these rules, they have done little more by their innovations, than given to the world an additional artificial system.

CHAPTER II.

ON THE ACTUAL STATE OF OUR KNOWLEDGE WITH RESPECT TO THE CLASSIFICATION OF THE LINNÆAN SCARABÆI.

M. Latreille has lately, in the third volume of the *Regne Animal* of M. Cuvier, and also in the new edition now publishing of the *Dictionnaire d'Histoire Naturelle*, applied the name of *Lamellicornes* to an artificial division comprising all the insects which compose the genera *Lucanus* and *Scarabæus*, as they were left by Linnæus in his last edition of the *Systema Naturæ*. Indeed the connexion between these genera is so evident, that in the *Fauna Suecica* and the ten first editions of the *Systema Naturæ* we find them combined under the general name of *Scarabæus*; and even now it is difficult, nay even impossible, to consider them separately, without overlooking several important characters and curious properties which belong to both. This difficulty may in some manner account for a wider range being taken in this investigation than seems necessary for the original purpose I had in view. The central object of the following remarks is nevertheless still the genus *Scarabæus* of the twelfth edition of the *Systema Naturæ*; and if I touch on the genus *Lucanus*, it is only so far as is rendered necessary by the abovementioned affinity. The genus *Scarabæus* then, as it was constituted by the learned Swede in the later editions of his immortal work, consisted of *Coleoptera antennis clavatis, capitulo fissili*[a]; while the genus *Lucanus*, which owed its origin to Scopoli, in the *Entomologia Carniolica*, was described by Linnæus as *Coleoptera antennis clavatis, clavâ compressâ latere latiore pectinato-fissili*[b]. The latter genus, which is certainly better defined thus, than it originally was by Scopoli[c], seems to have also had the advantage in this respect over the Linnæan definition of *Scarabæus*, as the peculiar character of the antennæ of this last group can hardly be said to have been in the above words correctly described. Linnæus also divided the *Scarabæi* into groups depending upon the horns and protuberances of the head and thorax; but it was unfortunate that he could hardly have pitched upon a more variable or artificial character, as will readily be perceived by inspecting the table given in the introductory chapter.

Not content with the separation of the *Lucani* from the genus *Scarabæus*, Scopoli attempted another but less useful innovation, in distributing the insects of the latter genus according to the number of spines or teeth on the fore-legs; but this method was even worse than the previous one of Linnæus. Scopoli, however, proposed two other methods of arrangement, one according to the number of articulations in the *clava* of the antennæ[d], and the other according to the manners of the different insects themselves[e]. The first plan is clearly artificial, and even erroneous, as in the case where he conceives that there exists any truly bifid *clava* among the *Lamellicornes*. But the second is so deserving

[a] Linn. *Syst. Nat.* vol. i. p. 541. ed. 13. [b] *Ibid.* p. 559.

[c] "Antennæ apice dentibus quatuor, uno latere pectinatæ." Scop. *Ent. Carn.* 1. But this character would almost restrict the genus to *Lucanus Cervus*. [d] Scop. *Ent. Carn.* 2. [e] *Ibid.* 3.

of our attention, from being the first attempt ever made to arrange these insects naturally, that I shall give it at length.

"*Scarabæi Floræ famuli.*"

"*Anthophylli, nuptias plantarum promovent; auratus, nobilis, maculatus, littoralis, figulus, argenteus, libator, squalidus, alpinus, variegatus.*

"*Phyllophagi, larvas Lepidopterorum fugant; melolontha, eremita, nasicornis, solstitialis, oblongus, minimus.*

"*Stercorei, radices plantarum nutriunt; stercorarius, vernalis, lunaris, fimetarius.*"

The errors are obvious. But still this plan, faulty and fanciful as it was, must be allowed to have been the nearest approach hitherto made to truth, and the deepest penetration into that part of Entomology which is really the province of the naturalist.

De Geer has the honour of having been the first to perceive all the advantages to be derived from the mode of arrangement indicated by Scopoli. But, sensible of its imperfections, he instituted a new method of division, which was truly worthy of this great physiologist, and remains a striking proof of the advantage which he, in studying the manners of these insects, had over those who were content with describing them from their cabinets[a]. His method of distribution was into three families, as follows:

1. *Scarabées de terre.*
2. *Scarabées des arbres.*
3. *Scarabées des fleurs.*

Oryctes and *Trox* were thus no longer, as by Scopoli, made

[a] In this case, at least, De Geer has shown the futility of Fabricius's opinion, "Nimis vero habitui adhærere est stultitiam loco sapientiæ invenire."

phyllophagous insects; and many other discrepancies were avoided[a].

In the interval between the publication of the *Entomologia Carniolica* and De Geer's sixth volume, and probably without the knowledge of either work, Geoffroy divided the original Linnæan genus *Scarabæus,* by the separation from it of the exscutellated insects under the name of *Copris,* and of those composing Scopoli's genus *Lucanus* under the name of *Platycerus.* The institution of the genus *Copris* was in some degree an improvement, though founded on such bad characters, that coprophagous insects, such as those forming Latreille's family of *Geotrupini,* were put in the same genus with *Cetonia,* from which they were obviously distinct, once that the necessity was seen of carrying the investigation further among the *Lamellicornes* than was allowed by that first principle of affinity, the form of the antennæ.

Fabricius, sensible of the heterogeneous composition of Geoffroy's genus *Scarabæus,* broke off[b] from it the genera *Trox, Melolontha, Cetonia,* and *Trichius*[c]. The three first are natural groups, that show how correct was the eye of this great man in seizing generic distinctions. I say "the eye," because it is worthy of remark, that the characters given to these several divisions in his *Genera Insectorum* prove that he had consulted his newly invented method of investigation but little in their formation. It ought

[a] De Geer was also aware of the true place of *Hister,* and its intimate connexion with *Lucanus.*—De Geer, *Gen. Ins. Retz.* p. 18.

[b] *Systema Entomologiæ,* I. xi.

[c] "The organs of manducation in this genus resemble those of *Cetonia* so much, and indeed the affinity throughout between these genera is so great, that one is surprised how Fabricius should have separated them at such an early period of his career."—*Oliv.* vol. i. no. 6. p. 1.

also to be remembered, that the genera *Melolontha* and *Cetonia* had already been indicated by De Geer, and that the union of Geoffroy's genus *Copris* with *Scarabæus* in the *Systema Entomologiæ* was a retrograde step in the science, which many years afterwards the entomologist of Kiel found it necessary to correct[a]. One advantage, however, attended the formation of the Fabrician genus *Scarabæus*, which was, that the connexion between the insects afterwards named *Geotrupes* by Latreille and Geoffroy's genus *Copris* was thereby re-established.

Olivier was aware of the imperfection of Geoffroy's genus *Copris*, and therefore adopted the genus *Scarabæus* of Fabricius, with all his other genera except *Trichius*; for which omission he gives sufficient reasons, considering the state in which entomology then was.

This French naturalist also divided the Fabrician genus *Scarabæus* as follows:

1. *Les Scarabées qui ont des mandibules, et qui n'ont point de lèvre supérieure.*
2. *Les Scarabées qui ont des mandibules, et une lèvre supérieure.*
3. *Les Scarabées qui n'ont ni mandibules ni lèvre supérieure.*

These three groups are strictly natural; and making allowance for the incorrectness of the principles on which the above distinctions were founded, Olivier may be said to have brought the natural history of De Geer's *Scarabæi terrestres* to the state in which it now stands. For if we except the names bestowed on the foregoing three divisions of the Fabrician genus *Scarabæus*, and the more

[a] *Suppl. Ent. Syst.* p. 28.

precise anatomical characters given to them in Latreille's *Genera Insectorum*, it will be found that the arrangement of this branch of the *Lamellicornes* has since undergone but little further improvement. Latreille has indeed combined Olivier's "*Scarabées qui ont des mandibules sans lèvre supérieure*" with the "*Scarabées des arbres*" and the "*Scarabées des fleurs*" of De Geer, under the general name of the family of *Scarabeides:* but it is difficult to perceive the advantages derived from this alteration; and it may even be questioned whether in several instances it be altogether conformable to nature. The publication, however, of the *Précis des Genres* conferred, by the distribution of insects into families, the most signal benefits on this as well as on every other branch of entomology. In this work Latreille divides the *Lamellicornes* into two families, which answer to the genera *Lucanus* and *Scarabæus* of Linnæus; and these he again subdivides into genera. He also gives the names *Scarabæus* and *Geotrupes* to Olivier's first and second divisions of *Scarabæi*, and restores the Geoffroyan genus *Copris*, while this as well as all the other genera are infinitely better defined than ever they were before. In the *Histoire Générale des Crustacées et des Insectes*, the same author establishes four families, viz. *Lucanides*, *Scarabeides*, *Geotrupini*, and *Coprophagi*. The same plan is pursued in the *Genera Crustaceorum et Insectorum* and in the *Considérations Générales*. But in the last two works these four families are united into one group, to which he afterwards gave the name of *Lamellicornes*. It remains now only necessary to mention the institution of the genus *Aphodius* by Illiger, of *Rutela*[a] and *Glaphyrus* by Latreille, as alterations that bring our general knowledge of the lamellicorn insects to

[a] The genus *Rutela* was indicated by Olivier. *Ent.* i. no. 6. p. 4.

the state in which it is at present. Many other valuable genera are indeed to be found in the various works of authors[a]; but, with the exception of the genus *Anoplognathus* of Dr. Leach, they add but little to our general knowledge with respect to the arrangement of the Linnæan *Scarabæi*.

[a] *Lethrus*, Scopoli; *Hexodon*, Oliv.; *Gymnopleurus*, *Oryctes*, *Hoplia*, Illiger; *Cremastocheilus*, Knoch; *Goliath*, Lamarck; *Onitis*, Fab.; *Ateuchus*, Weber; *Sisyphus*, *Onthophagus*, *Ægialia*, *Amphicoma*, *Anysonyx*, Latr.; *Psammodius*, Gyll.; *Geniates*, *Apogonia*, *Bolbocerus*, Kirby.

CHAPTER III.

ON THE NOMENCLATURE OF THE LINNÆAN SCARABÆI.

THE preceding chapter may be considered as containing a brief but pretty accurate outline of our knowledge with respect to the classification of this very important branch of entomology. M. Dumeril has indeed distributed the *Scarabæi* of Linnæus into *Petaloceri* and *Prioceri*, the first of which names I have for convenience adopted, though neither of them express any thing but the genera *Scarabæus* and *Lucanus* as they exist in the later editions of the *Systema Naturæ*. The term *Prioceri* seems even to be so far objectionable, that serrated antennæ by no means, as will be shown, constitute the precise natural character of the division[a]. There are also some other changes or rather reforms (for it seems hard to call that an innovation which has the right of priority to support it) which appear absolutely necessary; and the explanation of this truth will form the principal subject of the present chapter.

Scarabæus[b] appears to have been originally the name

[a] An additional reason for not adopting this word is, that Mr. Kirby has lately given the name of *Priocera* to a new genus in the family of *Cleridæ*.

[b] The origin of the word *Scarabæus* is not very clear; at least its derivation from σκάπτω, as given by Fabricius and Olivier, seems quite irreconcileable with the most common rules of etymology. To me it appears difficult to obtain the word at all from the Greek; and when we consider that it never occurs but in the Latin authors, there is little reason to doubt its being of Etruscan origin. If however it be a point of necessity that

used by the Romans to designate the Coleoptera[a] in general, as *Κάνθαρος* might have done among the Greeks. It may also be understood as having embraced some Orthoptera, such as the genera *Acheta* and *Gryllotalpa*[b]. Pliny, however, gives a particular description of the sacred beetles of the Egyptians under this title[c], and it was accordingly restricted to these remarkable insects by Mouffet and the earliest modern naturalists. The name *Scarabæus* has in truth had so many different applications given to it, that it would seem above all others to be that which for ever ought to remain undisturbed. Linnæus, Scopoli, and their immediate followers may nevertheless be considered as the only persons who properly applied it; and Geoffroy, in giving the name of *Copris* to the exscutellated insects, may be said to have been the primary cause of all the uncertainty and changes to which the name *Scarabæus* has since been subjected. Indeed, when this last was taken away from the above-mentioned celebrated insects of Pliny with which Linnæus had left it, it became a matter of indifference to what division of the *Lamellicornes* it was applied. We find therefore, that though Fabricius in the first

it should come from the Greek, it is most likely to prove the corruption of a Doric word, and the primitive may possibly be *σκαριφάομαι* from *σκάριφος* *penicillus*.

Σκαριφάομαι. ξύω, σκάπτω, γράφω, (*Hesych.*) scarifico, fodio.

Scarabæus for Σκαραφαῖος, as *balæna* from φάλαινα. In the same manner the Italians still say *escaravajo*.—The verb Διασκαριφῆσαι is also properly applied to the action of animals which scratch or dig up the earth with their claws.

[a] Plin. *Hist. Nat.* xi. 34. "Quibusdam pennarum tutelæ crusta supervenit ut Scarabæis."

[b] *Ibid.* "Alii focos et prata crebris foraminibus excavant nocturno stridore vocales." Which evidently applies to the crickets.

[c] *Ibid.* xxx. 30. "Scarabæum qui pilulas volvit. Propter hunc Ægypti magna pars Scarabæos inter numina colit."

edition of his *Entomologia Systematica* gave the name of *Scarabæus* to all the *Scarabæi terrestres* of De Geer, with the exception of those composing the genus *Trox;* and that therefore he comprehended under this name the true insects; yet in the *Systema Eleutheratorum* he gives it to the modern *Geotrupidæ* alone. As he had it in his power to apply the term properly when the genus *Ateuchus* was separated by Weber from *Copris,* it is to be regretted that so many excellent opportunities of rectifying the nomenclature should have been neglected. The alterations in systematical arrangement made by Olivier rendered it possible, and even easy, for him also to have assigned the name to its proper place. But unfortunately the Fabrician names were adopted where they ought not to have been; and the consequence is, that the naturalist points out as a *Scarabæus* an insect totally different from those known under that appellation to the antiquarian, the artist, and the scholar. Now it so happens that these mischievous changes have taken place in the quarter of all others the most conspicuous, and consequently are the most hurtful to the interests of entomology, as hardly any insect is to be reckoned so celebrated in antiquity as the true *Scarabæus.* On the ground then of priority of right, as well as of absolute necessity, the name *Scarabæus* is here restored to the *Ateuchus sacer,* Fab.; and to the genus *Scarabæus* of Latreille I have assigned the name *Dynastes,* in other respects always adopting the generic names of the last-mentioned entomologist[a].

There remains, however, still to be mentioned a peculiarity of nomenclature, which, though by no means ori-

[a] "Abstineamus a tali mutatione, quæ tantummodo confusionem et tandem ruinam scientiæ parit." *Philos. Entom.* p. 113.

ginal, or even new, is nevertheless I believe, with the exception of Mr. Kirby's *Century of Insects* in the 12th volume of the *Linnæan Transactions,* now for the first time generalized in entomology.

In botany we often see the name of the family taken from that of the genus which is considered as affording more peculiarly the type of construction by which the former is characterized. In entomology also, Latreille has used the same plan; as when he names the family of *Geotrupini* from the genus *Geotrupes,* the family of *Scarabeides* from *Scarabæus,* &c. But, unfortunately, unless his work be kept constantly in the hand, we have no method of knowing from the name of a group whether it means a family, section, tribe, or any other of his numerous subdivisions. This is the natural result of his having neither generalized the abovementioned mode of forming *family names,* nor even their terminations[a]. To remedy this inconvenience I have followed the suggestion of Mr. Kirby, and designated families by the patronymic termination in *-idæ,* which, though not classically correct in the case where the primitive has a feminine termination, is nevertheless preferable to any other I have been able to devise, as well on account of uniformity as *euphoniæ gratiâ.*

With respect to the general principles of Nomenclature I have no remarks to offer, nor indeed would such a subject be altogether suitably introduced within the limits of a monograph. But it is really impossible not to express

[a] Count Hoffmansegg of Berlin has suggested an improvement in the termination of new generic names, the value of which will readily be understood by those who possess entomological cabinets. He proposes that the new name should always, if possible, be of the same gender with the genus to which the species originally belonged.

regret that so much mystery and importance should be attached to the formation of names; and that so many excellent naturalists should set no higher value on their time, than to employ it in disputing each other's titles to the invention of a few technical words. Natural history would indeed suffer but little injury were the prevailing ambition to invent new names altogether to cease; while it is not surely too much to expect that it might derive more advantage from a stricter investigation of affinities than that which is at present adopted. Nevertheless, such are not the sentiments of scientific men in some parts of the continent, particularly Germany, where entomology is truly a "war of words," and where to coin a barbarous name and to institute a new genus appear to be mistaken for one and the same thing. There are two facts difficult it seems in that country to be assented to, but which ought to be apparent at this time of day to every person who has paid any attention to the subject: First, genuine specific, nay even genuine generic distinctions do not constitute the *perfection* of natural science; and secondly, nomenclature is not a department of natural history, but only a convenient instrument whereby an acquaintance with it may the more easily be cultivated.

Insecta Coleoptera, Herbivora, antennis clavatis, capitulo plerumque 3-phyllo lamellato, pedibus fossoriis, tibiis externe dentatis vel spinosulis, duobus anticis præsertim, tarsis plerumque pentameris.

Lamellicornes } *Lat.*
Byrrhii }

Insecta RECTICERA.

Lucanus } *Linnæus.*
Hister }

Antennæ fractæ, capitulo haud flabellato;
Mandibulæ valde exsertæ.

I. SAPROPHAGA.

Hister, *Linn.*
Histeroides, *Gyllen.*
Histeridea, *Leach.*

Antennæ sæpius 11-articulatæ, clavâ compactâ.

- Corpore convexo.
  - *Insecta adhuc incognita.*
  - ONTHOPHILIDÆ?
  - ABREIDÆ?
- Corpore depresso.
  - OMOLEPTIDÆ?
  - HISTERIDÆ?

I. THALEROPHAGA.

Lucanus, *Linn.*
Lucanides, *Lat.*
Prioceri, *Dum.*

Antennæ sæpius 10-articulatæ, capitulo pectinato fissili vel subserrato.

- Corpore convexo.
  - LAMPRIMIDÆ . . Lethrus.
  - ÆSALIDÆ.
  - SYNDESIDÆ.
- Corpore depresso.
  - PASSALIDÆ.
  - LUCANIDÆ . . Sinodendron.

Insecta PETALOCERA. *Dumeril.*

Scarabæus. *Linnæus.*

Antennæ rectæ, capitulo flabellato;
Mandibulæ clypeo plerumque obtectæ vel raro exsertæ.

I. SAPROPHAGA.

Scarabæi terrestres. *De Geer.*

INSECTA materiis decompositis vel putrescentibus victitantia. Pedibus validis (posticis ab aliis subremotis), tibiis latis, elytris sæpius ad anum pertingentibus.

Character analogus.

- I. Coprophaga, vel succis excretoriis victitantia.
  - GEOTRUPIDÆ . . . . Mandibulæ porrectæ corneæ . .
  - SCARABÆIDÆ . . . . Mandibulæ membranaceæ . . . .
  - APHODIIDÆ . . . . Maxillæ processu membranaceo
- I. Xerophaga, vel materiis siccioribus victitantia.
  - TROGIDÆ . . . . . . Maxillæ dentatæ
    Mandibulæ acutiusculæ laniatores
  - DYNASTIDÆ . . . . Maxillæ dentatæ vel inermes . .
    Mandibulæ obtusæ molares vel incisoriæ

I. THALEROPHAGA.

Scarabæi florales } *DeGeer.*
Scarabæi arborei }

INSECTA materiis vivis vel vigescentibus victitantia. Pedibus gracilioribus, tibiis subangustis, elytris rarius ad anum pertingentibus.

- I. Anthobia, florum vel arborum succis victitantia.
  - RUTELIDÆ.
  - CETONIIDÆ.
  - GLAPHYRIDÆ.
- I. Phyllophaga vel folia mandibulis rodentia.
  - MELOLONTHIDÆ.
  - ANOPLOCNATHIDÆ.

CHAPTER IV.

ON THE NATURAL AFFINITIES WHICH THE LINNÆAN SCARABÆI BEAR TO EACH OTHER.

THE preceding general arrangement was obtained in an attempt to combine the anatomy with the *habitus* of insects, and more especially by considering their organs of manducation with a continual reference to the manner of living. This method of considering entomology, besides the very questionable merit of novelty, possesses no small portion of interesting facts in its developement, as the following observations will prove.

The herbivorous pentamerous Coleoptera[a] *which have clavate antennæ, and their anterior tibiæ externally spinose or dentated*[b], that is all the *Lamellicornes* of Latreille, together with the Linnæan genus *Hister*, may be divided into two branches, viz. *Rectocera* and *Petalocera*, which are simply to be distinguished thus—the former by antennæ as it were broken, and the latter by having them straight, or at least forming no sharp angle in their extent.

[a] I had originally, for the sake of convenience, comprised all these insects under the general name of *Acanthopoda*; but was subsequently induced to cancel it, from a fear that it might give rise to erroneous notions of *division*. For it is not to be imagined that the *Acanthopoda* could have represented any natural division, since their extreme genera may be shown to be connected with other *Coleoptera* in as intimate a manner as we shall see that they are among themselves. The *Acanthopoda*, therefore, could only have been considered as forming four links in a chain, and not as an insulated tribe.

[b] This definition is a good instance of the difficulty of finding characters

I shall for the present confine my remarks to the *Petalocera*. These appear to branch out into two columns of five families each; one of the columns consisting of *Saprophagous insects*, or such as feed on putrid or decomposed vegetable matter, and the other of *Thalerophagous insects*, or such as live on green or fresh vegetable food. The saprophagous column answers to the "*Scarabées de terre*" of De Geer, and the *Scarabées des fleurs et ceux des arbres* of the same author are both comprised under the name of *Petalocera thalerophaga*. It is also observable that each column consists of two groups; the first, of insects which have membranaceous maxillæ, and therefore live on juices, and as it were by licking their food; and the second, of insects which have corneous or crustaceous maxillæ, and therefore live on a more solid species of food, and by mastication.

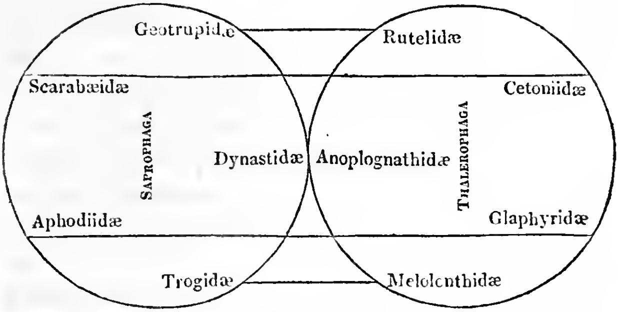
It will next be remarked, that the families in one of these columns have each a striking similarity of general form to the corresponding families in the other column: thus the *Rutelidæ* and *Geotrupidæ* have their body in general subconvex; the *Scarabæidæ* and *Cetoniidæ* have it generally depressed; the *Aphodiidæ* and *Glaphyridæ* less so; the *Trogidæ* and *Melolonthidæ* have it very convex, while the *Dynastidæ* and *Anoplognathidæ* have this sort

which shall not lead to an artificial distribution. For were the young entomologist to insist upon every one of the four characters in the definition being distinct, he would necessarily exclude from the group many *Histeres* because not herbivorous, the genus *Trachyscelis* because not pentamerous, the genus *Platycerus* because the antennæ are scarcely clavate, and many of the genus *Trox* because the anterior tibiæ are not always externally spinose. It may however be safely asserted, that when any insect does not possess some two of these four characters, it ought not to be considered as belonging to the group.

of affinity carried even still further, as in the genera *Dasygnathus* and *Amblyterus*, of which descriptions will be found in the Appendix. But it is in the construction of the mouth that the most remarkable analogy betrays itself, and consequently is in some degree evident in the manner of living, so that each saprophagous insect may be said to have a thalerophagous one corresponding to it.

Such analogies, nevertheless, must be gathered from the most general view that can be taken of the different groups, and even then are often obscured by real or apparent exceptions. So that, however interesting to the philosopher, they serve but to show that in the creation a general plan was pursued, the infinite shades of deviation from which, in the execution of the details, must render its complete developement by our limited faculties almost hopeless. But to return:—It will next be perceived that each of the columns into which the *Petalocera* are divided, forms a circle; for on the one side we find the *Geotrupidæ* connected with the *Dynastidæ* by means of the genera *Orphnus*, MacL., and *Oryctes*, Lat.; and on the other, the *Rutelidæ* with the *Anoplognathidæ* by means of *Pelidnota* and *Areoda*, both new genera, now for the first time published.—Again: these two circles will be found in a manner to touch one another at the families of *Dynastidæ* and *Anoplognathidæ*, which are, as before stated, intimately connected with each other by such genera as *Dasygnathus* and *Amblyterus*.

The following figure, therefore, which represents two circles, touching one another and composed each of five analogous ganglions, will express well the natural position of the *Petalocera* among themselves.



Such an arrangement is important, were it only that by its means we find connected in the most satisfactory manner the *Rutelidæ* with the *Cetoniidæ*, the *Geotrupidæ* with the *Dynastidæ*, the *Dynastidæ* with the *Anoplognathidæ*, the *Trogidæ* with the *Aphodiidæ*, the *Dynastidæ* with the *Rectacera*,—all which are separated according to the common systems, although their affinity must be obvious to the most careless observer.

An attentive observation of the two circles has led me also to suspect that each of them is divisible into two others, or, which is the same thing, that the insects composing the extremity of each column approach in their general construction to those which form the middle of the same column. Thus the genus *Hybosorus*, MacL., in the family of *Geotrupidæ*, resembles *Ægialia* and *Orphnus*[a], while the African genus *Popillia*, Leach MSS., (*Melolontha bipunctata*, Oliv.,) and the well known Chinese insect *Melolontha viridis*, Fab., which forms the new genus *Euchlora*, evidently connect the *Rutelidæ* with the *Melolonthidæ*. The inferences that might be deduced from such a disposition, were it perfectly established, are highly interesting; but the present perhaps is not the moment for enlarging on them.

[a] These as well as the other affinities mentioned in this chapter will be found demonstrated at length in the Appendix.

CHAPTER V.

REMARKS ON THE LINNÆAN GENERA LUCANUS AND HISTER.

THERE are some truths curious and even interesting, which are nevertheless overlooked or despised on the sole account of their having been singly and without comment introduced to our notice. The idea of making use of them as premises from which some inference may be drawn is thus often paralysed; and they accordingly accumulate, until the science which they were intended to illustrate becomes neglected as a barren mass of insulated facts. Such would be the fate of natural history in an especial manner, were we to adopt the vulgar opinion, that it is a science of observation alone. But luckily we know from experience the very reverse to be the case, and that any branch of knowledge, where the true value of a remark can never be perceived until it be connected with others so as to form a regular whole, must therefore depend as much on the employment of our reasoning faculties as on that of the eyes. De Geer, in describing the parts of the mouth in *Geotrupes stercorarius*, Lat., made known an anatomical structure quite as complicated, or even more so than the analogous parts in vertebrated animals, although formed on a totally distinct plan: yet at the time he only added one solitary unconnected fact to the stock then in the possession of entomologists. But the value of De Geer's observations is now established, since Fabricius and his followers have proved that the nature and manners of the insect bear an immediate relation to the form and texture of its organs of manducation. In the same way there will be found in this chapter several remarks on the *Recticera*, which, though by no means new, will nevertheless be shown to deserve greater attention than they have hitherto obtained.

It may in general be observed of the *Recticera*, or *Insecta herbivora, pentamera, antennis quasi fractis*, that Nature seems to have dispersed them over the globe much more sparingly than the *Petalocera*; the truth of which will appear from the inspection of any extensive entomological collection. They will however be found to branch off like the *Petalocera* into two columns, the one of saprophagous insects, composing Linnæus's genus *Hister*, and the other of thalerophagous insects, being the same with his *Lucanus:* and it is worth the noticing, that as both circles of the *Petalocera* seem to contain about the same number of species, so there is something like equality perceptible in the contents of the columns of Saprophagous and Thalerophagous *Recticera*.

As the *Recticera* are few in number, and these few are but imperfectly known, it can hardly be a matter of surprise that we should not here perceive the infinite gradations of construction which render the *filiation* of Nature among the *Petalocera* comparatively easy to be seized.—A considerable hiatus accordingly often occurs among the *Recticera*: but that there is no reason to conclude that insects do not exist to fill up such chasms, I shall prove by the description (in the Appendix) of some new insects belonging to the column of Thalerophagous *Recticera*. We shall see there two new genera, which I propose to name *Nigidius* and *Figulus*, intervening between the types of the *Lucanidæ* and *Passalidæ*, possessing the antennæ of the former and the general appearance of the latter, with a construction of the mouth which bears evident analogies to that of both. A family which I have called *Syndesidæ* is clearly connected with the *Passalidæ* by the antennæ and impressed thorax; while their convex form of body, indistinct maxillæ, and short mentum, seem to prove their affinity with *Æsalus*, F. The antennæ also of this last genus, which I suspect however to be not quite in the circle, approach to those of *Lamprima*, Lat., which again joins the *Lucanidæ*, and thus completes the circles by means of two new genera, to which I have given the appellations of *Ryssonotus* and *Pholidotus*.

I have not been able to discern much lateral affinity between the corresponding families of Saprophagous *Petalocera* and Thalerophagous *Recticera*, except at the extremities of the columns, or, which is the same, at the points at which the circles touch one another. In the construction of the mouth, the *Æsalidæ*, *Syndesidæ*, and *Passalidæ* bear no resemblance to the *Scarabæidæ*, *Aphodiidæ*, and *Trogidæ*. Indeed, in proportion as the general plan of construction differs, it is clear that we ought not to expect much affinity in the details. Thus a very conspicuous analogy may and does exist between the two columns of *Petalocera*, and even between the two columns of *Recticera*, which by no means can be expected to be so distinct between a Recticerous and a Petalocerous column.

Nevertheless it appears to be a law of Nature never to arrive suddenly at a complete change of form; for we find the *Æsalidæ* resembling the genus *Trox*, F. in general appearance, while the *Syndesidæ* may be called the *Aphodii* of the Thalerophagous *Rectocera*; and the *Passalidæ* from their colour and depressed body are, as it were, the *Scarabæidæ* of the same tribe.

With respect to the extreme families of the column, as it is here that the passage from one circle to the other takes place, we find the organs of manducation and the manner of living in each to be most beautifully connected by the genera *Sinodendron*, Lat., and *Lethrus*, Lat. The former of these remarkable insects was placed by Fabricius with some *Bostrichidæ*[a], as well on account of the antennæ as from other causes; and Latreille boasts of having avoided such arrangement, and made it an *Oryctes*, by paying attention to the number of the tarsi[b]. But it is doubtful whether the separation on the last account be not even more artificial than the junction on the first; for these various alterations are rather proofs that our systems are artificial, than that the place last assigned to such anomalous insects ought always to be considered the best. The fact is that *Sinodendron* has evidently some sort of affinity to the *Bostrichidæ*, which would be well worth the trouble of investigation; while nothing also can be more just than the observation of Latreille, "*que le sinodendron est un oryctès avec des antennes de lucane*[c]." This learned and acute entomologist has not however, as might have been expected, made use of this genus to connect his families of *Lucanides* and *Scarabæides*. It is true, indeed, that in his last works he places

[a] *Syst. Eleuth.* vol. ii. p. 376.

[b] *Hist. Nat. des Crust. et des Ins.* vol. x. p. 15. [c] *Ibid.* p. 156.

the *Sinodendron* with the *Lucanides;* but in the third volume of the *Regne Animale,* and more especially under the article *Lamellicornes* in the *Dictionnaire d'Histoire Naturelle,* he appears to think that the *Cetoniidæ* come the nearest to the *Lucanidæ* of all the *Petalocera.* "*Dans quelques espèces les mandibules des males sont beaucoup plus grandes que celles de femelles; c'est ce qu'on observe dans les Lucanes et dans plusieurs Cetoines exotiques; d'autres males de ce dernier genre ainsi que ceux de* Goliath *ont l'extremité anterieure du chaperon divisée en deux parties representant quelquesfois des cornes. De ces rapports et de quelques autres j'en ai conclu que les Cetoines et les Trichies etoient de tous les Scarabées de Linnæus, ceux qui se rapprochoient le plus de ses Lucanes.*" But though the genus *Cetonia* does indeed always with this author immediately precede *Lucanus,* I cannot but think that, after having so acutely pointed out the affinity which *Sinodendron* bears to both *Oryctes* and *Lucanus,* he must have given the above reasons for uniting this last to *Cetonia,* more from an experience of the difficulty of placing them otherwise, according to our modern systems, than on any very evident grounds of affinity. If I may be allowed to differ in opinion with an entomologist of such celebrity, and to whom the science is so much indebted, I should say that the *Cetoniidæ* are of all the *Petalocera* the most unlike to the *Recticera,* and that their membranaceous mandibles can never be assimilated to the immense corneous mandibles of the *Lucanidæ.* On the other hand, I hope to prove that no insects in either column of the *Petalocera* resemble the *Recticera* so much, in general form and construction of the mouth, as the *Geotrupidæ* and *Dynastidæ.* And with respect to the junction of the *Cetoniidæ* to the *Lucanidæ*, on account of the bifid clypeus of the *Goliathi* bearing a resemblance to the gigantic mandibles of *Lucanus*, one can only express astonishment that Latreille should be able to reconcile himself, by such very fanciful reasoning, to an arrangement so evidently unnatural. Both *Cetonia* and *Lucanus* are without doubt insects which live on vegetable juices; but then the maxilla of the former is a thin membranaceous plate proper for the expression of the nectar of flowers, whereas the maxilla of *Lucanus* is a long delicate brush of quite a different form, though extremely well contrived for its object—to lick up the sap flowing from the wounds of trees[a].

Let us now examine the genus *Lethrus*, which appears to have opposed as many difficulties to entomologists as *Sinodendron*:—it will be interesting to see this hitherto anomalous insect occupying the important place of a link between the *Petalocera* and *Recticera*. Scopoli first instituted the genus[b]; and Fabricius added a new species[c], from its possessing the convex form of body, infundibuliform clava to the antennæ, porrect mandibles, and setose maxillæ, which so strongly characterized the type. As however this new insect was supposed to want the labrum, and its maxillæ also were penicilliform, Schreibers asserted it to be a *Lucanus*[d]. Fabricius had previously hinted that it might prove a new genus, and Latreille accordingly placed it under the name *Lamprima* among his *Lucanides*. Now it is evident that these three great naturalists were all so far right, and only wrong in that Fabricius was not able to connect it with *Lucanus*, nor Schreibers and La-

[a] *Hist. Nat. des Crust. et des Ins.* vol. x. p. 243.

[b] Scop. *Intr. Hist. Nat.* p. 439.

[c] *Syst. Eleuth.* vol. i. p. 2.

[d] *Trans. Linn. Soc.* vol. vi. p. 185.

treille with *Lethrus.* Latreille indeed takes notice of an "*organization particulière*[a]" in *Lethrus,* which separates it from *Geotrupes,* but does not remark that this same peculiarity of construction unites it to *Lamprima,* though probably on this very ground Professor Pallas[b] and others had already made it a *Lucanus.* I shall not, however, depend solely on the opinions of systematic writers to prove the connexion between *Lethrus* and *Lamprima,* but resort to observations already recorded. The following characters are extracted from Latreille's *Genera Crustaceorum et Insectorum,* and are common to both genera.

1. *Antennæ articulis ultimis clavam infundibuliformem formantibus, articulo basilari elongato, conico.* This character belongs to *Geotrupes.*
2. *Mandibulæ validissimæ corneæ porrectæ.* This character is common to *Geotrupes* and *Lucanus.*
3. *Maxillæ in Lamprimâ filiformes setosæ. Maxillæ, in Lethris processu terminali pilis spinulisque corneis, elongatis ciliato.*

It will I hope be allowed that nothing can more satisfactorily show the affinity existing between the *Lucanidæ* and *Lethrus,* than this last remarkable analogy in the construction of the maxillæ. I shall therefore now consider it as in a manner proved, that we are to pass from the *Dynastidæ* to the *Lucanidæ* by means of *Sinodendron,* and from the *Geotrupidæ* to the *Lamprimidæ* by means of *Lethrus.* I have but one more remark to make on the Thalerophagous *Recticera*; which is, that the consideration

[a] *Hist. Nat. des Crust. et des Ins.* vol. x. p. 139.

[b] "Lucanus apterus.—Insectum anomalum inter *Lucanos* et *Scarabæos* coprideos ambiguum." *Icones Insect.* Pallas. 1.—*Nov. Com. Petrop.* Laxman tom. xiv. p. 594.

of their affinity to the *Petalocera* leads us to examine the nature of the genera that form the links of connexion. These genera I propose to call *osculantia,* from their occurring as it were at the point where the circles touch one another, and to distinguish them from *genera annectentia,* or those serving to unite the family in their own circle. These *genera osculantia,*—such as *Sinodendron, Lethrus, Platycerus,* and as I suspect, also *Æsalus,* have in preference to all others a special right to be termed natural, and appear in general to possess a remarkable character, which is the fewness of species of which they are composed[a]. I have mentioned the genus *Platycerus* as one of these, because it will be easily perceived that its form enters with difficulty into the circle of Thalerophagous *Recticera,* and is indeed, as Gyllenhall well observes[b], the connecting link with the *Trogositæ,* to which it approaches in colour, general form, and antennæ, though these last are mostly heteromerous insects, without teeth on the anterior tibiæ. However, as it is not at present my object to discover where this path might lead me, I proceed to the consideration of the Saprophagous *Recticera*.

There are few entomologists who have not been struck with the general resemblance in manners and appearance between these and the Saprophagous *Petalocera;* but no one has attempted to define in what the analogy between them consisted. Soon after Linnæus had instituted the genus, and placed *Hister* immediately after *Scarabæus,* Scopoli said

[a] It ought to be observed that this peculiarity is not so remarkable in the genera which connect the two circles of *Petalocera* with each other, and therefore it may perhaps belong solely to those singular insects which serve to connect the more discordant groups.

[b] Gyllen. *Ins. Suec.* vol. i. p. 73.

"*neglectis antennis* Histerem *a Scarabæo nemo distinguet*[a]." Degeer, whose entomological sagacity one can never sufficiently admire, placed *Hister* next to *Lucanus*, and remarks, that it appears to form a link between the *Scarabæi* and *Dermestes*. Latreille makes it a member of his family *Sphæridiota*, and remarks that "*aucun insecte de la division des Byrrhes n'a comme les escarbots ces deux charactères, antennes brisées, mandibules avancées*[b]:" and indeed it is true; for such are the characters of his family of *Lucanides*, to which *Hister* naturally conducts us from the *Byrrhi*. This affinity did not escape the usual accuracy of Gyllenhall, who places his new family *Histeroides* immediately after the *Lucanoides*, and before *Sphæridiota*, with the just observation that "*Familia* 10*ma* D[i] *Latreille* Necrophagi *nempe comprehendit genera plura nimis discrepantia, quare aptius censui* Histeres *a reliquis separare*[c]."

Not having sufficiently studied the Saprophagous *Recticera*, I shall not attempt to say where or by what osculant genera they are connected with the thalerophagous circle. It may be, that these interesting insects are not yet discovered: but my point will be sufficiently established if I can prove that the *Histeridæ* have a strong affinity to the *Lucanidæ* in general; and if I can show the existence of insects belonging to one circle which want some of its distinctive characters, and thus approach to the other. For this purpose, in the first place, I take the following analogous characters from the description of a profound naturalist, who never seems to have suspected the affinity, and

[a] *Ent. Carn.* p. 13.

[b] *Hist. Nat. des Crust et des Ins.* vol. ix. p. 191.

[c] Gyllen. *Ins. Suec.* vol. i. p. 74.

consequently, in using his words[a], I can be in no danger of being charged with an attempt to force Nature, as it were, to submit to what may hereafter be termed a theory of entomology.

1. *Histeris* "Antennæ thorace breviores, ad basin mandibularum insertæ; fractæ. Articulo basilari maximo, conico, ad extima crassiori, incurvo; octavo clavæ 3-articulatæ basin efficiente."	1. *Lucanidarum* "Antennæ thorace non longiores, fractæ; Capitulo e quinque, quatuor aut tribus lamellis composito." *Lucani* "Antennæ articulo primo longissimo, incurvo, ad apicem sæpius crassiore."
2. *Histeris* "Labrum exsertum, crustaceum, transverso quadratum."	2. *Passali* "Labrum crustaceum, transverso-quadratum, penitus exsertum."
3. *Histeris* "Mandibulæ corneæ, validæ, crassæ, processu interno bidentato."	3. *Lucanidarum* "Mandibulæ corneæ, validissimæ, porrectæ, dentatæ."
4. *Histeris* "Palpi filiformes, articulo ultimo longiore, subcylindrico, obtuso; maxillares paulo longiores."	4. *Lucanidarum* "Palpi filiformes, articulo ultimo subovali aut subcylindrico; maxillares longiores."
5. *Histeris* "Maxillæ laciinis duabus inæqualibus, marginibus internis fimbriato-hirsutissimis; externâ majore, subovato-trigonâ, laciniâ internâ ungue minuto, corneo, bifido, aut duplici genere constructo."	5. *Passali* "Maxillæ processibus corneis, spinosis, internè dentatis; apicali validiore, subtrigono, interno dentibus duobus aut unico."
6. *Histeris* "Mentum quadratum marginis superi medio emarginato."	6. *Passali* "Labium quadratum, mento profunde emarginato."

[a] *Gen. Crust. et Ins.* vol. ii. p. 46, 130, 131, 136.

It seems superfluous to add any thing to these characters in order to prove the near relation which *Hister* bears to *Lucanus*: but notwithstanding these, and the dentated anterior tarsi, Latreille, in the third volume of the *Regne Animale*, places his tribe *Histerides* between *Silpha*, L. and *Clerus*, L. I am not aware of his reasons for this arrangement; but if it be on account of any resemblance of the larvæ, I should fear that there is an error somewhere. That he is right in asserting in the *Dictionnaire d'Histoire Naturelle*, Art. '*Escarbot*,' that *Hister* can neither be comprised with his Lamellicorn insects nor with his *Sphæridiota*, no one can doubt; but it is surely as clear that it bears a greater affinity to both of these than either to a *Clerus* or a *Silpha*.

In the next place it seems possible that an osculant genus will occur somewhere about the place of *Dorcas*: for *Hister maximus*, L. an insect from Senegal, approaches in some degree to the form of *Lucanus alces*, and is remarkable for having its head as exsert as any of the Thalerophagous *Recticera*. But these difficulties will, I trust, soon be cleared away by my learned friends the Baron Dejean and Dr. Leach, who have both been of late occupied with the examination of the Linnæan *Histeres*. Not having myself studied them in detail, I have adopted the principal groups of the last-mentioned entomologist, given in the *Zoological Miscellany*, and which appear *prima facie* to be very natural. The chasm which occurs, and prevents the completion of the circle, is left to be filled up at some future period, by insects which are to represent the *Lamprimidæ* among the Saprophagous *Recticera*.

To conclude then this long digression,—which I hope, however, will not be found foreign to my original purpose of investigating the nature of the Linnæan *Scarabæi*,—it must be confessed that, excepting the situation of *Hister*, which for the reasons assigned can no longer be held doubtful, every thing with respect to our farther knowledge of the Saprophagous *Recticera* remains yet to be done.

CHAPTER VI.

GENERAL REMARKS ON THE GEOGRAPHICAL DISTRIBUTION OF THE PETALOCERA.

THE geography of natural history is as yet but an infant branch of the science, which may be said to owe the principal nurture it has received, as well as its birth, to the labours of the enlightened Humboldt. It had, it is true, been already observed by Buffon, that the animals of the new world are different from those of the old; and various travellers had shown that the productions of different countries bear a character peculiar to each. But these were all rude and fortuitous observations, which had no view whatever to general consequences, or to the developement of those laws by which it is now certain that the geographical distribution of organized matter was regulated at the creation. M. Humboldt and our celebrated countryman Mr. Brown have both contributed greatly towards the discovery of these laws, so far as they relate to the vegetable kingdom; but the geography of animals is as yet enveloped in some degree of obscurity; and in entomology above all, nothing has yet appeared to dispel these clouds, excepting the excellent *Mémoire* of M. Latreille, which is published in the *Annales du Muséum*. But this paper, proof as it undoubtedly must ever remain of the profound learning and inimitable tact for observation of its author, is still rather a collection of facts than an arrangement and application of such facts to the discovery of the general limits by which the dispersion of insects over the earth is restricted. This imperfection, if it be one, is however to be attributed solely to the almost insuperable obstacles which impeded his researches.

Insects are, it need hardly be said, a despised set of beings; though, were we not accustomed to judge of them by their individual size, and were we to look at their numbers and effects, they would assuredly be found among the most powerful agents which nature employs in maintaining the equilibrium of the animal kingdom. The joint consequence, however, of the neglect which they have suffered and of their numberless swarms is, that, compared with the whole number of species, we are acquainted with but few. Well then may Latreille say that the imperfect state of our catalogues has prevented him from pursuing any other plan than that which he has adopted.

Having, however, had the good fortune to inspect almost every collection of note in Europe, excepting those of Vienna and Berlin, I conceive myself in possession of data sufficient to justify an attempt to combat the difficulty under which M. Latreille laboured, and to offer to entomologists the following rough estimate of the various geographical proportions in which the families of *Petalocera* occur. It would, nevertheless, be highly improper not to acknowledge that such calculations, after all, are but vague approximations to the truth, which have nothing to support their accuracy, but inferences drawn from the inspection of many and extensive entomological collections. As such then I give them.

The leading principles upon which organized beings appear to have been dispersed over the globe, are few and simple. The presence of caloric, to whatever cause this may be owing, is undoubtedly the chief excitement of energy in the vital principle; which fact is demonstrated not only by the myriads of organized beings which swarm within the tropics, but also by the ingenious observations of Humboldt and Latreille. These gentlemen have both shown that the highest mountains in the warmest climes exhibit, as we ascend towards their summits, all the various gradations of organized matter which each hemisphere of the whole globe presents as we proceed from the equator to the pole. Still it must not be imagined that a horizontal circle traced round the mountain, or the parallel of latitude which encircles the hemisphere, are necessarily either of them accurate isothermal lines. Experience indeed teaches us the contrary, and fully confirms those inferences we should have drawn from the consideration of the different meteorological effects likely to arise from the variation of the surface of the soil, and other similar causes. Vegetation, for instance, which requires the absence of extreme cold rather than the presence of extreme heat, is likely to extend itself in its tropical form towards the poles farther on a dry continent than on a marshy or low one. Tropical plants will therefore thrive better in Thibet and other inland parts of Northern Asia than they would do were we to transport them to places of the same latitude in America. In this last country the extremes of heat and cold are too widely asunder, and accordingly the vegetation of Canada by no means corresponds either in its general character or number of species with that of places in France under the same latitude.

Animals also are subject to the same sort of limitation with plants: that is, they have to fear extreme cold rather than extreme heat[a]. Such animals therefore as can avoid this cold—either by passing it in a state of torpidity, or by the habit of burrowing in the earth, or by living in the sea, or by artificial clothing,—will in general be found the most widely dispersed, and the least to affect local situations. And insects which can escape the extremes of cold, not only by passing them in the torpid state of *pupa*, but by being generally, when in this torpid state, buried in the earth, must in a special manner be little sensible to the cold winters of northern climates. What they chiefly require is the presence of heat during some period of their existence; and the greater, within certain limits, is the heat, the more active will be their vital principle. On the American continent the extremes of heat and cold in the course of the year are, as is well known, incomparably greater than in places of the same latitude in Europe. We may therefore readily conceive how particular families of insects will inhabit a wider range of latitude in the former country than in the latter. We see also how insects may swarm in the very coldest climates, such as Lapland and Spitzbergen, where the short summer can boast of extraordinary rises in the thermometer, because the energy of the vital principle in such animals is, within certain limits, proportionate to the degree of warmth to which they may be subjected, and escapes in a manner the severe action of cold.

It is on the above principles also that I would account for what may seem at first sight an extraordinary circum-

[a] The white bear of Greenland, *Ursus maritimus*, L., appears to dislike warmer climates, from the great obstacles he encounters towards the enjoyment of his favourite element, and the procurement of his food in countries where he cannot float about on the ice. This animal hates drought rather than heat.

stance in the geography of insects; namely, that their tropical structure extends much farther north in America than in Europe; that is, in a manner directly the reverse of that which we have seen to be followed by plants. Examine *Copris carnifex*, F., *Cetonia nitida*, F., *Rutela* 6-*punctata*, Lat., and other New York insects, and compare them with insects of the same families from Brazil. The difference between the general structure of these will be found infinitely less than that which would result from a comparison of the entomological productions of the neighbourhood of Madrid with those of the banks of the Congo.

Nevertheless, though I contend that the insect tribes suffer less in cold climates than plants, and hope to have proved it to be the case, it does not therefore follow that the prevalence of cold has no effect towards the destruction of insect life. We know the very reverse of this to be the truth, and that the diminution of the number of species becomes very conspicuous as we advance towards the poles. But this I imagine is owing to the short continuance of warmth rather than to the low degree of it while it exists[a]. And accordingly we find that insects, such as gnats, musquitoes, &c., which pass their larva state in water, thus avoiding extreme cold, and whose existence in their perfect state being naturally ephemeral, must therefore suffer little from the shortness of the summer,—are no where more troublesome than in the very coldest climates. Whereas the number of coleopterous insects, which, being naturally longer lived, require a longer continuance of warmth, is sensibly diminished in these dreary countries.

[a] Heat, properly speaking, never absolutely ceases to exist; but it is here for convenience understood as commencing at 32° of Fahrenheit.

The *Petalocera*, however, occupy so important a place in the œconomy of nature, that we may easily perceive it to be impossible to assert in what latitude they altogether cease to exist. But though it may not thus be easy to prescribe limits of latitude to any of the Petalocerous families, it is otherwise with respect to the longitude; for we find that the *Glaphyridæ* have never as yet been found but in the old world, nor the *Rutelidæ* but in the new. As to the remaining eight families, they appear to have been confined within no limits of longitude, nor indeed of habitable latitude, though we shall see that some families are more plentiful in particular climates than others. Thus the *Aphodiidæ* seem to be most numerous in rather high latitudes, the *Geotrupidæ* in temperate climates, and the *Scarabæidæ* in tropical. The *Trogidæ* and *Melolonthidæ* appear to be scattered rather equably over the globe, which may in some degree arise from their partiality to a particular soil. The *Dynastidæ*, *Cetoniidæ*, *Anoplognathidæ* and *Rutelidæ*, though found in the temperate zones, are all most numerous in the warmer climates; but the two first families recede much farther from the equator than the two last. The *Glaphyridæ*, however, of all the Petalocerous families appear to be the most confined in their range of climate.

In some cases also the geography of the *Petalocera* is affected by local circumstances; for the *Dynastidæ* which are common in America and on the European Continent, have never yet been discovered in England, although the *Oryctes nasicornis* inhabits even the high latitudes of Sweden. If however the truth of the preceding remarks be allowed, such incidents are readily accounted for, since a Petalocerous insect of a tropical family may readily be expected to avoid an English cold summer rather than a Swedish cold winter.

In other cases the distribution of the *Petalocera* appears to have been regulated by a higher purpose. Thus, if my observations on the subject have not deceived me, the species of coprophagous insects from within the tropics are to those from without, nearly in the proportion of 4:3; which, if we reflect on the services rendered in hot climates by these scavengers of nature, appears to be a limitation that is in some measure required by necessity. A similar purpose of utility may account for the species of coprophagous insects, that is, those composing the three families *Geotrupidæ*, *Scarabæidæ*, and *Aphodiidæ*, being to the number of species which compose the remainder of the Saprophagous Petalocera in the proportion of about 3:2.—Ignorant as we are of the habits of the *Rutelidæ* and *Anoplognathidæ*, it is impossible at present to carry the same kind of investigation among the thalerophagous insects; though it may excite some little curiosity to know what proportion the species of phyllophagous *Petalocera* bear to those which feed on flowers. If it be allowable to argue from the general œconomy of nature, it would seem that the number of the former ought to be predominant, and this I suspect to be really the case.

But this highly amusing subject must be left to some future period, when the continued prosecution of discoveries by intelligent travellers shall have supplied entomologists with that information from which alone such calculations must always be derived.

FAMILIARUM SYNOPSIS.

- **PETALOCERA.**
  - **SAPROPHAGA.**
    - Maxillæ processubus membranaceis. Insecta succis excrementitiis victitantia.
      - Mandibulæ porrectæ corneæ. — 1. Geotrupidæ. Sub stercore vel boletis putridis terram fodientes.
      - Mandibulæ sub clypeo latitantes membranaceæ.
        - Palpi maxime hirti, labiales articulo terminali abrupte minore. *Coleoptra non longiora quam latiora.* — 2. Scarabæidæ. Stercoricolæ in crepusculo volitantes.
        - Palpi glabri articulis subæqualibus cylindricis. *Coleoptra longiora quam latiora.* — 3. Aphodiidæ. Stercoricolæ in sole volitantes.
    - Maxillæ corneæ.
      - Maxillæ processubus duobus, interno dente arcuato corneo sæpius instructo. Labrum distinctum subquadratum. *Ano obvoluto.* — 4. Trogidæ. Sabulicolæ materiis putrescentibus victitantes.
      - Maxillæ dentatæ vel inermes, sed processu unico et sine unco arcuato. Labrum clypeo occultum. *Ano detecto.* — 5. Dynastidæ. Xylophagi, in cortice lignove putrido habitantes.
  - **THALEROPHAGA.**
    - Maxillæ corneæ. Clypeus suturâ transversâ divisus.
      - Maxillæ dentatæ vel inermes. Labrum trigonum. — 6. Anoplognathidæ. Phyllophagi? sed mores reverâ adhuc incogniti.
      - Maxillæ dentatæ. Labrum lineare vel sæpius emarginatum. — 7. Melolonthidæ. Sabulicolæ materiis vigescentibus victitantes.
    - Maxillæ processubus membranaceis. Insecta florum vel arborum succis victitantia.
      - Mandibulæ sub clypeo latitantes.
        - Mandibulæ corneæ. Labrum exsertum. — 8. Glaphyridæ. Anthobii, sed mandibulis corneis florum forsan petala destruentes.
        - Mandibulæ membranaceæ. Labrum clypeo obtectum. — 9. Cetoniidæ. Anthobii, sed mandibuli smembranaceis florum vel arborum succos bibentes.
      - Mandibulæ porrectæ corneæ. — 10. Rutelidæ. Mores adhuc incogniti.

CHAPTER VII.

ON THE FIVE FAMILIES OF PETALOCERA WHICH LIVE ON PUTRID OR DECOMPOSED VEGETABLE MATTER.

SINCE from the circumstance that has been mentioned of their disposition in circles, it becomes very troublesome to arrange the *Petalocera* in a cabinet according to their natural affinities, the series prefixed to this chapter may be adopted for the purpose; and it is perfectly natural, provided the connexion of the extreme families *Geotrupidæ* and *Rutelidæ* with the centre families *Dynastidæ* and *Anoplognathidæ*, be always borne in mind. The characters given to the ten families in this table may, however, be thought too brief for the inexperienced entomologist: and it is true indeed, that they only express the forms of construction to one or other of which every Petalocerous insect tends, and not those at which they all actually arrive. Thus the *Rutelidæ* and *Geotrupidæ* do not all possess a membranaceous process to their maxillæ; but the genera *Chasmodia* and *Geotrupes*, which perhaps are the types of the families, possess such. I have therefore imagined that it might be of some little service to attempt the still more detailed definitions of each family which follow; though to me it appears that any advantage which may thus be gained, will be at the expense of some natural affinity. And for this opinion I have no less authority than that of Linnæus, who could never be persuaded to define his natural orders in botany, from a conviction that the investigation of nature by means of preconceived rules and definitions, is an attempt as absurd as it would be to investigate truth by means of a set of prejudices. He felt that the student in the more profound branches of the science ought to have already paved the way for this sort of research, by that intimate and extensive knowledge of species which can always be most easily acquired by artificial methods. We see, therefore, that naturalists must always owe a large portion of gratitude to those who may by the help of artificial systems have made the productions of nature generally known: for it is with the materials collected by the humble labours of these indefatigable men, that the world can alone expect that the foundations of our knowledge with respect to nature should ever be laid.

Fam. I. GEOTRUPIDÆ.

Antennæ *decem vel undecim articulatæ;*
Articulo basilari subconico, vix elongato;
Capitulo magno, triphyllo, subgloboso.

Labrum *exsertum, crustaceum, transversum, subquadratum; margine antico ciliato.*

Mandibulæ *exsertæ, corneæ, validissimæ, subtrigonæ, depressæ, ad apicem subarcuatæ.*

Maxillæ *crustaceæ; margine interno vel apicali membranaceo aut fimbriato hirsuto.*

Palpi *maxillares filiformes.*

Labium *bipartitum,* mento *bifido vel integro.*

Caput *lateribus utrinque ante oculos auriculatim sæpius dilatatis;* Clypeo *parvo, angulato, depresso.* Corpus *orbiculato-ovale aut suborbiculare, undique convexum.* Thorax *latius quam longius extensus; Scutello* *sæpius distincto.* Pedes *validi, tibiis anticis dentatis, spinis apicalibus instructis; tibiis quatuor posticis apice sæpius dilatatis.*

Observations.

The characters hitherto given by entomologists to this family, which is altogether the same as the *Geotrupini* of Latreille, have been founded on the scrutiny of a few well known European insects. To use such definitions therefore strictly would be equivalent to the exclusion of many true *Geotrupidæ* from their natural place. Concisely describing these insects, it may be said that they differ from the *Scarabæidæ* by their corneous mandibles, and from the *Dynastidæ* by their exserted labrum. But such characters, like all others, are subject to an infinity of shades, and may even altogether disappear in some insects of this family, hereafter to be discovered. In such anomalous cases however, it will, I think, be always found that the insects belong to extreme genera, or to those which are close on the limits of other families.

The *Geotrupidæ* are coprophagous or boletophagous. Some extreme genera of the family, however, feed on roots, and may often be considered as even lignivorous. The types or central insects of the family, which are the best known, excavate cylindrical holes in the earth under their food, and thus approach in their manners as well as form to some of the *Scarabæidæ*.

From the *Geotrupidæ* which I have had opportunities of seeing, it may be calculated that the proportions of those from within the tropics, from the temperate zones, and from latitudes higher than 60°, are to one another nearly as 2, 10, and 1. And by way of proof that the *Geotrupidæ* are principally confined to temperate climates, I may observe that the tropical insects of this family principally belong to the extreme genera, such as *Athyreus*, and *Hybosorus*, the former of which approaches to the *Scarabæidæ* and the latter to the *Dynastidæ*.

Fam. II. SCARABÆIDÆ.

Antennæ 9- *vel* 8-*articulatæ capite paulo longiores;*

Articulo primo elongato, aliorum conjunctim longitudine, cylindrico, ad apicem basinque paulo crassiore; secundo brevi subconico vel subgloboso.

Clavâ magnâ triphyllâ.

Labrum *clypeo occultatum, membranaceum, in medio carinatum, antice ciliatum.*

Mandibulæ *sub clypeo latitantes, basi corneæ, deinde in laminam productæ elongatam, lanceolatam, compressam, membranaceam, latere interno et apice fimbriatis.*

Maxillæ *crustaceæ, laciniis duabus instructæ; apicali transversâ, subrotundatâ, fungosâ, membranaceâ, fimbriatâ, lobo interno homogeneo, subtrigono, pariterque fimbriato, apice subacuto.*

Palpi maxillares *filiformes, labialibus vix duplo longiores;*

Articulo ultimo ad basin et apicem graciliore.

Palpi labiales *maxime hirti, articulis subdilatatis;*

Articulo tertio aut terminali parvo, aliis abruptè minore, in nonnullis obsoleto.

Labium *membranaceum, mento occultatum, apice bifidum, laciniis pone palpos et eorundem usque ad* *articulum secundum productis, paululùm extus arcuatis, fimbriatis.*

Mentum *crustaceum, subquadratum, profundè emarginatum.*

Caput *subsemicirculare; clypeo sæpe dentato, interdum cornuto.* Corpus *orbiculato-ovale, convexum vel depressum; abdomine brevi, elytris haud obtecto.* Thorax *transversus; scutello rarissime distincto, subtrigono.* Pectus *magnum, ideoque femora intermedia ad basin latè dispartita.* Pedes *validi, unguibus minimis; tibiæ anticæ extrinsecus 3-dentatæ, apice calcare uno instructæ, tarsis exiguis, in quibusdam obsoletis; tibiæ mediæ apice 2-calcaratæ, posticè calcare uno instructæ.*

Observations.

The *Scarabæidæ* occupy a most important place in the economy of nature, and possess so very distinct a form that they are only likely to be confounded with the *Aphodiidæ;* from these, however, they may be distinguished by their elongate lanceolate mandibles and large pectus. Several genera of the *Scarabæidæ,*—such as *Onitis, Onthophagus,* &c.—approach so nearly to *Aphodius,* that here, as in most cases where families meet, it will be found most difficult if not impossible to draw the line of demarcation. There is less likelihood of confounding them with the *Geotrupidæ,* because, though several insects in both families evidently approach to one another in general form and structure, yet none that I have yet seen can accurately be said to fill up the interval that occurs between the corneous porrect mandibles of the one family, and those which are membranaceous and concealed under the clypeus in the other. But let this sole distinction be overlooked, and some of the *Geotrupidæ*, such as the genus *Athyreus*, will find a place among the *Scarabæidæ*.

The *Scarabæidæ* are all strictly coprophagous; and this great affinity in their manner of living is in all probability the cause of the organs of manducation being so similar throughout the family, as by no means to supply the distinctive characters that might have been expected from the marked variety of their general forms. Owing to this extraordinary similarity in the *instrumenta cibaria* of the different insects which compose the group, Latreille has more than once proposed to make but one genus of them, ascribing to the modern genera the name of sections. But though I have had reason to know that the father of modern entomology is far from thinking that genera, as commonly understood, exist in nature, it is nevertheless easy to perceive that alterations of the above sort must resolve themselves into the idea of natural genera. For if the animal creation knows any other absolute distinction than that of sex and species, and the groups insulated by these other absolute distinctions are to be termed *genera*, it is clear even to an axiom, that where such natural divisions cease to be apparent, genera can be said no longer to exist. Nothing, however, has yet occurred in the course of my observation but what has demonstrated the truth of the principles upon which the present investigation was commenced. These were, as I have already stated, that any other difference that may exist between animals than those of sex and species, is not absolute, but must be considered as arising solely from the imperfection of our own knowledge of Nature's productions; and that genera consequently become artificial, and only useful as serving to subdivide our more general ideas. In my opinion, therefore, the *Scarabæidæ* compose such a numerous family that for the sake of convenience we not only ought to retain all the established genera, but in several cases even to add a great many more to the present list, requiring only that they shall always be supported by characters visible to the naked eye.

This same difficulty of subdivision is not by any means peculiar to the *Scarabæidæ*, but will be experienced also in the equally numerous family of *Cetoniidæ*, which answers to those insects in the other circle. The *Scarabæidæ* also constitute the only family of the saprophagous circle containing insects having the produced sternum and lobate thorax, which form such remarkable characters in some of the *Cetoniidæ*:—all which circumstances prove, if farther proofs were indeed wanting, that these two families bear to each other a certain analogical relation.

The *Scarabæidæ* afford a curious example of the artificial nature of the sections that may be founded on the disposition of the tarsi. If the *Heteromera* for instance be a natural section, as stated in some of the latest entomological works, a genus such as *Onitis* ought *à fortiori* to compose a like division, since in one at least of the sexes it wants the tarsi of the fore-legs altogether. Yet how obviously would such an arrangement oppose all our notions of natural affinities!

In none of the *Coleoptera* perhaps does the general structure of the feet assume so extraordinary an appearance as with the *Scarabæidæ*. The externally dentated and somewhat curved fore-feet of these, with the tarsi nearly obsolete, can only vie in the anomaly of their form with the hind-legs proceeding from a transverse moveable trochanter, and placed so near the hinder extremity of the body, and so far from each other, as to give the insect in walking the most awkward appearance possible. This peculiar formation is nevertheless particularly serviceable to its possessors, in rolling the balls of excrementitious matter in which they inclose their eggs.

Proceeding upon the data which I have been able to collect, it may be said that the tropical *Scarabæidæ* are to those from without the tropics nearly as 5 : 1. Out of 450 species and upwards in my father's collection, only nine are natives of England; and of these nine, no less than eight are *Onthophagi*, which I consider as composing an extreme genus of the family, not the less interesting from having been noticed by Pliny[a].

Fam. III. APHODIIDÆ.

Antennæ *articulis novem, capite paulo longiores;*

Articulo primo elongato, aliorum conjunctim vix longitudine, cylindrico, ad apicem paulo crassiore; secundo hemisphærico;

Capitulo subgloboso-ovato, triphyllo.

Labrum *sub clypeo latitans, membranaceum, margine antico vix ciliato, medio subacuto.*

Mandibulæ *clypeo obtectæ, ad basin corneæ, deinde in laminam brevem, compressam, dilatatam, coriaceam aut vix membranaceam productæ; latere interno et apice haud fimbriatis.*

[a] "Tauri vocantur Scarabæi terrestres, ricino similes; nomen cornicula dedêre. Alii pediculos terræ vocant." Plin. *Hist. Nat.* lib. xxx. c. 12.

Maxillæ *laciniis duabus subæqualibus; apicali membranaceâ, fungosâ, margine supero extrorsum rotundatâ, interdum minore, processu interno crustaceo, obtuso.*

Palpi maxillares *filiformes, labialibus fere triplo longiores;*

Articulo ultimo aliis longiore, ovali-cylindrico, ad basin paulo graciliore.

Palpi labiales *fere glabri, articulis subglobosis;*

Articulo tertio aut terminali aliis majore, orbiculato-ovali.

Labium *minutum, membranaceum, sub-pilosum; mento occultatum, apice bifidum.*

Mentum *crustaceum, subquadratum, versus apicem angustius, margine antico emarginato.*

Caput *subsemicirculare;* Clypeo *sæpe tuberculato, nunquam dentato.* Corpus *ovatum aut ovale, ad apicem rotundatum, suprà convexiusculum.* Elytra *abdomen superne et ad latera obvolventia.* Thorax *transverso-quadratus;* Scutello *semper distincto.* Pedes *validi, omnes æque dissiti; tibiis anticis tridentatis, intus lineâ impressis pilisque fimbriatis.*

Observations.

The *Aphodiidæ* differ from the *Scarabæidæ* in having short dilated coriaceous mandibles, and the pairs of feet at equal distance from each other. They are also sufficiently separated from the *Trogidæ*, in having their labrum concealed under the clypeus, and by their mandibles being thin, compressed, and scarcely to be called corneous. All the insects known of this family have the scutellum distinct:

they comprise the least of the *Petalocera* ; and though resembling each other excessively in general structure, differ extremely in the manner of living, some being coprophagous, and others living on putrescent vegetable matter generally marine. These last insects consequently lead to that family of *Petalocera* which frequents sandy situations.

Of all the Saprophagous *Petalocera* the *Aphodiidæ* are the most common in England, and seem to replace with us the want of the *Scarabæidæ*. They appear indeed to be equally frequent over the whole of the north temperate zone, and I have made out the proportion of tropical insects of this family to be to those from countries without the tropics as 1 : 8. None have hitherto been brought from New Holland, though we are acquainted with *Aphodiidæ* from the Cape, which is nearly of the same south latitude. The coprophagous insects of New Holland seem indeed to be principally composed of the genus *Onthophagus* or of insects approaching to it, though even these occur but rarely. This rarity of coprophagous insects in New Holland is of course the natural consequence of that great peculiarity of the Australasian continent, namely, the want of all large herbivorous mammalia except of the marsupial kind. Still I have little doubt but that if the marine detritus of the coast of New Holland were properly searched, we should acquire the knowledge of several insects approaching to *Psammodii* in habit.

Fam. IV. TROGIDÆ.

Antennæ *breves, novem vel decem articulis, basilari crasso;*

Capitulo triphyllo, ovato, transverso, lamellarum disco utrinque sæpius convexo.

Labrum *coriaceum, exsertum, sæpius hirsutum.*

Mandibulæ *corneæ, crassæ, validæ, intus arcuatæ, interdum dentatæ, apice acutissimo.*

Maxillæ *laciniis duabus, internâ corneâ unidentatâ vel dentibus instructâ, interdum unco corneo valido processus hujus loco; laciniâ externâ vel membranaceâ et vix fimbriatâ, vel corneâ et ciliis spinuliformibus aut dentibus corneis armatâ.*

Palpi maxillares *maxillis longiores.*

Palpi labiales *articulo ultimo ovato, plerumque crassiore.*

Mentum *irregulare.*

Caput *subquadratum,* Clypeo *brevi, antice convexo.* Corpus *ovatum, plerumque valde gibbum, subtus planum;* Coleoptra *maxima, gibboso-convexa, fornicata, ad latera undique deflexa, ano ipso obvoluto.* Thorax *transversus; Scutello distincto.* Pedes *formâ variantes; tibiis anticis sæpe dentibus haud munitis.*

Observations.

The *Trogidæ,* though by no means a family having such strong general characters impressed on it as either of those we have hitherto considered, may nevertheless be distinguished from them all with considerable facility. Their antennæ in the first place have the *lamellæ* of their clava convex on both sides; so that the three joints of which this is composed are always very distinct; whereas in the *Geotrupidæ* the first and second joints of the clava are one or both infundibuliform, so that the whole becomes to the naked eye united under the form of a globular mass. Again, from the *Scarabæidæ*, *Aphodiidæ*, and *Dynastidæ*, the *Trogidæ* are generally to be distinguished by their exserted labrum. This family of all the Saprophagous *Petalocera* appears to contain the fewest species, and moreover seems to be distributed in nearly equal portions over the tropical and temperate climates. Another peculiarity attending it is, that it contains apterous insects, which are unknown as yet among all the other families of *Petalocera*.

If the observations of the more modern entomologists are altogether to be relied on, the economy also of the *Trogidæ* differs in some cases considerably from that of the other Petalocerous insects. As, however, this is a question by no means decided and rather interesting, I shall enter briefly into the discussion of it.

The genus *Ægialia* is found upon the seashore with the *Psammodii*, to which it bears so remarkable an affinity; and in all probability lives with these insects on putrid seaweed, or other marine detritus. The genus *Acanthocerus*, the type of which appears to be *Trox spinicornis*, Fab., cannot, any more than *Ægialia*, be considered to feed on the dried carcases of animals, as the slight construction of its mandibles and membranaceous maxillæ must render it altogether unfit to live on any but the most soft and pulpy substances. *Trox horridus* of Fabricius, which is distinguished from most others of the original genus by a triangular labrum, and by its body being apterous and elytra connate, I have separated from the rest, under the generic appellation of *Phoberus*. This insect, as I conceive, does not feed on dried cadaverous substances; because it may be observed that all insects intended to live on animal matter partially dispersed and collected in masses, are furnished with wings, in order to convey them the more rapidly to the objects pointed out by their instinct. Thus the genera *Silpha, Hister, Dermestes,* and indeed all other necrophagous insects, are winged; whereas the genera *Pimelia, Brachycerus,* &c., which live like *Phoberus* on sandy deserts, are apterous, a formation which must arise from the particles of which their food is composed being so universally and generally spread over these plains as to render rapid and distant change of place quite unnecessary. It remains therefore only to consider the nature and economy of such of the *Troges* as are provided with wings, of which division are all those hitherto known as European. Olivier says of these, that they are to be met with on the ground in the fields, and in sandy and rather dry places; and that they are sometimes observed on dried animal substances, occupied in gnawing the cartilaginous parts which serve as the last connexion for the bones of carcases from off which the flesh has been long devoured or consumed. Latreille makes nearly the same remark in his *Histoire Générale des Insectes;* and Mr. Kirby mentions in the Introduction to Entomology, his having found these insects on a ram's horn. I was myself present in the forest of Fontainebleau, with the last mentioned entomologist, when he took a specimen of *Trox* from off a horse's scull; but it would have been difficult to have discovered either cartilaginous matter or fleshy substance on these bones, which appeared from their colour to have been long exposed to the action of the atmosphere. Indeed nothing can strictly be said to have been determined with respect to the manners of the *Troges,* except that these insects are attracted to dried bones: but whether this be owing to their whiteness[a], or to the fleshy substance that may still remain attached to them, or to any vegetable matter whose growth may be particularly favoured by the presence of such substances, it would be difficult to say. Pallas even, who observed several of these insects in Siberia, only says that "*sub cadaveribus æstivo ardore exsiccatis cum Histeribus et Dermestibus hospitatur;*" from which expression it must be considered as anticipating an observation, if we conclude with Olivier that the insect *feeds* on such carcases. To these remarks I have only to add another circumstance, which I hope will excite the entomologist to study the economy of these insects, and so decide whether in reality they form an exception to the herbivorous disposition of the rest of the *Petalocera.*—In the *Memoires pour l'Histoire des Insectes,* Degeer says of his *Scarabé à tubercules* (which according to Schönherr is the *Trox luridus* Fab.), that M. Acrelius had found it in rotten wood in Pennsylvania.

Of all the *Petalocera,* the *Trogidæ* appear to approach the nearest in general habit to the Saprophagous *Rectocera,* though they differ most widely in the characters of the mouth. They delight in cadaverous matter like the *Hister.* Like this last insect their head is sunk in the thorax in a very peculiar manner, and moreover both of them have the curious habit when alarmed of counterfeiting death, by applying their feet and antennæ close to the body, and ceasing all motion until their fear may have subsided. There is also a most striking general

[a] There are few entomological collectors not aware of the advantages to be derived from exposing in the sun any thing white, such as linen, &c. for the purpose of attracting the Coleoptera.

similarity of construction in the genus *Acanthocerus* and several of the Saprophagous *Rectocera,* such as *Sphærites glabratus,* (*Hister glabratus* F.) &c. But that character which is as striking in the Saprophagous *Rectocera* as it is in the three other columns forming the subject of this work,—namely, the anterior tibiæ being dentated,—is often in the *Trogidæ* indistinct; so that we have here another proof of the absurdity of restricting nature to any characters which are not obviously and directly founded on the manner of living.

Fam. V. DYNASTIDÆ.

Antennæ *articulis decem, basilari longo, conico, hirsuto; secundo subgloboso; 3° 4° 5° et 6° brevissimis transversis, paulo sensim latioribus; tribus ultimis capitulum triphyllum ovatum sæpius breve formantibus.*

Labrum *membranaceum, clypeo sæpius fere penitus occultatum, ejusque paginæ inferæ adhærens, margine antico rotundato, sericeo pilorum fasciculo sæpius fimbriato.*

Mandibulæ *subtrigonæ, corneæ, basi crassæ, latere externo sæpe eminulo, suprà versus apicem concavæ vel planæ, subtus convexiusculæ.*

Maxillæ *dentatæ vel inermes, caule crustaceo, processu unico, corneo vel coriaceo, hirsuto vel setoso.*

Palpi maxillares *articulo basilari minimo.*

Palpi labiales *menti versus apicem inserti.*

Mentum *pilosum, convexum, elongatum, labium occultans, apice obtuso vel truncato.*

Caput *subtrigonum; clypeo sæpe cornuto.* Corpus *subtus* *sæpius pubescens, coleoptris abdomen postice non obtegentibus.* Thorax *sæpe cornutus, vel mucronatus vel excavatus.* Scutellum *distinctum, triangulare.* Sternum *nunquam productum.* Pedes *validi, tarsorum unguibus indivisis.*

OBSERVATIONS.

This family is remarkable as well for containing some of the most bulky of coleopterous insects, as for the difference which often occurs in the external appearance of the sexes. It may be separated from the *Trogidæ* and *Geotrupidæ* with ease on examining the labrum, which in the *Dynastidæ* is almost always concealed under the clypeus, instead of being distinct as in the other two cases. I have here, as also in the corresponding family of the circle of Thalerophagous *Petalocera,* in some manner disregarded the shape of the maxillæ for the sake of general habit. Latreille in his various works has made a distinct division of the *Dynastidæ* which have their maxillæ unarmed. But the general habits and appearance of the genera *Oryctes* and *Dynastes* being so very similar, and several insects occurring to fill up the chasm between them, I conceived that it would be an artificial interruption of the order of Nature, to place two such insects as *Oryctes nasicornis,* Illig. and *Scarabæus Boas,* Lat. in different families.

The *Dynastidæ* live either in rich vegetable mould or in the putrid detritus which results from the decomposition of trees. Perhaps also some are strictly lignivorous, particularly the large foreign species of *Dynastes;* but the truth is, that the economy of these insects has hitherto been so little studied, that it is almost entirely from analogy that we must decide on their manner of living. Olivier, with whose first family of *Scarabæi* the *Dynastidæ* coincide, says, with great propriety, that "*aucun ne se trouve dans les bouses et les fientes des animaux.*" Yet, in the zoological part of Humboldt's accurate work on South America, this learned author states, that the *Geotrupes Ægeon* of Fabricius is found "*à Chilo près de Quito sur des bouses de vache*[a]." Now, though a circumstance being thus mentioned in so celebrated a work might lead us to suppose that the insect is coprophagous, it may clearly be demonstrated from analogy, and particularly from the dissection of the parts of the mouth, that if such were the situation of *Dynastes Ægeon* when found, it could only be accidental. The texture indeed of the maxillæ, which are always corneous; the construction of the feet, which though strong are by no means dilated; the size of their tarsi and ungues, and their comparatively small pectus, forbid us to suppose that any of the family of *Dynastidæ* can be coprophagous.

There is, however, a curious distinction, to which we have before alluded, existing between certain insects of the family of *Dynastidæ;* namely, the maxillæ being dentated in some species and unprovided with teeth in others. These last are most known to entomologists, from the *Oryctes nasicornis,* which is their best type, being very common in tan-beds and rich vegetable mould on the continent; but more especially from the celebrated Swammerdam having early made this animal with its larva the object of very detailed and accurate anatomical researches.

Degeer mentions that in shifting a dungheap at Stockholm, which had remained so long on the same spot as to

[a] *Voyage de Humboldt et Bonpland. Observations de Zoologie et d'Anatomie comparée.* Vol. 1. p. 182.

have been entirely changed into a rich mould, he one day dug out a prodigious quantity of the larvæ of *Oryctes nasicornis,* accompanied by specimens of the perfect insect. We see therefore that the unarmed maxillæ suit very well with the consistence of the substance which this species has chosen for its food. But do all the *Dynastidæ* live in the same manner? This is a question that in the present state of the science cannot be answered. It is possible that those which are provided with teeth to their maxillæ have to act on harder materials than the rich mould or soft tan on which the *Oryctes* lives. It may be that the genus *Dynastes* is truly lignivorous, or at least feeds on wood and other vegetable matter when in a less decomposed state than seems suitable for the insects with unarmed maxillæ. But these are points yet to be determined; and certainly are more interesting, more worthy of examination, and more likely to advance the cause of the science, than the simple discrimination of species and synonyms.

The *Dynastidæ,* though a numerous family, are by no means equably dispersed over the globe; Europe containing only three or four species, whereas on the other hand the torrid zone is pestered with these insects, formidable however rather from their size than from any noxious qualities. I have calculated the proportion of species from countries within the tropics to be to those from without about 8 : 1. and there is reason to believe that this estimate comes very near the truth.

Some insects of this family approach excessively close to the thalerophagous circle, as will be seen by the anatomical details in the Appendix. In fact, it is no easy matter to distinguish the *Dynastidæ* from some of the *Anoplognathidæ* and *Rutelidæ:* but the best distinctive marks will probably be found in the exserted labrum of the *Anoplognathidæ*, and in the transverse suture of the clypeus and porrect sternum of the *Rutelidæ*; one or other of which characters is always observable in such insects as are most likely to be confounded with the *Dynastidæ*.

On the whole then, the preceding descriptions indicate the existence of a circular group consisting of five families, the colour of which is almost always lurid or black. The insects composing this group have the clava always short and thick, with a number of articulations to the antennæ, which varies from eight to eleven. Their feet are always robust, and the ungues of their tarsi, when they exist, are undivided. Such are the few vague circumstances which, together with the nature of their food (which is invariably in a state of putrescence or decomposition), are almost all the external characters that can be ascribed to the Saprophagous *Petalocera*.

CHAPTER VIII.

ON THE FIVE FAMILIES OF PETALOCERA WHICH FEED ON GREEN OR LIVING VEGETABLE MATTER.

THE Thalerophagous *Petalocera*, as far as has yet been observed, have never more than ten joints or less than nine to their antennæ; so that they possess neither so many or so few as some of the insects which compose the other circle. The clava, which is always rather elongate, except in a few insects of the family of *Glaphyridæ*, is here often composed of more than three joints, which we have never seen to be the case with the saprophagous insects. The feet are also in general less robust than in the last circle, but in the families of *Rutelidæ* and *Anoplognathidæ* they sometimes arrive at an enormous size[a]. The ungues of the tarsi are also often divided; and the insects on the whole are of a gay appearance, generally possessing much metallic splendour.

Fam. VI. RUTELIDÆ.

Antennæ[b] *decem-articulatæ ;*

[a] Such is the case with the famous Kanguroo Beetle (*Scarabæus Macropus*, Francillon; *Cetonia Macropus*, Kirby) and the *Melolontha chrysochlora* of Humboldt, the natural situation of both which insects is between the types of the *Rutelidæ* and *Anoplognathidæ*.

[b] If the genus *Hexodon* should, as is stated by Olivier, really possess

Articulo basilari turbinato, parum elongato, septimo minimo pateriformi;

Capitulo 3-phyllo elongato.

Labrum *margine antico coriaceo, conspicuo, brevissimo, sæpius emarginato.*

Mandibulæ *corneæ, validæ, subcompressæ, plerumque exsertæ, latere externo eminulo, sæpius crenato aut dentato.*

Maxillæ *corneæ, ad apicem dentatæ, latere interno interdum membranaceo, ciliato.*

Palpi maxillares, *articulo ultimo subcrassiore.*

Palpi labiales *breves.*

Mentum *planum, subovatum, versus apicem paulo coarctatum, apice truncato, sæpius emarginato, ad angulos dilatato.*

Caput *subtrigonum aut subquadratum, nunquam cornutum.* Clypeus *suturâ vix distinctâ, margineque reflexo.* Corpus *subconvexum aut depressum, ovatum; Elytris abdomen postice haud occultantibus.* Thorax *transverso-quadratus; Scutello semper distincto.* Sternum *antice productum.* Pedes *robusti, femoribus posticis interdum incrassatis; tarsorum unguibus divisis aut indivisis.*

Observations.

The *Rutelidæ* are, on account of their structure and use in connecting the other families, perhaps the most interesting of the *Petalocera*. How great their affinity is to the

eleven joints to the antenna, it will form a remarkable exception to the rule followed in the structure of the rest of the family. But as Latreille says that there are only ten joints, I have not thought proper to take any notice of Olivier's opinion in the above general characters of the family.

Dynastidæ has been already shown; and if our attention be transferred to the thalerophagous insects, we shall also experience no trifling difficulty in the attempt to separate them from the *Cetoniidæ* and *Anoplognathidæ*, but especially from the latter. In fact, the principal distinction that I have observed to exist between these families is, that the mandibles of the *Rutelidæ* are generally prominent, whereas those of the *Anoplognathidæ* are concealed beneath the clypeus; the maxillæ of the latter are also more obtuse than those of the former family, which are always sharply dentated at the apex. With respect to the *Cetoniidæ*, their membranaceous mandibles form an obvious and easily seized character of separation. It is indeed not a little curious, that while we observe among the *Rutelidæ* and *Geotrupidæ* that such genera as *Macraspis* and *Athyreus* approach so nearly in habit and general form to the respective families of *Cetoniidæ* and *Scarabæidæ*, there should still be the same parallel distinction kept up in both circles with respect to the texture of their mandibles.

The *Rutelidæ* may be said to have been first indicated by Olivier, who formed his third division of *Cetonia* of such insects as those composing the new genera *Macraspis* and *Chasmodia*. This excellent entomologist remarked that they appear to connect *Cetonia* with *Melolontha*, but in some respects to approach nearer to the last. This hint was considerably improved upon by Latreille, who united with the above insects the *Melolontha 6-punctata*, Fab., and gave to the whole the generic name of *Rutela*. In the *Histoire Générale des Insectes et des Crustacés*, M. Latreille also observes that the *Rutelæ* have the palpi, maxillæ and mentum of *Melolontha*, with the labrum of

Cetonia, and the mandibles of *Dynastes*; but notwithstanding, in his later works he places them at a distance from *Cetonia*; so that, if this order of distribution be natural, these insects would appear to have a greater affinity to *Glaphyrus* than to the *Cetoniidæ*. But it requires only the slightest examination to perceive that the *Rutelidæ* form a point of union for the families of *Melolonthidæ*, *Anoplognathidæ*, and *Cetoniidæ*, and that they come excessively near to the *Dynastidæ* in the true genus *Rutela*, of which the type is *Rutela lineola*, Lat.

The *Rutelidæ* may perhaps vie with the *Cetoniidæ* for beauty, and certainly exceed them in metallic brilliancy. They are peculiar to the new world, with the solitary exception of *Hexodon reticulatum*[a] Oliv.; of which however neither the country nor the natural situation in the system is as yet accurately determined. Out of upwards of eighty species of this family in my father's collection, I only know two or three from without the tropics, and none from higher latitudes than 40°.

No observations have hitherto been made on their manner of living; but analogy would induce us to conclude that it must be intermediate between that of a *Cetonia*, which feeds on flowers, and that of a *Melolontha*, which feeds on leaves.

Fam. VII. CETONIIDÆ.

Antennæ *articulis decem glabris, ante oculos vix sub clypei latere insertæ;*

[a] *Hexodon unicolor* of Olivier and Fabricius appears to be only a variety of *H. reticulatum*.

Articulo basilari, magno, crasso, deflexo, tuberculiformi;
Capitulo 3-phyllo, ovato, longitudinem antennarum totam præter articulum basilarem æquante.

Labrum *membranaceum, clypeo absconditum, aut vix prominulum, margine antico ciliato, emarginato, lateribus rotundatis.*

Mandibulæ *compressæ, tenues, lanceolatæ, membranâ subquadratâ intus auctæ, hujus latere externo producto et basi vix corneis vel corneis.*

Maxillæ *corneæ, subtrigonæ, latere interno membranaceo, ciliato; processu terminali integro, sæpius compresso, setoso, fimbriâve hirsuto, laciniâve instructo.*

Palpi maxillares *articulo ultimo aliis longe majore, elongato.*

Palpi labiales *menti lateribus excavatis inserti, articulis duobus baseos brevibus.*

Mentum *et* Labium *connata, emarginato-bifida.*

Caput *quadratum, rarissime cornutum, clypei lateribus sæpius parallelis, diametro longitudinali et transverso æquatis aut illo majori; oculis prominulis vix clypeo insertis sed illi affixis.* Corpus *ovatum, sæpius depressum, semper planiusculum.* Thorax *forma irregulari;* *Scutellum sæpius distinctum.* Sternum *sæpe productum.* Pedes *graciles.* Tarsi *unguibus æqualibus, acutis, indivisis.*

Observations.

The membranaceous texture of the mandibles and maxillæ of the *Cetoniidæ* proves that these insects in the perfect state are intended to live on vegetable juices. Thus the *Cetonia Morio*, Fab., and probably many others of the darker-coloured species are often to be found regaling themselves with the sap which flows from the wounds of trees; while *C. aurata*, F. with its more brilliant companions is only to be found on flowers.

Olivier united the Fabrician genus *Trichius* with *Cetonia:* and if indeed the state of the science at that time be taken into consideration, this arrangement was rather an improvement than otherwise; for the genera were few into which the *Petalocera* were then divided; and *Trichius* is so intimately allied to *Cetonia*, that with the early entomologists nothing could apparently be more useless than the institution of the genus, or more artificial than the principles upon which this institution was founded. Since the publication, however, of Olivier's work the science has made rapid progress, and *Trichius* may now with safety be regarded as a natural group of the *Cetoniidæ*, containing several genera, the institution of which is become necessary from the number of species that have of late years been added to our lists. That *Trichius* is a natural group is sufficiently clear from the larvæ of this genus living in putrescent wood, an economy in some measure different from the little that is known of *Cetonia*, and indeed from all we are acquainted with in the history of the other Thalerophagous *Petalocera*. The *Trichii* conduct us, almost without interruption, to the form of the *Glaphyridæ*, and it is not by any means unlikely that the habits of these two groups may in some respects approach nearer to each other than those of the first-mentioned insects and of the other *Cetoniidæ*. This family however may be distinguished from the *Glaphyridæ* by having their labrum concealed under the clypeus, whereas these last have it exserted and very prominent.

It has been already remarked, that while some *Scarabæidæ* are the only insects in the saprophagous circle which possess the porrect sternum of the *Cetoniidæ*, so some of the latter family are the only insects of the thalerophagous column which have their scutellum indistinct like many of the coprophagous insects. Again: if the *Scarabæidæ* are particularly remarkable among the petalocerous insects for the horns or inequalities on their clypeus and thorax, they have in this respect also an analogous relation to the *Cetoniidæ*, which form almost the only family of the thalerophagous circle as yet discovered that can boast of such peculiarities. On this account the genus *Goliathus* merits our attention; as we find that here the inequality of the clypeus constitutes a distinctive mark of the sexes as among the *Scarabæidæ*. The excavated or subcornuted thorax so common in the genus *Copris*, appears to be very rare with the *Cetoniidæ*: but even of this an example is afforded by *Cetonia cornuta*, Fab.; a singular insect from the Cape of Good Hope, which I have good reasons for believing to be the same species with the *Scarabæus Arcas* of Olivier!

The *Cetoniidæ* are in general very gay insects, as to colour; but rarely, if ever, can they be said to possess much metallic brilliancy, yielding in this respect to several of the *Rutelidæ*, *Glaphyridæ*, and *Anoplognathidæ*. Nothing however can exceed the beauty and lustre of the polish or the admirable variety of ornament with which their elytra are adorned. The larvæ live in the fattest vegetable soils: but notwithstanding the excellent observations of Degeer, much remains to be performed towards the elucidation of this part of their history.

It is difficult to collect sufficient data for the establishment of the geographical proportions of this family. It may nevertheless be observed, that there appear to be many more species within the tropics than there are without; and that the *Cetoniidæ* with a lobate thorax seem, with one or two exceptions only, to be all inhabitants of the new world.

Fam. VIII. GLAPHYRIDÆ.

Antennæ *decem-articulatæ, ante oculos sub clypei latere insertæ;*

Articulo basilari trigono, pilis longissimis instructo; Capitulo triphyllo sæpius subgloboso.

Labrum *exsertum, crustaceum, transverso-quadratum, margine antico recto lineari.*

Mandibulæ *dilatatæ, corneæ, absconditæ, aut saltem vix prominulæ, latere interno coriaceo vel membranaceo.*

Maxillæ *processu externo membranaceo aut coriaceo, interdum multidentato, sæpius elongato et hirsuto, Cetoniidarum illum simulante; processu interno corneo dentato.*

Palpi maxillares *hirsuti, articulo ultimo reliquis majori.*

Palpi labiales *fere eadem longitudine quam maxillares.*

Mentum *hirsutum, subquadratum, vix emarginatum.*

Caput *veluti in Cetoniidarum familiâ, clypeo integro, quadrato, margine reflexo. Oculi clypeo cincti.* Corpus *ovatum, depressum, squamosum vel pilosum, elytris plerumque ad apicem dehiscentibus, abdomine brevioribus.* Thorax *subquadratus aut suborbiculatus; Scutello distincto.* Pedes *longi, femoribus posticis interdum incrassatis; Tarsi elongati* *spinosuli, unguibus anticis æqualibus, indivisis, posticis interdum solitariis.*

Observations.

All the *Glaphyridæ* yet known are confined to the old world, and within zones of 25 degrees breadth on each side of the tropics: at least no insect of this family has as yet been discovered within the tropics, nor have any been brought from higher latitudes than 45°. Though by no means composing a numerous family, they are interesting from the obvious parallel they afford to the *Aphodiidæ*, in their change from membranaceous mandibles to those of a more solid texture. The membranaceous process of the maxillæ, exserted labrum, and subquadrate clypeus, will serve to distinguish them easily from the *Melolonthidæ*, with which they have a most obvious connexion. These insects all appear to frequent flowers. Pallas is the entomologist who has made the most accurate observations on them: but little can be extracted from his remarks, except that the *Glaphyridæ* would seem principally to be vernal insects, and that many of them are fond of the liliaceous flowers, which are with us but rarely if ever attacked by coleopterous insects. Professor Pallas likewise says, that it is very probable that the larva of an insect of this family lives on the bulbs of the tulip, but gives no reason for this opinion.

These insects from the hairiness of their bodies must be very useful in promoting the fecundation of plants, and may in their native climates fulfil the same functions which are in this country performed by several *Hymenoptera*. The *Cetoniidæ*, or perhaps these, which are spring insects and very common in Greece, appear to have been the Μηλολάνθη of the ancients, a name which Fabricius erroneously applied to other insects which are hardly ever seen on flowers. Eustathius describes the Μηλάνθη or Μηλολάνθη or Μηλολόνθη (for it had all these names) as an animal larger than a wasp, and so called either from its being produced ἐκ τῆς μηλεῶν ἀνθήσεως, or from its flying about fruit-trees when they begin to flower. Were the attempt to determine an insect from so vague a description justifiable, I should say that in all probability the Μηλολόνθη of the ancients was the *Trichius fasciatus* so common over all the continent. This is a vernal beetle constantly on flowers, which flies exactly like an hymenopterous insect[a], and might easily be compared with a wasp in point of colour and marking, as well as in size, by a more experienced observer than we can suppose Eustathius to have been. Indeed, I hardly know a coleopterous insect that would more readily be compared with a wasp than the *Trichius fasciatus*. Nevertheless Mouffet, who assembles together all the various opinions of his day with the classical authorities on this subject, thinks that the ancient *Melolontha* was a green insect with a metallic lustre, and thus refers the name to *Buprestis sternicornis* and *B. Chrysis*, which he supposes to be male and female of the same species. But these insects being natives of India, it is very unlikely that the Greeks should have had a name for them, and above all that they should have derived this name from their manners. Besides, the true *Melolontha* was not

[a] "Pendant le jour ils sont d'une grande agilité, et ils s'envolent alors avec facilité; c'est à dire, qu'ils sont toujours prets à voler; il leur faut três peu du temps pour ouvrir les étuis, au lieu que d'autres Scarabées balancent long temps avant que de prendre essor." Degeer, *Mémoires des Ins.* vol. iv. p. 300.

only a native of Greece, but Hesychius and the Scholiast on Aristophanes both positively state that it was of a yellow or gold colour.

Fam. IX. MELOLONTHIDÆ.

Antennæ *articulis novem vel decem;*
Articulo basilari conico, elongato;
Capitulo elongato, lamellis pro generibus et sexu numero variis a tribus ad septem.

Labrum *margine antico obvio, aut tenui et lineari transverso, aut crasso tum infra profunde emarginato.*

Mandibulæ *corneæ, validæ, clypeo absconditæ, crassæ, subarcuatæ, formâ valde irregulari, lateribus externis sæpius rotundatis.*

Maxillæ *breves crustaceæ, intus arcuatæ, processu corneo dentibus munito.*

Palpi maxillares *prominuli, articulo ultimo ovali aut ovato, paulo crassiore.*

Mentum *veluti e duplici parte formatum, aliâ apicali, subquadratâ aut subovatâ truncatâ, ad apicem angustiori, margine supero late emarginato, ad angulos rotundato; aliâ basilari, prioris stipite, subcordatâ, apice truncato.*

Caput *subquadratum; clypei suturâ transversâ semper distinctâ, lateribus rotundatis, margineque reflexo.* Corpus *subconvexum ovatum; Elytris abdomine brevioribus.* Thorax *transversus, subquadratus; Scutello distincto.* Sternum *rarissime productum.* Pedes *graciliores.*

Observations.

This family I had once proposed to name *Sericidæ*, because the type is not *Melolontha vulgaris*, but *M. brunnea*, Fab., forming a genus analogous to *Trox*, and which I have separated from the Fabrician genus *Melolontha* under the name of *Serica*. As, however, it is desirable that the families should be designated after well known genera, the term *Melolonthidæ* has been adopted in preference to the new name now given to the real type of the family. The *Melolonthidæ* are the least brilliant of the Thalerophagous *Petalocera*, and in this respect, as well as their subglobose convex form, compose an excellent parallel to the *Trogidæ*. Another interesting analogy is, that of all this circle the *Melolonthidæ*, as far as we know their history, seem to frequent sandy soils the most; but of this disposition the best example will be afforded by the insects composing Latreille's 3d division of *Melolontha*, which are in fact the types of this family. We have already shown how they may be distinguished from the *Glaphyridæ*; and it remains therefore only necessary to state their principal difference from the *Anoplognathidæ*, which consists in the triangular labrum, plane mentum, extended sternum, and thick strong feet of these, in opposition to the emarginate or subemarginate labrum, inflected mentum, rarely produced sternum, and slender feet of the *Melolonthidæ*.

The present family consists of insects some of which are the most common and most destructive of *Coleoptera*: nevertheless, little is known as yet of their economy, and still less of their internal anatomy. They are found in every climate: but whether it be owing to any peculiar indecision with respect to the family, or to any other cause, I have not yet been able to collect data of sufficient importance to be the foundation of any attempt to discover the rules of their distribution in nature. The *Melolonthidæ* as well as the *Glaphyridæ* are remarkable for hirsute or scaly elytra. This peculiarity even appears to have been one of the earliest entomological observations of Linnæus, who in his *Animalium Specierum in Classes, Ordines, Genera, Species, methodica Distributio*[a], makes the following remark: "*Scarabæorum larvæ vivunt tranquillè sub terrâ: harum pleraque fimo delectantur, et eo pascuntur. Hirsutorum Larvæ sub radicibus plantarum degunt et easdem consumunt; at Volatiles foliis arborum pascuntur.*"

But one of the most constant characters of this family, and which is indeed peculiar to it with the *Anoplognathidæ*, is the transverse suture which divides as it were the clypeus into two parts just before the eyes. This character is worthy of attention, as it will serve to distinguish easily the saprophagous and thalerophagous circles from one another even at the point where they approach the nearest. Thus the *Dynastidæ* have not this suture, whereas in the *Anoplognathidæ* it is most evident, and can moreover be traced without any difficulty throughout the greater part of the neighbouring family of *Rutelidæ*.

Fam. X. ANOPLOGNATHIDÆ.

Antennæ 9- *vel* 10-*articulatæ;*

Articulo basilari elongato, conico; secundo subgloboso; septimo pateriformi brevissimo;

[a] Ed. Lugduni 1755, p. 113.

Capitulo 3-phyllo elongato, ovato.

Labrum *exsertum, trigonum, antice medio productum.*

Mandibulæ *subarcuatæ, corneæ, validæ, apice sæpius subemarginatæ.*

Maxillæ *mandibuliformes, subarcuatæ, corneæ, dentatæ vel inermes, sæpius edentulæ.*

Palpi maxillares *subclavati.*

Palpi labiales *breves, articulo extimo subovato.*

Mentum *subtransversum planiusculum, medio sæpius producto, basi palpigerum.*

Caput *semicirculare aut subquadratum;* Clypeo *suturâ transversâ distinctâ.* Corpus *ovatum.* Thorax *transversus, subquadratus; Scutello distincto.* Sternum *sæpius productum.* Pedes *robusti, femoribus posticis interdum incrassatis.*

Observations.

This family derives its name from an Australasian genus nstituted by Dr. Leach, and which appears to be the type of the family. The triangular labrum, mandibuliform maxillæ, and singularly acuminate mentum, will of themselves be sufficient to indicate what other genera ought to be associated with *Anoplognathus* to form the family. At the same time due regard ought to be paid to the modifications which these several characters may undergo in different genera. But though the *Anoplognathidæ* will thus be found to be composed of a number of very distinct insects, no additions have yet been made to the original genus, with the exception of Mr. Kirby's remarkable genera *Geniates* and *Apogonia*.

The external appearances by which the sexes of insects are distinguishable from each other, though not forming a *convenient* test of the accuracy of a method of classification, compose nevertheless a field of discovery well worth the trouble of exploring. With the *Melolonthidæ* this difference is principally observable in the form of the clypeus and the antennæ, which often undergo modifications which vary in the sexes. In the *Anoplognathidæ*, on the other hand, the antennæ cannot be considered as presenting the most obvious distinction between the appearance of the sexes, though this may still chiefly consist in some organ or process of the head. Thus in the first division of the genus *Anoplognathus*, the clypeus of one sex is porrect and subquadrate, with the anterior margin reflexed, subtruncated and wider than at the base; while in the other sex the clypeus, though its anterior margin be still reflexed, forms a sort of semicircle attached by the suture to the frons. In the second division, that is, in Dr. Leach's proposed genus *Repsimus*, this sort of distinction becomes less apparent, and is replaced by a difference in the size of the posterior tibiæ. In others of the *Anoplognathidæ*, as the genus *Geniates* of Mr. Kirby, the male is distinguished by a stiff pencil of hairs affixed to the mentum, which is thus in a manner bearded, while the anterior tarsi are dilated. This dilatation of the anterior tarsi is a character not only wanting in the female of *Geniates*, but also in all the other petalocerous insects which have come under my inspection.

If we may judge from the singularity of their structure, the economy of these insects must be very remarkable. Their thick robust feet form indeed so great a contrast to those of the Thalerophagous *Petalocera* in general, that we are led to conjecture a proportionate difference in their manner of living. The *Anoplognathidæ* are, however, evidently phyllophagous; and I am inclined to believe that the larvæ of some of these insects are the New Holland *grubs*, said to be as useful to the natives as an article of food as they are injurious to the agricultural hopes of the European settlers. In this vast island and in South America the *Anoplognathidæ* are very numerous, and appear to take the place occupied in the old world by the *Melolonthidæ*. They are also (though not so plentifully) found in Europe and Asia, but on the whole appear never to recede farther from the equator than about latitude 45°. It may be proper here to mention that Mr. Kirby's genus *Apogonia*, which belongs to this family, and which he suspects to be South American, is ascertained from specimens in the cabinet of the Linnæan Society and in that of my father to belong to the East Indies.

CHAPTER IX.

CONCLUDING REMARKS.

CHARACTERS for the ten families of *Petalocera* more detailed than the preceding may perhaps have been expected of me; but to keep the middle path between a too copious and too meagre description of a natural group is perhaps one of the most difficult tasks that can be imposed on a naturalist. If brevity be aimed at, and the family be sketched in few words, objects however unlike its type are necessarily admitted, and confusion is the unavoidable result. If on the other hand the characters become numerous, there is a constant danger of something being excluded from its natural situation; because in proportion always to the number of details in the description is the liability of such to exceptions. In acknowledging however my inability to make the descriptions of the families more precise, I am led to imagine that this inability proceeds from a cause inseparable from the nature of the subject, and in a great degree independent of myself. So far then from laying any claim to the merit of precision, I could even wish, in offering the above characters to entomologists, that some expression implying doubt were prefixed to each. In describing species, each of which Nature has manifestly insulated, a failure in precision denotes an inability to seize their characteristic marks;—it is in short a glaring fault: but where, on the other hand, no distinct lines of demarcation have been imposed, as for instance, at the limits of families, the arrangement ought to be viewed with suspicion, according as the descriptions become precise. Let the family of *Geotrupidæ* be examined; it is the only one of the ten foregoing families which seems to have hitherto occurred to entomologists. Olivier first made it a division of his *Scarabæi;* Fabricius termed it a genus, and Latreille a family: it may therefore be considered as peculiarly distinct, having so early attracted the notice of such celebrated naturalists. Let us, I repeat, take the most obvious characters that have been proposed for this family, and examine whether they will apply to all the insects which properly belong to it. It may indeed be urged that if any insect does not conform to the characters laid down for the family, it cannot with accuracy be referred to it; but little ingenuity is requisite to perceive that such an argument amounts to the forcing of Nature to comply with the rules of an artificial system. The general habit and appearance of a nondescript species may leave not a shadow of doubt as to its true place in the order of existence; and nevertheless it may not agree with all the characters given by systematists to its real family. Those laid down by Latreille for the *Geotrupini* are excellent, and so far natural as they relate to the specimens which he had examined or even seen; but there are insects which belong to the family, and which nevertheless prove that almost every one of these characters ought to be considered as liable to exception. If, however, Latreille's descriptions be looked upon only as forming a type of construction to which these anomalous insects approach in a greater or less degree, we shall then be compelled to do honour to the ingenuity which could elicit characters so marked from such endless varieties of form. Still, it is not the distinct scutellum that constitutes the family of *Geotrupidæ*, for in the genus *Athyreus* this organ is not visible; nor yet are the exsert mandibles a distinctive character, for in *Elephastomus* they are concealed. Even if the antennæ be characterized as 11-jointed, genera such as *Hybosorus* and *Orphnus* occur having only ten articulations, or at least having the eighth joint indistinct and almost obsolete. Yet *Elephastomus, Athyreus, Orphnus,* and *Hybosorus,* have all the general habit and characters of the *Geotrupidæ*. In short, such is the variety of structure that I fear no solitary character can be considered as constant; and I can only say of the maxillæ, that they have been found less variable than other parts of the insect. As for the above characters which I have ventured to propose for the families, they could only be drawn from such insects as I had the means of dissecting; and it therefore may be anticipated, notwithstanding all the care bestowed on the designation of these groups, that insects will soon occur to prove that in this respect I am as subject as any of my predecessors to the charge of inaccuracy.

Families are then evidently artificial; that is, they are in the present state of the science considered natural only so far as they may be secluded from the rest by chasms which we are by no means to suppose to have been left by Nature, but rather to be the necessary result of our imperfect knowledge of species. Thus the *Cetoniidæ* seem at first sight to be a most natural family; but how near do we observe the *Glaphyridæ* to approach them?—nay, it is almost impossible to determine where a chasm occurs in the links which lead us on through the families of *Melolonthidæ*, *Anoplognathidæ*, and *Rutelidæ*. If then between the genus *Chasmodia* and the nearest genus to it of the *Cetoniidæ* a greater chasm than usual should occur, why should we conclude that the Creator has left the chain at this place imperfect?—This question is the more forcible, as Nature is plainly here proceeding towards the general habit of the *Cetoniidæ*; which indeed is evident as well from the place ascribed by Fabricius and Olivier to the modern *Rutelidæ* in their respective systems, as from that sort of bifid clypeus and labrum which is peculiar to *Chasmodia*, finding no parallel among the Thalerophagous *Petalocera* except in the family of *Cetoniidæ*[a].

If the families in the other circle and among the *Rectocera* are apparently more natural, that is, in the common acceptation of the word, more easily and precisely defined, it is only because there the natural chain is more imperfect, and the chasms more frequent. Yet it is remarkable how, as our knowledge of species is advanced by the labours of collectors, even these apparently natural (or more properly speaking, artificial) families are confined or encroached upon by newly discovered species. The genera *Elephastomus* and *Athyreus*, already alluded to, are proofs of this; why then may not an insect yet occur with membranaceous mandibles, of which it may be difficult to say whether it ought to be ranged with the *Geotrupidæ* or the *Scarabæidæ*?

In proportion as the chain of organized beings becomes more complete in a particular family, it is easy to see that there must be greater difficulty in its subdivision; and it is on this account that in the families which are considered to be the most *natural*, the difficulty of making what are termed *good* or *natural* genera is the

[a] *Cetonia Brownii.* Kirby *Trans. Linn. Soc.* vol. xii. p. 465.

greatest. It is not that several very distinct peculiarities of structure which might lead at once to generic characters are not to be observed in certain species of the family; but then, unfortunately for a certain class of naturalists, each of these peculiarities is so gradually shaded off into some one of the others, that it is impossible to fix accurately the place where any of them absolutely ceases. A strange paradox is the consequence; namely, that in those very places where Nature is most perfectly displayed to our view, she is often thought to be the most difficult to comprehend.

It has moreover been no little misfortune to the science that the study of exotic insects should have been comparatively neglected. The common saying, that we ought first to be well acquainted with our own indigenous insects before we meddle with exotic, is erroneous, inasmuch as to comply with it is impossible. It has led to notions of natural genera and natural families[a], that depended more on the extent of the cabinets and collections studied by the ento-

[a] "Dispositio insectorum sistit divisiones sive conjunctiones eorum; et est artificialis quæ classes et ordines, vel naturalis quæ *genera*, species, et varietates docet." *Phil. Ent.* 78.

Linnæus falls into the same mistake, when he says "Classis et ordo est sapientiæ, genus et species Naturæ opus." *Syst. Nat.* i. 13.

It is curious to observe the inconsistencies into which the most sagacious men are led by erroneous opinions. Fabricius, after having laid down as above that *genera* are natural, thus defines them: "Genera tot sunt quot similiter constructa instrumenta cibaria proferunt diversæ species naturales." *Phil. Ent.* 80. From which it must evidently follow that the *instrumenta cibaria* afford natural characters. Yet soon after he says, "Dispositionem artificialem a solis instrumentis cibariis desumpsimus." *Phil. Ent.* 85. That is, from the very organs that he had previously made to afford characters proper for a natural classification!

mologist than on any distinctions made by Nature. He indeed, who flatters himself with the idea that the families, tribes, genera, and sections, which he has laid down on paper are so many natural *divisions*, can only be compared to the person who, because he may find the meridians and other circles of an armillary sphere convenient for the division of the heavens, should therefore imagine that they must exist in nature. In one and the other case artificial modes of distribution are resorted to, which, however ingenious in themselves, are but sad proofs of the limited state of our faculties, when we consider that without such instruments the vastness and sublimity of the Creation cannot be comprehended.

But it may be objected, that since families are artificial there ceases to be a farther use for them in any system professing to be natural: the same however may be said of genera, which, when they are not osculant, experience proves to be even more artificial than families:—yet of what astonishing service has the institution of genera been to our knowledge of the creation[a]! It is not the use of families or genera that is hurtful to science, but the bending of Nature to enter by force into these several divisions of our own invention, which we are always induced to do the moment we deceive ourselves and imagine them to be natural.

The foregoing families I do not offer therefore as groups precise and well defined; nay, such I conceive it impossible to make: but if they can be imagined as each containing a peculiar type of formation, to which all in it are in some

[a] It will however be easily seen from the foregoing pages, that I by no means subscribe to the doctrine, that "generum characteribus fixis tota nititur scientia entomologica." *Phil. Ent.* 88.

degree assimilated, though subject to various shades of difference that at length lead them into a neighbouring family, this idea will perhaps be found more consonant to what is observed in nature than any other which can be proposed. It was with this view of the subject that I endeavoured to discover the types of formation, or to pitch upon such insects as seemed to possess a peculiar construction, to which all the others more or less approached. The attempt seemed so far useful, as it might lead a person without possessing a collection for study, to acquire a very perfect idea of all the various forms of *Petalocera* which were likely to occur to his notice. And it was accordingly imagined that they might be represented by some of the most familiar insects as follows:

Geotrupes stercorarius, *Lat.*	Rutela lineola, *Lat.*
Scarabæus sacer, *L.*	Cetonia aurata, *F.*
Aphodius Fossor, *F.*	Amphicoma hirta, *Lat.*
Trox sabulosus, *F.*	Melolontha brunnea, *F.*
Oryctes nasicornis, *Illig.*	Anoplognathus viridiæneus, *Leach.*

There are few collections so poor as not to boast the possession of these ten insects, an intimate acquaintance with which is all, I venture to affirm, that is requisite for a general knowledge of the structure of the *Petalocera*[a]. At the same time as only five of them are British, it may be well to observe how necessary for the entomologist is the study of exotic insects.

It only remains, by way of conclusion, to say a few words on the principal objections that may be brought against the preceding observations. 1st, That though characters

[a] It is to be observed that no account is made here of osculant genera.

drawn from the organs of manducation may be natural, yet from their minuteness they are not easily seized, and require too much time for study. 2dly, That the principles of arrangement here laid down are too difficult for general adoption.—To the first of these I shall only reply, that in botany microscopical dissections of a much more minute and difficult nature are often practised, and have led to the most curious and satisfactory results. And to the second objection I cannot answer better than in the terms of an illustrious botanist[a], who has lately discovered something in the disposition of the natural family of the *Compositæ* analogous to what I have observed in the *Petalocera*.

" *Quand on se propose de faire une classification naturelle, il faut avant tout se résigner à voir la Nature absolument telle qu'elle est, et non pas telle que nous la disposerions pour la commodité de notre étude. Cette réflexion suffit pour réfuter toutes les objections qui ont été faites contre notre travail.*

" *La multiplicité de nos tribus, la minutie et l'équivoque de leurs caractères toujours difficiles à observer, et souvent réduits à des nuances indécises, enfin l'impossibilité d'approprier cette méthode de classification à l'usage habituel dans la pratique ordinaire de la botanique ; tous ces défauts ou plutôt tous ces inconvéniens ne sauroient nous être imputés s'ils résultent nécessairement de la nature même des*

[a] *Dict. des Sciences Naturelles*, Art. *Composées.*—Soon after I had explained the curious developement of the Lamellicorn insects in circles to my friends Dr. Leach and Mr. Ritchie in Paris, a number of the new *Dictionnaire des Sciences Naturelles* appeared, in which the latter gentleman pointed out to me M. Cassini's *tableau*. This however, though I am not botanist enough to understand it fully, seems to have been drawn up on the first slight and very imperfect glimpse obtained of the remarkable disposition of Nature.

choses. En conclura-t'on qu'il faut renoncer à classer naturellement les Synantherées et s'en tenir à une classification artificielle? Nous répondrons avec M. de Mirbel (Elémens de Botanique) *que le but que se propose le botaniste est moins de rendre la science facile, que solide, profonde et vaste.*"

APPENDIX.

Genera Entomologica ad animadversiones præcedentes illustrandas, necnon quædam nova ad naturalem Petalocerorum ordinem detegendum nunc primum constructa.

COLEOPTERA, Herbivora antennis clavatis, capitulo plerumque triphyllo; pedibus fossoriis, tibiis extrinsecùs dentatis vel spinosulis, duobus anticis præsertim; tarsis plerumque pentameris.

Observatio. Divisio fere artificialis, et nisi quod commoda sit vix retinenda.

I. RECTOCERA.

Antennæ quasi fractæ capitulo haud flabellato. *Mandibulæ* valde exsertæ.

Obs. Familiarum Synopsi haud elaboratâ, opus volui minimè ingratum amicis peritioribus committere. Multa vero tentamini obstant, quæ vel specierum cognitarum e paucitate vel e discrimine sexuali, in his quàm difficili, orta sint.

A. *SAPROPHAGA.*

Hister, *Linn.* Histeroides, *Gyllen.* Histeridea, *Leach.*

Antennæ sæpius undecim-articulatæ, clavâ triphyllâ, compactâ. Elytra abdomine breviora. Caput sæpius parvum, retractum.

Obs. Confer Paykullii et Leachii Monographias, hanc ad genera cognoscenda, illam ad species determinandas necessariam.

B. *THALEROPHAGA.*

Lucanus, *Linn.* Lucanides, *Lat.* Lucanoides, *Gyllen.* Prioceri, *Dum.*

Antennæ sæpius decem-articulatæ; Capitulo pectinato, fissili, vel subserrato vel subcompacto.

Elytra abdomen obtegentia. Caput magnum, exsertum.

Rectocerorum Thalerophagorum Generum Synopsis.

Familiæ.	*Characteres.*			*Genera annectentia.*	*Genera osculantia.*
1. Lamprimidæ.	Maxillæ elongatæ.			Pholidotus.	
	Maxillæ breves	Antennarum capitulo pectinato.		Ryssonotus.	
		Antennæ subclavatæ.		Lamprima[a].	
				* * * *	
2. Aesalidæ.	....			Æsalus.	
				* * * *	
3. Syndesidæ.	....			Syndesus.	
				* * * *	
4. Passalidæ.	Antennarum capitulo 5-lamellato.			Paxillus.	
	Antennarum capitulo 3-lamellato.			Passalus.	
					Chiron, *Scolytidis affinis?*
5. Lucanidæ.	Maxillarum laciniâ internâ crustaceâ.	Maxillæ unco corneo instructæ.		Nigidius.	
		Maxillæ haud unco corneo instructæ.		Figulus.	
					Sinodendron, *Dynastidis affine.*
	Maxillarum laciniâ internâ membranaceâ.	Antennæ subperfoliatæ.	Mentum antice integrum.	Doreas.	
			Mentum antice emarginatum.	Ægus.	
		Antennæ capitulo pectinato.	Labium bifidum.	Lucanus.	
			Labium integrum.	Ceruchus.	
					Platycerus, *Trogositis affinis.*

[a] *Lethrus* genus osculans *Petaloceris* potius referendum.

Fam. LAMPRIMIDÆ.

Antennæ thorace breviores; articulo basilari elongato, conico, recto, tribus vel quatuor lamellis capitulum efformantibus.

Labrum penitus tectum vel deflexum.

Mandibulæ (maribus saltem) maximæ, intus hirsutissimæ, apice multidentatæ.

Labium bilobum, hirsutissimum; *Mento* subquadrato.

Corpus convexum vel convexiusculum; Caput thorace multo angustius. Thorax lateribus deflexis, elytris latior.

I. *Genus*. PHOLIDOTUS.

Antennæ articulo basilari aliis conjunctim fere longiore.

Mandibulæ (mari saltem) capite triplo longiores, apice incurvæ, dentatæ, intus serratæ, hirsutissimæ.

Maxillæ processu terminali elongato, ut in Lucanis penicilliformi.

Palpi elongati, gracillimi; Maxillares articulo tertio ultimo vix longiore.

Mentum hirsutissimum, subsemicirculare, labii lobis penicilliformibus.

Caput subquadratum, transversum, vix emarginatum. Corpus subdepressum, thorace quam in Lamprimis convexo, at sterno vix producto. Tibiæ anticæ extus serratæ, 6-dentatæ. Tarsi appendice sub unguium origine insertâ, elongatâ, ad apicem bidentatâ.

OBS. Instrumentis cibariis accurato examini etiamnum subjiciendis, diagnosis generica valde incerta est Pholidoto.

SPEC. 1. *Pholidotus lepidosus*.

P. atroferrugineus nitidus, squamulis argenteis confertissimè aspersus, tarsis nigris.

MAS mandibularum apice interno bidentato; Capite lineis duabus elevatis angulum formantibus.

Mus. D. MacLeay.

FEMINA hactenus incognita[a]?

Habitat in Braziliâ.

II. *Genus.* RYSSONOTUS.

LUCANUS, *Kirby.*

Antennæ articulo basilari aliis conjunctim vix longiore; capitulo pectinato, haud abrupte distincto.

Mandibulæ apice multi-dentatæ, dentibus tribus intùs instructæ.

Maxillæ breves, penicilliformes, vix ultra articulum Palporum secundum attingentes.

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[a] Insectum quoddam Braziliense genus novum forsan constituat, sed Pholidoto affinitate proximum videtur.

CASIGNETUS?

Antennæ articulis tribus ultimis clavam quam in Histeribus perfoliatam formantibus.

Palpi breves; maxillarium articulo secundo brevissimo.

Mentum transversum, semicirculare.

Caput trigonum Geotrupis singulariter illum simulans; Corpore thoraceque depressis. Sternum vix productum. Articulus tarsorum quintus ante ungues processu longissimo bifurcato armatus.

Spec. *Casignetus geotrupoides.* Anne Pholidoti femina?

C. fusco-violaceus, capite thorace elytrisque versus scutellum scabrosis, corpore subtus æneo squamis argenteis asperso.

Mas nondum detectus?

Femina mandibulis depressis, quam in Geotrupe stercorario acutis arcuatis.

Mus. D. MacLeay.

Obs. Insectum Lamprimis habitu proximum. Equidem nullus dubito instrumentis cibariis adhuc neglectis, et sexuali discrimine tantas difficultates obstante, quin genus proprium efformare vix habendus sit Casignetus. At nemini utinam displiceat, insectum quod ita benevolis entomologiæ cultoribus apertiùs manifestetur, hoc modo me nunc descripsisse.

Palpi elongati gracillimi; Maxillares articulis arcuatis, tertio ultimo breviore.

Mentum transverso-quadratum antice emarginatum.

Corpus depressum, capite transverso-quadrato. Sterni rudimentum distinctum. Tibiæ anticæ extùs sexdentatæ, tarsorum appendice sub unguium origine insertâ, setosâ.

Obs. Thorax medio canaliculatus, inæqualiter rugosus; Scutello triangulari. Genus corpore, capite, et mandibulis Lamprimæ, at Lucani antennis indutum, ut cuivis insecta intuenti statim patebit.

Spec. 1. *Ryssonotus nebulosus.*

R. niger obscurus, elytris fuscis cinereo-nebulosis, thorace punctato: dorso late canaliculato foveis quatuor utrinque insuper impressis.

Mus. D. MacLeay.

Lucanus nebulosus. *Kirby, Trans. Linn. Soc.* vol. 12. p. 411.

Habitat in Australasiâ.

Sexuum diagnosis haud rite cognita.

III. *Genus.* Lamprima, *Latreille.*

Lucanus, *Schreibers.* Lethrus, *Fab.*

Antennæ articulo basilari aliis conjunctim breviore; capitulo subgloboso foliato, articulis quatuor formato, quorum primus minimus dentiformis vix conspicuus.

Labrum minimum, inter mandibulas deflexum, latitans oblongum, suprà carinatum, angulis anticis rotundatis, hirsutis.

Mandibulæ maximæ, crassæ, et maris saltem intus hirsutissimæ.

Maxillæ brevissimæ, setosæ.

Palpi breves, crassiusculi, articulis subovatis; Maxillares articulo ultimo illo antecedente longiore.

Labium membranaceum, bilobum, pilosum.

Mentum transverso-lineare vel potius semi-ellipticum, margine antico convexo.

Corpus ovale. Caput oblongo-quadratum, antice emarginatum, triangulo medio magno, subexcavato, marginibus elevatis, glabris, antice ante oculos subprominentibus. Thorax convexus, margine utrinque angulato, deflexo. Pectus canaliculatum, punctatum. Sternum in cornu productum. Tarsi spinâ sub unguium origine insertâ, gracili, apice divisâ.

MAS. Mandibulæ porrectæ, validæ, capite fere duplo longiores, intus hirsutissimæ. Tibiæ laminâ corneâ, triangulari, apicali calcari adjunctâ.

FEMINA. Capitis triangulum quam in mare obsoletius. Mandibulæ multo breviores, fere glabræ. Thorax magis punctatus et scaber. Tibiæ anticæ multo graciliores, apice minus emarginatæ, pilis aliquot ferrugineis solitariis, denteque ad angulum internum laminæ loco corneæ sat-longo, acuto.

OBS. Ultimus clavæ articulus fere bifidus, oculis quapropter quibusdam Antennæ undecim-articulatæ videantur! An quo genus reverâ Australasicum Geotrupidis hæret nexûs aliam detegamus notam?

SPEC. 1. *Lamprima aurata.*

L. viridi-aurea nitens, pectore plano.

MAS capite angulis obtusis; mandibulis apice 3-dentatis, intus unidentatis; elytris subrugosulis haud lævibus; tibiis anticis vix punctatis, 6-dentatis, dentibus tribus ultimis subremotis.

L. aurata. *Lat. Nouveau Dict. d'Hist. Nat.* vol. xvii. p. 278.

Lamprima ænea. *Lat. Genera Crust. et Ins.* vol. ii. p. 152.

Lamprima ænea. *Lat. Hist. Nat. des Crust. et Ins.* vol. x. p. 240.

Lucanus æneus. *Don. Ins. of New Holland,* tab. i.

Lucanus æneus, Var. *Schreibers, Trans. Linn. Soc.* vol. vi. p. 187.

Lethrus æneus. *Fab. Systcm. Eleuth.* tom. i. p. 2.

β. Var. parva tibiis anticis quinquedentatis.

γ. Var. cupreo-aurata.

FEMINA thorace elytrisque quam in maribus magis punctatis, tibiarum anticarum spinis conicis, rectis.

Lamprima cuprea. *Lat. Nouv. Dict. d'Hist. Nat.* vol. xvii. p. 279.

β. Var. cæruleo-viridis.

γ. Var. cupreo-aurata.

SPEC. 2. *Lamprima Latreillii.*

L. cæruleo-viridis nitida, elytris lævibus punctatis, pectoris canali utrinque puncto impresso.

MAS mandibulis apice 3-dentatis, intùs unidentatis; tibiis anticis 6-dentatis, dentibus æquè dissitis.

Lucanus æneus, Var. cærulea? *Don. Ins. of New Holland,* tab. i.

FEMINA adhuc latet.

OBS. In honorem Dom. Latreillii, qui, in Entomologiâ hodiernos ante omnes longe latèque celebris, ordinem insectorum naturalem primus indagavit.

SPEC. 3. *Lamprima ænea.*

L. aurato-viridis, elytris rugulosis, corpore subtus piloso.

MAS mandibulis apice vix 2-dentatis, intus unidentatis; tibiis anticis 7-dentatis.

Lamprima ænea. *Lat. Nouv. Dict. d'Hist. Nat.* vol. xvii. p. 279.

Lucanus æneus. *Schreibers, Trans. Linn. Soc.* vol. vi. p. 185.

Lethrus æneus. *Fab. Syst. Eleuth.* tom. i. p. 2.

OBS. Variat anticarum tibiarum numero dentium 6—8.

FEMINA nigro-ænea cum nitore violaceo; thorace quam in maribus magis punctato.

β. Var. fere nigra.

Lucanus æneus. Fem. *Schreibers, Trans. Linn. Soc.* vol. vi. p. 188.

SPEC. 4. *Lamprima pygmæa.*

L. aurato-viridis nitens, elytris læviusculis vix punctatis.

MAS capite angulis subacutis; mandibulis apice bidentatis intus unidentatis; tibiis anticis septem-dentatis; corpore subtus glabro.

Femina latet.

Obs. I. Generis quidem rari, difficillimi, et ad methodum naturalem exponendum pretiosissimi mihi nunc species vix sexus determinasse liceat. Hoc vero in tentamine consultiùs duxi Schreibersii quoad sexus diagnosem vestigia sequi quam cel. Latreillii, qui sententiam scilicet ut Lamprimæ mandibulis haud porrectis species distinctæ sint putandæ primus prætulit. Sexuale autem inter Rectocera discrimen tantæ difficultatis est, tantique fortasse momenti ut leviter perstringi non debet sed ad accuratius examen revocari.

Obs. II. Species ac varietates superscriptæ, quibus omnibus, quod obiter notatu vix indignum sit, ad suturam striâ obsoletâ utrinque impressa sunt elytra, in Mus. MacLeayano hospitantur.

Fam. AESALIDÆ.

Antennæ articulo basilari incurvo, compresso.

Labrum distinctum.

Maxillæ processu apicali brevissimo; interno nullo vel haud exserto.

Labium integrum, minimum, glabrum.

Mentum transverso-quadratum.

Corpus supra valde convexum.

Obs. Hujus familiæ characteres specie unâ solum cognitâ haud facile sunt desumendi. An igitur familia sit vera, vel genus osculans tantummodo censeatur, affirmare nequeo; fateor enim Aesali locum in systemate jam memoratum non eum esse qui omni ex parte mihi arrideret. Attamen res ulterius examen requirit, et naturæ assectatoris strenuissimi, qui Aesali larvam detexerit, quæstionem, nisi fallor, proprium sit expedire.

IV. *Genus.* AESALUS, *Fabricius.*

AESALUS, *Lat.* LUCANUS, *Creutzer. Panzer.*

Antennæ capitulo perfoliato.

Mandibulæ apice acutæ, arcuatæ, sublunatæ, superne mascu in ramum cornuve obtusum productæ.

Maxillæ brevissimæ, haud distinctæ, processu compresso, apice rotundato hirsuto.

Mentum breve, planum, truncatum, integrum.

Corpus quadratum, ad apicem rotundatum. Thorax immarginatus, margine antico concavo caput excipiente. Tibiæ latæ, compressæ, extus inæqualiter multidentatæ.

OBS. Antennis, thoracis charactere caput excipientis, et tibiis examini subjectis, hoc genus Histeribus affiniusculum esse videatur; sed instrumenta cibaria adhuc sunt examinanda.

SPEC. 1. *Aesalus scarabæoides,* Auctorum.

Fam. SYNDESIDÆ.

Antennæ glabræ, vix fractæ, articulo basilari elongato, conico, arcuato.

Labrum haud distinctum.

Mandibulæ maris capite duplo longiores.

Labium et *Mentum* brevissima, vix distincta.

Caput brevissimum, transversum. Thorax velut in Passalidis ab abdomine magno intervallo disjunctus. Corpus elongatum convexum, coleoptrorum lateribus abruptè declivibus, scutelloque inter elytra producto. Pectus magnum. Pedes haud breves, postico pare ab aliis distante.

OBS. Hujus familiæ diagnosis eâdem de causâ quam Aesalidarum forsan fallax, at familia ipsa vera.—Quanti tamen hiatus replendi, quot nodi peregrinatoribus adhuc solvendi sunt!

V. *Genus.* SYNDESUS.

SINODENDRON, *Fab.* LUCANUS, *Don.* LAMPRIMA, *Lat.*

Antennæ articulo secundo subgloboso, tertio majori conico, reliquis septem (masculis saltem) clavam lamellatam, magnam, rotundatam, depressam formantibus.

Mandibulæ elongatæ, fere rectæ, conicæ.

Palpi Maxillares mandibularum fere longitudine, articulo ultimo cylindrico, ovato, aliis longiore.

Corpus cylindricum, capite oculis conjunctim vix latiore. Scutellum minutum. Thorax convexus sulco dorsali longitudinali. Tibiæ anticæ serratæ, extus dentatæ.

OBS. Genus quidem singulare corporis formâ, antennis, thorace ab abdomine et pedum postico pare ab aliis distantibus Passalis propinquans; at vero quâ cum Aesalo devincitur affinitas haud satis patet.

SPEC. 1. *Syndesus cornutus.*

S. obscure ferrugineus, capite emarginato angulis porrectis, thorace punctato antice subcornuto, elytris crenato-striatis.

MAS mandibulis apice bidentatis.

Mus. D. MacLeay.

FEMINA simillima, at mandibulis haud porrectis inermibus.

Sinodendron cornutum. *Fab. Syst. Eleuth.* vol. ii. p. 377.

Lucanus parvus. *Don. Insects of New Holland,* tab. i. 4.

Lamprima. *Lat. Regne Animale,* vol. iii. p. 290.

Habitat in Terrâ Van Diemenii.

OBS. Hocce insectum cel. Fabricius descripsit dicendo, "Antennæ lamellis sex:" at maris antennæ decem-articulatæ sunt clavæ lamellis septem distinctè observandis. Feminam non adhuc vidi.

Fam. PASSALIDÆ.

Antennæ sæpius villosæ, arcuatæ, vix fractæ, articulo basilari parum elongato.

Labrum magnum, crustaceum, penitus exsertum.

Mandibulæ breves, dentatæ, arcuatæ.

Maxillæ processubus corneis dentiformibus, spinosis, intùs dentatis, apicali validiore.

Palpi Labiales menti dorso insertæ.

Mentum crustaceum, subquadratum, fossulâ utrinque versus basin impressâ.

Corpus oblongum, depressum. Thorax ab abdomine magno intervallo disjunctus. Scutellum in abdominis pedunculum immersum. Coleoptra lateribus abrupte deflexis. Pedes breves, postico pare pectoris causâ ab aliis distante.

Obs. In hac familiâ, cujus diagnosis nondum prorsus detegatur sexualis, characteres offerunt perutiles maxillæ et mentum.

VI. *Genus.* Paxillus.

Passalus, *Lat. Web.*

Antennarum clavâ quinque lamellis.

Labrum transverso-lineare, fere glabrum.

Palpi subcrassi; Maxillares articulo ultimo aliis conjunctim fere longiore, subovato, apice subacuto; Labiales ad fossulas menti anticas inserti, articulis crassis, secundo et tertio fere eadem latitudine.

Maxillæ processu apicali dentiformi, acuto; interno unidentato.

Mentum subquadratum, latum, ultra palpi labialis articuli extremitatem secundi utrinque extensum, lateribus rotundatis, margine antico lobato tricuspidato.

Thorax canaliculatus. Pedum par secundum extùs vix pilosum.

Obs. Paxilli Passalis efformantes simillimum genus quod Syndeso antennis labroque minore convenire ducatur, ex Americâ meridionali hactenus solum apparuerunt.

Spec. 1. *Paxillus Leachii.*

P. ater nitidus, corpore valde depresso, thoracis lateribus punctatis: angulis anticis planis, elytris punctato-striatis, tibiis anticis extùs 4-dentatis.

Mus. D. MacLeay.

Obs. Amicitiæ nomen dedi.

Spec. 2. *Paxillus crenatus.*

P. ater nitidus, thoracis lateribus punctatis: angulis anticis profunde impressis, elytris crenato-striatis, tibiis anticis extùs 6-dentatis.

Habitat in Brasiliâ, Demerarâ.

Mus. D. MacLeay.

Obs. Corpus quam P. Leachii convexius.

VII. *Genus.* Passalus, *Fabricius.*

Passalus, *Fab. Lam. Lat.* Lucanus, *Linn. Degeer. Oliv.*

Antennarum clavâ trilamellatâ.

Labrum transverso-quadratum.

Palpi Maxillares crassi, articulo ultimo aliis conjunctim breviore, cylindrico, apice obtuso. Labiales mediocres ad anticam menti fossulam inserti, articulo ultimo graciliore.

Maxillæ processu apicali subtrigono, in dentem acutissimum desinente; interno bidentato.

Mentum subquadratum, ultra palpi labialis articuli extremitatem secundi haud extensum, lateribus subrotundatis, margine antico lobato, tricuspidato.

Par pedum secundum pilis ferrugineis extùs densissime obtectum.

Spec. 1. *Passalus interruptus,* Auctorum.

Obs. *P. emarginatus, cornutus,* &c. huic generi associandi.

VIII. *Genus.* Chiron.

Scarites, *Fab.* Sinodendron, *Fab.* Passalus, *Illiger. Lat.*

Antennæ novem-articulatæ, articulo basilari elongato, cylindrico, secundo globoso, tertio conico, 4°, 5° et 6° brevissimis, reliquis tribus clavam ovatam formantibus.

Labrum transverso-quadratum, penitus exsertum.

Mandibulæ breves, vix exsertæ, validæ, arcuatæ.

Palpi Maxillares graciles, menti versus apicem inserti, articulo ultimo subulato, tertio subconico sed vix secundo longiore.

Mentum semicirculare vel potius subtrigonum.

Corpus cylindricum, elytris abdomen haud obtegentibus. Caput transversum, ab thorace nullo intervallo disjunctum, sed eâdem omnino latitudine. Scutellum minimum vix distinctum inter elytra productum. Pedes sat breves, femoribus incrassatis, tibiis anticis dilatatis digitatis.

Obs. Hujus generis apud Cel. Latreillium primum indicati, maxillas haud examinavi. Sexualis distinctio adhuc latet.

Spec. 1. *Chiron digitatus.*

C. ater nitidus, thorace punctulato, elytris punctato-striatis, suturâ pedibus corporeque subtùs ferrugineis.

Sinodendron digitatum. *Fab. Syst. Eleuth.* vol. ii. p. 377.

Scarites cylindricus. *Fab. Ent. Syst. Supp.* xliv. 8.

Passalus Cylindrus. *Illig. Mag. fur Inseck.* i. 163.

* * * * *Lat. Regne Animale,* vol. iii. 292.

Habitat in Indiâ Orientali. Mus. D. MacLeay.

Obs. Hujus insecti anomali Passalos ut mihi videtur Scolytidis nectentis D. Illiger cum prioribus affinitatem de capitis antennarum pedumque characteribus facillimè perspiciendis primus deprompsit. Chironis vero structura antennis novem-articulatis, clavâ trilamellatâ compressâ, corporis pedumque formâ a Scolytidis, Platypo præsertim, haud longe recedit.

Fam. LUCANIDÆ.

Antennæ glabræ, fractæ, articulo primo longissimo, subcylindrico, clava 3 vel 4 lamellis.

Labrum sæpius cum clypeo connatum, rarissime distinctum.

Mandibulæ in maribus maximæ.

Maxillæ externe compresso-dilatatæ laciniâ apicali coriaceâ compressâ setosâ.

Palpi articulo ultimo elongato, ovali; Maxillares plane longiores, articulo secundo tertio multo longiore. Labiales articulo ultimo antecedente multo longiore.

Labium membranaceum, mento fere absconditum, laciniis duabus apicalibus hirsuto-penicillatis.

Mentum magnum, transverso-quadratum vel subsemicirculare.

Corpus sæpius depressum, elytris abdomen obtegentibus. Clypeus formâ irregulari, variâ. Thoracis margo posticus ab abdomine haud longe remotus. Scutellum plerumque distinctum. Pedes sæpius elongati, antici præsertim.

IX. *Genus.* NIGIDIUS.

Antennæ articulo secundo subgloboso, distincto; Clavâ trilamellatâ pectinatâ.

Labrum exsertum, crustaceum, minutum, bilobum.

Mandibulæ breves, triquetro-trigonæ, validæ, arcuatæ.

Maxillæ processu apicali setoso fimbriave hirsuto, apice obtuso, latere externo convexo, laciniâ internâ subtrigonâ, concavâ, ad apicem intus unco corneo instructâ.

Palpi Maxillares articulo primo minutissimo, secundo elongato conico, tertio brevi subconico, ultimo multo longiore, conico, apice obtuso. Labiales articulo primo elongato, gracili, processu pectinato armato, secundo brevi subgloboso, tertio crassiori obtuso.

Labium hirsutum; mento transverso-quadrato, plano, margine antico emarginato.

Corpus parallelopipedum depressum. Caput trapeziforme, oculos amplectens. Thorax canaliculatus, ab abdomine brevi intervallo disjunctus. Scutellum inter elytra distinctum minutum triangulare.

Obs. Genus Passali formam pulcherrimè simulans et ei omnino affine.

Spec. 1. *Nigidius cornutus.*

N. ater nitidus, mandibulis tridentatis, clypeo punctato antice mucronato, elytris inter strias elevatas triplici punctorum impressorum ordine instructis: apicibus punctatis, tibiis anticis 7-dentatis.

Mas mandibularum margine supero et externo in ramum cornutum producto.

Femina mandibulis brevioribus haud cornu supero instructis.

Habitat in Australasiâ.

Mus. D. MacLeay.

X. *Genus.* Figulus.

Lucanus, *Oliv. Fab.*

Antennæ articulo secundo minutissimo, vix distincto, clavâ trilamellatâ.

Labrum haud distinctum.

Mandibulæ breves, validæ, triquetro trigonæ.

Maxillæ laciniâ apicali securiformi, setosâ vel pilis longissimis formatâ, internâ crustaceâ, ovatâ, compressâ, haud unco corneo armatâ.

Palpi Maxillares articulo secundo crassiore, cylindrico, tertio præcedente haud breviori, ultimo longiori ovato, apice obtuso.

Mentum transverso-quadratum, concavum, margine antico emarginato.

Corpus parallelopipedum depressum. Caput transversum, oculos amplectens, margine antico recto. Thorax canaliculatus, ab abdomine brevi intervallo remotus. Scutellum minutissimum, lineare, inter elytra immersum.

Obs. Genus Passalis quoque simillimum, sed labri maxillarumque causâ quam Nigidius ab illis remotius. Huic generi et antecedenti nomina dedi in honorem Nigidii Figuli equitis Romani, qui Scarabæos cornubus prælongis bisulcis dentatis forcipibus in cacumine Lucanos primus vocasse apud Plinium memoratur.

Spec. 1. *Figulus striatus.*

F. ater nitidus, mandibulis apice 3-dentatis, clypeo concavo obscure punctato, thorace quadrato antice unidentato: lateribus punctatis, elytris punctato-striatis apice punctatis.

Mas. Tibiis anticis extus 8-dentatis.

Femina? Minor tibiis anticis extùs 6-dentatis.

Lucanus striatus. *Oliv. Ins.* i. 19. tab. 4. fig. 14.

Lucanus striatus. *Fab. Syst. Eleuth.* vol. ii. p. 253.

Habitat in India Orientali, Insulis Mauritio Bourbonensi.

Mus. D. MacLeay.

Obs. Mandibulæ profecto quidem tridentatæ, quamvis unidentatæ apud Olivierium et Fabricium dicuntur. An eadem species? Descriptiones vero cel. auctorum insecto nostro alias aptissime conveniunt.

XI. *Genus.* DORCUS*, *apud Germanos in Specierum Catalogis.*

LUCANUS, *Linn. Fab. Oliv. Lat. Web.* PLATYCERUS, *Lat.*

Antennæ clavâ fere perfoliatâ, quadrilamellatâ, articulo ultimo majori semicirculari.

Labrum clypei fere processus exsertus, corneus, transversus.

Mandibulæ arcuatæ vel falcatæ, breves, intùs dentatæ.

Maxillæ processu apicali recto, cylindrico, membranaceo, pilis fimbriato; laciniâ internâ membranaceâ, dilatatâ.

Palpi Maxillares elongati, articulis tribus ultimis compressis ultra clypeum eminulis, secundo lato conico, tertio brevi conico, quarto longiore ovato, apice obtuso. Labiales breves.

Labium bilobum, lobis cylindricis hirsutis, quam in sequentibus brevioribus.

Mentum breve, semicirculare, planum, margine antico integro recto.

Corpus depressum, lateribus subrotundatis. Caput latitudine fere thoracis. Thorax vix canaliculatus. Scutellum trigonum, postice fere rotundatum.

OBS. Weberi *Lucanus lunatus, piceus,* &c. huic generi associandi?

SPEC. 1. *Dorcus parallelipipedus.*

D. niger haud nitidus, mandibulis longitudine capitis: dente medio elevato, labro late truncato, thorace lateribus rectis, superficie totâ subtilissime punctatâ.

* Optimè dixit cel. Latreille, art. *Ocydrome, Nouveau Dict. d'Hist. Nat.* tom. xxiii. p. 129. "Je remarque que plusieurs naturalistes s'empressent, comme par une anticipation titulaire, de donner des noms à quelques coupes, qui leur paroissent devoir former de nouveaux genres, sans se donner la peine d'en établir les caractères. Ce ne sont que de simples indications, *et qui n'imposent aucune loi.*"

* Lucanus parallelipipedus. *Fab. Syst. Eleuth.* ii. 251. 16.
Lucanus parallelipipedus. *Panz. Fn.* f. 19.

SPEC. 2. *Dorcus tuberculatus.* Anne D. parallelipipedi sexus alter?

D. superne rugoso-punctatus, labro emarginato, capite bituberculato.

Dorcus tuberculatus. *In Specierum Germanicarum Catalogis.*
Lucanus parallelipipedus. *Oliv.* i. 17. 11. tab. iv. fig. 9.
Idem. *Lat. Nouveau Dict. d'Hist. Nat.* xviii. p. 225.
Lucanus Capra. *Panzer Fn.* lviii. f. 12.

OBS. Hanc speciem, quæ Germanis videtur distinctissima, præcedentis marem Olivierius cum Geoffroyo et feminam Latreillius cum Bergstraesser putavere. At aliàs distribuuntur hæc insecta a Gyllenhallo et Panzero. "Mirum certe videtur," ait Gyllenhallus, "discrepantias tanti momenti solummodo sexui diverso tribuendas esse; anne potius species distincta? Dom. Panzer loc. cit. contendit alterum sexum Luc. Capræ tuberculis frontis destitutum esse, sed figuram clypei non memorat, nec talem vidi, quare certius dijudicare nequeo."—*Entomologia Britannica,* p. 49, etiam consulenda.

XII. *Genus.* ÆGUS.

LUCANUS, *Fab.*

Antennæ clavâ fere perfoliatâ, vix quadrilamellatâ, articulo ultimo majore semicirculari.

Labrum haud distinctum.

Mandibulæ porrectæ, falcatæ, inermes.

Maxillæ processu apicali sub mento latitante.

* Insectorum synonyma frequentiorum quæ pauca necessaria mihi visa sunt solum retuli, et omnia quidem præter ea quæ ad observationes jam scriptas exponendas utilia judicaverim sedulo omisi. In hoc opere non species determinandas, sed ordinem naturalem elaborandum esse, satis patebit.

Palpi Maxillares breves, articulo ultimo ultra mentum solo apparente.

Mentum transverso-quadratum, antice emarginatum

Corpus depressum antecedentis illi generis simillimum. Clypeus emarginatus vel potius 2-dentatus. Scutellum minutum. Tibiæ quadridentatæ.

Obs. Genus sequenti nimis affine; at palpis brevibus et clavâ antennarum perfoliatâ nihilominus distinctum.

Spec. 1. *Ægus chelifer.*

Æ. ater nitidus, capite thoraceque punctatis, elytris striato-punctatis.

Habitat in Australasiâ.

Mus. D. MacLeay.

Obs. *Lucanum cancroidem* Fabricii haud examinavi, at generi Dorco potius pertinere videtur.

Spec. 2. *Ægus interruptus.*

Æ. atro-ferrugineus, capite thoraceque punctatis, elytris lateribus punctatis ad suturam utrinque striis tribus impressis: duabus aliis interruptis.

Habitat in India?

Mus. D. MacLeay.

Spec. 3. *Ægus obscurus.*

Æ. obscurè ferrugineus, capite thoraceque punctatis, elytris striatis.

Mus. D. MacLeay.

Obs. Mandibulæ breves; sed feminæ forsan characterem efforment. Hæc species a *Lucani punctati* apud Fabricium descriptione colore ferrugineo solum differt, et illius mera forsan varietas haberi debet.

Spec. 4. *Ægus inermis.*

Æ. niger, capitis thoracisque lateribus punctatis, dorso lævi nitido, elytris subpunctatis.

Lucanus inermis. *Fab. Syst. Eleuth.* ii. 251.

Habitat in Sumatrâ.

Obs. Hanc speciem hactenus mihi non visam, ab aliis distinctam propter Fabricii descriptionem habeo.

XIII. *Genus.* Lucanus, *Scopoli.*

Lucanus *Auctorum.*

Antennæ clavâ neutiquam perfoliatâ, at pectinatâ, trilamellatâ vel quadrilamellatâ, articulis subæqualibus.

Labrum haud distinctum.

Mandibulæ in masculis maximæ, glabræ, cornua referentes vel intus dentatæ.

Maxillæ medio unidentatæ, processu apicali, elongato, longissimo, exserto, cylindrico, setoso.

Palpi Maxillares elongati, graciles, filiformes, articulo secundo aliis conjunctim longiore. Labiales breves, articulis subæqualibus.

Labium bifidum, penicillis elongatis, setosis, exsertis.

Mentum latum, transversum.

Corpus subdepressum formâ irregulari. Scutellum distinctum rotundatum.

Genus ad interim sic dividatur.

A. Antennarum clavâ trilamellatâ.

Spec. 1. *Lucanus femoratus.* Oliv.

B. Antennarum clavâ quadrilamellatâ.

* Thorax corpore angustior.

Spec. 2. *Lucanus Cervus.* Lin.

** Thorax corpore latior.

Spec. 3. *Lucanus Alces:* Oliv.

Obs. Entomologis reverâ nodus Gordianus; sexus enim unus et alter ejusdem speciei figurâ et habitu externis, instrumentisque cibariis quam specierum diversarum duo mares vel duæ feminæ inter se longiùs sæpissime dissident. Labri etiam quod insuper Rectoceris haud raro cum clypeo cônnatum est, structura semper attentione digna, in Lucanis veris alteram difficultatem præbeat. Aliqui tamen in sexuali diagnosi*, labrique structurâ, characteres forsan lateant, quibus, ut opinor, ante omnes alios ad ordinem naturalem elaborandum quasi idoneis fides daretur. His autem malè intellectis, vix etiam adhuc investigatis, ut de Rectocerorum speciebus segregandis quibusdam in Entomologiâ doctis scrupulus olim injectus fuerit, sic alios et tyrones nodi inter Lucanidas toties solvendi hujus generis, posthac certè dividendi, à studio nunc omnino deterreant. Nos igitur quodammodo oportuerit transitum ab Ægo per hoc genus ad Ceruchum et Lamprimidas facilem ut suprà demonstrare; et quamvis characteres sic evoluti artificiales, nexus ipsi profecto naturales esse sentiantur.

XIV. *Genus.* CERUCHUS.

PLATYCERUS, *Geoff. Lat. Gyllen.* LUCANUS, *Linn. Degeer. Fab. Oliv. Panz. Payk.*

Antennæ capitis longitudine, capitulo trilamellato, pectinato.

Labrum parvum, membranaceum, integrum, sub clypei acumine reconditum.

Mandibulæ porrectæ, validæ, intus dentatæ, hirsutæ.

Maxillæ processu terminali brevi, penicilliformi, intus laciniâ breviori setosâ auctæ.

Palpi mandibulis breviores; articulis elongatis, gracilibus.

Labium integrum, apice ciliatum, laciniis obsoletis.

Mentum corneum, pentagonum, concavum.

Corpus elongatum subdepressum, abdomine elytris obvoluto. Scutellum breve, triangulare. Tibiæ anticæ multidentatæ. Tarsi appendice setosâ, bifurcatâ, sub unguium origine insertâ.

SPEC. 1. *Ceruchus tenebrioides.*

C. suprà ater nitidus umbilicato-punctatus, antennis palpis-

* Lichtenstein, *Trans. Linn. Soc.* vol. vi. p. 35.

I 2

que rufis, elytris substriatis, corpore infrà fusco, pedibus nigris: tarsis paulo dilutioribus.

Platycerus tenebrioides. *Lat. Gen. Ins. et Crust.* vol. ii. 133.

Platycerus tenebroides. *Gyllen. Ins. Suec.* vol. i. p. 68.

Lucanus tenebroides. *Fab. Syst. Eleuth.* ii. 252. 21.

Mas. Caput magnum, thorace latius, mandibulis capite longioribus, arcuatis, in medio dente magno armatis, thorace brevi, transverso, ante medium foveolâ rotundâ utrinque impresso.

Femina magis obscura, crebriùs et profundiùs punctata, capite angustiori, mandibulis minoribus, thorace longiore rugâ transversâ in medio elevatâ.

β. Var. tota pallida rufescens, e nymphâ nuper deprompta.

Habitat in Europæ borealis truncis putridis, pini præsertim.

Mus. D. MacLeay.

Obs. Hujus generis, quod ad constituendum præclaræ Gyllenhalli descriptioni gratias habeam, Pholidotus necnon alia Lamprimidarum genera ad calcem recurrunt.

XV. *Genus.* Platycerus, *Geoffroy.*

Platycerus, *Lat. Gyllen.* Lucanus, *Linn. Fab. Payk. Panz. Degeer. Oliv.*

Antennæ capite multo longiores, capitulo quadrilamellato.

Mandibulæ validæ, lunatæ, haud valde porrectæ, intus obtusè dentatæ, glabræ.

Palpi articulis brevibus, subovatis; Maxillares mandibularum fere longitudine.

Mentum semicirculare, planum.

Corpus depressum Trogositæ staturâ. Caput thorace transverso angustius. Scutellum breve rotundatum. Tibiæ anticæ bidentatæ.

Obs. Genus adhuc examinandum.

Spec. 1 *Platycerus caraboides*

P. cæruleus aut virescens punctulatus, subtus obscurior fere nigricans, elytris punctato-striatis tarsisque rufescentibus.

Platycerus caraboides. *Lat. Gen. Ins. et Crust.* vol. ii. p. 134.

——— *Gyll. Ins. Suec.* i. 70.

Lucanus caraboides. *Fab. Syst. Eleuth.* ii. 253. 23. &c. &c

β. Var. pectore abdomine pedibusque rufis, ore piceo.

Platycerus rufipes. *Gyllen. Ins. Suec.* i. 70.

Lucanus caraboides. (var.) *Illig. Mag.* iv. 104. 24.

Lucanus rufipes. *Fab. Syst. Eleuth.* ii. 253.

——— *Herbst Col.* iii. 311. 11. *Fab.* 34. f. 8.

——— *Panz. Fn.* 58. f. 14.

γ. Var. supra tota chalybea.

Platycerus chalybeus *Germanorum.*

δ. Var. tarsis nigris.

Platycerus nigripes *Germanorum.*

Habitat in Europæ sylvis.

Mus. D. MacLeay.

Obs. Antennarum articulis extimis majoribus et uno latere productis, labro parvo, mandibulâ exsertâ, palpis maxillaribus subfiliformibus, articulo ultimo longiore ovato cylindrico, maxillæ laciniis duabus, quarum apicali elongatâ compressâ, intus et ad apicem pilis ciliatâ, ut et corpore depresso virescenti, ad Platyceros accedit Fabricii genus Trogosita.—Imò verò *Trogositam Mauritanicam* insectum pentamerum esse notatu dignum sit, cujus tarsorum articulus primus ut sæpe in Rectoceris Thalerophagis parvus retractus videatur. Hanc ideo Trogositam inter Lucanoides suos optimè posuit acutissimus Gyllenhallus, genus enim reverâ distinctum, forsan osculans eam constituturam suspicor.

XVI. *Genus.* Sinodendron, *Fabricius.*

Scarabæus, *Linn.* Lucanus, *Kirby.*

Antennæ omnino ut in Cerucho.

Labrum exsertum, coriaceum, antice convexum.

Mandibulæ breves, corneæ, validæ, sub clypeo reconditæ.

Maxillæ processu duplici; apicali membranaceo ciliato, interno dentiformi.

Palpi Maxillares articulo secundo elongato, conico, subarcuato, tertio brevi, terminali ovato apice obtuso. Labiales articulo ultimo crassissimo, aliorum conjunctim longitudine.

Mentum angustatum, integrum, valde retusum, labio brevi conico, carinato.

Corpus convexum, cylindricum, ano obvoluto. Scutellum parvum, obtusum.

SPEC. 1. *Sinodendron cylindricum.*

S. nigrum profunde impresso-punctatum cicatriculosum: punctis umbilicatis: umbilico perforato.

Sinodendron cylindricum. *Lat. Gen. Ins. et Crust.* tom. ii. p. 101.

MAS. Capitis cornu recurvo, posticè fulvo hirto, thorace anticè truncato quinquedentato.

FEMINA. Capitis cornu brevi recto, thorace antice vix retuso.

Habitat in Europæ ligno putrido.

OBS. Insectum prorsus singulare, cujus cum Orycte affinitas a Cel. Latreillio pulcherrimè exponitur *Gen. Ins. et Crust.* vol. ii. p. 100. A Rectoceris labro mento mandibulis thorace corporisque staturâ differt. Genera ità anomala quæ aliis semper adhuc difficultates objecerint, structurâ penitus spectatâ, opinionem nostram confirmare potius quam labefactare videantur.

Rectocerorum omnia Thalerophagorum genera quæ ad manus mihi fuere jam recensui; et ordinis hiatus naturalis quos exposuerim, his insectis per orbem perparcè diffusis adeoque in musæis rarissime inventis, mihi tam suppletu difficiles fuisse vix Entomologo mirum erit.

II. PETALOCERA.

Antennæ rectæ, capitulo flabellato. *Mandibulæ* clypeo plerumque obtectæ vel raro exsertæ.

Obs. A Lamprimidarum familiâ per *Lethrum cephalotem* inter Geotrupidas transducimur.—Hiatus autem adeo perspicuus est quo Lethrus a Rectoceris sejungitur ut vix lateat entomologum neque ullo discrimine egeat apertiori.

A. *SAPROPHAGA.*

Pedes validi (posticis ab aliis subremotis); tibiæ latæ, ac elytra sæpius ad anum pertingentia.

Fam. GEOTRUPIDÆ.

Genus. Orphnus.

Geotrupes, *Fab.*

Antennæ decem-articulatæ, basilari magno, vix elongato, conico; secundo subgloboso; tertio, quarto, quinto, sexto et septimo brevissimis, transversis; ultimis paulo sensim latioribus, capitulo lamellato plicatili, subgloboso.

Labrum clypeo fere occultatum, margine antico solum exserto.

Mandibulæ exsertæ, arcuatæ, subtrigonæ, basi crassæ, extus rotundatæ, apice acutæ, intus unidentatæ.

Maxillæ inermes, processu unico crustaceo, triquetro-trigono, sed laciniæ apicalis loco fasciculo ciliato, extus arcuato, ciliis spinosulis.

Palpi Labiales articulo ultimo majore, subovato.

Mentum subquadratum apice truncato.

Clypeus in masculis unicornis. Corpus ovatum. Thorax antice truncatus aut excavatus, coleoptris abdomen posticè non obtegentibus. Tibiæ anticæ extus tridentatæ; aliæ lineis transversis ciliatæ.

Spec. *Orphnus bicolor.*

O. supra niger subtus brunneus, thorace retuso bidentato:

lateribus punctatis, capitis cornu brevi erecto plano, elytris vix striatis.

Geotrupes bicolor. *Fab. Syst. Eleuth.* vol. i. p. 9. n. 27.

Habitat in Indiâ. Mus. D. MacLeay.

Obs. Orycti genus simillimum, ab illo enim antennarum capitulo subgloboso, labro exserto, maxillarum processu apicali ac mento breviore tantùm differt.

Genus. Hybosorus.

Scarabæus, *Fab.* Geotrupes, *Fab.*

Antennæ decem-articulatæ, articulo basilari magno, crasso, piloso; secundo subgloboso vel conico; quinque proximis pateræformibus; octavo infundibuliformi duos ultimos excipiente et clavam ita rotundatam subconicam formante.

Labrum exsertum, crustaceum, antice valde convexum.

Mandibulæ validæ, exsertæ, falcatæ, vel valde arcuatæ, apice acutæ, haud dentatæ.

Maxillæ laciniâ apicali acutâ, cultelliformi, membranaceâ, compressâ, fimbriatâ, internâ subcrustaceâ intus ad apicem unidentatâ.

Palpi Maxillares articulo basilari incurvo, minutissimo, piloso; secundo oblongo conico; tertio brevi conico; ultimo elongato-cylindrico apice subacutiori. Labiales articulo ultimo fere aliis conjunctim longiore.

Mentum oblongo-quadratum, lateribus convexis, margine antico emarginato, ligulâ vix distinctâ.

Corpus ovatum, convexum; capite semicirculari; scutello distincto, elytris abdomen obtegentibus, tibiis anticis extus tridentatis.

Obs. Genus quidem Orphno proximum, sed Ægialiæ maxillas palpos et mentum habens!—Dispositionem adeo circularem tam inter Petalocera Saprophaga maxillis membranaceis quam inter illa etiam corneis indicari, nobis incidit suspicio. Et cum porro talis quidem inter Thalerophaga ordo nequaquam difficillime distinguendus est, iis qui amovere vela quibus systema naturale obtenditur cupiant conjecturæ hujus verisimilitudo in speciebus examinandis forsan posthac apparebit, etsi nullis adhuc certis rationibus niti ducatur.

SPEC. *Hybosorus Arator.*

H. ater, thorace lævi, elytris striato-punctatis.

Scar. Arator. *Fab. Ent. Syst.* vol. i. p. 33. n. 106.

Geotrupes Arator. *Fab. Syst. Eleuth.* vol. i. p. 91. n. 75.

Habitat in Hispaniâ, a D° Dejean ibi lectus. Apud Fabricium Caput Bonæ Spei locus Hybosori naturalis est, at Clar. viri sententiam in suspicionem vocare vellem; sex enim species in Mus. MacLeayano asservatæ Europæ meridionali, Africæ boreali ac Indiæ orientali sunt propriæ.

Genus. ELEPHASTOMUS.*

SCARABÆUS, *Schreibers.*

Antennæ undecim-articulatæ, articulo basilari conico, parum elongato, pilis longissimis instructo; articulo secundo breviori, crasso, subconico, sex proximis brevissimis, pateriformibus; articulo nono et undecimo hemisphæricis, medium omnino fere absconditum intercludentibus, clavam magnam oblatam subsphæroidem ita formantibus.

Labrum lateribus rotundatis transversum, sublineare, et clypei ad superficiem perpendiculare.

Mandibulæ triquetro-trigonæ, falciformes, apice intus bidentatæ, margine interno submembranaceo.

Maxillæ corneæ, arcuatæ, intus dente acuto et ad apicem laciniâ obtusâ ciliis spinosulis armatæ.

Palpi Maxillares longissimæ, labialibus fere triplo longiores, articulo basilari minutissimo, subgloboso; secundo longissimo, cylindrico, arcuato, apice obtusiori; tertio breviori, conico, apice crassiore; ultimo longitudine secundum fere æquante,

* Propriè *Elephantostomus*—nomen ob euphoniam curtatum.

cylindrico, elongato, lanceolato, apice graciliore. Labiales articulo basilari minutissimo subgloboso; secundo sub-cylindrico arcuato; ultimo eâdem longitudine, sub-semicirculari, sub-cylindrico.

Mentum lateribus angustatis, brevissimum, verticaliter deflexum, et apice profunde emarginatum aut potius bilobum, lobis rotundatis.

Labium fere nullum.

Clypeus thorace multo angustior, posticè ad utrumque latus in lobum ocularem dilatatus, anticè in medio extensus, et in laminam subquadratam versus apicem sub-emarginatam, solidam imperforatam productus. Rostri hujus apex crassior, furcatus; furcis lateralibus deorsum spectantibus. Os sub clypeo totum latitans, instrumentis cibariis verticaliter deflexis structuram in hac familiâ anomalam formantibus. Corpus subtus undique hirtum, valde convexum; thorace subretuso, inermi, elytris totum corpus ambientibus. Scutellum magnum, triangulare, planum. Pedes hirti, femoribus anticis et posticis incrassatis; tibiis anticis extrorsum sex-dentatis; tibiis mediis et posticis triquetris.

SPEC. 1. *Elephastomus proboscideus.*

E. ferrugineo-nigricans, clypei cornu brevi erecto obtuso emarginato, antennis ferrugineis, thorace mutico subretuso ad latera punctis impresso, elytris punctato-striatis.

MAS processu rostriformi gracili, longitudine totius clypei et subtus capitis laminâ in medium elevatâ paululum supra os fulcro verticali apice furcato munitâ.

FEMINA capitis cornu quam in mare subobtusiori, rostro multo breviore latiore; clypeo subtus in medium elevato sed fulcro verticali haud instructo.

Scarabæus proboscideus. *Schreib., Trans. Linn. Soc.* vol. vi. p. 189.

β. Var. rufescens e nymphâ nuper deprompta.

Habitat in Nova Hollandiâ. Mus. D. MacLeay.

Genus. ATHYREUS.

SCARABÆUS, *Fab.? Gmel.?* COPRIS, *Fab.?*

Antennæ fere omnino ut in Elephastomo, nisi clavæ margine rotundiori.

Labrum latum, transverso-quàdratum, anticè vix trilobum, lobis rotundatis.

Mandibulæ corneæ, validæ, triquetro-trigonæ, subarcuatæ, superne planæ, extus bidentatæ, apice interno pariter bidentato margineque interno membranaceo.

Maxillæ laciniâ apicali subcrustaceâ, triangulari, dilatatâ, margine antico ciliato, spinosulo; laciniâ internâ processubus duobus munitâ, hoc spiniformi et illo dilatato, spinosulo.

Palpi articulo labialium ultimo maxillarium illum fere longitudine æquante.

Mentum subquadratum, profunde emarginatum, lateribus sinuatis, postice convexis, tum angustatis, et in lobum utrinque desinentibus.

Labium bifidum, laciniis ciliatis.

Clypeus thorace multo angustior, posticè ad utrumque latus in lobum ocularem acutum dilatatus, anticè in laminam subquadratam superficie inæquali prolongatus; hoc processu antico in medio elevatione tricuspidatâ instructo, cornu medio longiore, basi lineam longitudinalem distinctam vel obsoletam formante.

Corpus valde convexum, subtus hirsutum, thorace antice mucronato postice lobato Scutellum lineare, inter elytra productum haud distinctum. Pectus magnum, pedum secundum par alterum ab altero late separans.

OBS. Genus admodum singulare capite neglecto a Copride haud distinguendum; sed ab Elephastomo quoque haud longe distat. Insecti mihi non adhuc visi descriptione apud Fabricium recensitâ, *Copris Æson* (vel *Scar. Bous Ent. Syst.* 149. 160.) huic generi appropinquare videtur.

Spec. 1. *Athyreus bifurcatus.*

Niger punctis elevatis scaber, thorace antice mucronato: dente elevato lato bifurcato, elytris striis elevatis glabris minutis: suturâ hirsutâ ferrugineâ.

Habitat in Braziliâ.

Mus. D. MacLeay.

Spec. 2. *Athyreus tridentatus.*

A. ferrugineus scabriusculus, thorace in medio excavato glabro tridentato: dente apicali longiore, aliis lateralibus obtusioribus, elytris vix striatis.

Habitat in Braziliâ.

Mus. D. MacLeay.

Spec. 3. *Athyreus bidentatus.*

A. ater scabriusculus, thorace in medio excavato glabro bidentato: dentibus lateralibus obtusiusculis, elytris obsolete striatis.

Habitat in Braziliâ.

Mus. D. MacLeay.

Obs. *A. bifurcato* scutellum vix distinctum, et tibiæ anticæ quinquedentatæ sunt, dum clypei cornu medium basi lineam distinctam longitudinalem efformat; speciebus autem duabus aliis scutellum indistinctum, tibiæ quadridentatæ, et clypei obsoleta est linea longitudinalis.

Fam. SCARABÆIDÆ.

Circulo naturali, quem inter Scarabæidas efformant Coprides Americanæ pedum unguibus nullis *floriger, splendidulus, Carnifex, conspicillatus, festivus, Mimas, Faunus, Belzebul, Jasius, Lancifer* ac aliæ ineditæ, accedit Athyreus.

Genus. Phanæus.

Scarabæus, *Linn. Oliv. Degeer.* Copris, Onitis, *Fab.*

Antennæ novem-articulatæ, articulo secundo brevi, pateriformi vel semicirculari, tertio, quarto, et quinto longioribus, sexto breviori; clavâ infundibuliformi, articulo primo subtrigono secundum et tertium excipiente, margine externo subemarginato; articuli secundi margine interno ferri equini instar ferente; articulo ultimo operculiformi margine externo emarginato.

Instrumentis in Cibariis haud valida patet distinctio. Hæc enim Insecta Coprophaga sunt, et in Mundo Novo Onitis generis officiis fungantur. Vide *Oliv. Ent.* t. vii. f. 50. a—ubi palporum labialium articulus basilaris notatu dignus sit.

Caput subtrigonum, sæpissime cornutum, clypeo sæpius bidentato vel emarginato. Thorax puncto utrinque impressus, abdomine antice sæpius latior, lateribus sinuatis marginatis, margine postico punctis sæpius duobus impressis, lineâ utrinque elevatâ rarius obsoletâ. Pectus planum, sæpius canaliculatum, sterno acuto vel carinato. Pedes validi; Tibiæ anticæ tri- vel quadri-dentatæ, tarsis obsoletis, sed spinâ articulatâ ad apicem. Tibiæ posticæ conicæ, tarsis gracillimis, unguibus nullis.

Obs. Color metallicus vel nigro-lucidus nunquam obscurus. Elytra sulcata vel striata.

Hoc in circulo quinque formæ Typi sunt notandi.

TYPUS 1. Clypeus antice bidentatus. Thorax margine postico vix acuminato, punctis duobus impressis. Pectus haud longius quam latius, canaliculatum, antice carinatum. Tibiæ extus quadridentatæ dentibus subacutis.

Spec. 1. *Phanæus bellicosus.*

P. nigro-violaceus, subtus niger, thorace antice excavato, lineis utrinque duabus elevatis, elytrorum striis vittæformibus.

Mas. Capitis cornu longo recurvo; in medio thoracis postico cornubus duobus compressis, erectis, brevibus, bidentatis, fossulâque inter cornua magnâ impressâ.

Scarabæus bellicosus. *Oliv. Ent.* i. 3. p. 103. n. 118. t. 22. f. 32.

Copris bellicosa. *Schönherr Syn. Ins.* i. p. 44. (*rectè, at Fabricii error animo invito retinendus*).

FEMINA? Capitis cornu brevissimo erecto, utrinque unidentato, thorace prominentiâ triplici: intermediâ latâ transversâ supra canaliculatâ, tuberculo acuto utrinque munitâ.

Mus. D. MacLeay.

Habitat in Brasilia.

OBS. 1. Huic *Copris lancifer* Fab. *Scarabæus Jasius* Oliv. et *Onitis Jasius* Fab. associandi.

OBS. 2. Recte observat Schönnherrius cum Illigero, vol. i. p. 31, quod *Scarabæus Jasius* Oliv. et *Onitis Jasius* Fab. species distinctæ sint putandæ; at quoniam prorsus affines sunt, in errorem levem lapsus est ipse Insectorum Synonymiæ celeberrimus auctor, qui speciem unam Oniti et alteram Copridi attribuit. Ut confusio demum evanescat, has species distinguam.

SPEC. 2. *Phanæus Jasius.*

P. nigro-viridis, capitis cornu breviusculo suberecto: lateribus unidentatis, thorace punctato rugoso excavato anticè retuso posticè longitudinaliter canaliculato, femoribus viridibus.

MAS? Capitis cornu reflexum, subacutum: parte stipitali longiore, thorace anticè excavato, suprà tridentato: dentibus minutis, æqualibus, acutis.

β. Var. Thorax nigrior, suprà glabriusculus, vix longitudinaliter canaliculatus; dente intermedio majore.

FEMINA. Capitis cornu transversum, brevissimum: dentibus utrinque obsoletis, thorace medio excavato: processu antico transversali, truncato, lineari.

Scarabæus Jasius. *Oliv. Ins.* 3. 109. 126. t. 7. f. 50.

Copris Jasius. *Illig. Mag.* iii. p. 143.

Habitat in Demerarâ, Cayennâ.

Mus. D. MacLeay.

SPEC. 3. *Phanæus Dardanus.*

P. nigro-viridis, capitis cornubus duobus brevibus basi connatis, thorace antice carinâ bidentatâ instructo.

Onitis Jasius. *Fab. Syst. Eleuth.* 1. p. 28. n. 8.

Mas. Thorax fossulâ utrinque sub carinæ dentibus unidentatâ; his subacutis lineâ transversâ sinuatâ elevatâ postice conjunctis.

Femina? Mare minor. Thorax fossulâ utrinque haud profundâ vix unidentatâ, carinæ dentibus obtusis, lineâ elevatâ minus distinctâ.

Mus. D. MacLeay.

Hæc species, quæ capitis cornu et thorace bidentato *Copridi Mimanti* Fab. propinquat, e Braziliâ nobis est allata.

Obs. 3. Insecta alia duo quæ speciebus et sexubus diversis attribuenda sint, vix pro *P. Jasii* varietatibus habenda, Entomologis adhuc proponam.

Phanæus Abas?

Mas niger vix viridis. Capitis cornu longiusculum, paulo recurvum lateribus unidentatum: parte stipitali breviore, thorace excavato, suprà glabriusculo, prominentiâ triplici: intermediâ latâ truncatâ canaliculatâ, aliis dentiformibus, pedibus nigris.

Habitat in Insulâ Trinidad. Mus. D. MacLeay.

Phanæus Acrisius?

Femina nigra vix viridis. Capitis cornu transversum, lineare, dentibus utrinque nullis, thorace excavato, suprà prominentiâ utrinque vix elevatâ, glabriusculo; subtùs processu antico transversali semicirculari munito.

Habitat in Braziliâ.

Mus. D. MacLeay.

TYPUS 2. Clypeus antice sub-bidentatus. Thorax margine postico acuminato, punctis duobus impressis. Pectus fere duplo longius quam latius, canaliculatum, anticè carinatum. Tibiæ extùs tridentatæ dentibus obtusis.

Spec. 4. *Phanæus Mimas.*

P. niger et viridi-aureus, capite obsolete bicorni, thorace inermi retuso angulato, elytris inauratis.

Scarabæus Mimas. *Linn. Syst. Nat.* p. 545. n. 17.

———————— *Oliv. Ent.* 1. 3. p. 108. n. 125. t. 7. f. 50.

Copris Mimas. *Fab. Syst. Eleuth.* 1. p. 45. n. 68.

Mas Capite lineâ transversâ elevatâ cornubusque duobus brevibus, basi connatis; thorace anticè valde elevatiore, angulis subporrectis.

Femina mutica, capite lineis duabus transversis elevatis, thoraceque lineâ aliâ transversâ semicirculari elevatâ anticè instructo.

Mus. D. MacLeay.

Habitat in Americâ Meridionali.

Obs. 4. *Copridem Mimantem* forte ad Onitis genus amandandam esse suspicatus est cel. Fabricius, at affinitas illa Phanæi circuli omnis pro charactere est habenda.

Obs. 5. *Phanæo Mimanti Copris Faunus* Fab. *Belzebul* Fab. et *Scarabæus Belzebul* Oliv. adhuc associandi.

Obs. 6. Si in *Copridis Jasii* descriptione hallucinatus sit Fabricius, errorem similem cel. Olivier haud equidem vitavit. Mas enim sui *Scarabæi Belzebul* a Fabricii *Copride Belzebul* differt, et species sic distinguantur.

Spec. 5. *Phanæus Belzebul.*

P. niger, capitis cornu brevi haud recurvo: basi corniculo utrinque armatâ, thorace punctato-rugoso prominentiâ triplici: intermediâ multo latiore, elytrorum striis versus apicem subobsoletis.

Scarabæus sulcatus. *Drury Ill.* 1. t. 35. f. 1.

Scarabæus Belzebul. *Fab. S. Ent.* p. 23. n. 88.

———————— *Fab. Ent. Syst.* 1. p. 46. n. 152.

Scarabæus Belzebul femina. *Oliv. Ent.* 1. 3. 107. 124. t. 14. f. 136.

Copris Belzebul. *Fab. Syst. Eleuth.* 1. p. 37. n. 32.

Mas. Capitis cornu erectum, corniculis ad basin distinctis, thorace antice sub prominentiâ intermediâ excavato, corniculis utrinque acutis.

Femina capitis cornu brevissimo subprostrato: corniculis ad basin obsoletis, thorace antice truncato; corniculis utrinque subobtusis.

Habitat in Insulâ Jamaicensi.

Mus. D. MacLeay.

Obs. 7. Speciem semper icone determinari apud Druræum oportet: descriptiones enim ejus plerumque nihili sunt, tabulæ autem accuratissimæ.

Obs. 8. *P. Belzebul* sectioni præcedenti inter Phanæum quem (*Abantem* mihi) ex insulâ Trinitatis descripsi et *P. Dardanum* propinquat: hujus enim thoracem, illius autem capitis cornu ad basin unidentatum habet.

Spec. 6. *Phanæus Moloch.*

P. niger, capitis cornu basi tuberculo utrinque inconspicuo, thorace glaberrimo antice retuso spinoso: partis superioris in medio lineâ longitudinali impressâ, fossulâque cornu externum a duobus aliis lateralibus utrinque dividente, elytrorum striis latis haud profundis.

Mas? Capitis cornu longum recurvum. Thorax corniculis septem, septimo transverso, apice emarginato, in medio thoracis lineæ longitudinalis ad originem protenso.

Femina. Capitis cornu brevius vix recurvum. Thorax tuberculis sex fere æqualibus, subacutis, septimo medio emarginato nullo.

Scarabæus Belzebul mas. *Oliv. Ent.* 1 3. 107. 124. t. 14. f. 136. a.

Copris Belzebul. *Schönnheri Syn. Ins.*

Habitat in Braziliâ vel Insulâ Jamaicensi?

Mus. D. MacLeay.

TYPUS 3. Clypeus antice emarginatus. Thorax margine postico acuto, lobo parvo punctisque duobus obsoletis vel vix conspicuis. Pectus paulo longius quam latius, antice acutum haud canaliculatum, at puncto longitudinali posticè impressum. Tibiæ extùs tridentatæ dentibus acutis.

SPEC. 7. *Phanæus Columbi.*

P. nigro-virescens nitidus subtus niger, capitis cornu vix recurvo, clypeo antice nigro subtilissimè rugoso ante oculos virescente, thorace punctato-rugoso antice retuso, canali profundo utrinque impresso, medio supero vix canaliculato, elytrorum sulcis haud profundis.

MAS? Capitis cornu apice emarginatum. Thorax prominentiâ inter fossulas laterales quadrispinosâ, spînis externis majoribus.

Mus. D. MacLeay.

Sexus alter adhuc latet.

Habitat in Braziliâ.

OBS. 9. Insectum *Phanæo Columbi* affinitate proximum, quod ab illo capitis cornu apice simplici, thorace antice bispinoso et lineâ utrinque elevatâ ad angulos porrectâ subcorniculatâ solum differt, in Musæo MacLeayano hospitatur.—An sexus alter?

OBS. 10. In *Phanæi Columbi* tibiis anticis sub spinâ ad apicem articulatâ tarsorum rudimentum latitans, singulare, minimum, vix conspicuum, articulatum, et ad apicem ciliis duabus gracillimis longissimis instructum detexi.

TYPUS 4. Clypeus antice subemarginatus. Thorax margine postico acuto, lobo magno, punctis duobus posticis omnino deperditis. Pectus haud vel vix canaliculatum in sternum acutum recurvum inter pedes productum. Tibiæ anticæ extus tridentatæ, dentibus apicalibus acutis, altero obtuso vel subobsoleto.

MAS cornutus.

FEMINA mutica.

SPEC. 8. *Phanæus festivus.*

P. rubro-æneus, thorace glaberrimo anticè prominente.

Scarabæus festivus. *Oliv. Ins.* 1. 3. 110. 127. tab. 8. fig. 21.

Copris festivus. *Fab. Syst. Eleuth.* 1. p. 32. 5. 10.

MAS capitis cornu erecto ad planum dorsi pertingente, thorace bicorni, medio inter cornua compressa nigra intus recurva elevato, subcanaliculato, antice haud excavato.

FEMINA capite lineâ transversâ elevatâ, thorace mutico nigro maculato antice prominentiâ triplici; intermediâ latiore, lineâ transversâ elevatâ angulum ad apicem formante.

Scarabæus festivus. *Linn. Syst. Nat.* 2. 552. 52.

Mus. D. MacLeay.

Habitat in Americâ meridionali.

OBS. 11. In hujus insecti feminâ tarsorum anticorum rudimentum iterum detexi.

OBS. 12. *P. festivi* apud Linnæum, Fabricium, Olivierum ac alios character specificus malè depromptus est, hæc enim species adeò facillime cum duabus sequentibus concoloribus erat confundenda.

SPEC. 9. *Phanæus hilaris.*

P. rubro-æneus thorace glaberrimo, antice excavato.

MAS capitis cornu erecto ad dorsi planum haud pertingente, thorace bicorni, medio inter cornua compressa nigra maculâ nigrâ conjuncta haud intùs curvata, antice excavato.

FEMINA capite lineâ transversâ bituberculatâ instructo; thorace antice excavato bimaculato, maculis nigris.

Mus. D. MacLeay.

Habitat in Demerarâ.

SPEC. 10. *Phanæus lautus.*

P. rubro-cupreus, thorace antice punctato prominente.

MAS capitis cornu recurvo, thorace retuso nigro maculato antice prominentiâ triplici, intermediâ latiore lineâ transversâ elevata semicirculari ad apicem instructâ.

Femina capite bituberculato, thorace nigro maculato antice prominentiâ quadruplici instructo intermediis acutioribus.

Mus. D. MacLeay.

Habitat in Braziliâ.

Obs. 13. *Phanæi lauti* mas, nisi thorace antice punctato, capite cornuto et colore rubro-cupreo a *Phanæi festivi* feminâ vix differt.

Obs. 14. Ad *Phanæos festivum, hilarem* et *lautum, conspicillatus* Fabricii et Humboldtii adjungendus.

TYPUS 5. Clypeus integer rotundatus. Thorax abdomine haud latior, margine postico acuto, vix lobato, punctis posticis interdum in mare vix unquam in feminâ prorsus obsoletis. Pectus canaliculatum, antice acutissimum, haud productum. Tibiæ extus tridentatæ, dentibus distinctis.

Mas cornutus.

Femina mutica.

Spec. 11. *Phanæus Carnifex.*

P. thorace cupreo-aurato: rugis distinctis elevatis; punctis posticis in mare obsoletis in feminâ distinctis, elytris viridi-æneis multipliciter striatis: rugis elevatis confluentibus inter strias scabris.

Scarabæus Carnifex. *Linn. Syst. Nat.* p. 546. no. 22.

——————— *Oliv. Ins.* 1. 3. p. 135. n. 161. p. 6. f. 46. a. 6.

——————— *Drury Ins.* 1. p. 35. f. 3—5.

Copris Carnifex. *Fab. Syst. Eleuth.* 1. p. 48. n. 84.

Mas capitis cornu longitudine thoracis incurvato acuto, thorace depresso inermi plano medio triangulari: angulis posticis productis subacutis.

Femina capitis cornu brevissimo emarginato, thorace convexo antice truncato lineâ transversâ elevatâ instructo.

β. Var. thorace viridi-æneo ac elytris violaceis.

Mus. D. MacLeay.

Habitat in Americâ septentrionali.

OBS. 15. Apud Olivierum figura 86, tab. 10, hanc ad speciem haud pertinet, at insecto *P. splendidulo* Fab. affini forsan est assimilanda.

OBS. 16. *Phanæi Carnificis* characteres ità recensui, ut varietatibus à sequentibus vix speciebus facilius dignosceretur.

Phanæus vindex?

P. thorace cupreo-aurato suprà bicorni: inter cornua lineâ elevatâ transversâ; rugis distinctis elevatis; punctis posticis in utroque sexu obsoletis, elytris viridi-æneis multipliciter striatis.

MAS capitis cornu brevissimo haud capitis longitudine acuto vix recurvo, thorace bicorni medio subexcavato: cornubus compressis obsoletis.

Scarabæus Carnifex var. *Drury Ins.* 1. p. 35. f. 4.

FEMINA capite tuberculato: tuberculo transverso, thorace supra subexcavato quadrato.

Mus. D. MacLeay.

Habitat in Americâ boreali, *P. Carnifici* nimis affinis.

Phanæus igneus?

P. thorace cupreo-aurato: rugis inconspicuis elevatis: punctis posticis in mare saltem distinctis, elytris viridiæneis inter strias punctis impressis.

MAS capitis cornu capitis longitudine incurvato obtuso, thorace depresso plano: angulis lateralibus posticis in cornua compressa intus subcurvata productis.

Mus. D. MacLeay.

FEMINA adhuc latet.

Habitat in Georgiâ Americæ borealis.

OBS. 17. His *C. splendidulus* Fabricii ac *C. floriger* Kirbii associandi, sed a quinto formæ typo longiùs recedentes per alias species adhuc ineditas ad *P. bellicosum* Entomologum denuo reportant.

OBS. 18. Phanæus omnis his quinque typis facile referendus est; ac circulus undique connexus ita formatur quem ut suprà e triginta speciebus in musæo MacLeayano asservatis sedulo evolvi. En naturæ arboris dichotomi corpora omnia proferentis terrestria organica ex ramusculis extremis aspicias unum!

Obs. 19. Si genus Circulum undique connexum significare valeat, tum præterea si omnis divisionis generici cogitatio ex animo extirpata fuerit Phanæum pro genere aliquatenus naturali oporteat haberi. Si vero genus contrà pro divisione sit habendum, quis Phanæo terminos præscribet?

Obs. 20. *P. Carnifex* formatam e stercore pilulam conjunctis viribus per totam æstatem usque in foveam determinatam volvere ac volutare apud Linnæum dicitur; An omnium Phanæorum mores ab uno discantur?

Obs. 21. Insecta quæ Phanæi circulo proximè accedunt, formâ vero quæ distinctâ fruuntur sunt *Copris Carolinus* Fab. *C. Hesperus* Oliv. *C. Nisus* Oliv. *C. tridens* Fab. ac *Onitis Bison* Fab.

Genus. Scarabæus, *Linné.*

Scarabæus, *Linn. DeGeer. Oliv.* Copris, *Geoff.* Ateuchus, *Web. Fab. Lat.* Actinophorus, *Sturm.*

Antennæ articulis novem, articulo primo cylindrico, ad apicem et ad basin paulo crassiore, secundo subconico, tertio, quarto, quinto et sexto duobus ultimis præsertim brevibus, tertio et quarto subconicis, quinto et sexto pateræformibus, septimo, octavo et nono capitulum ovatum subcompressum transversum formantibus, septimo pateræformi alios fere includente.

Labrum subquadratum, ad apicem subacutum, angulis anticis rotundatis.

Mandibulæ ad basin tricuspidatæ, deinde in laminam vix concavam, trigonam, externe corneo-coriaceam, intus coriaceo-membranaceam productæ, latere interno et apice villis brevibus fimbriatæ.

Maxillæ laciniâ apicali multo majore subquadratâ, margine externo subarcuato fimbriato; lobo interno dentiformi acuto.

Palpi Maxillares articulo basilari minimo, secundo et tertio obconicis, secundo majore, externo ovali cylindrico longissimo, secundo fere duplo longiore. Labiales menti ad angulos superos inserti, articulo basilari subconico vix secundo majore, sed aperte longiore quam latiore, latere interno arcuato.

Labium laciniis subtrigonis.

Mentum subquadratum, lateribus convexis.

Clypeus subtrilobus, lobo medio latiore emarginato, utrinque bidentato. Corpus depressum, elytrorum margine externo post humeros nec profunde nec abrupte sinuato. Pedes villosi, tibiis anticis extus quadridentatis; posticis ad apicem oblique truncatis, inde tarsis illarum lateribus posticis insertis; tibiarum earundem ipso apice cum calcare in spinam validam producto, tarsorum dimidii ad minus longitudine.

SPEC. 1. *Scarabæus Sacer.*

S. obscuro-niger, occipite bituberculato, elytris sublævibus lineis sex impressis obsoletis.

Scarabæus Sacer. *Linn. Syst. Nat.* ed. 13. vol. i. p. ii. p. 545.
————— *Oliv. Ent.* vol. i. no. 3. tab. 8. fig. 59.
Ateuchus Sacer. *Fab. Syst. Eleuth.* tom. i. p. 54.
————— *Lat. Gen. Ins. et Crust.* vol. ii. p. 77.

Habitat in Europâ australiori, Africâ.

Mus. D. MacLeay.

OBS. 1. Hoc genus circuli nondum examinati partem forsan constituens, prorsus artificiale videtur, at sic fere omnia!

A Fabricii Ateuchis genera Gymnopleurum et Canthonem jamdudum separavit Cel. Illiger; illa autem insecta Coprophaga *clypeo radiato* celeberrima Scarabæi nomine sola dignatus sum. Tertiæ apud Latreillium *Gen. Crust. et Ins.* vol. 2. p. 78. sectionis Ateuchi *Pilularius* Linn., &c. nomen retineant.

Fam. APHODIIDÆ.

Locum inter Scarabæidas et Trogidas Aphodiidarum verum generum anatomiâ indicari vix opus est, Ægialiæ enim apud Latreillium (*Gen. Ins. et Crust.*) et Psammodii characteres apud Gyllenhallum consuluisse sufficiat.

Fam. TROGIDÆ.

Genus. ACANTHOCERUS.

TROX, *Fabricius.*

Antennæ decem-articulatæ, articulo basilari crasso triangulari, uno angulo antico in spinam acutam producto, altero truncato, articulum secundum parvum subconicum recipiente; capitulo ut in Troge articulis divergentibus fere pectinato.

Labrum deorsum spectans, exsertum, transverso-quadratum, margine antico vix emarginato.

Mandibulæ exsertæ, corneæ, validæ, oblongæ, crassæ, subpentagonæ, supra concavæ latere externo rotundato; apice exteriori subacuto, interiori unidentato, margine interno ciliato.

Maxillæ intus ad basin corneæ unidentatæ, laciniâ terminali membranaceâ, dilatatâ, quadratâ vel subrotundatâ, intus ciliatâ.

Palpi Maxillares articulo basilari minutissimo, secundo, tertio et quarto subconicis, hoc longissimo cylindrico apice obtuso. Labiales breves, articulis secundo et tertio subconicis.

Mentum quasi e duplici parte formatum, aliâ apicali cordatâ ad basin truncatâ, carinatâ, margine antico emarginato, lateribus rotundatis, elevatis; alterâ prioris stipite transversâ concavâ, margine antico recto, lineari.

Clypeus porrectus subquadratus, margine antico lobato, lobo subacuto. Os sub capite latitans, instrumentis cibariis verticalibus. Corpus ovatum, valde convexum, elytris abdomen globosum longe obtegentibus. Thorax lunaris, margine postico semicirculari, vel angulis posticis emarginatis. Scutellum magnum, distinctum. Pedes, postici præsertim, magni, lati, compressi, subcontractiles; tibiis extus arcuatis, basi angustioribus, fere acutis; anticis vix extus dentatis, alteris inermibus. Tarsi graciles, quatuor posticis pone tibias reflexis latitantibus.

OBS. 1. Genus antennarum formâ et habitu generali Trogidis sane affine, cum illis ergo recte ponendum. Maxillarum vero structura mandibulæque exsertæ Hybosori propinquitatem haud parvam satis demonstrant, dum clypeo instrumenta cibaria occultante et situ oris verticali Elephastomo aliquatenus quoque Acanthocerus conferatur. An subdivisio bina circularis rursus nobis in suspicionem sit adducenda? Ulterius jam progredi nequeo licet conjecturam supradictam aliquantulum confirmaverit hujus insecti singularis anatomia.

SPEC. 1. *Acanthocerus æneus.*

A. æneus, antennis corporeque subtus ferrugineis, capite antice punctato postice cum thorace glaberrimo, elytris punctato-striatis: punctis elevatis rarissimis vix distinctis, pedibus obscure æneis.

Habitat in Americâ boreali.

Mus. D. MacLeay.

OBS. 2. *Trox spinicornis* Fab. Syst. Eleuth. vol. i. p. 112. huic generi associandus.

Genus. PHOBERUS.

TROX, *Fab. Oliv.*

Antennæ decem-articulatæ, articulo basilari triquetro-trigono, magno, crasso, piloso, secundo oblongo globoso, tertio conico graciliore, quarto, quinto, sexto et septimo pateræformibus.

Labrum subsemicirculare, crustaceum, antice vix emarginatum, ciliatum, lateribus rotundatis.

Mandibulæ validæ, breves, crassæ, triquetro-trigonæ, arcuatæ, inermes, apice acutissimæ.

Maxillæ hirsutæ, processu interno spinis duabus hirsutis elongatis, intùs arcuatis, acutis, armato; terminali coriaceo-membranaceo, vel potius pilis longissimis instructo.

Palpi Maxillares articulo secundo conico, tertio breviori conico, ultimo cylindrico ovato. Labiales breves, articulo ultimo cylindrico ovato, aliis subcrassiore.

Mentum breve, subquadratum, margine antico truncato, ciliato, et lateribus convexis.

Caput semicirculare. Corpus convexum, apterum, subtus planiusculum. Thorax scabriusculus, caput excipiens, marginibus lateralibus dilatatis; scutello haud distincto. Elytra abdomen longe obtegentia. Tibiæ anticæ vix dentatæ.

Obs. A Troge instrumentis cibariis et corpore aptero distinctum, sed ad circulum eundem certe pertinens.

Spec. 1. *Phoberus horridus.*

P. ater, thorace elytrisque spinosis: his striis quinque spinosis margineque ciliatis.

Trox horridus. *Fab. Syst. Eleuth.* vol. i. p. 111.

——————— *Oliv. Ins.* 1. 4. 5. 1. tab. 1. fig. 2.

Scarabæus pectinatus. *Pall. Icon.* 1. p. 10. tab. A. fig. 10.

Habitat ad Caput Bonæ Spei.

Mus. D. MacLeay.

Genus. Cryptodus.

Antennæ dum contrahuntur ut in Troge sub thoracis lateribus inflexæ, novem-articulatæ, articulo basilari glabro, dilatato, triquetro-trigono, reliquos usque ad clavam operiente, articulo sexto vix distincto, septimo vel capituli primo dilatato, subconico, duobus aliis dilatatis.

Labrum corneum, semicirculare, margine solum exsertum.

Mandibulæ nec validæ nec crassæ, triquetro-trigonæ, arcuatæ, apice acutissimæ, ad basin sinu interrupto unidentatæ.

Maxillæ glabræ, corneæ, validæ, processu terminali spinis duabus glabris elongatis intus arcuatis acutissimis instructo; laciniâ internâ, loco ciliarum præcedentis generis, spinis tribus minutissimis acutis nunc armatâ.

Palpi Maxillares fere omnino ut in Phobero. Labiales mento absconditi, intus labii ad latera inserti, articulo ultimo duobus aliis conjunctim multo longiore, conico-cylindrico, gracili, subobtuso, stipite conico.

Labium membranaceum, pilosum, mento prorsus absconditum, processubus duobus formatum; primo menti ad perpendiculum in stipite affixo, subquadrato, marginibus emarginatis; secundo sicut ferrum equinum brachiis duobus horizontalibus instructo, membranaceis, ciliatis; omni ita galeam reversam aliquantulum simulante.

Mentum maximum, instrumenta cibaria, labri margine excepto, omnino occultans, subpentagonum, antice convexum, angulis subacutis, lateribusque sinuatis.

Caput planum, ut in Coprophagis subsemicirculare. Corpus ut in Phileuro glabrum, depressum, oblongo-ovatum. Thorax transverso-quadratus. Scutellum distinctum triangulare. Elytra abdomen postice haud occultantia. Tibiæ anticæ extus tridentatæ.

Obs. Genus valde anomalum, forsan osculans, Trogidarum antennis mandibulis et maxillis etsi formâ prorsus novâ et singulari indutis dotatum; huic igitur familiæ Cryptodus associandus quamvis mento labroque omnino differt, Passalisque habitu generali et maxillis appropinquare potius videatur.

Spec. 1. *Cryptodus paradoxus.*

C. ater punctis impressis scaber, capite bituberculato, elytris inter strias elevatas punctis excavatis cum aliis minutissimis ornatis.

Habitat in Australasia.

Mus. D. MacLeay.

Genus. MÆCHIDIUS.

TROX, *Kirby.*

Antennæ novem-articulatæ, articulo basilari magno, elongato conico, secundo brevi conico, tertio graciliori conico, quarto brevissimo, quinto et sexto pateræformibus; capitulo ovato, lamellis lanceolatis acutis.

Labrum crustaceum, antice concavum, margine fere ut in Melolonthidis emarginato.

Mandibulæ ut in Troge breves, triquetro-trigonæ, extus arcuatæ apice acutæ, intus inermes.

Maxillæ ut in Melolonthidis crustaceæ, sinuatæ, apice multidentatæ.

Palpi Maxillares articulo secundo conico, tertio vix breviori, externo cylindrico apice truncato. Labiales brevissimi.

Mentum magnum, lateribus truncatis, quasi e duplici parte formatum, hac stipitali, aliâ terminali inflexâ antice emarginatâ.

Caput subsemicirculare, haud transverse suturatum, clypeo antice emarginato, oculos haud ambiente, margine reflexo. Os labri et menti concursu omnino clausum. Corpus oblongum, ovatum, glabrum, depressum, elytris postice non opertum. Thorax transversus, subconvexus, antice emarginatus, lateribus convexis, margineque postico truncato vix obtusangulo. Scutellum triangulare. Pedes validi, ut in Troge, subcompressi, tibiis anticis extus tridentatis.

SPEC. 1. *Mæchidius spurius.*

M. oblongus scaber subcinereus, elytris seriatim papillatis.

Trox spurius. *Kirby, Linn. Trans.* v. 12. p. 462.

Habitat in Australasiâ.

Mus. D. MacLeay.

OBS. Hoc insectum inter Trogem et Melolontham intermedium, et forsan proprio generi esse celeberrimus Kirby primus observavit. Non equidem dubito quin Trogidis propius sit existimandum.

Fam. DYNASTIDÆ.

Genus. DASYGNATHUS.

Antennæ decem-articulatæ, articulo basilari longiusculo, septimo minutissimo, pateræformi.

Labrum membranaceum, clypeo penitus occultatum, margine antico transverso, bilobo, crustaceo, pilis longis instructo.

Mandibulæ corneæ, compressæ, breves, cultelliformes, supra planæ, superficie inferiori inæquali, margine externo rotundato piloso, interno membranaceo vel fimbriâ instructo.

Maxillæ breves, caule crustaceo valido, subtrigono, processu apicali penicilliformi, vel e setis longiusculis formato.

Palpi Maxillares crassi, articulis secundo et tertio conicis, extimo ovato aliis crassiore et longiore apice subobtuso.

Mentum subquadratum, valde convexum, setis rigidis munitum, lateribus rotundatis, margine antico depresso, emarginato, angulis acutis.

Caput subquadratum, haud transverse suturatum, clypeo porrecto, lateribus rotundatis, margine reflexo crassiusculo. Corpus subtus pubescens, oblongum, ovatum, haud elytris postice obtectum. Thorax marginatus. Scutellum parvum, apice rotundatum. Pedes validi, tibiis anticis extus tridentatis.

SPEC. 1. *Dasygnathus Dejeanii.*

D. nigro-brunneus, subtus pilis ferrugineis opertus, clypeo antice punctato, thorace glabro, elytris profunde striatis ad latera scabriusculis: striis obsoletis, ano punctato glabro.

Habitat in Australasiâ.

Mus. D. MacLeay.

In honorem Dom. Baronis Dejean Galli, qui inter bella externa discordiasque civiles scientiæ deditus, Europæ entomologiam omnis indagavit, solertissimus cultor ac observator acutus.

Obs. In Petalocerorum maxillis examinandis hujusque generis præsertim, quam facile et gradatim dentes maxillares spinarum spinæque rursus ciliarum se formâ induant, Tyronibus operæ pretium sit observare.

B. *THALEROPHAGA.*

Pedes plerumque graciliores, posticis ab aliis æque dissitis; elytra sæpius ad anum haud pertingentia.

Fam. ANOPLOGNATHIDÆ.

Genus. Amblyterus.

Antennæ decem-articulatæ, articulo basilari setoso, secundo, tertio, quarto et quinto globosis, sexto et septimo brevibus pateræformibus.

Labrum crustaceum, hirsutum, exsertum, antice sub lobum deflexum.

Mandibulæ corneæ, breves, validæ, subtrigono-triquetræ, supra planæ, extus arcuatæ, pilosæ, vix emarginatæ, margine interno sub-bidentato.

Maxillæ crustaceæ, subcylindricæ, apice obtusæ, pilosæ, et dentibus minutissimis instructæ.

Palpi Maxillares graciles, articulis secundo et tertio conicis, externo lanceolato, aliis conjunctim longiore, apice subacuto. Labiales articulo ultimo ovato crasso.

Mentum subquadratum, valde hirsutum, convexum, medio antice producto, depresso, truncato, angulis rotundatis palpigeris.

Caput subquadratum, transverse suturatum, clypeo antice rotundato, margine subreflexo. Corpus ovatum, elytris postice non opertum, scutello magno triangulari. Sternum non productum. Pedes validiusculi, tibiis anticis extus tridentatis.

Spec. 1. *Amblyterus geminatus.*

A. brunneus subtus pilis testaceis obtectus, clypeo thoraceque punctatis æneo-olivaceis, scutello glabro æneo, elytris æneis brunneis punctatis: seriebus quatuor punctorum per paria ordinatis, ano hirsuto, pedibus æneis pilosis.

Habitat in Australasiâ.

Mus. D. MacLeay.

Obs. Hoc in genere ad Rutelidas fere attinente Pelidnotæ mandibulas et mentum cernamus, dum instrumentis cibariis Chasmodiæ propinquare habeatur Dasygnathus. Haud tamen necesse duco Dynastidarum affinitatem cum Amblytero jam ulterius præferre, quum genera inter se habitu generali quam maxime cohærentia efformant.

Genus. ANOPLOGNATHUS, *Leach.*

Antennæ articulis decem, basilari conico, crasso, secundo subgloboso, quatuor proximis subconicis, septimo pateræformi brevissimo, capituloque elongato semi-ovato piloso.

Labrum corneum transversum, antice medio acuminatum.

Mandibulæ breves, subcompressæ, validæ, subtrigonæ, basi crassæ, apice obtusæ, edentulæ, integerrimæ, extus convexæ, intus acutæ, margine concavo.

Maxillæ mandibuliformes, plane inermes, validæ, corneæ, subtrigonæ, fornicatæ, apice obtusæ, subemarginatæ.

Palpi Maxillares subclavati. Labiales breves, articulo secundo brevissimo, externo ovato, vix ultra mentum prominulo.

Mentum subquadratum, ad basin utrinque emarginatum, angulis palpigeris, in medio processu porrecto subreflexo munitum.

Caput subquadratum, transverse suturatum, clypeo in fœminis semper rotundato semicirculari, sed in maribus interdum angulato, margine antico in uno et altero sexu reflexo. Corpus sub-convexum, ovatum, ano nudo saltem in uno sexu. Sternum sæpius ad pedum primi paris originem acute productum. Pedes validissimi, tibiis anticis in maribus saltem vix extus tridentatis, tarsorum unguibus indivisis et inæqualibus.

In duas divisiones commode distribui potest Anoplognathi genus.

* *Menti apice sub-acuto recurvo.*

Mas clypeo producto subrostriformi, lateribus late emarginatis, antice truncato, convexiusculo, margine reflexo.

Femina clypeo semicirculari.

Spec. 1. *Anoplognathus viridi-æneus.*

Anoplognathus viridi-æneus punctulatus, elytris basi punctatis: punctis in strias subdigestis, pedibus castaneis, tarsis nigris.

A. viridi-æneus. *Leach, Zool. Miscellany,* vol. 2. p. 44.

Melolontha viridi-ænea. *Don. Ins. New Holl.*

Habitat in Novâ Hollandiâ. Mus. D. MacLeay.

Obs. *A. viridi-tarsis* Leach, *rugosus* Kirby, *inustus* Kirby, huic generis sectioni associandi.

* * *Menti apice truncato subrecurvo. Genus* Repsimus, *Leach, MSS.*

Maris femora et tibiæ valde sunt incrassatæ, at clypeus in utroque sexu semicircularis. In his a sectione priore differentiæ cardo præcipue vertitur.

Spec. 2. *Anoplognathus Dytiscoides.*

A. niger nitidissimus, clypeo atro subrugoso: punctis duobus postice impressis, thorace atro-ferrugineo, elytris glaberrimis atris, corpore subtus nigro pilis albidis ad abdominis latera præsertim hirsuto, pedibus rufis, tarsis nigris.

Habitat in Australasiâ. Mus. D. MacLeay.

Spec. 3. *Anoplognathus Brownii.*

A. rufus nitidissimus, capite nigro rugoso postice haud bipunctato, thorace rufo, elytris brunneis glaberrimis, corpore subtus nigro pilis albidis ad abdominis latera præsertim hirsuto, pedibus rufis, tarsis nigris.

Botanicorum hodiernorum principi hanc speciem dicavi præcedenti nimis affinem ab illo in Australasiâ lectam, et meo cum patre amicissime communicatam.

Obs.—Secundam Anoplognathi sectionem novum esse genus sibi persuasum habet vir in scientiâ naturali omni celeberrimus, Entomologiâ præcellens, D. Leach; nec mihi quidem displicuisse hujus sententiam putari vellem, parvi quoniam plane interest utrum diligentiâ observentur divisiones artificiales, an cuique liceat eas contemnere. Si vero ordinem præcedentem ad pulcherrimam sectionum affinitatem inter se exponendam aptiorem fuisse habuerim, Entomologi adeo in errorem duci minus quam in veritatem mihi videntur.

Genus. Leucothyreus.

Antennæ decem-articulatæ, articulo primo conico, piloso, secundo sub-globoso, articulis tertio et quarto longiusculis, cylindricis, gracillimis, septimo brevissimo pateræformi; capitulo semi-ovato piloso.

Labrum magnum antice lobatum, lobo vix obtuso.

Mandibulæ breves, subtriquetro-trigonæ, supra planæ, apice crassiores, integræ, obtusæ, extus arcuatæ, pilosæ, intus subacutæ.

Maxillæ mandibuliformes, validæ, breves, vix arcuatæ, sed medio quasi fractæ, apice obtusæ, subbidentatæ.

Palpi Maxillares subclavati; Labiales brevissimi articulo ultimo vix ultra mentum obvio.

Mentum transversum, subquadratum, basi palpigerum, medio antice producto; processus hujus apice crasso, vix recurvo, profunde emarginato.

Caput subquadratum, transverse suturatum, clypeo semicirculari, margine reflexo. Corpus oblongo-ovatum convexiusculum; thoracis lateribus sinuatis; sterno haud producto. Pedum femora haud incrassata; tibiis anticis extus vix tridentatis. Tarsorum ex unguibus unus indivisus alter bifidus.

Spec. 1. *Leucothyreus Kirbyanus.*

L. capite thoraceque æneis punctatis; hoc utrinque squamis albidis asperso, elytris viridi-brunneis haud nitidis obsolete punctatis; lineis quatuor subelevatis, scutello albido squamis obtecto, corpore subtus cupreo; lateribus albido-squamosis, ano scabriusculo lituris duabus albo-squamosis, pedibus æneis.

Habitat in Braziliâ. Mus. D. MacLeay.

Ob consilia mihi amicissime oblata, dixi in honorem Dom. Kirby, qui opere nunquam nimis laudando *Monographiâ Apum Angliæ* nomen Anglicanum in summa scientiæ naturalis fastigia attulit.

Obs. Ex Leucothyreis in Geniatem ac alia Anoplognathidarum genera maxillis multidentatis facili gradu ducimur.

Fam. MELOLONTHIDÆ.

Genus. Serica.

Scarabæus, *Linn.* Melolontha, *Fab. Oliv. Lat.*

Antennæ articulis decem, basilari crasso clavato piloso, secundo globoso, tertio et quarto subcylindricis brevibus, quinto conico, sexto et septimo pateræformibus, hoc vix distincto; capitulo trilamellato, maris valde elongato angusto.

Labrum emarginatum, pilosum.

Mandibulæ brevissimæ, crassæ, trigono-triquetræ.

Maxillæ mandibulis duplo longiores, trigono-triquetræ, intus ad apicem sexdentatæ, caule subquadrato, margine interno recto.

Palpi Maxillares, articulis omnibus præter extimum pilosis, hoc aliis conjunctim breviore, cylindrico, apice subacuto. Labiales articulis primo secundoque hirsutis, ultimo acutissimo, vix incurvo.

Mentum oblongo-quadratum, stipite convexo vel antice retuso; parte apicali carinâ vel lineâ elevatâ transversâ; margine antico emarginato.

Corpus breviter ovatum, convexum, elytris elongatis. Thorax brevissimus, transversus; scutello oblongo-triangulari. Pedes tenues, tarsis longissimis, unguibus æqualibus ad apicem bifidis; dente supero graciliore, longiore, acuto.

SPEC. 1. *Serica brunnea.*

S. rufo-testacea glabra, clypeo punctato: vertice plerumque nigricante, thorace vix punctulato: puncto utrinque obsoleto fusco, elytris obsolete punctato-striatis.

Melolontha brunnea. *Fab. Syst. Eleuth.* ii. 170. 54.

Scarabæus brunneus. *Marsh. Ent. Brit.*

Scarabæus brunneus. *Linn. Syst. Nat.* ii. 556. 72.

Habitat in Europæ sabulosis.

Genus. EUCHLORA.

MELOLONTHA, *Fab. Oliv.*

Antennæ articulis novem, basilari conico elongato, secundo, tertio, quarto, quinto et sexto brevibus subglobosis; capitulo ovato, triphyllo, elongato, antennarum longitudinis totius haud dimidium æquante.

Labrum prominulum, clypeo fere absconditum, margine antico lineari, ciliato, emarginato, lateribus rotundatis.

Mandibulæ latitantes subtrigonæ supra planæ, latere externo rotundato, interno ciliato ad apicem tridentato.

Maxillæ caule subtrigono-triquetro, ad apicem inflexæ sexdentatæ.

Palpi Maxillares articulo terminali cylindrico ovato. Labiales articulis secundo et ultimo longitudine æqualibus, hoc subulato.

Mentum subquadratum, margine antico emarginato, angulis truncatis rotundatis ac lateribus sinuatis, postice valde convexis.

Caput subquadratum, clypeo lateribus rotundatis, margine reflexo. Corpus ovatum convexum, postice elytris haud opertum. Thorax subquadratus, ad basin duplo longior quam latior, latere postico sinuato vix lobato. Scutellum parvum cordato-truncatum. Sternum haud productum. Pedes validiusculi tibiis anticis bidentatis. Tarsorum ungues posticorum indivisi, reliquorum ex unguibus unus bifidus alter indivisus.

SPEC. 1. *Euchlora viridis.*

E. glabra punctata supra viridis subtus cupreo-aurata, pedibus cupreis.

Melolontha viridis. *Fab. Ent. Syst.* ii. 160. 23.

Melolontha viridis. *Oliv. Inst.* i. 5. 29. 31. tab. 3. fig. 21. b.

β. Var. Elytris cupreo-marginatis.

Habitat in Chinâ. Mus. D. MacLeay.

SPEC. 2. *Euchlora Jurinii.*

E. nitidissima punctata supra viridi-olivacea subtus viridi-cuprea, thorace utrinque punctis duobus impressis, pedibus viridibus.

Habitat in Javâ.

Mus. D. MacLeay.

Dixi in honorem illius Entomologiæ magistri præcellentis D. Jurine apud Genevenses anatomiæ artisque chirurgicæ doctissimi professoris.

OBS. 1. En genus Asiaticum Areodæ proximum, speciebus e pluribus constans, quod a Melolonthidis quidem mandibulis extus integris sub clypeo latitantibus, maxillis sinuatis, et sterno haud producto, a Rutelidis contra labro tenui prominulo, et mento subquadrato vix retuso haud longe distat. Hîc igitur inter Petalocera Thalerophaga subdivisio duplex eadem quam circulos duos inter Saprophaga jam formantem observavimus, facile discernatur.

OBS. 2. Inter Euchloræ genus et *Rutelam ignitam* Oliv. *Cyanipedem* K. &c. veniunt *Cetonia Macropus* K. (Anglice, *Kangaroo Beetle*) et *Melolontha chrysochlora* Humboldt. Obs. de Zool. et d'Anat. Comp.

Genus. CHALEPUS.

SCARABÆUS, *Voet.* MELOLONTHA, *Fab. Oliv.* GEOTRUPES, *Schönherr.*

Antennæ quasi fractæ, articulis decem, basilari subconico vel potius antice lobato, secundo subgloboso minuto, sexto septimoque majoribus pateræformibus; capitulo triphyllo, subcompresso elongato ovato.

Labrum sub clypeo latitans, margine antico lunari vix obvio, infra subemarginato.

Mandibulæ ad basin crassæ, triquetro-trigonæ, extus arcuatæ, apice acutæ, intus inermes.

Maxillæ crustaceæ, validæ, elongatæ, subcompressæ, vix sinuatæ, apice sexdentatæ, dentibus brevibus validis corneis.

Palpi Maxillares articulo primo vix distincto, secundo subconico, tertio breviori conico, ultimo elongato cylindrico ovato, ad apicem basinque graciliore. Labiales breves ad menti loborum dorsa inserti, articulo primo gracili conico, secundo breviore crassiore conico, extimo cylindrico ovato.

Mentum subquadratum, versus apicem utrinque paulo angustatum, margine supero profunde emarginato, lobis subrotundatis—Supra convexum, margine postico emarginato vel potius excavato.

Caput subquadratum vel trapezoide, transverse suturatum, clypeo antice truncato vix emarginato. Corpus subconvexum, thorace transverso lateribus convexis, margineque postico truncato. Sternum non productum. Elytra abdomen haud obtegentia. Tibiæ anticæ extus tridentatæ.

SPEC. 1. *Chalepus geminatus.*

C. nigro-piceus nitidus, capite thoraceque punctatis, elytris punctato-striatis: striis geminatis interstitiisque punctatis.

Scarabæus fimosus Surinamensis. *Voet. Ins.* 21. 140.

Melolontha geminata. *Fab. Syst. Eleuth.*

Melolontha dubia. *Oliv. Ent.* vol. i. no. 5. p. 32. tab. 3. fig. 20. *a. b.*

Geotrupes lugubris. *Schönherr. Synon. Ins.* vol. 1. p. 21. t. 2. f. 1. a.

Habitat in Americâ meridionali. Mus. D. MacLeay.

Obs. 1. A synonymiâ laudatâ nomen derivatur genericum. *M. geminatam* Fab. Syst. Eleuth. suæ *Apogoniæ gemellatæ* congenericam esse suspicatur Cl. Kirby, Linn. Trans. v. xii. p. 404. Familiis autem diversis hæc insecta, nisi fallor, distribuenda sunt; descriptione enim apud Fabricium et Schönherri Synonymiâ Insectorum collatis, *M. geminatam* pro novi generis typo Americani, Euchloram vel genera Rutelidarum extima Dynastidis annectentis esse habendam mihi persuasissimum est; Apogonia vero Anoplognathidis apud Kirbium recte associata pro genere omnino Asiatico, hujus familiæ extremo, habeatur.

Obs. 2. Si faciem suam Heteromerorum personâ occultasse animo Chalepus fingatur, Hexodontis genus statim videbimus. Quod enimvero patri meo summâ benevolentiâ dedêre Musæi Gallici administratores doctissimi, auspice cel. Latreillio, illi exemplari antennæ desunt. Anatomiâ vero hujus insecti tam rari quam singularis reliquâ nuperrime perpensâ, Labro brevi corneo subemarginato; Mandibulis corneis crassis triquetro-trigonis arcuatis apice subacutis; Maxillis crustaceis, validis, elongatis, vix sinuatis apice sexdentatis; Palpis maxillaribus articulo primo minimo, secundo conico, tertio breviori conico, ultimo elongato, labialibus brevibus, articulo primo et secundo conicis extimo cylindrico ovato; Mento subquadrato margine supero emarginato; Capite subquadrato, clypeo antice truncato vix emarginato—Hæc omnia et adhuc alia Chalepi proximitatem satis mihi monstraverunt. Quoad corporis formam a Petaloceris Hexodon longe distat, illam Heteromerorum potius referens ut genus inter Asidam et Erodium ponendum primo intuitu prorsus esse videatur. Characteres enim procul dubio Pimelidis cum illo communes sunt, nempe, Caput thorace multo angustius, illius margine antico profunde emarginato intrusum, Oculi parvi, Elytra subtus inflexa dilatata corporis latera involventia, Scutellum breve, Pectus brevissimum fere nullum, cum corpore denique ipso suborbiculari supra convexo subtus plano. Quum vero hæc ipsa Trogidis quodammodo adsunt, inter Troges et Chalepum Hexodontis situm quasi temporarium, examine ulteriori si minus emendatione carentem eruditis offerre haud incautus vellem.

Fam. GLAPHYRIDÆ.

Interea dum hæc familia inter Melolontham et Cetoniam a Latreillio recte disponitur, genera quædam extrema vel horum potius typos *Amphicomam abdominalem* (Lat. Gen. Ins.) et *Trichium trilineatum* (Fab.) indicasse sufficiat.—Fateri autem oporteat hanc dicendi rationem nullas leges agnoscere posse, ideoque generum Petalocerorum Synopsi diutius esse attendendum.

Obs. Hic locanda sunt genera *Monochelus* Knoch et *Anthipna* Eschscholtz *Act. Acad. Imp. Scient. Petrop.* vol. vi. p. 472. quorum ultimum, monente Leachio, duas divisiones genericas Latreillianas Amphicomam et Anysonychem continere videtur.

Fam. CETONIIDÆ.

Genus. Platygenia.

Antennæ decem-articulatæ, articulo basilari magno crasso, conico, parum elongato, secundo subgloboso; sexto lato pateræformi; septimo brevissimo, vix distincto; capitulo subcompresso, elongato ovato.

Labrum clypeo penitus tectum, lato-transversum, subcordatum, submembranaceum, antice emarginatum, hirsutissimum.

Mandibulæ breves, basi crassæ, corneæ, latere externo producto, corneo, lanceolato, apice rotundato vel obtuso, membranâ subquadratâ, translucidâ, fimbriatâ intus auctæ.

Maxillæ laciniâ internâ subtrigonâ, dilatatâ, apice emarginatâ, setosâ; terminali fasciculis penicilliformibus elongatis instructâ.

Palpi Maxillares articulo secundo subgloboso, tertio subconico, extimo subovato cylindrico, apice obtuso. Labiales in ore sæpe latitantes, versus menti angulos inserti.

Mentum latissimum, subquadratum, in medio concavum, lateribus subemarginatis, margineque antico emarginato, subreflexo.

Caput quadratum; clypeo integro margine subreflexo. Corpus depressum, subtus vix pilosum, postice elytris haud opertum. Thorax latus depressus, lateribus convexis, margine postico truncato. Scutellum mediocre subtrigonum. Sternum non productum, pectore magno, medio hirsuto. Pedes validi; Tibiis anticis extus bidentatis, posticis intus hirsutissimis.

Obs. Genus inter Cetoniidas formæ singularis et habitus fere Saprophagi, nullo tamen modo Rectoceris accedens. At verbis quid opus est? Si Lucanis Cetoniidæ annectantur, actum est ilicet de omni ordine naturali.

Spec. *Platygenia Zairica.*

P. atra nitida, capite punctato, thorace glabro, elytris striatis, ano et corpore subtus atro-ferrugineis haud nitidis.

Mus. D. MacLeay.

Insectum in ripas Zairæ fluminis Africani insalubres a Domino Cranch, pro scientiis naturalibus et entomologiâ imprimis heu! quantum deflendo, nuper lectum.

Genus. Gymnetis.

Cetonia, *Fab. Oliv. Latr.*

Antennæ articulis decem, basilari subgloboso magno, clavâ triphyllâ ovatâ.

Labrum margine antico ciliato, emarginato, lateribus rotundatis.

Mandibulæ breves, processûs latere externi fere sinuato, apice obtuso vel rotundato.

Maxillæ laciniâ internâ membranaceâ, ciliatâ, processu terminali articulato, compresso, fimbriâ hirsutâ instructo.

Palpi Maxillares vix ultra maxillarum apicem productæ, articulis primo et secundo brevibus, penultimo conico, ultimo subcylindrico apice truncato. Labiales menti lateribus excavatis inserti, articulis duobus baseos conicis, externo longissimo ovato.

Mentum cordato-truncatum, ad basin et ad latera depressum, utrinque paulo angustatum, et lineis duabus elevatis angulum ad apicem formantibus instructum; margine antico profunde emarginato, lateribus rotundatis.

Caput subquadratum; clypeo supra irregulari. Corpus ovatum depressum, ad humeros latius, elytrorum margine externo ad basin abrupte sinuato. Thorax subtrigonus, antice angustior et truncatus, postice lobatus, lobo magno triangulari apice subobtuso. Scutellum minimum. Sternum tuberculiforme, vix ad pedum secundi paris originem obtuse productum. Pedes graciles tibiis anticis bidentatis, fere tridentatis, unguibus æqualibus indivisis. Scapulæ secundi et tertii pedum paris distinctæ.

SPEC. *Gymnetis nitida.*

G. viridi testacea, capite spinâ incumbente.

Scarabæus nitidus. *Linn. Syst. Nat.* ii. 552. 52.

Cetonia nitida. *Fab. Syst. Eleuth.* ii. 139. 24.

———————— *Oliv. Ent.* i. 6. 18. 14. tab. 3. f. 16.

Habitat in Americâ boreali.

Mus. D. MacLeay.

OBS. In speciebus quibusdam, genus proprium forsan efformantibus, scutellum prorsus evanescit.

Fam. RUTELIDÆ.

Formæ typi omnis inter Rutelidas mihi posthac præponendi tempus sit; pauca tamen quæ ad hanc familiam cognoscendam lectori utilia sint nunc præmonere licet.

Tres sunt Rutelæ typi apud Cl. Latreillium, qui tot genera adeo indicasse dicatur.

1. *Melolontha punctata*, Fab.

Cetonia ignita (Oliv.) et *R. cyanipes* K. hoc cum insecto affinitatem haud levem habent, tametsi instrumentis cibariis, maxillis præsertim, illas differri suspicor.

2. *Cetonia Lineola*, Fab.

Genus quidem distinctum quod Rutelæ nomen retineat. Huic *Rutela pulchella* K. proprii generis insectum proximè accedit, at sic genericè dignoscatur.

Rutela Lineola. Mandibulæ intus tridentatæ.

Maxillæ breviores arcuatæ, ad apicem sexdentatæ at laciniis duabus majoribus vix instructæ.

Palpi maxillares articulo secundo et tertio fere eâdem longitudine, extimo elongato, ovato, apice truncato.

Mentum subquadratum, margine antico emarginato, angulis truncatis lateribusque vix sinuatis.

Rutela pulchella. Mandibulæ intus inermes.

Maxillæ elongatæ, rectiusculæ, ad apicem laciniis duabus tridentatis instructæ.

Palpi maxillares, articulo secundo longiore, extimo maximo, ovato lanceolato, apice subacuto.

Mentum oblongo-quadratum, margine antico emarginato, angulis anticis subacutis rotundatis, lateribus valde sinuatis.

A *Rutelá pulchellá*, nisi instrumentis cibariis nondum examinatis, *R. Liturella* K. vix longe recedat.

3. *Cetonia Chrysis*, Fab.

Huic formæ typo accedunt *Cetonia fucata* Fab., *smaragdula* Fab., *clavata* Fab., *lucida* Fab., *splendida* Fab., *lateralis* Oliv. &c. Alium adhuc typum quem Cel. Latreillius haud quidem cognoverat Chasmodiæ genus constituere putavi.

Obs. Hexodon genus est fere Saprophagum quod perperam Rutelidis associatum fuisse censeo.

Genus. Chasmodia.

Antennæ articulis decem, basilari magno, subarcuato, conico; secundo subgloboso; tertio longiore, subcylindrico; quarto, quinto, et sexto brevibus; septimo brevissimo pateræformi; capitulo ovato elongato.

Labrum porrectum, ciliatum, bifidum, laciniis rotundatis.

Mandibulæ validæ, corneæ, elongatæ, subtus canaliculatæ, latere externo profunde emarginato, extra clypeum eminulo, interno membranaceo ciliato, apice interno integro.

Maxillæ corneæ, bidentatæ, supra membranaceæ, ciliis productis penicilliformibus.

Palpi Maxillares, articulo tertio subgloboso, quarto ovato apice obtuso. Labiales graciles, ad angulos menti inserti, articulo extimo subacuto.

Mentum elongatum, concavum, lateribus sinuatis, vel ad palporum insertionem profunde excavatis, apice truncato maximo ciliato.

Caput subquadratum, clypeo profunde emarginato, margine reflexo. Corpus ellipsoide depressum; Thorax duplo longior quam latior; Scutello magno trigono. Sternum usque ad pedum primi paris originem productum haud acutum. Pedes validiusculi, tibiis anticis tridentatis, posticis subcompressis. Tarsi mediocres unguibus indivisis.

Spec. 1. *Chasmodia viridis.*

C. atro-viridis nitidissima glaberrima, thorace marginato, clytris obsoletissime striatis, ano et corpore subtus ad latera rugosis, femoribus et thorace subtus pilosis, tarsis nigris.

Habitat in Braziliâ.

Mus. D. MacLeay.

SPEC. 2. *Chasmodia bipunctata.*

C. nigro-castanea glaberrima subtus nigrescens, capite thoraceque brunneis; hujus margine flavescente, scutelli margine nigro, elytris castaneis obsoletissime striatis, ani nigrescentis punctis duobus abdominis segmentis ad latera et sterni apice flavescentibus, pedibus castaneis.

Habitat in Braziliâ.

Mus. D. MacLeay.

Genus. MACRASPIS.

SCARABÆUS, *Drury.* CETONIA, *Fab. Oliv.*

Antennæ clavâ magnâ oblongâ, longitudinis totius illarum haud dimidium æquante. Articulo basilari conico parum elongato.

Labrum transversum, margine antico subsemicirculari, exserto, coriaceo, integro, hirsuto, apice subacuto.

Mandibulæ subtrigonæ, compressæ, supra concavæ, latere externo eminulo, emarginato, vix bidentato, apice interno subemarginato.

Maxillæ intus margine membranaceo instructæ et ad apicem processubus duobus tridentatis corneis productæ.

Palpi Maxillares articulo extimo magno subgloboso ovato. Labiales articulo ultimo elongato ovato.

Mentum elongatum subquadratum concavum, lateribus sinuatis, apice truncato haud ciliato vix emarginato.

Caput subquadratum, clypeo rotundato margine reflexo. Corpus ellipsoide depressum; thorace duplo longiori quam latiori, latere postico emarginato. Scutellum maximum elongato-trigonum. Sternum ad capitis originem productum acutum. Pedes validiusculi, tibiis anticis tridentatis, posticis subcompressis; tarsorum ex unguibus unus indivisus alter bifidus.

SPEC. 1. *Macraspis quadri-vittata.*

M. atra nitida, thoracis margine omni elytrorumque vittis duabus flavis.

Scarabæus Cineta. (cinctus?) *Drury Ins.* 3. tab. 44. fig. 4.

Cetonia quadri-vittata. *Oliv. Ins.* 1. 6. 92. 7. tab. 8. fig. 65.

Cetonia fucata. *Ent. Syst.* 2. 145. 69.

Habitat in Americâ meridionali.

Mus. D. MacLeay.

SPEC. 2. *Macraspis bi-vittata.*

M. supra testacea nitida subtus nigra, capite fulvo lineâ transversâ nigrâ, thoracis duabus maculis scutelli fulvi margine elytrorum vittâ ac suturâ nigris, pedibus testaceis.

Habitat in Americâ meridionali.

Mus. D. MacLeay.

OBS. Speciem priorem ad animum revocans.

Genus. PELIDNOTA.

SCARABÆUS, *Linn.* MELOLONTHA, *Fab. Oliv.* RUTELA, *Lat.*

Antennæ articulis decem, basilari magno subarcuato conico; secundo subgloboso, tertio longiore subcylindrico, quarto, quinto et sexto brevibus, septimo brevissimo, pateræformi; capitulo ovato.

Labrum exsertum transversum, subsemicirculare, pilosum vel ciliatum, margine antico emarginato.

Mandibulæ subcompressæ, triquetro-trigonæ, supra planiusculæ, latere externo arcuato emarginato, intus ad apicem bidentatæ.

Maxillæ corneæ, crassæ, pilosæ, incurvæ, intus ad apicem sexdentatæ, dentibus acutissimis.

Palpi Maxillares articulo basilari brevi subcylindrico, secundo longiore, tertio breviore ad apicem crassiore, externo ovato subcanaliculato. Labiales breves articulo ultimo ovato.

Mentum breve quadratum, postice convexum vel retusum, lateribus sinuatis, margine antico emarginato angulis rotundatis.

Caput subtrigonum, haud transverse suturatum; clypeo rotundato obtuso margine reflexo. Corpus ovatum convexum postice elytris haud opertum. Sternum brevissimum subretusum. Scutellum mediocre semicirculare. Pedes validiusculi, tibiis anticis extus tridentatis, tarsorum unguibus inæqualibus.

SPEC. *Pelidnota punctata.*

P. testacea, elytris maculis tribus fuscis distantibus.

Scarabæus punctatus. *Linn. Syst. Nat.* 2. 557. 78.

Melolontha punctata. *Fab. Syst. Eleuth.* 2. 166. 28.

——————— *Oliv. Ins.* 1. 5. 22. 18. tab. 1. f. 6.

β. Variat maculis indistinctis.

Habitat in Americâ boreali.

Mus. D. MacLeay.

Genus. AREODA. *Leach,* MSS.

Antennæ decem-articulatæ, articulo basilari oblongo, conico, piloso; secundo brevi subgloboso; tertio, quarto, quinto, sexto et septimo brevibus; ultimis tribus clavam elongatam sublanceolatam formantibus.

Labrum corneum, margine antico obvio crasso, infra profunde emarginato.

Mandibulæ corneæ, validæ, subtrigonæ, supra planæ, latere externo integro rotundato, interno ciliato et ad apicem emarginato vix tri-dentato.

Maxillæ validæ, corneæ, inflexæ, apice sex-dentatæ.

Palpi Maxillares articulo basilari brevi, secundo elongato conico, tertio brevi conico, ultimo elongato ovato vel cylindrico apice subacuto. Labiales menti lateribus inserti, articulo ultimo subcrassiori ovato.

Mentum subquadratum, versus apicem utrinque paulo angustatum, ad apicem inflexum, truncatum, vix emarginatum, angulis vix rotundatis.

Caput subquadratum, clypei lateribus rotundatis margine reflexo. Corpus ovatum, convexum; coleoptris abdomen haud obtegentibus. Thorax subtrapeziformis, ad basin fere duplo longior quam latior, latere postico sinuato vix lobato. Scutellum mediocre cordato-truncatum. Sternum usque ad secundi pedum paris originem porrectum. Pedes validiusculi, tibiis bidentatis; tarsorum unguibus indivisis.

SPEC. *Areoda Leachii.*

A. viridis nitidissima supra lurida splendore viridi-aureo, capite thoraceque punctatis, elytris punctatis striatis: striis geminatis, scutello glabro, ano viridi subtilissime densissimeque punctato, pedibus viridiaureis.

Habitat in Braziliâ.

Mus. D. MacLeay.

OBS. 1. Genus Euchloræ proximum inter Anoplognathidas et Rutelidas ponendum; Areoda enim Anoplognathi feminæ omnino habitu similis est, sed ore toto differt.

OBS. 2. Hoc a genere distat OPLOGNATHUS (Kirby MSS.) mandibulis extus subemarginatis apice tridentatis, maxillis vix sexdentatis, palpis labialibus menti dorso insertis, mento apice emarginato angulis rotundatis, clypeo quadrato, truncato, angulato, &c. Ut facie externâ Anoplognathi feminam Areoda, sic primæ sectionis marem simulat Oplognathus; ex quo efficitur trium generum affinitatem videri posse apertissimam.

SPEC. *Oplognathus Kirbii.*

O. viridis nitidissimus supra luridus splendore viridi-aureo, capite punctis scabro, thorace glaberrimo punctato bimaculato: maculis nigris, elytris striato-punctatis, ano viridi subtilissime densissimeque punctato, pedibus viridi-castaneis.

Habitat in Braziliâ.

Mus. D. MacLeay.

END OF PART I.

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Horæ Entomologicæ:

OR

ESSAYS

ON

THE ANNULOSE ANIMALS:

BY

W. S. MACLEAY, Esq. A.M. F.L.S.

VOL. I. PART II.

CONTAINING

An Attempt to ascertain the Rank and Situation which the celebrated Egyptian Insect, *Scarabæus Sacer*, holds among Organized Beings.

Frederic Moore
from the
Executor
of the late
Th. Horsfield
1 Aug. 1859.

"*Le mal n'est pas même fort grand si par des nouvelles observations on trouve s'être trompé dans ses idées; il n'y a lors qu'à les changer selon le résultat de ces observations ultérieures, et par ce moyen le vrai Système de la Nature peut enfin se développer.*"—DEGEER, Mem. pour servir à l'Hist. des Ins. Vol. 7. p. 668.

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MDCCCXXI.

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HORÆ ENTOMOLOGICÆ.

PART II.

CHAPTER I.

INTRODUCTORY. *

In the former Essay it has been remarked as a subject of regret to Entomologists, that the systems on which their favourite science is pursued should be so far from natural; and that while the internal anatomy and exterior formation of Insects have been studied with the utmost perseverance, the important point of the connexion of these studies with Physiology in general should have been altogether neglected. It has also been observed that this neglect appears the more extraordinary, as it is manifest that no natural arrangement can be expected unless the anatomy of these animals be considered with continual reference to their habits and manner of living; for the mere consideration of the form and number of the various parts composing the body of an insect, can evidently lead to little else than artificial divisions, if the uses for which these several parts were intended be not also taken into account. Proceeding then on the plan of examining the structure of organs with relation to their uses, I have attempted to discover the principal affinities which the insects comprised

* Marginal notes by Dr. Horsfield.

in the Linnæan genus *Scarabæus* bear to each other. I have, moreover, endeavoured to show that the order of these affinities may be represented by two circles meeting at one point, and having altogether an analogous structure at their corresponding points. Relations of analogy have thus been distinguished from those of affinity; and it was advanced by way of example, that though *Dynastes Hercules* might approach nearer to *Scarabæus sacer* in affinity than *Cetonia aurata*, yet that these last, namely the *Scarabæus* and *Cetonia*, had the most analogous formation.

nalogy

With respect to my anatomical observations and the affinities dependent on these, I have had the satisfaction to perceive that their accuracy, so far at least as they related to the particular tribe of animals under consideration, has never yet been disputed. But it has been objected that in the ardour of discovery I have advanced my principles too far, and have argued from a solitary and singular fact to the existence of a circular disposition throughout nature. I have been told that the idea of a chain of beings returning into itself militates against those notions of an ascending scale in nature, which not only are inculcated by revelation, but which have not even been disputed by those naturalists who have been the most celebrated for scepticism. It was argued therefore, that the principles of the former Essay, thus opposing themselves to the most evident dictates of reason and revelation, could never be generally adopted; and that though the affinities I had pointed out might exist, yet that they were more probably only apparent, or at least the effect of accident; that in short my theory was *in cunabulis*, and too weak, too fragile, to command attention, until I should have first demonstrated it to hold good throughout all nature. Long however before it was ventured to put the first part of this work to the press, I had ascertained that the peculiar order which was first observed in the *Petalocerous* insects existed throughout all that portion of organized matter which I had been in the habit of studying; and that the chain of affinities always returning into itself might be represented by any curve, such as a circle or ellipse, having this property. It was even once intended to publish the general application of this fact before the particular discovery of it which had been made in the *Scarabæi* of Linnæus; but on reflection I was induced to brave those criticisms which it was easy to foresee would be my portion, and to let the public, as nearly as possible, arrive at the same conclusions by the same order and means that I had used myself; assured that the publication of this second Essay, when compared with that of the first, would convince naturalists that I had never advanced general principles until there was some good reason for supposing them to be general; and that I had never adopted a new theory until that theory had almost lost the right to the name, and had become a mass of facts, observed indeed by others, but now for the first time arranged so as to form one regular whole. I might indeed, according to what was once my intention, have published the general plan first; but as this course of proceeding would necessarily have led me to assume facts in proportion as the masses of beings under consideration became less general, the truth of the whole might have been disputed, or at best have rested its sole title to credit on certain casual circumstances; so that if I had then attempted to make use of such an instrument in the examination of small groups, I might with some justice have been accused of first advancing an hypothesis, and then endeavouring to explain facts on the assumption of its truth. It was therefore preferred to proceed differently, under the idea that if the facts in detail which had originally led to my present opinions on Natural History were fairly stated, they must induce every person to draw the same conclusions with myself. To state these facts was to propose no new hypothesis, but to expose myself, as I might be right or wrong, to the full assent or flat contradiction of every person who had studied the *Scarabæi* of Linnæus. If the accuracy of the table of affinities which had been drawn up on the presumption that my observations were correct, was once assented to, it was said that it might be expressed by two circles; and in this I did not expect that the circles would have attracted criticism, because it was evident that these only represented the chains of affinity returning into themselves, and that therefore it was useless to deny generally the truth of the circle, while certain affinities were unmolested of which it was only used as a symbol. It was in short manifest that the accuracy of the affinities ought to have been examined, and that if these were found incorrect or false, the foundations of the fabric being gone, it followed as a matter of course that the superstructure must fall. The affinities however have remained undisputed, and the circle is even supposed by naturalists to hold good among the *Petalocera*, though some deny that it exists generally throughout nature. In the actual state of natural science it is presumptuous no doubt to assert positively that the general distribution of organized matter is in circles; but I am in some degree contented to submit to this charge, because my observation has never been found absolutely to contradict the hypothesis, and because the only argument hitherto advanced against it does not depend upon experiment, but on the supposition that to admit its truth is to deny the existence of an ascent in the scale of created beings.

The object, therefore, of the present Essay is to show in a general but very rapid manner, that the phænomena which have been already recorded by learned anatomists and naturalists are sufficient to give us a distant view of a system which will embrace the whole of nature;—that this system, though apparently complicated, is possessed in all probability of a symmetry and unity superior to any thing we can conceive, on considering the variety with which they are combined;—that the most beautiful analogies become conspicuous even on the very slight glimpse which I am able to give of it;—and finally, that so far is this plan from militating against the doctrines of revealed religion, that it will be found to depend on these as some of its very best supports.

It must be evident, however, that it is almost impossible to be free from error in an investigation like the present, which embraces a general view of so vast a region as that of Zoology, the limits of which have always appeared more distant, more immeasurable, as the examination of them has become more profound. No publication on Natural History has ever yet appeared unassailable to criticism, and on the other hand, there are very few indeed which have not some merit to claim. It ought not however to be suspected that the labours of naturalists have been useless in proportion to their inaccuracy, or that theories have been injurious to the degree that they may have been false. So much the reverse of this has been the case, that science has gained as much by attempts to prove others to be in the wrong, as ever it has done by the implicit belief that they were in the right. Such confidence in the accuracy of others ought never to be accorded until the opinion advanced shall have been tried by several and severe tests. Had therefore my fears of criticism been given way to, I should certainly never have ventured on a work where I must be sure to merit it, and on the publication of new opinions which scarcely ever escape it; but I reflected that in the study of nature, the will to criticize produces investigation, and that investigation must always tend to the development of the truth; so that if I should be altogether in the wrong, the probability is, that some good to Natural History will have been occasioned in calling forth that investigation which is to convince the public that I am mistaken. In the present happy state of science, which is founded solely on observation and experiment, the proposition of a false theory tends no less indirectly to advance human knowledge than the discovery of a truth advances it directly. The great enemy to the progress of Natural History has hitherto been indolence, or, at least, the disposition to rest satisfied with the actual state of a science which till very lately has been wholly illusory. The inconsistencies of anatomical systems and of nomenclative methods have justified, as I conceive, the following search for some more satisfactory mode of studying nature than those hitherto adopted. In this search, however, I must compare myself to a person, who having taken a careful survey of a very small district, and thus having been enabled to form from analogy some general ideas of the surrounding country, then ascends a neighbouring eminence to view it. His description of the general character of the tract of land stretched out before him will probably be correct, while at the same time he may be very inaccurate in the details. These, before they merit confidence, at least require that more minute survey which as yet he has only been able to bestow on a single spot. In like manner I am now about to state the general appearance which nature has presented to my view; but as to the details, I would always, even where they relate to the peculiar objects of my study, the *Petalocerous* insects, rather ask the experienced naturalist if they are not the facts, than say to the inexperienced that they are.

This part of my work therefore differs from the former in as much as it takes more the character of an hypothesis, and as such deserves more suspicion. It is not however an hypothesis answering to Sir Isaac Newton's definition, "*Quicquid ex phænomenis non deducitur hypothesis vocanda est*;" for it is entirely dependent upon observed facts which its object is to connect. It is an hypothesis rather because too few phænomena have hitherto been observed by naturalists, than because any have yet been found to contradict it. And though it may be evident that, in order to ascertain the truth with accuracy, the plan pursued in the former Essay, which is analytical, ought to be adopted; yet I imagine that when the present confused and artificial state of arrangement is considered, the following remarks, with all their imperfections and inaccuracies, will add to our knowledge of nature. analytical

In the former part of this volume I had a very convincing proof of the accuracy of my observations on the *Petalocera*, by the insects of this family which had hitherto been considered anomalous, such as *Lethrus cephalotes*, *Hybosorus Arator*, *Anoplognathus viridi-æneus*, &c., now

occupying situations which were so far from being insulated, that they showed the existence of such insects to be necessary in order to complete the chain of connexion. It was thus I learned, that the transition from one of the families I had instituted to the other was so regular, both in their habits (as far at least as had been observed) and their general appearance, that no greater separation could be drawn between them than such as might arise from the
p. 322 idea of there being five principal points, knots or types of form in every circle, to one or other of which all the animals in that circle might be referred. With this idea of the *Petalocerous* insects, I was naturally induced to examine the *Lucani* of Linnæus to which the passage was so evident by means of the genus *Lethrus*. The result of this examination, while it served to convince me that the general disposition of the *Lucani* was similar to that which had been so satisfactorily demonstrated to exist among
p. 31 the *Petalocera*, still, to my vexation, left several chasms that made the new circle far less perfect than those into which the *Scarabæi* had just been resolved. The attention however of certain friends, who with the greatest liberality laid their entomological collections open to my scrutiny, soon removed almost all those difficulties, and I became anxious to know whether the same regularity held good generally among the other *Coleoptera*. The *Lucanidæ* of Latreille being a family the insects of which are known to live in their perfect state on green or living vegetable matter, they seemed to form a parallel to the *Thalerophagous Petalocera*; and the question that presented itself was, whether any animals exist agreeing more nearly with the *Lucani* in general character than with any other tribe of insects, but which nevertheless differ from them

in their economy? Among other families of Latreille which, in order to answer this question, I examined with care, was that of the *Sphæridiota*. Of these Latreille's first sub-family, the *Histeridæ*, differed so completely from the others in every essential character, that they could not fail to be compared with the *Lucani*—a comparison which proved beyond a doubt that these singular animals form the passage between Latreille's very dissimilar families of *Lucanidæ* and *Byrrhidæ*. An order and symmetry became thus visible, which gave the surest testimony that they existed in nature, and there was now some reason to suspect that the same regularity extended itself throughout Entomology, if not throughout all nature.

But it may be well to observe here, that it is no objection to an arrangement being natural, that particular beings should appear by its means to be insulated or widely separated from others. It is sufficient that evident affinities should never be overlooked, much less interrupted. The truth of this position will be manifest on considering how many races of animals, by means of the ancient revolutions which may have ravaged this planet, or other causes, have become totally extinct or at least removed from our view, and moreover how comparatively ignorant we are still of the natural productions not only of exotic regions but even it may be said of Europe itself. On the other hand, every organized being seems to have had certain limits of locality prescribed to it by nature; so that until we can imagine ourselves acquainted with every possible production of this globe, and the experience of ages shall then have failed in the endeavour to connect them, naturalists can never be entitled to consider the chain of creation as broken.

Satisfied of this truth, I attempted to take a general view of insects, disregarding all anomalous genera, or even such families as did not seem very clearly defined. The groups thus formed I then endeavoured to connect on some principle of natural affinity, paying always the greatest attention to physiology, and finally leaving the first inaccurate outline to be corrected by future observations. This plan though evidently imperfect in many respects, as was indeed to have been expected in a first rough sketch, nevertheless produced, in my opinion, an arrangement so far more natural than the systems ordinarily adopted, that instead of continuing to trace the extreme fibres to the root of the tree, I ventured to begin at the root, in order to meet the ramifications which had already been traced.

An unity of plan in the animal part of the creation became thus more remarkable; for though I could find many chasms in the chain, no where, after an accurate examination, was it certain that any anomalous interruptions occurred. Nay, the singularities of the animated part of the creation which had hitherto appeared so extraordinary to naturalists, as serving only to defy all arrangement, were here usually the very links required in order to arrive at connexion. So that nature appeared to me to have branched out in the animal kingdom, if at least it was allowable to judge of the whole from one ramification, in a most beautiful and regular though intricate manner, that might be compared to those zoophytes which ramify in every direction, but of which the extreme fibres form by their connexion the most delicate circular reticulations.

These introductory observations have been deemed useful, in the first place in order to give the reader a general idea of the object of the former Essay, which so few are likely to understand, without having previously acquired that knowledge of the subject under discussion which neither their time nor their opportunities may have allowed them to attain. Secondly, such a preface it is hoped will prepare experienced Entomologists for that chain of reasoning in the following chapters which leads to so many novelties in Natural History; novelties however that will be found on examination to depend much less on any new observations than probably many in this country will imagine. The observed facts and metaphysical opinions hereafter stated I have always indeed preferred to adopt on the assertion of others, as well because I should thus appeal to authority of infinitely greater weight than my own, as in order that I might confine within the narrowest possible bounds that bias towards a favourite hypothesis, from the danger of indulging which I do not flatter myself so much as to fancy that I can be wholly free. A general list therefore of the authors consulted will be inserted in a future volume; and in the mean time, though it is hardly necessary in any work of this age on Natural History to cite the names of Cuvier, Lamarck, Latreille and Savigny, since an appeal to such authorities is always understood, I have peculiar reasons for stating that it is to the labours of these distinguished naturalists that I feel myself more particularly indebted.

What has been introduced into this Essay of a metaphysical nature may on the first view seem misplaced, from its having to all appearance so little connexion with the prefixed title. To those who may retain this opinion after the perusal of the volume, I can only say that some indulgence on this head is expected, because observations on machines in motion would be incomplete without some inquiry into their moving cause, and would moreover if published alone have a tendency injurious to others as well as to myself. And should the critic scruple to admit the full efficacy of this apology, I shall finally shelter myself under the excellent observation of Mr. Hume: "That all the sciences have a relation to human nature, and however wide any of them may run from it, they still return by one passage or other."

CHAPTER II.

DEFINITIONS.

THE following preliminary definitions, which with very few exceptions coincide with those of the most celebrated naturalists and metaphysicians, appear to me so little objectionable, that I cannot refrain from proposing them as the foundations on which I could wish all my subsequent observations to repose.

1. *Nature* is a word which has many different significations; but it will for our purpose be sufficient to consider it either as a collective name for the whole of the beings which compose the universe, or for the original properties with which these beings may be invested. Finally, we shall consider it as a term applicable to the laws which govern the universe; a meaning which has often caused the word to be figuratively used in denoting the Divine Providence whence these laws originate; and it must be confessed that this metaphor is very convenient, though it has sometimes had the bad consequence of seeming to refer effects either to other effects, or to causes which are only secondary.

2. The knowledge of the laws of the universe, of the beings which compose it, and of their properties, is the object of *Natural Science;* and it must be obvious from

this definition that no study can be more extensive, since it may in some measure be said to include every other.

3. When the attention is more particularly directed to the properties of time and space, and to the laws of matter, the branch of Natural Science so studied has in our language been called *Natural Philosophy*, or *Physics*.

4. On the other hand *Natural History* in the widest sense of the term has been the name applied to that study which more particularly embraces the properties of matter. It deserves notice, however, that there is a great difficulty in separating distinctly these two branches of Natural Science, as in fact the properties of matter are nothing but the necessary consequences of the general laws by which the universe is governed, where these are specially and particularly applied towards the formation of the various beings which exist in nature. And it is on this account that it is hard to say whether Chemistry and those sciences which are called physical ought not all to be considered as the true province of Natural History. For though it has been attempted to define *Dynamics* as a science of calculation, *Chemistry* as a science of experiment, and *Natural History* as one of observation, it is unfortunate for the seeming simplicity of these terms, that all the three sciences depend more or less on observation, and relate in some degree to the properties of matter. Indeed in the cases of Chemistry and Natural History, it appears absolutely requisite, before we can admit them to be distinct sciences, that we should know experience and observation to be incompatible with each other.

It is nevertheless true that Natural History, properly so called, can hardly in any degree be considered as a science depending on calculation; and perhaps this negative property, could we draw a sufficiently distinct line between calculation and analogy, would serve the best to distinguish it from the mixed sciences. Analogy is well known to be the very foundation of Natural History, not however so much by our thus arguing, as in metaphysics or mathematics, from things known to things unknown, as by acquiring from the comparison of two things placed before our eyes more accurate ideas of the nature of both. Though therefore analogy be rarely applied by the naturalist to considerations of quantity as in the mixed sciences, yet such considerations occur often enough to render it extremely difficult, if not impossible, to define exactly the object of his study.

Even in Mineralogy, which has hitherto been considered in the true department of Natural History, a system of laws has been discovered that seems to depend entirely on calculation; and thus the connexion of the study with Chemistry, of which indeed it appears only a branch, has in one sense become still more evident than it was before. If Mineralogy then be within the pale of Natural History, by what rule are we to exclude Chemistry? And if Chemistry be admitted, which of the mixed sciences cannot be shown to have a right to enter? Now to consider Natural Philosophy as forming only a division of Natural History seems quite contrary to the ordinary classification of human knowledge, and affords, I think, a very obvious reason either for restricting the objects of the latter science, or for giving it an importance to which it has never yet been thought entitled. But for the present we return to the consideration of the beings which constitute the universe, and whose laws and properties form the whole Science of Nature.

5. *Natural Beings*, or those which have a real and proper existence in the universe, appear to be of two very distinct sorts, *Continuous* and *Incontinuous*.

6. Of continuous and infinite beings, or those necessarily existing without interruption from eternity to eternity, we know only three, viz. One intelligent, the *Deity*, or *Primary Cause;* two unintelligent, *Time* and *Space*.

7. It is a necessary truth perfectly demonstrable, that the Deity or Primary Cause of every existence that has had a beginning, must be omnipotent, and we know from *à posteriori* evidence that he is perfectly wise and good. He is the universal primary cause, and is therefore eternal, omnipotent, infinite, and one. Every other perfection attributed to him is not necessary, any further than as being the consequence of his divine will; for to suppose such qualities otherwise necessary, and therefore independent upon his will, would evidently be to deny that omnipotence which is his most incontestable attribute. A power existing in any being must either have been imparted by a foreign cause, or be self-existent; or finally, it must have originated in the being which possesses it. By an attribute of the Deity we understand a power existing in him. Now that an attribute which requires a subject should exist of itself, is perfectly unintelligible; and it is quite as impossible to understand how a quality should be imparted to the Deity by another cause, when he is himself the universal primary cause. It only remains for us, there-

fore, to assign the perfections of God to himself as their sole origin. It is the universal dominion of a spiritual being which constitutes God; and so sensible was Sir Isaac Newton of this truth, that he chose thus to define the Deity, not even by his intelligence, goodness, and other perfections, as is usually done, but by his omnipotence, from which all his other qualities flow by the exertion of a perfectly free will.

8. If we meditate on the nature of a continuous being, the mind is soon confounded by ideas too vast for its comprehension; but this difficulty is no more than what we anticipate in the consideration of an all-powerful and perfectly intelligent being. We know by experience our own power, our own intelligence, to be circumscribed by very narrow limits, and thus are in some measure led to expect an immeasurable and inconceivable distance between omnipotence and human weakness. But it is very different when we turn our attention to the unintelligent continuous beings Time and Space. We are surprised to find our minds so easily lost in the endeavour to comprehend beings such as these, absolutely without intelligence or active power, and intimately connected with every action of our lives; and we are induced to suppose that the error lies rather in our manner of considering them, than in any natural incapacity of our soul. The great Newton, therefore, thought that the Deity constituted them: and some of his followers, proceeding on this idea, imagined that time and space are but attributes of God, being abstract terms for his qualities, eternity and immensity. Our inability to comprehend them is however far from being thus lessened, since, though it is impossible to conceive the existence of an attribute without that of its subject, it is well

known that an atheist can conceive the existence of both time and space. Eternity and immensity seem indeed to be nothing but names given to the common property of these beings, namely, their continuity; and though we are ignorant how God can be continuous, except with reference to time and space, this seems to be rather an argument for their distinct existence than for the contrary. All time is without doubt the duration of the Deity's existence, and all space is the place which his intelligence pervades. This we are certain of, but further than this we know nothing.

Time and space are evidently not causes, and on the other hand it is impossible to understand how they can be effects. We thus come to the inconceivable conclusion, that they are neither causes nor effects. We know them to be destitute of all active power; and yet it is as difficult to imagine that they can be annihilated or created, as that there can be a time which is no time, or a space which is no space. In short, those men who are the most convinced of their inability to comprehend the nature of time and space, seem to be those who have the most accurate knowledge of them.

9. The continuous and infinite beings are only three, whereas incontinuous and finite beings, or those contingently existing, seem to be innumerable: these are however evidently of two very distinct sorts, of which one is unintelligent, the other intelligent, viz.

1. *Forms of Matter.*
2. *Secondary operative causes.*

But as it is to these and to the nature of their union that the following investigation will principally relate, we shall hereafter have to consider more fully their properties.

In the mean time, as another mode of dividing natural beings will make their several characters more clear, I need hardly apologize to the reader for so soon giving him an example of the difference between division and arrangement, and showing him how far they are from being, as some naturalists think, synonymous.

10. There are, says Mr. Locke, but two sorts of beings in the world which man knows or conceives. To these this famous metaphysician gives the names of *cogitative* and *incogitative*, answering very nearly to what we have hitherto termed *intelligent* and *unintelligent*.

Intelligent beings are the only operative causes or principles which we can conceive. But their most obvious quality is their incapability of mensuration. Unity is their great characteristic, and it is impossible to conceive parts of them.

The study of the nature of intellectual beings constitutes Metaphysical science, and informs us that there are only two sorts of such beings, the distance between the powers of which is infinitely great.

1. One universal *Primary* and continuous cause, or God, in whose hand is the life of every living thing.
2. Many *secondary* and incontinuous causes, such as a human soul, which has been to a certain degree created an independent principle by God, and which during his pleasure will continue to enjoy its free agency.

11. Of unintelligent beings we know only three sorts,

1. *Matter*,
2. *Space*,
3. *Time*,

the study of which constitutes the science of Natural Philosophy [a]. They differ from intellectual beings in that they are all capable of mensuration, and the human mind can only conceive parts of them. Time and Space are co-existent with and attendant upon the Deity, being both eternal. The immensity of Space is however wholly different from its eternity, nor ought they to be confounded. Matter is the work of the Creator, and its existence is necessarily neither eternal nor immense.

It is perhaps impossible to define either Time, Space, or Matter; we know them only by their properties. The two former consist of parts, and are therefore divisible, but differ from Matter inasmuch as it is impossible to conceive how one of their parts can exist without its connexion to another part, whereas every part of Matter is a distinct being which may exist without the other parts. We may therefore say that Time is capable only of mensuration; Space, of figure and mensuration; whereas Matter is capable not only of these, but also of incontinuity. Our most accurate ideas of Matter appear to be those which we acquire from its relation to Time and Space. Such relations, however, appear in general to be peculiar not to matter alone, but to all incontinuous beings.

[a] Many philosophers both ancient and modern have supposed another kind of natural beings to exist, namely, immaterial images of things, the immediate objects of perception, which have been termed species, forms, phantasms, impressions, or ideas. The Monads of Leibnitz are yet another sort of hypothetical beings; but we shall take no notice of either, further than to say, that if we admit the existence of ideas as immediate objects of perception, it follows that there is nothing else in the universe but ideas; and if we admit the existence of monads, it equally results that there is no necessity for the existence of any thing than monads.

12. No material particle can exist but with time and in space. Mobility is the name given to that quality of a material particle by which it is made to change one portion of space for another, and consequently the quantity of it must depend on the space described. The velocity of a particle of matter is measured directly by the space described, and inversely by the time of description. Motion and velocity are therefore not beings, but merely certain relations which particles of matter may bear to space or time.

13. No particle of matter can pass from one moment of time to another without existing throughout the intermediate interval. Neither can any particle be moved from one place to another without going through an intermediate space. Hence we perceive the continuity of time and space to have a strong influence on matter; whereas the incontinuity of this has no effect on time and very little on space, except so far as a greater or less apparent occupation of it may be occasioned by a new arrangement of particles.

14. No two material particles can occupy the same place at the same time; which relation of matter to time and space is termed its *impenetrability* or *solidity*, since one particle of matter must leave the portion of space it occupies before this can be occupied by another.

15. No particle of matter can be in different places at the same time; and this property constitutes its metaphysical identity.

16. Particles of matter when collected together in a mass of any degree of size or compactness form a *body*, which may either be organic or inorganic.

17. An *inorganic body* is an inert or brute mass of matter, of which the component particles are collected together by juxta-position alone. Such bodies are said to have never lived, and their proper arrangement is as yet unknown.

18. An *organic* or *organized body* is a mass of matter of which the component molecules are or have been in motion on being collected together by intus-susception. Such a body is said to live or to have lived.

19. By the term *life* we would express that faculty which certain combinations of material particles possess, of existing for a certain time under a determinate form, and of drawing while in this state into their composition, and assimilating to their own nature, a part of the substances which may surround them, and of restoring the same again under various forms. This life must not be confounded, as it has too often been, with the life of an immaterial intelligent being, which is totally distinct, and seems to be nothing else than a name given to the duration of its existence or happiness. It is therefore only to the first mentioned faculty that the observations immediately following ought to be supposed to relate.

20. How this faculty is acquired, what is its immediate

cause, or, in other words, whether there may not be several mediate causes between it and the Primary Cause, are questions to the solution of which we are totally incompetent. Like gravity and electricity, we know life only by its effects, or rather we are acquainted with the three only as so many names given to certain combinations of effects. The particular combination or series of effects which we call life, differs from gravity or electricity in the circumstance that these effects are totally different from each other. They however all concur to the same object, namely, the preservation of the individual and of the species. We observe however that during life, organic bodies can resist most of those chemical and more general laws which govern inorganic matter, and can modify the inert properties of this by an apparatus of organs specially constructed for the purpose. And on the whole we conclude that it is not a being enjoying a distinct existence, but an adherent quality which must necessarily have a subject. It is a motive quality of matter like gravity, and without matter for its subject we have no reason to suppose that it can exist. It is to the organic body what the expansion of steel is to a watch, or that of steam is to the engine; but if we ask what is expansion? what is life? we can get no answer but a recital of their effects.

21. The slightest study of the different systems of generation among the lower animals will show how erroneous is the notion of those who would consider the life of each organized body as a distinct immaterial being, superadded to its material structure. The most minute embryo or germ enjoys a vegetative life while attached to its parent stock, yet every experiment proves that it has as yet no

independent existence. Besides, if life be supposed to be superadded to a body at some particular time, it follows that previous to that period the body must have been a mass of inert matter. Now though this might have been the case when the species was first created, every observation at present shows that the ovum has a vegetative existence from its very first formation in the ovarium, and fully possesses that faculty which we have termed life. In observing one of the least perfect of animals, such as a polype, we find life propagated solely by cuttings or spontaneous fission. There is nothing that resembles a new life; we merely witness a division of that which already existed, and conclude that there is every probability of all the animals of the particular species so multiplied, being, like the grafts of an apple tree, merely the continuation of one individual. Even in the most perfect animals the ovum is separated from the parent stock by spontaneous fission, and though incapable of generating immediately other ova, is in other respects a mass of cellular tissue, organized in a degree quite as perfect as are the *Infusoria*. The above remarks apply with equal truth to vegetables; and it may be said that there is a life in all organized beings, which is merely a continuation of that originally imparted to each of the species. It is the life of the unimpregnated ovum and seed, and the only sort of life which the lowest tribes of plants and animals can possess. It is the common property of the species, which for a time is deposited with every individual.

22. But there is a second degree of material life peculiar to the more perfect plants and animals, namely, that whereby various organs are constantly forming in the body.

It may be termed the life of *organification,* or that by which the various organs of the being are constructed and repaired. The lower tribes of animals and vegetables are incapable of this life, and before the ovum itself can obtain the principle of organification it must be impregnated. Impregnation of the ovum may take place while it is yet in the ovarium, as in plants and some hermaphrodite animals; or after fission while it is in another part of the parent's body, as in the more perfect animals; or finally, after it has quitted the body of the parent, as in the case of frogs and fishes. In whatever species organification exists there must be particular organs for generating ova, and others for imbuing them again with organification; but there are many circumstances which might be adduced to support the belief, that, whether from disease or other causes, there are periods when other parts of a body besides the ovarium may produce living germs, and demonstrate thus the polype nature of the cellular substance.

23. On the whole, then, organized beings differ from inorganic matter,

1st. In repairing, by the incorporation of foreign substances, the loss to which from various causes they may be subject.

2dly. In the emission by transpiration or otherwise of the molecules which made once part of their body.

3rdly. In a regular development of magnitude till they may have reached that limit which may have been prescribed to them by the Author of their existence.

4thly. In the power of producing at some period or other of their life beings similar to themselves.

5thly. But still more particularly in what appears to be the first state of organization, namely, the existence of a flexible cellular substance, the *tissu areolaire* of the French, containing fluids circulating freely in the intervals which separate the reticulated fibres of which it is composed.

24. Fibres, lamellæ or filaments are the most simple solid parts of an organized body; they are the elementary molecules of its cellular substance as far as our methods of mechanical division will allow us to discern. The existence of this cellular substance is a natural result of the foregoing definition of a living body; since it was necessary, in order that foreign substances should be incorporated in such a body, that its composition should be porous for the free admission of these molecules.

25. It appears then that the formation of the germ depends upon the life of the parent stock; it is in fact a portion of its organization, which on being impregnated may itself be capable of organification. When before impregnation, the germ is disorganized; or when after it, the principle of organification is extinct; when, in brief, the motion of the fluids in the cellular substance ceases, the body is said to die. On this event the distinctive appearances of organization, and particularly the cellular substance itself, rapidly disappear, and the body gradually dissolves and separates into the various species of inorganic matter which formed its chemical constituents, and which are soon assimilated again by new living beings.

26. Though for the sake of simplicity, and in order to

avoid as much as possible what may be accounted as matter of opinion, death has in the foregoing paragraph been considered as merely the cessation of life; yet it may be proper to observe, that those physiologists appear to have reason on their side, who make it generally an inevitable and necessary consequence of life. In the higher animals and plants, indeed, we are certain that if death should not be produced by accidental causes, it is sure in due time to result from the fibres which compose the cellular substance growing so thick and rigid, that the fluids cannot penetrate through their interstices. In this sense a body receiving nourishment may be said to imbibe death: so true it is, that by living we die.

27. It is probable, from the clearest principles of analogy, that the foregoing observations apply with equal truth to all matter, whether terrestrial or not. But as beings beyond the reach of sublunary examination may give rise to conjecture, but cannot produce real knowledge, the widest signification of Natural History has been with propriety rejected, and we are taught to regard the science as relating solely to the phænomena and properties of those natural bodies which are found in connexion with our globe. And this seems indeed to be the least vague acceptation of the term; though some there are, who by taking into view the mighty distinction which exists between brute matter and that which is organized, and by regretting that there should be no name peculiarly appropriated to the study of this last, have rather unequivocally shown their wish to limit the province of Natural History still more, and to confine it to the investigation of the properties and appearances of terrestrial organized

beings. But this I suspect to be a method of arrangement quite as liable to objection, as that afforded by the earlier and more popular distribution of Nature into three kingdoms. In the first case we have indeed two natural, but I fear somewhat arbitrary divisions of matter into organic and inorganic. This may appear paradoxical. They are natural, because no person accustomed to study the works of Nature can deny their having a real existence; but they are too strongly marked, and even appear arbitrary, when we reflect that there is nothing to show that some organized beings are not more widely separated from others than they are from inorganic matter. We have, besides, no reason to believe that the various forms of matter are not separated by other natural chasms quite as distinct as those which separate organic matter from inorganic. Those divisions so much insisted on by Peter Ramus, which consist of two members, one of which is contradictory to the other, are sure to be complete, but unfortunately one or both are always too comprehensive; and this appears to be in a peculiar manner the fault of the division of matter into organic and inorganic. No person denies the existence of this division in nature, still less is the use of it to be despised; but as there are forms of inorganic matter to all appearance as distant from each other as any organized being can be from an inorganic one, it is evidently liable to be abused. This objection, though in a less degree, refers also to the division of Nature into three kingdoms; but the great fault of both methods undoubtedly is the interposition of strongly marked distinctions where they are generally if not always obscure. Matter, whether organized or in a brute state, whether animal, vegetable, or mineral, is very little if at all different in itself. Yet Natural History having attracted the attention of the world long before Chemistry, it remained long unobserved that organized matter was nothing but a peculiar modification of brute matter acted upon by the vital principle. It was in some measure forgotten that man himself, the most perfect of organized beings, had been subjected to the dread sentence, "Dust thou art, and to dust thou shalt return;" and the mineral kingdom was thus separated from the other two, without its being considered upon what basis the true nature of this separation ought to rest.

The truth however is, that the first great division of Matter is not yet ascertained; and the knowledge of it, to say nothing of the celestial bodies, must in a great degree depend on the labours of the chemist, who has hitherto so little elucidated the nature of heat, light, and many others of those subtle substances which are possibly forms of matter. Until this great desideratum of natural science shall be attained, we must remain satisfied with the division of Matter into organic and inorganic, not only as perfectly agreeable to what we should be led to expect from analogy, but as convenient, provided we do not form erroneous ideas of its real signification. It ought always however to be borne in mind, that an organized being is nothing but inorganic matter modified, and undergoing the temporary influence of a certain energy with which we are totally unacquainted except as to its effects. This energy then, or life, is to be accounted the true distinctive principle in material bodies; and though the crystallization of a mineral may show that even brute matter has been subjected to certain laws by nature, yet there is nothing to be found in it any ways resembling the assimilation, development, and generation which have been shown to constitute the principal functions of organized matter. Nay, so truly incompatible do these functions seem with matter in a brute state, that when they cease to exist, organized matter soon falls within the province of the mineral kingdom. It follows therefore, that as we have seen incontinuous beings to be dependent on continuous beings for their existence, so we may safely account inorganic matter to be the *officina* from which organized matter has been constructed; and it is in this sense alone that it shall be considered in the following pages.

CHAPTER III.

ON THE DISTINCTION OF AN ANIMAL FROM A VEGETABLE.

Schweig. 174. [anterior]

It requires but little observation to see that organized matter is of two different sorts, animal and vegetable—but it is by no means equally easy to state in what the difference between them consists.—"*Rien ne semble,*" says Cuvier, "*si aisé à définir que l'animal: tout le monde le conçoit comme un être doué du sentiment et de mouvement volontaire; mais lorsqu'il s'agit de déterminer si un être qu'on observe est ou non un animal, cette définition se trouve souvent très difficile à appliquer.*" The line of demarcation which has been allowed to be indistinct even between the mineral kingdom and organized matter, is then said by one of the first Zoologists to be at least equally so when we attempt to distinguish the animal from the vegetable; and Lamarck observes, that hitherto it has been found impossible to make this distinction without interfering with truths already established, and without contesting principles which are universally considered as axioms. Indeed, it is a certain fact, that no naturalist as yet has proposed characters which can be considered either as truly applicable to all known animals, or of so precise a nature as to distinguish them clearly from vegetables. The reason assigned for this has been, that anatomists hitherto have confined themselves to the examination of the most complicated organizations; so that the modifications which take place in the form of the organs, and the limits by which the faculties of these organs are prescribed, as we trace them down the scale of animal life, have been comparatively neglected. But though there may be no small degree of truth in this remark, the fact is, that a very great difficulty indubitably exists in the subject itself, which, independently of the manner in which it is treated, opposes almost invincible obstacles to the clear distinction of the two species of organized matter.

It is not assuredly in the *circulation* of the fluids in animals that this distinction can be safely said to exist; for while we are as yet ignorant of the true nature of that great motion in the more perfect plants, called the flowing of the sap, there are many animals, and those not of the most simple structure, in which nothing like circulation has as yet been detected. The distinction does not consist, as some authors will have it, in the nutrition of animals taking place by *digestion*, and that of plants by *suction*; for it is difficult to conceive how the simplest form of animals is nourished at all, unless it be by absorption of fluids by their external surfaces. It is not in *respiration*; for air is the universal nutriment of organized matter; the penetration of which into an organized body is so necessary to its vitality, that whether it takes place by peculiar organs for the purpose, or by the whole of the surface, death appears to be the inevitable consequence of the exclusion. It is not in *motion*, because some animals are as completely destitute of the power of locomotion as plants: unless by motion is meant irritability; in which case, motion and sensation are resolvable into one and the same faculty, the former depending on the contraction of the muscular fibre, which again depends on the influence of the nerves. Neither is it in the presence of *azote* as a chemical constituent of animal bodies, for this is allowed also to exist, though in a much smaller degree, in vegetables.

There remain however three characters of distinction which appear more capable of support; and I shall accordingly adopt them in stating that vegetables are to be distinguished from animals

1st. By the elaboration for their nourishment of fluid matter received by an absorbent external surface, whereas in animals it is received by an absorbent internal surface; this last being called the intestinal cavity, and its inner l. Luc: 22 surface being furnished with innumerable pores or vessels, which Boerhaave considered as real *internal roots*. — Luc: 22

2ndly. By the exhalation of oxygen and absorption of carbonic acid, whereas animals exhale this last and absorb oxygen.

3rdly. By the want of a nervous system and consequently of sensation, whereas animals possess both[a].

It has been objected to the first of these three characters that an intestinal cavity has not yet been perceived in the infusoria, and that in the polypes this cavity may be turned inside out, like a glove, without the ordinary functions being disturbed. But it is possi-

[a] Mirbel has attempted to add another peculiar characteristic to vegetables, namely, that it is the office of them alone to transform inorganic matter into organized living bodies, whereas animals feed only on organized matter. This remark appears however to be more ingenious than accurate, since many animals of the lower tribes and some Heteromerous Coleoptera have been observed to feed on inorganic matter.

ble that the excessive minuteness of the infusoria may account for our not having yet observed an intestinal cavity in them: and with respect to the polypes, the pretended objection is in reality none; as though the intestine of these animals may be turned inside out, yet the food is constantly received *into* it, and the nourishment consequently absorbed by that surface which may happen to be internal.

The second character seems much more exceptionable; for M. Biot is said to have discovered that several species of Coleopterous insects may exist in a vacuum without inconvenience, and it would above all be difficult to apply the rule of the absorption of oxygen to the intestinal worms.

To the third character it may be objected that a nervous system has not yet been detected in all animals; and also, that several vegetables, such as the sensitive plant, possess irritable properties; finally, that all plants appear to direct their organs to what is natural and beneficial to them in such a manner as to render it at least very questionable whether they be not endowed with sensation. To these objections it may be answered, in the first place, that in all animals where a nervous system has been detected, their sensation has been discovered to depend on it; we are hence led to assume that all animals in which sensation is observable must have it depending on a nervous system.

It may be proper to say a few words here on what we mean by a nervous system, which is thus made the great characteristic of an animal. Filaments of a peculiar medullary substance dispersed throughout an organized body on different plans are called the *Nerves*. The plan of the dispersion of these filaments is called the *Nervous System*.

The nerves are the medium of sensation whether active or passive, whether of volition or pain; for every fleshy fibre or muscle receives a nervous filament, and when the communication of this with the rest of the system is interrupted, we perceive that the fibre thus insulated ceases as well to obey the will acting upon the centre or centres of the nervous system as to communicate any sensation to the source of that will. But it may be going too far to say that the fibre ceases in this case to feel, for we observe certain external agents to act upon the nerve, and cause contractions of the muscular fibre even after its separation from the rest of the body. Irritation of the nerve therefore, though we know from experience that it can be produced by an operative principle like the human mind, seems also to be a mechanical process, as is certainly the action of the nerve on the fibre. It is possible, then, that both these effects may have an unintelligent mediate cause, such as electricity for instance, and this is one of the most important circumstances to be borne in mind while we investigate the metaphysical nature of pain in irrational animals.

We observe also on comparing different sorts of nervous systems, that the contraction and irritability of the separated fibre is greater in those animals whose medullary substance is less concentrated; which in some degree proves that the irritability of the muscular fibre depends on the proportion of nerve remaining in it after separation from the rest of the body. Now it is possible that all the difference between the most simple class of vegetables and the least organized of animals is, that the homogeneous gelatinous substance of which the latter are composed, possesses, dispersed throughout the mass, those nervous molecules which when united in the more perfect animals form the source of that exquisite sensation which gives them their superiority over the vegetable kingdom. And this hypothesis assumes the characterof probability, when it is considered that in four out of five distinct sorts of animals four different sorts of nervous systems have been discovered, but none for the fifth; that in the most perfect class of animals there prevails a diametrically opposite system to the one here supposed to exist in the least perfect class; and lastly, that the system here proposed would be of exactly such a nature as to accord with the actual phænomena,—for instance, the nervous system itself would be indistinct, while the sensitive molecules being dispersed throughout the mass, would render the animals themselves peculiarly irritable.

In the next place, the difference between the phænomenon which occurs when the feelers of a polype are touched and that which the leaves of the sensitive plant exhibit on a similar occasion has been accurately stated by M. Lamarck. The first is a true contraction of the part as it were into itself, which contraction appears to result from the injury experienced by that process of the nervous system which ramifies through the feeler touched. In the case of the sensitive plant there is nothing like this nervous contraction of the part touched, but only, as Lamarck styles it, an articular plication of the neighbouring parts, without any of their dimensions being altered. To this last phænomenon however this author will not allow the appellation of *irritability*, though I cannot but think that the distinction he draws between animal sensation and animal irritability is merely verbal, and by no means founded on observation or analogy; while, on the other hand, it seems no easy matter to understand how the change which takes place in the disposition of the parts of the sensitive plant on being touched does not proceed from *irritability!* I shall therefore apply the word *sensation* to that peculiar property of the animal kingdom which from muscular or fibrous contraction into itself of the part affected, evidently depends on some secondary action of the nervous system; whereas, I shall for the present ascribe to *irritability* those phænomena which without any fibrous contraction of the parts merely result from a change in their disposition among themselves, and which, for aught we know, may proceed always from a simple mechanical cause.

To the latter cause alone, then, or mechanical irritability, will the remarkable properties of the *Mimosa sensitiva*, the *Hedysarum gyrans*, the *Dionæa muscipula*, and other vegetables, be referable; and indeed these opinions are borne out by one of the first botanists on the Continent, who defines vegetables as "*sensibilitate, voluntate et motu proprio destituta*," and animals as acted upon by two natural forces, viz. *vis vitalis* and *sensibilitas*, whereof, the former is according to him "*corporibus organicis omnibus communis et sui inscia*," and the latter "*animalibus propria et sui conscia*." If these notions be correct, the *vis vitalis* will be the same with the vital principle described in the preceding chapter by its effects, and the *sensibilitas* will be no other than that imponderable fluid by which Cuvier supposes the nerve to act on the animal fibre, or still more likely it will be the connexion between some intelligent principle and the nerve itself. When this connexion is interrupted the *sensibilitas* may be considered as dormant, and the animal as in the case of its sleep remains only acted upon by the *vis vitalis*, and may be compared to a vegetable. Buffon therefore observed that plants may be accounted sleeping animals, an idea which has been almost universally followed by succeeding naturalists, and which if it cannot from observation be proved to be correct, is nevertheless ingenious and highly poetical.

On the whole however it appears that animals are to be distinguished by the existence of an absorbent intestinal cavity, and of a nervous system, and that both these marks become indistinct in the infusoria and polypes. It follows therefore that the infusoria and polypes, which are the most simple of all animals in structure, approach nearest to the vegetable nature.

CHAPTER IV.

ON THE ANIMAL KINGDOM GENERALLY.

ORGANIZED Matter may be generally described as ramifying into two branches which represent the animal and vegetable kingdoms, and which touch one another very nearly, if not precisely, at those points where the organization of each is the least complicated. "It is certain," says Lamarck, "that if the vegetable kingdom could be shown to connect itself or pass into the animal kingdom by any points of their respective series, it would be by those alone which are the most simple in their organization; so that the passage from the least perfect plants to the least perfect animals would be quite insensible. All naturalists have perceived this truth; and in fact it is in such a point, namely, where organization is the most simple, that animals appear to approach nearest to plants. Now, if the chasm which separates the kingdoms at these points be imperceptible, we shall be obliged to admit that instead of forming a chain, plants and animals present two distinct branches, united at their base like the two branches of the letter V."

Such indeed is the real state of the case; though with this celebrated naturalist it is an opinion advanced only to be rejected, because he cannot discern that there exists any point of union between the kingdoms. We have, however, already seen that the only difference between some of the minute gelatinous vegetables of the Linnæan order *Algæ* and the *Infusoria* is the supposed presence in the latter of a nervous system and an absorbent intestinal canal, neither of which however as yet has been observed, nor indeed reckoned to exist in the lowest animals except from analogical induction. We are therefore forced to acknowledge that like the letter V plants and animals present two distinct branches united at their base. Now, as the great object of the present Essay is to trace one of the ramifications of this dichotomous tree to its extreme fibres, I shall proceed to ascertain, if possible, the first natural groups into which the animal kingdom may be resolved; and for this purpose shall follow the excellent method devised by M. Virey.

In the first place, we observe a tribe of beings which have one principal centre to their nervous system, the great trunk of which, with the said centre, is contained in a bony articulated case, which forms the axis of the whole body, and composes the vertebræ and scull of these animals, which are therefore named VERTEBRATA.

In a second form of animals the skeleton is as it were external, so as to envelop the whole body, and is divided by transverse folds into a certain number of rings, to the internal surface of which the muscles are always fixed. Their nervous system consists of two long strings of medullary matter, passing through the whole of the body, and united to each other at small distances into several knots, or ganglions. These ganglions may be said to perform for the parts which surround them the function of so many brains, and for a certain period even to be sufficient for nervous sensibility after the animal has been cut in pieces. The animals constructed on this plan have obtained the name of ANNULOSA.

In a third form there is no articulated skeleton either external or internal, the muscles being attached solely to the skin, which is itself in general soft, though often protected by a calcareous or stony crust, termed the *shell*. These animals, remarkable like plants for the variety of modes in which the sexes are combined, have their nervous system composed of several scattered masses or ganglions united together by nervous threads. They are called MOLLUSCA, and are almost all aquatic.

A fourth form of animals presents to our view the organs of locomotion and sense arranged in a circular disposition round a centre, so as to give a sort of radiant appearance to the whole body. Their substance is more or less gelatinous with the fibres indistinct. The nervous system of these imperfect beings is but little known as yet; though M. Tiedemann in his *Mémoire sur l'Anatomie des Astéries*, which was crowned by the French Institute, conceives that the whitish threads which proceed in a radiant direction from around the mouth, and which extend themselves through the whole length of the arms of these animals, form a sort of nervous system which from the pulpy nature of the medullary matter seems to correspond with the gelatinous composition of the animals themselves. They are all aquatic, and are named RADIATA.

There still remains a fifth form of animals to be considered—beings which cannot in the present state of knowledge be better described than as masses of a transparent homogeneous, mobile, and sensible pulp. There are however to be observed in this transparent pulp innumerable minute granulations, which may be considered as the nervous molecules dispersed over, or as it were confounded with, the substance of these animals, so as to impregnate the whole with sensibility.

This last division I propose to name ACRITA.

On considering the gelatinous composition of these animals, the dispersion of the nervous molecules through their substance, and the absolute certainty that they are destitute of every sense except perhaps those of taste and touch, we are led to connect them with the *Mollusca*, whose substance is always mucous and often even gelatinous—whose nervous system, though collected into several *ganglions*, or *centres of sensibility*, has nevertheless these ganglions dispersed with little if any arrangement throughout the whole mass of their body—and whose senses, so far at least as we are certain of their existence, seem to be confined to those of taste and touch, with the exception of a few animals of the division which possess the organs of sight, and still fewer which possess those of hearing.

Nevertheless, on comparing the *Acrita* with the *Mollusca*, we find that the organization of these last has become much more complicated, and that a distinct system of circulation and peculiar organs for respiration, digestion, and secretion are even visible in these animals, which connect them in a remarkable manner with a still more perfectly organized family—the *Vertebrata*.

These however by their red blood, their muscular heart, their jaws acting vertically, their distinct organs for sight, hearing, smell and taste, their sexes constantly distinct, their vertebral column and extreme concentration of the nervous system, are sufficiently insulated from the *Mollusca*, as well as from all other material beings. The group is therefore perfectly distinct and natural; yet if we attempt to define it by any one of the abovementioned various properties, little examination is requisite to convince us that the characteristic thus chosen either disappears in the least perfect of the *Vertebrata*, or passes imperceptibly into the neighbouring groups.

Thus in the fishes which compose the genera *Ammocœtus* Dum. and *Gastrobranchus* Bl. all those parts which ought to have constituted their skeleton as vertebrated animals become so soft and membranaceous, that they may be considered as having no bones. The organs of respiration and of manducation, the absolute want of the sense of sight, the general habits and external form of these singular fishes, all prove to us that they are connected with the *Annelides*, and that by them nature passes to the structure of the *Annulosa*. On the other hand, on examining some of the *Echinoderma* of Cuvier, such as those composing the genus *Comatula*, we may trace the articulated texture of the *Annulosa* into the division of *Radiata*, many of whose external forms are also exactly imitated by the sessile *Cirrhipedes*. Of the *Radiata*, again, the stellate form and the gelatinous semi-transparent substance are observable among the *Acrita*. So that the chain whose links we have endeavoured to unfold returns into itself, and we find that all animals form a circle composed of the following great divisions, viz.

ACRITA, 131

MOLLUSCA,

VERTEBRATA,

ANNULOSA,

RADIATA.

This arrangement of animals is, it is true, quite distinct from that generally adopted; but it will be seen that it is not only conformable to nature, but that it removes many of the discrepancies which shock the naturalist in the common systems. For instance, there is an acephalous animal of the division *Mollusca* (*Ascidia mamillaris* Linn.) which exists without any visible organs of sense, except that of taste, whose substance is little better than a homogeneous gelatinous pulp, whose inert nature seems to deprive it of any power like that of voluntary motion; a being which is consequently reduced to fix itself to solid bodies, or to be the sport of winds and waves; whose principal sign of life consists in the absorption and spouting forth of water, and whose animal properties in short are all comprised in its irritability, its circulation, and respiration. Yet because these two last qualities appear in this animal, whose existence is little better than vegetative, to bear some resemblance to the circulation and respiration in some of the *Vertebrata*, we find it placed in the common systems before the bee, which astonishes us by its industry and social qualities; before the ant, which excites our admiration by its frugality and courage; and before the other numberless insects, which by their manners and stratagems have often made the naturalist hesitate as to the point where he would draw the line, and separate instinct from reason.

Nevertheless, if the series of ganglions along the double nervous thread of insects, and the different ramifications which emanate from this remarkable system for the purpose of animating the members and organs of sense in the *Annulosa*, be considered, it may be asked whether this system does not present to the eye infinitely more order and harmony than the ganglions which are irregularly dispersed in the *Mollusca* throughout the whole body. But then the oyster, it will be urged, possesses a brain, though in fact that nervous ganglion which is said to be situated over the œsophagus, and therefore has been honoured with the title of brain, hardly deserves it more than that which is said to be placed at the other extremity of the body, and certainly not so much as the cerebral ganglion in the nervous system of the *Crustacea* and other annulose animals. Those *Mollusca* which possess a distinct head with tentacula and other organs of sense have undoubtedly a true brain, but that of an oyster has no other right to the name than the obvious analogy which its position is said to bear to that of the brain of a gasteropod. Such analogies, however, are almost always incontrovertible; and the naturalist, when anatomical demonstration is so powerful, had better accede to M. Cuvier's opinion that the acephalous *Mollusca* possess a brain and a general construction which, upon the whole, makes a nearer approach to that of the *Vertebrata* than is made by any annulose animal, but particularly those undergoing metamorphosis. When however we have admitted this, it cannot, I conceive, be therefore contended that an *Ascidia* has any superiority over the bee. No person, on comparing the two animals, will assert that the Mollusque has any quality that can be put in competition either with the intelligence or the complicated mechanism of the Insect. If we are to estimate by their anatomy the importance which different material beings are entitled to in the scale of creation, it may readily be supposed that with this object in view we ought to consider the complication of mechanism as the test of perfection, and not any fancied and often forced resemblance to the human structure. Nay, if this last rule be employed, the rudest artificial imitation will often deserve the praise of ingenuity in the construction superior to that of some of the most extraordinary productions of nature. The absurdity of such a conclusion may then show us that the works of the creation are not referable to the human figure as a standard of perfection, but that they ought to be appreciated according to the ingenuity displayed in their organization, and the variety of effects which may depend on it.

Indeed it must be remarked by the most careless observer, that many even of the vertebrated animals are far inferior to insects, both in the possession of those faculties by which we are accustomed to estimate the rank of the *Vertebrata* among themselves, as well as in complication of general structure. In proportion also as the organic structure is simple, it has been observed that the body is more capable of repairing, by reproduction, such parts as may have been lost; a principle which if applied to lizards and frogs, would evidently reduce them in the scale of being below many insects.

On the whole then it appears necessary, first, that the affinity of the *Mollusca* to the *Vertebrata*, which is so obvious in the *Cephalopoda*, should not be disturbed by any intervening division; secondly, that the annulose animals should not be separated from the *Gastrobranchus* and other cyclostomous fishes; and above all, that they should not be made subordinate in rank to such simple animals as compose the greatest part of the *Mollusca*. Now these conditions will all be fulfilled if the chain of nature be viewed as returning into itself; whereas they will be completely violated if we account it to be a regular line or ladder, commencing with the *Infusoria* and terminating in man, or indeed if we adopt any opinion that has hitherto been advanced on the subject by naturalists.

Another novelty in the plan now proposed is the division of the animal kingdom into five great groups instead

four

of four, as stated by Cuvier; but indeed both Lamarck and De Blainville have already sufficiently, though not directly, proved the necessity of the *Acrita* being separated from the *Radiata*. "*La dénomination d'animaux rayonnés,*" says Lamarck, "*ne leur convient pas plus que la précédente* (*Zoophytes*); *car elle ne peut s'appliquer qu'à une partie d'entr'eux; et il s'en trouve beaucoup parmi eux qui n'ont absolument rien de la forme rayonnante.*" The very name of *Radiaires*, as given by Cuvier to the last division he makes in the scale of animals, evidently excludes his *Intestinaux*, *Polypes nus*, *Polypes à polypiers*, and *Infusoires*. It is true that many of the *Polypi*, such as the *Polypes à polypier*, inhabit tubes which take a variety of radiated forms, but there is nothing to show that the animals themselves have the radiated organization which is so conspicuous in the *Asterias*, *Echinus*, &c. For if the tentacula or feelers with which the mouth of a polype is furnished be conceived to indicate the animal as belonging to the *Radiata*, we shall by the same rule be obliged to place in this group many of the *Annulosa* as well as *Mollusca*. As for the intestinal worms, they exhibit at present to the naturalist nothing but a mass of confusion, which will require a great portion both of time and trouble to unravel. M. Cuvier observing that some of them have at least two nervous fibres or threads shooting out from a circle round the mouth, has considered this property as indicative of their connexion with the *Radiata*. But this observation would in my opinion be of much greater force in proving them to be annulose animals, and I have indeed but little doubt that many of them possess a much greater affinity to the *Annulosa* than is at present suspected.

The *Polypi* and *Infusoria* are upon the whole a little better understood, and accordingly form the greatest part of that group which from the difficulties it throws in the way of the observer I have here named *Acrita*. To some indeed of the animals comprised under this denomination M. De Blainville has applied the name of *Agastria*; but it does not seem expedient to adopt a word which is with accuracy applicable to so very small a part of the group.

In general I could wish to state a novel opinion with the arguments on which it may have been founded briefly, since it is an ungracious as well as a disagreeable task to have to clear the way for its reception by refuting prevalent notions. But in investigations of this sort some names possess an authority which to dispute is of itself presumptuous, but which to slight would be absolute folly. One of the first naturalists of the age, who has instituted several primary divisions which are popular on the Continent, will therefore in the following remarks consider that they have proceeded solely from a love of truth and an ardour for the promotion of natural science, and that were not the doctrines criticised likely from their ingenuity to mislead, they would never have been impugned. Animals have by this author been divided into *Vertebrated* and *Unvertebrated*. Now this division, as M. Cuvier perceived, errs more in its nature, of which we have already exposed the defects, than in its particular relation to Zoology. The objection to it is not that it is contrary to truth, but that it does not state enough, and that the young naturalist, placing full reliance on it, may be led to conceive that animals have been formed on only two distinct plans. Had the animal kingdom however been divided into radiated and not radiated, or into annulose and not annulose, both of these methods would have been equally applicable with that proposed by the celebrated author of the *Histoire Naturelle des Animaux sans Vertèbres*. He has, indeed, himself been sensible in some measure of this, as appears from his later division of animals into Intelligent, Sensible, and Apathetic; where those which are vertebrated are styled *Intelligens*, Insects and Mollusca are considered *Sensibles*, and the Radiata and Polypes are *Animaux Apathiques*. Without discussing the propriety of these three degrees of comparison, and the perspicuity with which they are defined, it will be sufficient to state, in order to prove that a system founded on them must be erroneous, that some fishes and some reptiles are as truly or even more defective in intelligence than are many insects; and, on the other hand, that the Cirrhipedes and many insects, such as the larvæ of *Diptera*, are as apathetic, in Lamarck's sense of the word, as any of the *Intestinal* worms. It is not easy to perceive, moreover, why an *Echinus* ought to be considered as showing less signs of life than an Ascidia, or Oyster; yet all these conclusions, so contradictory to the naturalist's personal observation, are the direct consequences of a system founded on Lamarck's scale of intelligence.

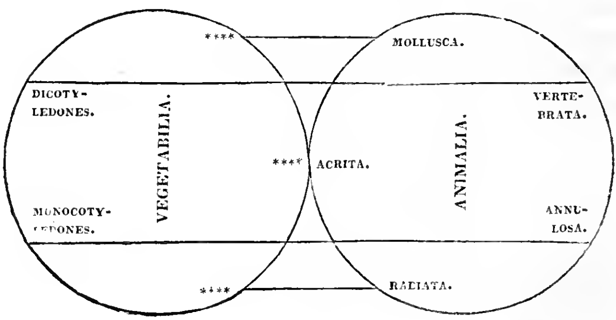
Animals may no doubt be classed according to the degrees of intelligence which each may display; but it is absurd to imagine that intelligence is divisible into three sorts, more than into any other number. There is nothing that I am aware of which can be adduced in favour of this hypothesis. It seems perfectly arbitrary, since every person, whether naturalist or not, knows that the intelligence of man is one degree, that of a horse another degree; in short, that as we can judge of intelligence only by its effects, and these effects differ not only with the species but also with the individual, it may be said of the *Vertebrata*, at least, that there are as many sorts of intelligence displayed as there are individual beings, whilst of insects there are probably as many degrees of instinct as there are species.

It is also obvious that we cannot, without confusion, compare with each other in degree the different sorts of intelligence displayed by animals whose general structure is not only different, but also their nervous system, on the disposition of which their intelligence in so great a measure depends. Where indeed the intelligence is of the same sort, we may estimate its degree; but this can only be where all the beings under consideration are referable to the same type of form; and, above all, where their nervous matter has been dispersed on the same general plan. But as this is a subject I purpose hereafter more fully to discuss, I shall conclude this chapter with observing, that it must afford pleasure to those who have a taste for the analogies of nature, to perceive that no where are they more visible than between the animal and vegetable kingdoms. The difference which separates these appears to depend, as we have already shown, on the presence of a nervous system in animals. Yet it is worthy of attention, that those vegetables which are generally supposed to make the nearest approach to the other kingdom possess a degree of irritability, the cause of which has long excited the curiosity of philosophers, but as constantly baffled their efforts to detect it. The chemical analysis also of the lower tribes of plants indicates the presence of azote; and though it has been asserted that the irritability of the genus *Linckia*, or *Nostochs*, is entirely owing to the elasticity of the plant, and by no means to any nervous action; yet allowing this to be the case, we can only admire the beautiful regularity of nature, which, in order to mark the affinity between the lower tribes of plants and animals, has thus impressed a gelatinous vegetable with a degree of elasticity which is so similar to the nervous influence among the *Acrita*. Nay, many *Confervæ* have the same sort of generation with the Polypes; for, independently of the herbaceous and seminiferous matter contained in the interior of the articulations, as observed by Vaucher, there are also gelatinous tubercles which give rise to new plants. We need not therefore be surprised that several of the Linnæan *Algæ* should be still hovering in a state of uncertainty between the two kingdoms, but on the contrary be prepared to expect additional proofs of the analogy which the two great divisions of organized matter bear to each other.

No groups can be more natural than those of Monocotyledonous and Dicotyledonous plants. The latter are the *Vertebrata* of the vegetable kingdom, their hard or osseous parts being as it were in the middle, and thus affording the most perfect and intricate plan of vegetable construction. The monocotyledonous plants are not only annulose in structure, or bear their harder parts on the outside, but moreover have often that articulated construction which so remarkably distinguishes the corresponding beings in the animal kingdom. These are not new or wild fancies, but positive truths which, as they were first mentioned by Desfontaines, must excite our astonishment that they were not sooner known. Finally, it may be observed that the radiated form is to be found in the tribe of *Fungi*, and that if the analogy has failed to be so conspicuous between the *Jungermanniæ* or *Fuci*, and the *Mollusca*, this is perhaps to be attributed as much to the little acquaintance which botanists generally possess with the cellular plants of Decandolle as to any failure in this solitary case of a rule so general.

In taking leave here of the vegetable kingdom, and proceeding to investigate the probable place occupied by *Scarabæus sacer* among natural beings, I cannot but express a hope that those who have time, opportunity, and sufficient botanical knowledge for the purpose may direct their researches to this interesting but intricate field of discovery. The wonderful progress made of late years in Botany leads us to trust that ere long we shall be gratified with a general and connected natural plan of vegetable organization.

GENERAL VIEW OF ORGANIZED MATTER.



CHAPTER V.

ON CLASSES, OR THOSE NATURAL GROUPS INTO WHICH THE ANIMAL KINGDOM MAY BE RESOLVED ON ITS SECOND RAMIFICATION.

ANIMALS appear to have been created on two distinct plans; or, to make use of an idea frequently adopted in the course of this work, nature seems in the animal kingdom to have set out from inorganic matter by two different routes, which meet together and complete the circle among the *Annelides*, or *Crustacea*. This difference of construction may be thus represented: although properly speaking the rule applies only to the greatest part of the *Annulosa*, and not to the *Crustacea* or *Arachnida*. × 278

Animals in which no circulation of blood is visible,	ACRITA, RADIATA, ANNULOSA.
Animals in which the circulation of blood is perfectly distinct,	VERTEBRATA, MOLLUSCA.

In this last plan there is constantly a pulmonary or branchial respiration aimed at, with a perfect system of circulation for the nutritive fluid; in the other, not only is the existence of a circulation a question to which no small degree of doubt may be attached, but the system of respiration is of a nature quite different and apparently much less perfect. It has indeed been long since observed that the whole internal anatomy, and in particular the organs of respiration and circulation in the *Mollusca* and *Vertebrata*, differ entirely from the structure of the divisions of *Acrita* and *Radiata*, and from that of the greatest part of the *Annulosa*. Now, in the preceding chapter we have seen that the only method by which the unnatural interruption of the *Annulosa* and *Vertebrata* by the *Mollusca* may be avoided, is one which necessarily places the last mentioned group nearer in general construction than the *Annulosa* to the point of union between the two kingdoms of organized nature, that is, to the lowest of animals. It follows therefore, that though they undoubtedly possess a very complete system of respiration and circulation, the *Mollusca* are inferior in the scale of nature to the *Annulosa*.

If we are to judge of the rank of the *Vertebrata* by the distance at which they are removed from inorganic matter, or, which is the same thing, from the confines of the vegetable and animal kingdoms, some of the *Annulosa* ought to be found to possess an organization quite as intricate as the animals with vertebræ. This principle, I am aware, may be objected to; and indeed it is so very difficult to compare with one another two divisions of animals which differ completely in their anatomical structure, whose very senses, for aught we know, are of totally distinct natures, that it becomes useless to attack or defend the propriety of such comparisons. No animal displays so much docility for general purposes as some of those which are vertebrated; nor does any display instinctively such wisdom for a particular purpose as an insect. No animal can be compared to such as are Annulose for strength and swiftness in proportion to their size, for perseverance and industry; nor any to the *Vertebrata* for size, duration of life, and variety of pursuit during that life. The result therefore to which we shall always arrive in this comparison is, that the *Vertebrata* are the perfection of one plan of organization, as the *Annulosa* may be of another. There can however be no doubt as to which ought to be accounted the lowest and least complicated of animals. With these then, or the *Acrita*, I shall begin, and endeavour to trace my way round the circle developed in the last chapter.

Homogeneous gelatinous masses of pulp without any visible cavity, and propagated by buds or cuttings,—beings in which every character of life may seem absolutely destroyed by desiccation, but which, by the influence of humidity, light, and other natural agents, can resume their vital energy; beings sometimes fixed to a particular point of space, and often absorbing nourishment by their external pores,—would manifestly be classed among the lower and less organized tribes of vegetables, did we not observe that such a mass of pulp is not only in general endowed with the power of locomotion, but also is always extremely irritable. When, moreover, we observe that this irritability is manifested not by any mechanical action, or by any effect which we are likely to ascribe to a simple mechanical cause, but by a contraction of the injured part within itself, we are induced to suspect the presence of some nervous influence, and consequently that this gelatinous mass is an animal. The *Agastria*, or *Agastraires* of De Blainville, are indeed *Animals*, though they have neither distinct organs of sense, alimentary canal, nor even mouth; though they have, in short, so far as our present knowledge of them would lead us to believe, no internal digestion whatever to execute, but trust for nourishment, like plants, to the absorption of their external pores. They must be esteemed animals, on account of their peculiar irritability, but are vegetables in almost every other respect. Of such an ambiguous nature indeed are these simply constructed and minute atoms that they confound every notion, even the most clear, which we may have endeavoured to form of animal life; atoms that, were their importance to be estimated according to their size, would be utterly neglected in the study of nature, but which nevertheless, because organized matter in them is reduced to the most simple form of cellular tissue, and life, as it were, is at its very lowest ebb, have employed the time and labours of Hooke, Leuwenhoeck, Spallanzani, Müller, and Lamarck. And this method of investigation is surely more philosophical than that of those who attempt to form accurate ideas of animal life by studying it only in its most complex shape, which is just as if we could hope to penetrate into the depths of the Newtonian philosophy without being previously acquainted with the simpler elements of mathematical science.

ACRITA.

The genus *Monas* may be taken as the type of the *Infusoria*, since it consists of the smallest and least complicated of all known animals. From these, by means of beings still only visible by the assistance of a microscope, but gradually obtaining some sort of appendages so as to give them the definite form of which the *Monades* are destitute, we proceed to the *Polypi rudes*, which may perhaps be hereafter found to be a circular group, composed as well of Cuvier's *Infusoires rotifères* as of his *Polypes nus*. The *Polypi rudes* according to this idea, for which

Zuv: d. 89 - p. 66

naturalists are indebted to Lamarck, consist of animals which are so far advanced in organization as to possess a distinct mouth; this mouth having, at its entrance, either one or more wheel-like organs fringed and rotatory, or having such organs converted gradually into tentacula disposed in a circle. The *Infusoria rotifera* of Cuvier are the Polypes possessing the abovementioned wheel-like organs, which are suspected by this naturalist as well as by Dutrochet to be employed for purposes of respiration. It would seem indeed that some of those animals described as *Rotifera* by MM. Dutrochet and Leclerc, are far too complicated in their organization to belong to the *Infusoria;* animals which not only are in possession of an intestine, but also, having two apertures to this organ, approach nearer, as M. Savigny remarks, to the group we shall hereafter have to describe under the name of *Tunicata*. On leaving the *Monades* we are prepared for the curious wheel-like processes of the real *Rotifera*, first, by the genus *Trichoda* of Müller, and then by the *Polypes vibratiles* of Lamarck. The latter family, which is composed of the genera *Ratulus*, *Trichocerca* and *Vaginicola*, Cuv: 90. 91. has a vibratory fringe encircling the mouth, which is an imperfect sketch of that of the *Rotifera*.

The *Infusoria rotifera* are remarkable, inasmuch as in them we have the first instance of a testaceous covering for the animal, and consequently are led in some measure to expect the more calcareous excretions of the *Polypes* p 70 *à polypier* of Cuvier, or the *Polypi vaginati* of Lamarck. The *Rotifera* also present us in the genus *Vorticella* Bl. Cuv: p. 69 with the first example of composite animals, which we shall henceforward find so common among the *Acrita*. The *Vorticellæ* indeed are not covered with a shell, but have a contractile body, rather dilated, and fixed by a peduncle to different solid substances, so as singularly to represent certain monopetalous flowers. Of this nature is *Vorticella convallaria*. But the resemblance of such animals to flowers becomes still more manifest in the composite *Vorticellæ*, or those whose peduncles ramify; the discovery of a species of which (*Vorticella digitalis*) on a *Monoculus quadricornis* made De Geer, though a man to whom the wonders of nature were daily familiar, break out into raptures of admiration at the endless variety of the works of his Creator.

A celebrated naturalist pretends to trace animal nature from its most complicated organization to its simplest form; but nothing, among innumerable instances to be found in his work of his having forgotten this principle, can better show how widely apart anatomical skill is from skill in classification, than his placing the genus *Hydra*, "*les animaux de cette classe réduits à leur plus grande simplicité*," at the head of his Polypes. There seems however to be great reason for supposing, with Lamarck, that these simply constructed Polypes and the *Rotifera* are connected together by means of the *Vorticellæ*.

Leaving the *Rotifera*, we arrive at the *Polypi vaginati*, Cuv: 91 by means of the genus *Tubicolaria* Lam., which possesses the tubular oblong form and ciliated retractile mouth of the *Plumatellæ* Lam. In true Polypes the rotatory organs with which the mouths of the *Infusoria rotifera* are armed become tentacula, or feelers. These however are no longer mechanical instruments for creating whirlpools in the water, but sometimes simple, sometimes dentated, or ciliated, appear always to be furnished with muscles sufficiently strong to enable them to secure their prey and to conduct it to the entrance of the intestinal canal. Still the method in which this prey is seized is more analogous to the manner in which insects are entrapped by various plants, than to that peculiar will which we perceive in the more perfect animals when hungry. An object must irritate the tentacula of the Polype by contact before these will convey it to the mouth. The alimentary canal is indeed the principal characteristic of the Polypes; for, except in this respect, the structure of some of them can hardly be said to be more complicated than that of the Infusoria. The gelatinous pulpy body of the Polype is now however protected by an inorganic sheath, and the animal is in general composite.

By a *Composite Animal* we are to understand a conglomeration of the same species, adhering the one to the other, either by lateral appendages or by their posterior extremities, and which communicating together by such means, assimilate in common the nutriment which one alone has swallowed. It is a collection of animals which participate in a common life, while each enjoys an independent vitality for every part of its body. We have already seen instances of this compound organization among the *Polypes nus* of Cuvier, as in the genera *Vorticella* and *Cristatella*; but the difference between these and the compound sheathed Polypes seems to be, that each of the latter is insulated in front, and confined in a little cell formed of the horny crustaceous or stony matter which transudes from its surface, while by its posterior extremity, like the *Polypes nus*, it is connected with its fellows.

The *Polypi vaginati* are very numerous in nature, and constitute an ample and interesting field, in which a naturalist may acquire great honour. They appear to contain Rev: 70

among themselves some very beautiful and extraordinary types of form, than which none however is more interesting than the composite sheathed Polype. But this external stony sheath disappears in the Sponges and *Alcyonia*, or at least confounds itself with the common body of the Polypes. These very imperfect beings are supposed to connect together the *Polypi vaginati* and the *Polypi natantes*, that is, the two most complex forms of the circle of *Acrita*; and we thus, for the first time, see that in passing from one perfect plan to another, Nature makes use of some of her very simplest constructions. By means of the Sponges and the *Polypi tubiferi* of Savigny and Lamarck, we arrive at the *Polypi natantes*, where the structure of a sheathed Polype is completely reversed. It is the axis of the whole compound animal which is here stony, often hollow, and about which the Polypes combine to form a fleshy body of a constant and regular form. M. Savigny, whose discoveries in every branch of Natural History he endeavours to elucidate are equally important and interesting, considers the internal organization of the *Polypi tubiferi*, which he finds so complicated in comparison with the animals we have as yet had under consideration, to be analogous to that of the genus *Veretellum* among the *Polypi natantes*; and indeed the axis of these last is no longer distinct in the *Veretellum Cynomorium* (*Pennatula Cynomorium* Pall.). The compound structure of the *Polypi natantes* however is not so very observable in the genus *Virgularia*, which has neither the general form nor the habits of the rest. The animals composing this genus present a linear filiform body, which is sunk in the sand or mud so as to leave nothing but the polypiferous extremity of the animal exposed. Having thus clearly receded from the type of the *Polypi natantes*,

Cuv: 83
Polyp. nageurs

we may suppose ourselves near to the point whence we are to set out in order to procure another type of form.

From what we have now seen of the *Acrita*, it would appear that there cannot be improperly assigned to the group, any animal which unites to a soft pulpy consistence an organization so imperfect, as to have the alimentary canal either indistinct or when visible never provided but with one opening, a gemmiparous system of generation, and no traces whatsoever of vessels proper for the purposes of circulation and respiration. Such an animal, I repeat, would evidently not be improperly connected with the *Polypi* and *Infusoria*, since it possesses their distinguishing characteristics. Many of the intestinal worms, therefore, have been placed among the Polypes on the soundest principles of reasoning. Not however all that heterogeneous mass of beings which compose the *Intestinaux* of Cuvier, but only such of them as form the greatest part of his 2d and 3d divisions of *Intestinaux parenchymateux*, and of the *Vers mollasses* of Lamarck, beings that have their substance in general entirely consisting of cellular tissue, without any viscera. From the Polypes we appear to enter among these extraordinary animals, by means of the genus *Scolex*, and others, which to a gelatinous body add a terminal orbicular mouth surrounded by four flexible polymorphous tentacula or feelers. These appendages gradually vanishing in other species, the whole body becomes a simple vesicle, as the *Hydatis*, that extraordinary animal which is often found in myriads inhabiting the liver or brain of herbivorous animals, and sometimes infesting even man himself. Finally, the mouth itself disappears, and the body has no other characteristic property than being an elongated linear flattened mass of cellular tissue; which ac-

[illegible]
Vid Schweigg. p. 170, 1, 2. also p. 163.

cordingly brings us back to the *Agastria*, in the genus *Vibrio* of Müller, or those *Infusoria* to which belong what are vulgarly known as the *Eels of Vinegar*.

The most remarkable of the *Intestina* are the genera *Tænia* and *Botryocephalus*, not only on account of their being the most formidable parasites to which vertebrated animals have been subjected, but also from their probably forming a type of composite animals very distinct from the compound Polypes. The classical type of the latter seems to be a congeries of animals adhering to each other laterally; whereas, the above compound *Intestina* seem to consist each of a linear series of animals. It is an old but nevertheless to all appearance a perfectly just idea, that each articulation of a *Tænia* is a distinct animal; for we may observe each to be supplied with its peculiar organs, in the shape of one or two pores and gemmiparous masses placed in the middle of each lateral face of the articulation. It is true that to the whole articulated ribband which composes a *Tænia* there appears to be but one mouth by which the nourishment common to all can be received; but we have already seen that in the compound Polypes the food swallowed by one may serve to the nourishment of the whole; whence it may safely be concluded that a *Tænia* cannot be confounded with the articulated *Vermes*, but is truly acompound animal though of a peculiar sort.

On the whole then we have set out from the *Agastria*, or animals without mouth or alimentary canal, and, after passing through various different types of form, are now returned to the simple structure from whence we started, and the *Acrita* have been seen to compose a circle thus distributed in nature:

AGASTRIA, or INFUSORIA,
INTESTINA,
POLYPI NATANTES,
POLYPI VAGINATI,
POLYPI RUDES.

At first sight, however, there appears to be a want of that symmetry in this circle so observable in the others which compose the great divisions of the animal kingdom; for the *Radiata* have all a classical type to which their several structures may be referred, as also have the *Annulosa, Vertebrata* and *Mollusca;* whereas here we see Nature choosing every possible type of form, and sporting as it were with every thing like regularity. But this I apprehend is the consequence of a too rapid glance, since Nature, so far from forgetting order, has, at the commencement of her work, in these imperfect animals given us a sketch of the five different forms which she intended afterwards to adopt for the whole animal kingdom. In the soft mucous sluggish *Intestina* she has given the outline of the *Mollusca.* Mollusca In the fleshy living mass which surrounds the bony and hollow axis of the *Polypi natantes,* she has sketched a vertebrated animal. Vertebrata In the crustaceous covering of the living mass, and the structure more or less articulated in the *Polypi vaginati,* we trace the form of the *Annulosa;* Annulosa while the radiated forms of the *Rotifera* and the simple structure of the *Polypi rudes,* may in general remind us of the *Radiata.* Radiata

I by no means profess myself sufficiently informed on the subject to attempt, at present, a more rigorous and detailed subdivision of these animals, much less to criticise what has been already done in this province by learned anatomists. Nevertheless, I cannot but consider the analogy as deserving a severer epithet than vague, which has been used in order to unite the *Entozoa* with the *Echinoderma*. Because some of the *Intestinaux* of Cuvier have two fibrous lines, or muscular threads, shooting out from a circle round their mouths, it has been asserted that these animals afford traces of a *radiated structure;* but other naturalists appear to have drawn from the same observation a much more correct conclusion, in conceiving that these two fibres, where they exist, are but modifications of the ordinary nervous system of the *Annulosa,* allowance being made for their being animals far more imperfect than the usual types of this system of construction. It seems indeed impossible in an arrangement which has any pretensions to being natural, to separate some of the *Entozoa,* such as the *Nematoidea* of Rudolfi, far from *Lumbricus* and *Gordius*.

With respect to this new division of animals, which I have called *Acrita,* the following definition, which is nearly that of Lamarck, will serve to exclude such of the *Intestinaux* of Cuvier as deserve a higher place in the scale of nature.

Animalia gelatinosa polymorpha, interuneis nullis medullâque indistinctâ.

Os interdum indistinctum, sed nutritio absorptione externâ vel internâ semper sistit. Anus nullus.

Reproductio fissipara vel gemmipara, gemmis modo externis modo internis, interdum acervatis.

Pleraque ex individuis pluribus semper cohærentibus animalia composita sistunt.

The distinctive character of these animals is therefore principally negative as referred to animals, and positive as referred to plants. The simple texture of their cellular tissue is common to them with the Algæ; their gemmiparous generation bears resemblance only to the simplest part of the system of reproduction in the other tribes of animals, whereas, it is by no means uncommon in plants: the method likewise in which all of them live more or less by the absorption of their external pores, and their attraction by light, is only to be discovered besides in the vegetable kingdom. If a Polype be cut in pieces each of these will continue to live, and in time will take the form of the original individual, so that every point of such a body must be considered as having an independent life, like that of some of the lower vegetables. Lamarck accounts for this phænomenon by considering their alimentary canal to constitute a second absorbing surface, in no respect different from the absorbent external surface of the *Agastria*, so that any portion separated from these bodies may live for a time like the infusoria, until they have obtained the second or internal absorbent surface; an idea which is not only ingenious but perfectly consonant with our observation.

But this is not all. That remarkable, nay, wonderful property of the greater part of these animals, which consists in their enjoyment of a common vitality, is what we observe in the majority of vegetables. A vegetable, says Lamarck, may in general be considered as a collection of living individuals, each capable of absorbing nutriment which is all to tend to the general health of the plant: now what naturalist is ignorant that this is only to be compared throughout the animal kingdom, with those compound beings which we have seen to result from the union of many distinct individuals adhering to one another, and sharing a life common to all? If to these circumstances be added their still more singular general appearance, which with the earlier naturalists gained them the appellation of Zoophytes, we shall be under the necessity of acknowledging that the line of separation between animal and vegetable life is not so distinct as some philosophers would have us suppose, and that in fact no accurately distinctive character can be given, unless it be the presence of a nervous system in the former. So thought Linnæus when he described his *Zoophyta* as "*Composita Animalcula in bivio Animalium Vegetabiliumque constituta, veræ plantæ, sed systemate nerveo, sensus motusque organo instructæ.*" This indeed has been denied by Lamarck, and termed a perfectly gratuitous and improbable supposition; because on this view it would follow, as he thinks, that a fresh water Polype must have all the organs of a perfect animal, and consequently hears, sees, smells, &c. with every atom of its body. But this conclusion, so absurd in itself, seems to me to be rather absurdly arrived at; since, if the study of nature teaches us that where an organ ceases to exist the faculty can no longer be found, there can be no reason in the world to suppose that a *Monas* or Polype, which appears absolutely an atom of jelly destitute of any thing resembling an organ, should be gifted with the above powers. Besides, in examining the construction of those animals which enjoy their senses in the greatest perfection, we find the nervous matter on the whole to be very homogeneous, whether it communicates sound, light, odour, taste, or touch, to the great sensorium; so that though the nerves form thus the medium of communication from the organ of sense to the sensorium, they would be useless without the former, which is so peculiarly adapted for receiving impressions from external objects. If an animal, therefore, could be supposed to exist destitute of organs, and having its nervous matter melted down as it were into the general mass of the body, we should have an animal indeed destitute of every sense except irritability to the touch, but having this irritability equally perfect in every molecule of its body. We should then be obliged to consider it as a compound animal, made up of as many animals as there were molecules in the body; and it would in short be a polype as we see this animal to exist in nature.

TUNICATA. –

– vid. Schweigger, – p. 691: animalia tunicata, genera: Schweig. Tethyum Polyclinum Sigillina Polycyclus Botryllus Pyrosoma Mammaria Bipapillaria Ascidia Biphora (Salpa et Dagysa) aplidium Schweig. 690 – Schw: 692 {697 vid. fig. Savig. loc. cit.

A minute gelatinous irregular compound animal, without a head or distinct organs of sensation, inclosed in a cartilaginous or coriaceous cell, and whose mouth is furnished with six tentacula, cannot be far distant in nature from the *Polypi vaginati*, even though a second opening to the intestinal canal may now be distinctly traced. If moreover the individuals composing such an animal be disposed in regular systems, we may be allowed to refer it to a place near that of the *Flustræ* or *Cellulariæ*, in both of which genera this disposition is also very observable. The *Aplidium lobatum* of Savigny is an animal of the nature we have just described. It is a Polype by means of which we may leave the *Acrita* and proceed to explore our way into a more complicated region of organization.

Our knowledge of the anatomy of the *Tunicata*, or *Tuniciers*, as they have been named by Lamarck, is entirely owing to the brilliant discoveries of Pallas, Le Sueur, Cuvier, and Desmarest, but, above all, to the admirable patience and discriminative judgement of M. Savigny. From what we have said of the *Aplidium*, it cannot appear remarkable that such an animal continued long to

Le Cuv: II p 501. In Savigny genera Polyclinum, Aplidium, Didemnum Eucoelium, Diazona, Sigillina & –
Le Oken p 496 – 502. Mantelthieren.

be confounded with the *Acrita*. It is only the other day, indeed, that the last mentioned naturalist gave full force and developement to discoveries of Gærtner and Pallas, which had at first been neglected, and which at last became totally forgotten. The true Polypes however, as we have already seen, possess but one alimentary cavity, which is provided with only one external aperture, and is separated from the outer cuticle by a simple cellular substance. From these, then, the group we have now under consideration differs, in having two apertures to their intestinal canal, in being no longer a homogeneous mass of pulp, but offering to the view two distinct tunics at least, with a body divided internally into several cavities, which are furnished with viscera. It is in these animals we have the first indubitable vestige of a concentration of the nervous system, and of organs indisputably constructed for purposes of respiration, circulation, and generation. But notwithstanding all these proofs of a more complicated construction than that which the *Acrita* possess, some of the *Tunicata*, such as the genus *Eucœlium*, and that curious inhabitant of the Australasian seas, *Sigillina Australis* Sav., resemble the *Polypi vaginati* so much as to require the eye of the most experienced anatomist to distinguish them.

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Schweig: 691
& Savig: Mem:

The most singular however of the compound *Tunicata* are those perhaps which, like the *Botrylli*, display several stelliform or radiant systems, disposed in circles, ellipses, &c. round a central cavity or opening; the whole appearing, at first sight, to be a thin transparent radiated jelly coating marine substances. To a careless observer this appearance might be sufficient to confound them with the *Radiata*; but a little attention will prove to

Schw: 694
nov fig: cit:

our complete satisfaction, that each ray is a distinct animal, having its mouth at its external extremity and its rectum opening into a common cavity, which is the centre of the whole star. If the mouth of one of these rays be touched, that animal alone contracts itself; whereas if the centre of the star be irritated, every individual composing the system is equally contracted. Nevertheless, the judicious observations of our countryman Ellis on this subject were long neglected, and until the second part of the *Mémoires sur les Animaux sans Vertèbres* made its appearance every system of *Botryllus* was considered Oken 95
as one Polype, and every Polype as one tentaculum; though anatomy now shows that each of these pretended tentacula is provided with its own intestinal canal, its own branchiæ, viscera and ovaries. The rays of a *Botryllus* as well as each of those innumerable little beings composing the elegant *Pyrosoma*, which by its phosphores- Schw: 695.
cence charms many a dreary night on the Atlantic Ocean, and makes the sea to vie with the rainbow in brilliancy and variety of colour,—these all lead us to the *Ascidiæ* and *Salpæ*, which though no longer compound animals, still exhibit the same essential plan of construction. The *Ascidia clavata* of Cuvier (*Clavellina borealis* Sav.) in Schw: 696.
particular, affords us a disposition of the viscera which exactly resembles that of the compound *Tunicata*. The compound animal does not however become at once distinctly simple, for in general the individuals of the same species of *Ascidia* are grouped together, and when thus grouped put on an appearance of ramification; though this, as Cuvier observes, is not real, nor does it establish any organic union between the individuals, like that which exists in a *Botryllus*. The *Salpæ* also are generally found Schw. 697

united in the same manner as originally they were in the ovary, and swimming together in long chains, where the individuals are always disposed in a particular manner, according to the nature of the species.

The simple *Tunicata* possess a distinct branchial system of respiration, with a liver, heart, and in fine a complete system of circulation, which corresponds with that of the *Mollusca*. In the system of generation also, of both these groups, no small affinity may be discerned, at least the ovary of *Salpa scutigera* bears a remarkable resemblance to that of some *Gasteropoda*. But in order to obtain a distinct view of the progress we have made, it may be proper to give here a rapid sketch of the discoveries of Cuvier, detailed in his inimitable anatomical Paper on the structure of the *Ascidiæ*, or *Thethya* of Aristotle.

The body of one of these animals is divided into three cavities. First, the branchial, which communicates directly with the air at its upper aperture, and at the bottom of which is the true mouth or entrance to the intestinal canal. Secondly, the peritoneal cavity, which does not communicate directly with the open air, but which is traversed by the intestinal canal, originating in the branchial cavity and passing along by means of the rectum towards the anal aperture. Thirdly, the pericardial cavity, inclosing the heart, and communicating neither directly nor indirectly with the atmosphere.

The Tentacula of the Polypes are still visible, but perform a new office in the *Ascidiæ*. They are here no longer instrumental in catching the prey, but appear reduced to be simple auxiliaries of the system of respiration; they surround in fact the branchial cavity, and not the mouth properly so called, which is a small opening without lips or tentacula, situated at the lower extremity of the above-mentioned cavity. The internal coats of this branchial cavity are covered over with a reticulation of minute veins, which cross one another at right angles. Those which are vertical come from the transverse veins, which again are connected by their extremities with two large vertical trunks, each occupying one of the sides of the whole cavity. These two vessels open at opposite ends into the heart, which is of nearly the same diameter with them, and merely distinguished by being fusiform and more muscular. M. Cuvier conceives one of these trunks, which opens into the heart, to be the branchial vein by which the blood passes into the heart, and the other, which is much the longest, to be the Aorta distributing the blood throughout the body. So that the *Ascidiæ* have a system of circulation corresponding to that of the *Gasteropoda* and Acephalous *Mollusca*, that is, they have only the left or Aortic Ventricle without any other at the reunion of the *Vena cava* and pulmonary Artery. The *Ascidiæ* have a liver like that of the Acephalous *Mollusca*. It is of a darkish colour, and adheres in an intimate manner to the sides of the stomach, into which the bile is distributed by several orifices which are for that purpose in its sides. The nervous system consists, so far as has yet been observed, of but one ganglion, which is situated in the substance of the tunic and between the branchial and anal apertures. Amongst the numerous ramifications of medullary matter which proceed from this ganglion are two or three which go towards the œsophagus and there surround it with a nervous ring, which Cuvier considers to be the brain. This nervous system corresponds with that of the bivalve or Acephalous *Mollusca*. On the whole then, like many of these last-mentioned animals, the *Ascidiæ* are destitute of organs of locomotion; like these they have their mouth at the bottom of the bag opposite to the tube by which the water penetrates, and so placed that this water cannot arrive at the intestinal canal without having previously washed the surface of the branchiæ. There cannot therefore be the least doubt of our having now arrived among the *Mollusca*, and nearer to the Acephalous tribe than to any other of that divison.

× Divisionée by Cuv. VI ordres
p. 357 –
Cephalopodes
Pteropodes
Gasteropodes
Acephales
Brachiopodes
Cirrhopodes.
Vid. Table
Methodique
XIII, XIV, XV.
XVI, XVII

MOLLUSCA. ×

The *Acephala* then, like the *Ascidiæ*, are soft inarticular animals, without the principal organs of sense, and having the mouth concealed and always destitute of teeth; defects which force them to depend for subsistence on the corpuscles, which the water may convey to the entrance of their intestinal canal. The ample mantle no longer forms a bag, but is composed of two great lobes, which either opening in front envelop the body in the same manner as the cover of a book incloses its contents, or uniting together in front forms a sort of tube open at one or both ends. Between the two lobes of the mantle are the branchiæ no longer coating the sack, but composed of four membranaceous thin semilunar plates, striated transversely by the vessels on or between which the water passes. The mantle is no longer of a cartilaginous nature, but now is clothed with a bivalve calcareous shell. The heart, almost invisible at its first appearance among the *Tunicata*, becomes in these animals less gelatinous and more distinct. The blood goes to the heart from the branchiæ, and again from the heart by means of two arteries it is dispersed over the body without the aid of another ventricle. The cerebral ganglion is still placed on the œsophagus; but the nervous system becomes more complicated, always indeed consisting, it is said, of at least two ganglions, to wit, the cerebral and visceral. The liver is more voluminous, but otherwise is but little different from that of the *Ascidiæ*. The *Acephala* are perfect hermaphrodites, that is, sufficient of themselves for all the purposes of generation, and their young pass some time in the substance of the branchiæ before they are sent into the world.

Such is a very rude sketch of the characteristic properties of beings which will always attract some portion of interest, whether we consider their beauty or utility. The *Acephala* indeed may be said to comprise all the animals of the great division *Mollusca* that are particularly useful to mankind. The Oyster is a good example of the group. But there are some, as has already been stated, whose mantle having its lobes united in front possess shells open at the lateral extremities, so that the whole body becomes as it were tubular. Such is the family of *Solenaceæ* Lam. They are in fact animals, as Lamarck says, whose width has become excessive, while what, properly speaking, is their length has been proportionably reduced. We are led thence to the genus *Pholas*, extraordinary on account of the accessory pieces of shell which cover its hinge. These accessory pieces have however nothing to do with the ligament of the bivalve, as M. Lamarck has shown. Among the *Acephala* are also the well known ship worms (*Teredo navalis* Linn.) which, notwithstanding their vermiform appearance, are true bivalve *Mollusca*, whose shells are become too small for their body, while the exterior accessory pieces which we have noticed in the *Pholas* become here more developed, and unite so as to form a tube. In some cases, as in the genus *Aspergillum*, the bivalve shell confounds itself with this tube, which has in a manner the true shells inlaid into its substance.

These disguises, and this variety of change in natural forms, sadly distressed naturalists until they began to study the animals which inhabited the shells, as well as their habitations. The discovery of a bivalve shell inclosed in a testaceous tube was indeed a fact well calculated to excite surprise; and still more extraordinary must it have been to see the shell inlaid in the side of the tube, and forming part of it. We owe to M. Lamarck the explanation of these truths, a little attention to which may, as I conceive, also serve to show us how nature passes in the *Mollusca* from the bivalve animals to the univalve.

The genus *Bulla* cannot strictly be said to possess tentacula, or even head. On this account Cuvier has very happily named the family to which it belongs *Acera*, inserting it in a group, the rest of which are all provided with tentacula. But this deficiency of the principal organs of sense in a *Bulla*, its branchiæ covered by the mantle, the simple nervous system and the voluminous liver, embracing closely the several convolutions of the intestinal canal, are all properties which we have seen to belong to the *Acephala;* and were it not that these last have bivalve shells, and the other is a univalve, naturalists would no doubt have adopted some method of connecting them in their various systems. The nervous system of the *Acera* consists of two ganglions situated at the sides of the œsophagus, and united by a collar of the same nature, which surrounds the canal and is in fact the brain. From each of these two cerebral ganglions proceeds a nerve, which on meeting the other forms by the union the visceral ganglion. It is therefore manifest that, with the exception of the cerebral ganglion of the *Acephala* being divided here into two separate lobes, there is the strongest affinity between this nervous system and that of the Bivalve *Mollusca*. This affinity however is worthy of further examination. Let *Bulla lignaria* Linn. be the species under observation: we notice in the first place a fleshy disc, which serves for a foot; this is bisected by a transverse furrow, which extends equally over the back of the animal, and separates the hinder part which envelopes the shell from the anterior part of the body, which is free. This front division of the body, which is completely out of the shell, contains the œsophagus, stomach, brain, and salivary glands. The stomach occupies the greatest part, and is completely protected by three testaceous pieces, which form a sort of prism vulgarly called the gizzard. Two of these three pieces are flattish and precisely of the same form, so as to present what may be termed a regular bivalve; they are united together at the edges by a muscular substance composed of fleshy fibres, and in this fleshy tunic at the upper end is inlaid the third testaceous piece, which is oblong and irregular. This apparatus can be compared to nothing among the *Mollusca*, unless it be to the two valves of a *Pholas* with the insulated piece under the hinge. In the *Acera* it covers a no less important part of the body than the stomach; and we have already seen in the genus *Teredo* that the shell of an Acephalous animal may become too small for the body.

But if all doubt on the subject of a *Bulla* being the last vestige of the *Acephala* should disappear, it will still be necessary to account for its own univalve shell. This is in my opinion to be understood by the examination of the genus *Fistulana,* consisting of animals which Lamarck places in the same family with *Teredo.* The tube which covers the bivalve shell of *Fistulana* is swelled or dilated at its hinder extremity and closed all round except in front. Now let this tube be shortened, and the consequence will be that we shall have the form of the shells of *Bulla lignaria* or *hydatis.* So that if this principle of connexion be correct, paradoxical as it may appear, a *Teredo* is an Univalve Mollusque so far as regards its tube, and the genus *Bulla* is bivalve as to its gizzard; and in this curious manner may Nature have chosen to pass from the form of an Oyster and *Pholas* to that of an *Aplysia* and *Limax.*

But it must not be overlooked that great changes have undoubtedly taken place towards perfection in the anatomical structure of the Acera, and that a *Bulla* belongs properly to a very different class from the true bivalve *Mollusca,* though it may serve to unite them with the *Gasteropoda* of Cuvier. The branchiæ of the genus *Bulla* are of a more complex structure than those which we have observed among the *Acephala.* They are now transverse leaves subdivided each into still smaller folioles, and are attached to the two sides of a triangular membrane which adheres by one of its sides to the back of the animal. The œsophagus leads us to the gizzard, which opens into a membranaceous canal, still sufficiently inflated to deserve the name of a second stomach, and the rather because it diminishes at once after having received the biliary ducts. The lower side of the œsophagus is furnished with a rounded tubercle armed with teeth, which move by an undulatory motion, and can seize the food of the animal when the œsophagus is turned inside out, which it has the remarkable property of doing. The hermaphroditism also of the *Bulla* differs from that of the *Acephala*. We are thus prepared for the *Aplysia* where the branchiæ are similarly situated, the gizzard more formidably armed, the hermaphroditism and sexual organs the same as in *Bulla*. But in this new animal there are four stomachs; and the head, eyes and tentacula are all equally distinct. By means of the genera *Pleurobranchus* and *Onchidium* we arrive among the *Pulmonés* of Cuvier. Then probably the chain is to be followed through the *Pectinibranches*, *Scutibranches*, *Cyclobranches*, and *Inferobranches* of Cuvier, till we have the last form of his *Gasteropoda* in the genera *Doris*, *Tethys*, *Glaucus*, *&c.* Such at least do I imagine to be the path of Nature through the very intricate and numerous family of *Gasteropoda*, whether we take into consideration their general anatomy, or that most important part of it,—the nervous system. This we shall observe gradually getting more collected into one mass from the scattered system of ganglions in *Bulla* and *Aplysia*, till we arrive at the concentrated form which the medullary matter assumes in *Scyllæa* or *Doris*. There appear however to be exceptions to this regularity; but whether these are owing to the imperfect state of our acquaintance with their anatomy, or to other causes, is a question yet to be decided.

To the industry of Cuvier and Poli we owe almost all the knowledge we possess of the internal structure of the *Mollusca*: but it would be placing greater confidence in the observations of these learned men than they are justly entitled to, were we to rest contented with the little known at present of the *Cyclobranches* and *Scutibranches*. Less however remains to be done in Cuvier's family of *Nudibranches*, consisting of those beautiful animals, the simplicity of whose organs of digestion and reproduction, with the peculiar nature of the nervous system, prepares us for the singular family of *Pteropoda*. Until however the internal construction of such genera as *Glaucus* and *Eolida* be better known, it would perhaps be as well to follow the example of Peron, and to place these animals with the *Pteropoda*; at all events the principles on which these *Mollusca* might be thus united into one group would be infinitely more natural than those on which the family of *Gasteropoda* was originally formed. The genus *Clio*, which may be taken as the type of the *Pteropoda*, presents several points of construction to the observer which are well worthy of his most attentive consideration.

In calm weather, says Cuvier, those northern seas which like the land between the tropics astonish us so much by their fecundity of life, are seen to swarm with minute gelatinous Mollusques of the species *Clio Borealis*. They come by myriads to the surface of the water as if to respire, but the least touch is sufficient to make them sink towards the bottom and disappear. The nervous system of these little animals, which are supposed to form the principal food of the whale, is remarkably similar to that of the *Aplysia*, the brain being composed of two distinct lobes, from each of which runs a nervous thread to a ganglion which joins its fellow under the œsophagus by another nervous chord. In *Clio* as in *Aplysia* the salivary glands are long and narrow, floating at the sides of the œsophagus. But the genus *Tethys* perhaps will best show the affinity that exists between the *Gasteropoda* and *Clio*. Both these animals have their branchiæ uncovered, both have necks, and of all known *Gasteropoda, Tethys* is the genus which has neither tooth nor tongue to the mouth, forming thus an excellent prototype of what will be found to exist in *Clio.* The situations of the liver and of the intestinal canal form another proof of this affinity; and of the truth of the remark of the great naturalist who has said that the genus *Clio* "*est sans contredit voisin des limaces, des doris et des autres gasteropodes.*" It is worthy of attention also that the branchiæ of the *Nudibranches* are made use of in swimming, like the fins of *Clio.* From *Clio,* according both to Cuvier and Lamarck, we pass to the *Pteropoda* with an indistinct head, such as his genus *Hyale,* and so by means of the *Brachiopoda* return to the Acephalous *Testacea.*

It is however absolutely necessary to state here the difficulties which I have encountered, but have by no means been able to surmount, in the above arrangement of the *Gasteropoda;* difficulties which no doubt have their origin as much in my ignorance of Malacozoology as in the little general progress hitherto made in the knowledge of the innumerable species of *Mollusca* which inhabit the depths of the ocean. Still as the object of the naturalist is not to skim over difficulties but to dwell on them, not to propound systems so much as to state facts, I shall make a few observations on the *Gasteropoda* of Cuvier. These animals are the most perfectly constructed of the *Mollusca,* whether we consider their nervous system, their organs of sense and locomotion, the peculiarities of their structure for the purposes of circulation and respiration, or finally the marked distinction between their sexes. But on the other hand nothing can be more vague than the characters by which this numerous group coheres; for if we consider it as formed of animals creeping on a fleshy disc placed under the belly, there are several of the *Gasteropoda* which do not possess this character; though on the whole perhaps this distinction is the least liable to criticism, from its appearing to fail only at those points which in the above series I have considered as the extremities of the group. Cuvier has placed the *Cyclobranches* near his Acephalous *Mollusca*, though on what principle it is difficult to discover, unless it be on that which is at least as yet doubtful, namely their self-fecundation. Now this power, granting it to exist, when supported by other anatomical characters, would be most important for our purpose; but unsupported in a family like the *Gasteropoda*, in which the method of reproduction varies so constantly, it is absolutely of no value whatever; and when we see the genus *Chiton* placed close to the Oyster on such reasons, we cannot help concluding that among the *Mollusca* at least, the solitary consideration of the method of reproduction will lead us to no satisfactory results. This was too evident to escape the sagacity of Lamarck, who has accordingly formed his family of *Phillidiens* so as to include Cuvier's *Cyclobranches* and *Inferobranches*. The *Scutibranches* of Cuvier however have a direct and obvious affinity with the *Cyclobranches* by means of the genera *Capulus* and *Crepidula*, and again by means of the *Sigareta* they lead us to the genus *Buccinum* and others of Cuvier's *Pectinibranches*. But this author states that he is "*assez porté à croire que les Scutibranches sont des hermaphrodites qui peuvent se suffire à euxmêmes comme les Acephales;*" and on this account, as well as because the heart is pierced by the rectum and receives the blood by two auricles, he considers a certain affinity to exist between these animals, so different in every other respect.

The principal objection however which I have at present to the above arrangement of the *Mollusca,* in which I have almost entirely followed the learned Cuvier, is that the genus *Aplysia* and his other *Tectibranches* are more widely separated from the *Nudibranches* than their general anatomy appears to allow. If they be united, the *Gasteropoda* of Cuvier will evidently form a circular group, as Dr. Leach has had the goodness to point out to me. But however this may be, I have no doubt of there being some great error yet undetected in the principles upon which we are accustomed to arrange the *Mollusca,* and that we shall never arrive at the truth either by looking, like M. de Blainville, solely to the position and structure of the organs of respiration, or, like M. Cuvier, to the method of reproduction, as when he unites the *Cyclobranches* to the *Acephala.*

It may now seem invidious in me to indicate a probable remedy without showing, or at least trying its efficacy; but my inability at present to do either must be an apology for stating my firm belief to be that we have, in these curious animals, studied too little the nervous system; and that the best way to group the *Mollusca* naturally would be to follow up with more attention this most important of the various parts of animal structure. At all events, it is not to those collectors who are solely intent on the external form of a shell or the streaks of colour which ornament it, without the least idea of the form or structure of the animal by which it is inhabited, that the hope of discovering the true arrangement of the *Mollusca* can be held forth. The study of shells appears indeed to be indispensably necessary to the geologist. And no doubt the testaceous covering of an animal is always so intimately connected with its structure that it would be unpardonable in the naturalist, who ought to leave nothing without investigation, to forget shells. But, on the other hand, when we call to our recollection the lamentable error committed by Linnæus and his disciples in not following the example of our celebrated Lister in the arrangement of the *Mollusca*, we become convinced that there was about as much hope of their ever arriving at the truth by the means they chose to adopt, as that a collection of the wings of different insects should ever instruct us fully in the natural history of the several animals to which they belong. It is said that Klein formed an ornithological cabinet, in which the feet and beaks of birds were only to be seen, because, according to his notions, these were all the parts requisite for the proper arrangement of the feathered creation. He thought that it was possible to be a good ornithologist without knowing the least of a bird but its beak and claw. We may indeed laugh at this; but at the same time we ought to inquire whether similar ridicule may not with justice be extended to those conchologists who, having procured a shell, describe and classify it without deigning to bestow a single thought on the nature of the poor animal which constructed it for its habitation. A curious arrangement, as might have been expected, has come of this method of proceeding; for we have Annulose animals united to true *Mollusca*, merely because they have shells, and true *Mollusca* separated from this division, merely because they have no shells. In some cases even, as in the genus *Limax*, it is sufficient for the shell to be small in order to set it wide asunder from animals of the same family; but it would be endless as well as useless to detail the violations of natural order manifested by Linnæus in his systematical arrangement of the Mollusques, which have so truly constituted his stumbling-block.

It cannot however be denied, that could we adopt the notions of Linnæus as to the nature of the animals, the principles upon which he arranged their testaceous coverings are excellent, and such perhaps that to them every conchologist, who is not desirous to be acquainted with the true inhabitant of the shell, must in the end be obliged to resort. To those indeed who admire the splendour of the pencilling, the beauty of the enamel, and the variety of sculpture which exist in shells, it might be depriving them of at least an innocent amusement to object the trivial nature of their study as leading to no general results; but it may be as well to remind them that, unless they add to their satisfaction and to their knowledge by studying the structure of the animals themselves, there is no more science in the disposition of their cabinets than may appear in the tasteful arrangement of porcelain on a mantle-piece. The true and almost the only scientific object of the study of the shell out of the province of geology, seems to be the relation which it bears to the organs of respiration and circulation. Separate the shell from the animal, and much less acquaintance with the natural system is to be derived from this inorganic covering, than M. Klein obtained of his birds by seeing only their beaks and claws. Besides, collectors themselves, to lay aside the consideration of their time and talent being then properly directed, would be signally benefited in their own province by the study of the anatomical structure of the *Mollusca*. They would thus be necessarily free from all such frauds as those of Giæni, who so long imposed on them as a new genus of Multivalves, under the appellations of *Tricla* and *Giænia*, the apparatus which incloses the stomach of the *Acera*.

It will perhaps be noticed by the reader, that if I have hitherto aimed little at a general arrangement of the *Mollusca*, there has been a still weaker attempt made at any accurate designation of the classes into which these may be grouped. Nay, perfectly satisfied if it should be in my power to prevent the appearance of any great chasm in the route chalked out for myself, I have always adopted the divisions of M. Cuvier, since it must be obvious that a person is much less likely to be wrong in agreeing with this great anatomist, than in hazarding new speculations without sufficient knowledge of the subject to support them. Lamarck, however, has separated the *Acephala* of Cuvier from the *Mollusca*, under the name of *Conchifera*; though, as he rests the importance of this division upon points which are certainly of very secondary consideration, and which he himself acknowledges to shade gradually into the construction of his *Mollusca*, we can have no hesitation in pronouncing the alteration to be artificial. It is plainly a mistake which has arisen from his paying too much attention to the manner in which the hinges of bivalve shells are articulated, and too little to the observations of Cuvier and Poli, on the internal anatomy of the animals themselves. On descending into subdivisions, I am nevertheless inclined to believe the distinction which he institutes between the *Dimyaria* and *Monomyaria*, as two groups of *Conchifera*, to be excellent, and apparently much better than his great division of Cuvier's *Gasteropoda*.

He is himself even unable to give any satisfactory reason for this last innovation; for surely it is contrary to the first principles of Natural History, to admit that the bisection of a class can be otherwise than artificial, when it is almost entirely founded on the idea that the group, as it previously existed, was too numerous. As to Lamarck's *Heteropoda*, it can only at present be said, that Cuvier, whose opinion was founded on anatomical examination, considered them as *Gasteropoda*, and that the characters given to this proposed class by its author, who by the by appears only to have judged from their external appearance, are not sufficient to separate them from the *Pteropoda*.

A well known British Naturalist, who has paid more attention than any person in this country to the anatomy of the *Mollusca*, and whose observations on the subject are at this moment anxiously expected, will without doubt remove the obstacles which the natural arrangement of the *Mollusca* has hitherto had to encounter, and will place the science on a basis which will tend to make it of as much use to the general Zoologist, as to the many persons in England who cultivate Conchology alone. I shall therefore merely once more acknowledge, that what I have said of the *Mollusca* is an imperfect and hasty attempt to reconcile Cuvier's observations, as far as it was possible, with the existence of facts which I had previously reason to suspect from other considerations, and I shall now proceed to characterize generally this very peculiar group of organized beings.

The *Mollusca* are soft inarticular animals, breathing by branchiæ, or lungs, which vary in form and situation. They are moreover possessed of a complete system of circulation, also varying in its nature. Their white blood is circulated through veins and arteries, by means of a heart placed, not, as in fishes, between the veins of the body and the organs of respiration, but between these and the arteries. This aortic heart is one of the best characters for grouping the *Mollusca* together; and it is the more valuable, as these animals offer to the Naturalist almost every system possible of generation and digestion. They are furnished with an astonishing variety of organs of mastication and deglutition, their stomachs being sometimes simple, sometimes multiplied, and often armed with peculiar processes. They often possess salivary glands, and always a considerable liver. Some species have jaws and a tongue, other species neither; and this variation takes place in animals obviously so near to each other, as to have induced some persons to conclude, that little advantage in the arrangement of these animals is to be derived from the study of their system of nutrition.

The *Mollusca* are in general provided with a calcareous covering or shield, bearing no analogy whatever to the shell of coleopterous insects, but serving only for purposes of defence and of shelter to the soft humid skin of its possessor. These shells usually bear a strong relation to the disposition of the organs of circulation and respiration in the animals themselves; but though doubtless absolutely necessary to be studied, they are to be viewed with great caution in our attempts to arrive at the natural system. For since the organs of respiration and circulation themselves may lead and indeed often have led naturalists into evident errors of arrangement, so it is to be expected that the form of the inorganic covering, which nature appears to have provided for these parts by concrete exudations from the surface of the body, will produce conclusions still more vague and unsatisfactory.

The nervous system of the *Mollusca* is very peculiar, consisting of a certain number of medullary masses dispersed in different parts of the body, and of which the principal one, commonly called the *brain*, is situated over the œsophagus, which it encompasses with a nervous collar. The most general notion that we can form at present of the nervous system of the *Mollusca* is, that the medullary collar must always in its circumference contain four ganglions, which may either be united two and two, as it is probable they are in the *Acephala*, or all four together, as they are in the genus *Tritonia*. The brain is always composed of two of these lobes, which are generally connected, as in *Aplysia*, though sometimes separate, as in *Haliotis* and *Patella*. The remaining two ganglions of the collar send off nerves to the organs of respiration, &c. and are either united together, as in the common slug and *Patella*, or are separate, as in *Aplysia*. In the genus *Tethys* one lobe of the brain seems to be joined to one lobe of the inferior ganglions, that is, two and two together. There are often other ganglions distinct, such as two for the mantle, which appear however more particularly to belong to the *Cephalopoda*, and consequently are most manifest in those *Mollusca* which are the nearest to them in natural affinity. But whether these ganglions are united in the other *Mollusca* to the two inferior ganglions before mentioned, and so may have escaped detection, or whether they are altogether annihilated in these more imperfect animals, it must be left for future anatomists to decide. We may however be permitted to observe on the whole, that the nervous system of the *Mollusca* cannot at present be better characterized than as *dispersed*, that is, *having the ganglions scattered over different parts of the body*. The remarkable variety in the manner of this dispersion is beyond doubt the immediate cause of that want of uniformity which reigns throughout the organs of sensation, locomotion, respiration and digestion, and which occasions the *Mollusca* to be so especially difficult to arrange. The senses of the *Mollusca* seem to be confined solely to those of taste and touch, though Cuvier supposes them to be also able to smell. The black points which have obtained the name of eyes seem to serve less for sight than for touch; at least they display little if any sensibility of the presence of light, while their existence obviously increases the irritability of the tentacula as organs of touch. Cuvier has therefore well said, that the *Mollusca* ought to be considered as animals but little developed, hardly susceptible of industry, and which preserve their existence merely by their fecundity and their tenacity of life.

But we return to the genus *Clio*, as a passage whereby we may quit the *Mollusca* for other and more perfectly organized animals, namely, the

Cephalopoda.

The form of the *Clio borealis* is almost quite that of the genus *Loligo*, even to the fins. Its body is even terminated by an empty part, forming a sort of wrinkled tail or very depressed appendage, which, according to De Blainville, would also exist in the genus *Loligo*, were not this part rendered solid by the point of the protecting horny lanceshaped body which takes the place of the shell in these animals. In *Clio*, as in the *Cephalopoda*, the head is attached to the body by a neck; the eyes are in both situated in the head, and not at the extremity of tentacula. This head is in *Clio* crowned by six very long retractile conical tentacula, disposed in two lateral groups of three each, which, when retracted, give to the head an appearance of being formed of two great tubercles. Finally, the vertical mouth in *Clio* resembles in a very remarkable manner that of the *Cephalopoda* as to position. But notwithstanding these and other affinities, the general structure of the animal has undergone an almost thorough alteration; thus the head, which in the *Mollusca* was so indistinctly separated from the body, is now not only well defined, but in the cartilaginous ring which envelopes the brain presents the first vestige which we have yet seen of a skull. Hitherto we have seen but few animals endowed with the organs of sight; and when the eyes existed, or rather when we supposed these organs to exist, we have found them merely black points affording no trace of that peculiar organization which we are led from analogy to conceive necessary for the purpose of vision. But now we are arrived at animals possessing eyes, constructed on the same plan and hardly inferior in their construction to those of the most perfect *Vertebrata*. Hitherto we have seen no traces of an ear; but in the *Cephalopoda* the celebrated Scarpa has detected the sense of hearing, though the organs destined for that purpose are in their very simplest form. It would appear that neither in the Cuttlefish any more than in the *Mollusca* are there any organs peculiarly adapted for smelling to be discovered; but since they all, as we learn from the study of their manners, undoubtedly possess the sense, perhaps the conjecture of Cuvier is not improbable, namely, that the whole skin may be the seat of smell, from its resembling so much a pituitary membrane.

The peculiar character of the *Cephalopoda* which distinguishes them from all other animals is however their system of circulation. This they have been said to possess more perfect than all other animals; for besides the aortic heart of the *Mollùsca* they have two pulmonary ones. The little confidence that ought to be placed, at this point of the animal kingdom, on the organs of circulation as means whereby we may ascertain the true scale of nature, cannot better be demonstrated than by their being thus complicated in imperfect animals so very near to the *Mollusca* as are the *Cephalopoda*. Another peculiarity of these singular beings consists in the fleshy flexible arms or feet with which the head is crowned—those formidable muscular weapons the surface of which is armed with suckers to enable them to take still more firm hold of their prey. These feet are indeed the most essential parts of the animal, since with them the Cuttlefish seizes his food, with them he swims and walks. Their peculiar position gives the *Cephalopoda* two curious characteristics, namely, that they swim with their head behind and walk with it lowermost. The perfect circulation which exists in these animals leads us to suspect a corresponding peculiarity of respiration, and accordingly it is found that they are truly amphibious. They secrete a peculiar fluid of an intense black colour, which they employ for the purpose of obscuring the surrounding water, when they wish to conceal themselves either from their enemies or their prey. This character appears to link them more with the *Mollusca* than with the *Vertebrata*.

Striking the eye by their great size and whimsically complicated forms, which last hardly have a parallel in nature, the Cuttlefish necessarily attracted the attention of naturalists early, but no animals have perhaps been so difficult to place systematically. Cuvier indeed makes them in the *Regne Animal* immediately to follow the fishes; but that this is by no means a decided point we cannot better prove than by transcribing his own words. After having beautifully described the anatomy of the *Poulpe* or *Sepia Octopus*, in the *Mémoires pour servir à l'Histoire des Mollusques*, this excellent naturalist says, " *Il n'est sans doute personne qui, à la lecture de cette courte description, et à la vue des figures qui l'accompagnent, ne soit frappé de cet appareil de parties organiques, tout aussi développées et de même nature que dans les Vertébrés, employées à la composition d'un être entièrement différent, quant au plan et à l'arrangement général, tant intérieur qu'extérieur. Ces fibres, cette matière médullaire, ces artères, ces veines, ces valvules, ce parenchyme, ces intestins, cet œil, tout est semblable au fond, et tout est autrement entrelacé, autrement combiné. Si l'on excepte les organes de l'odorat, le système de la veine porte, les vaisseaux absorbans, le squelette, et les organes relatifs à l'urine, qui même sont peutêtre remplacés par la bourse du noir; nous retrouvons à-peu près ici toutes les fonctions qui s'exercent dans les poissons; et cependant il n'y a nulle ressemblance, nulle analogie de disposition. Même pour les imaginations les plus prévenues, les bras qui couronnent la tête ne deviendront point des nageoires; les cartilages qui renforcent le dos ne se changeront point en vertèbres; ces trois cœurs au fond de l'abdomen ne remonteront point vers la gorge pour se réunir en un seul. En vain chercherait-on à rapprocher ces Mollusques de quelques poissons, dont le squelette a presque disparu; ceux-ci n'en sont pas moins des poissons par tous leurs autres organes, par la forme de ces organes,* *par leur position mutuelle, par l'ensemble de la configuration, et rien de tout cela n'existe de même dans nos Céphalopodes. En un mot; nous voyons ici, quoiqu'en aient dit Bonnet et ses sectateurs, la Nature passer d'un plan à un autre, faire un saut, laisser entre ses productions un hiatus manifeste; les Céphalopodes ne sont sur le passage de rien; ils ne sont résultés du développement d'autres animaux, et leur propre développement n'a rien produit de supérieur à eux."* We thus have three different propositions clearly laid down, to the two first of which there cannot be the least objection, namely, that the *Cephalopoda* evidently connect the *Mollusca* and *Vertebrata* together, and secondly, that they have no affinity whatsoever with the fishes. But though both these positions are perfectly sound, I suspect the reasoning to be not so much so, which, in the consideration of natural affinities, would lay any stress on particular exceptions from a general connexion. We even find that M. Cuvier himself has placed both the *Brachiopoda* and *Cephalopoda* among the *Mollusca,* although the former have two aortic hearts only, and the latter group possesses one with two pulmonary. If therefore no conclusion could be obtained from the construction of the organs of circulation in one case, and he thought proper to disregard it, it is not easy to perceive why he should have paid such an absolute deference to it in another. If fallible in the group of *Mollusca,* the probability is that it may also be the cause of error in the *Cephalopoda.* On examining the genus *Clio* we find neither shell nor pulmonary hearts, while the arms, though surrounding the mouth, are observed by no means to be of a construction similar to those of the *Sepiæ.* Yet are we therefore to conclude that there is no affinity between them? Has M. Cuvier even drawn such a conclusion when he placed his *Pteropoda* immediately after his *Cephalopoda?* It is unquestionably true that fishes have little or no direct affinity with the *Cephalopoda;* but it is not the instancing any solitary or single case of dissimilarity, but the impossibility of finding any mode of connecting them, that will prove this. I know indeed no better proof of the fact, than that naturalists have been so long seeking to discover some such direct affinity, and have all failed in their endeavours to detect it. But single instances of discrepancy ought never to be employed to establish this truth, since, should we grant the accuracy of this mode of reasoning, there would be an end of every thing like the filiation of nature, or the gradual developement of animal organization. Every difference however trifling might then be brought forward to prove that Nature had committed a great saltus. M. Cuvier indeed in his third proposition appears too hastily to have set aside the old maxim of Linnæus, *Natura, opifex rerum, saltus non facit.* No person as yet can be sure that any saltus exists in nature, unless indeed the small interval which separates species may deserve that name. In the case of the *Cephalopoda,* as terminating a series, such a saltus could never be proved by any particular distinction existing between them and fishes, but by the impossibility of finding any general affinity between them and the *Vertebrata.* But so far from this, our author commences his statement of the subject with the full allowance of the existence of some such affinity, which indeed it would be ridiculous in any but a blind person to deny. Now convinced, as most persons are, that where there is an acknowledged affinity between the whole, there must necessarily be some affinity between the parts; it will at least be interesting to inquire briefly whether because the *Cephalopoda* have no direct connexion with the fishes, they must therefore have none with any others of the vertebrated animals.

For this purpose let us commence with the eye. The iris of this is of a golden colour in the *Cephalopoda*, in reptiles and in fishes. Naturalists have observed that there is a vestige of three eyelids in the *Sepiæ*, which we know only to be the case with the reptiles among the *Vertebrata*. The third eyelid is semitransparent in both reptiles and *Cephalopoda*, and is placed behind. The granulated glandular lobes behind the eyes are also common to both. The closed ear with the cavity of the tympanum nearly spherical, and its single trumpet-shaped ossiculum, is an imperfect sketch of that of the Chelonian reptiles. The semicircular canals are wanting in the Cuttlefish. In the tortoises they exist, but are remarkably short. Daudin has observed that of all the senses of reptiles, to judge from the simple structure of the nostrils, that of smelling must be the most imperfect; and Cuvier says, that he was unable to recognise any part specially constructed for this purpose in the *Cephalopoda*, though he adds that they appear to enjoy this sense, since they are known to be attracted by the odour of different substances. The coriaceous skin of the *Sepiæ* is very analogous to that of the soft tortoises. So much for the organs of sense.

Now if we proceed to consider the internal structure, and particularly the organs of digestion, the convex, hooked and sharp-pointed horny mandibles of the *Sepiæ* will be seen to inclose a tongue which, from its cartilaginous covering of transverse laminæ and projectile nature, necessarily calls to our recollection that of many reptiles. Like those of

Tortoises, their maxillæ are without teeth, though their tongue is more similar perhaps to that of the Saurian reptiles. It must however be acknowledged that the tongue of the *Cephalopoda* appears to approach nearer to that of some true *Mollusca*, than to that of any of the vertebrated animals, unless it be in its situation between the mandibles. The fleshy denticulated process which covers the mandibles of the *Cephalopoda* is another part of the mouth which must strongly remind the naturalist of the curious genus *Trionyx* among the Chelonians. The presence of a very complete salivary apparatus in the Cuttlefish, which is necessary from the triturating process employed in eating their testaceous food, may perhaps not coincide with that almost general character of reptiles, namely, that they swallow their food whole; but it is to be remembered that hitherto the anatomy of the Chelonians has not been so completely investigated as that of the other reptiles, and that it is precisely those animals which feed on the same sort of food as the *Cephalopoda*, which have the same organs for trituration, and therefore may be expected to require a salivary apparatus. But even though no organ of this sort shall be found, the immense size and apparent importance of the salivary glands is a character of the *Mollusca* rather than of any of the *Vertebrata*. At least this can demonstrate no affinity of the *Sepiæ* to fishes, since in these last, with the exception of one or two species, salivary glands have not been discovered. The œsophagus has a dilatation or crop in *Sepia Octopus*, like that of a bird; but in *S. officinalis* and *Loligo*, which approach the nearest to the reptiles, this crop is wanting so as to afford another remarkable affinity. Glandular grains also, analogous to the conical papillæ which line the œsophagus of the tortoise, may be detected lining that of *S. Octopus.* The spiral stomach of the *Cephalopoda,* its sudden dilatation, and its lining of longitudinal folds, may likewise be traced to the tortoise. The gizzard is a character common to birds and the *Cephalopoda,* and this may be accounted for by considering the near affinity which exists between tortoises and birds. In *S. Loligo* however, that is, one of the nearest of the *Cephalopoda* to the *Vertebrata,* this gizzard is smaller and more slender than in *S. Octopus.* The probability therefore is, that it is a structure by which these animals are to be referred rather to their own type than to any truly vertebrated animal. Nevertheless the whole of the alimentary organs of the *Cephalopoda* must be reckoned extremely analogous to those of reptiles, and particularly to those of the tortoises. The two-lobed liver with its situation, nay, even the two hepatic canals are all visible in a Chelonian reptile, in which, as well as in the *Cephalopoda,* the peritoneum, which comprehends all the viscera, is divided into several subdivisions in front, covering the liver and forming a sort of diaphragm. This peritoneum indeed is perfectly analogous to that of the vertebrated animals, and differs from that of the *Mollusca* in that it does not cover the brain nor the mass of the mouth in general. It is true that the rectum of the *Cephalopoda* opens in front of the neck, and it may be asked, What similar position of this organ is there among reptiles? But the proper method of putting the question is, What similar position can be found among the *Vertebrata?* since, in fact, it is a character of the *Mollusca* that the situation of the rectum should be subject to no general rule.

Cuvier says of the tortoises, "*Ces animaux se distin-*

guent au premier coup d'œil par le double bouclier dans lequel le corps est enfermé, et qui ne laisse passer au dehors que leur tête, leur cou, leur queue et leurs quatre pieds." Now, with the exception of the word *quatre,* this description, which he considers distinctive, would apply admirably well to the *Cephalopoda*. The study of the anatomy of a Chelonian reptile may serve to explain this. Such an animal will be found to be inclosed between two bony envelopes, one of which being more or less convex constitutes the upper surface of the animal, and the other being more or less flat constitutes the inferior surface. The union of these round the sides of the animal forms a thin edge or margin, analogous to that fleshy fin which runs along the whole side of the *Sepia officinalis*. Nay, in the soft tortoises, or the genus *Trionyx* of Geoffroy, the margin of the animal ceases to be osseous and remains constantly cartilaginous or coriaceous, so that the middle only of the upper shell is osseous, in this exactly resembling those *Cephalopoda* which have inserted in the middle of their back a long oval, convex, horny, or calcareous bone. We shall see hereafter that this is the first vestige of a skeleton, and it may be proper therefore to describe it more fully as it exists in the *Cephalopoda*. In the genus *Sepia* this bone or shell is thick, oval, and composed of an innumerable quantity of very thin calcareous laminæ, parallel to each other and joined together by minute hollow columns, which go perpendicularly from one to the other. It may be asked, whether this apparently anomalous structure may not serve in some measure to explain the composition of bones in the *Vertebrata*? At all events it cannot be considered as a general characteristic of the *Cephalopoda*; for in the genus *Loligo* this dorsal process is a long thin piece of horn, analogous to nothing known in the true *Mollusca*. In the genus *Octopus* we have the first indistinct trace of it in two small conical grains of a horny substance placed in the thickness of the back.

From the abovementioned two envelopes, therefore, which in a true Cuttlefish form a cartilaginous or coriaceous sack, but in the type of the *Chelonian* reptiles are bony, proceed in both tribes of animals a neck, head, and scull; for, as has been already noticed, a very distinct vestige of a scull may be seen in the *Cephalopoda*. The mode in which the species are reproduced is also in these last animals said to be similar to the known method of the Batracian reptiles. The eggs of the Calymary and of the *Cephalopoda* in general are united into small masses by a gelatinous substance similar to those of certain Reptiles; and the circumstance, mentioned by Cuvier, of the vitellus hanging to the body of a young Cuttlefish by a pedicle, is still analogous to what is observable in Birds and Tortoises. It may therefore be concluded with safety that the *Cephalopoda* come nearer to Reptiles than to any other vertebrated animals, and that of the Reptiles they come nearest to the *Chelonians*. The hiatus that occurs between them is indeed vast, and hardly requires to be mentioned, since its existence is sufficiently demonstrated by the circumstance that hitherto no person has thought of the affinity. Still there is nothing yet to warrant the bold assertions that the *Cephalopoda* are in their construction insulated beings "leading to nothing," that they are entirely different from the *Vertebrata*, and that here Nature has evidently made a *saltus*. Such doctrines can only be listened to when the bosom of the deep, and the vast tracts of land which remain, to the peculiar disgrace of England, still unexplored by the naturalist, shall have delivered up their treasures to the eye of science. At present, when we consider that it is but as yesterday that Geoffroy St. Hilaire first made known the soft tortoises, we can hardly say that tomorrow may not display to our view an animal still more remarkable, as tending to show us the true place of the *Cephalopoda* in nature. I would not however be supposed to assert that these two tribes of animals will ever be found actually to shade into one another; for it cannot be denied that the *Cephalopoda* possess a construction peculiar to themselves, and as distinct from that of the vertebrated animals as it is from that of the *Mollusca*. Their system of circulation and respiration is altogether confined to themselves; but certainly is most analogous, with the exception of the colour of the blood, to that of the vertebrated animals. The branchiæ act on the water which enters into the sac; but it would also appear that this water can penetrate into the two cavities of the peritoneum, which the venæ cavæ traverse in their passage to the branchiæ, and that it is thus enabled to act on the veinous blood by means of a glandular apparatus or sort of lungs which is attached to the venæ.

The dissimilarity in external form and even internal structure between the various animals which compose the group of *Cephalopoda*, proves that Nature is here vacillating, and on the point of deviating considerably from any form which we have hitherto considered. Who, for example, at first sight would believe that the Calmar or genus *Loligo* and the eight-armed Cuttlefish *(Octopus)* are so nearly allied? The former, with its short feet and long flat body, weighed down by its internal dorsal bone, seems to have no similarity to the latter, with its long tentacula and round short body. We could almost believe the genus

Octopus to be the type of the form, when we observe its activity and the complete adaptation of its extraordinary structure to its manner of life; and it is to the other animals, which deviating from this construction seem to be destined to inactivity, that we are to look for the means of quitting the group for that division of animals which to us must always be the most interesting on account of ourselves forming part of it.

Vertebrata.

Commencing with the Chelonian Reptiles, the naturalist enters on this group remarkable for three things, the perfection of its organization, the great size of the individuals which compose it, and the paucity of species which it contains, when compared with the group of *Annulosa*. Bones constitute the great characteristic of the *Vertebrata*; and it is accordingly with the examination of them that we ought to commence their study. In reptiles the bones are particularly cartilaginous; and, according to Caldesi, they have no medullary cavity in tortoises, thus affording an additional proof that what takes their place in the *Cephalopoda* is the dorsal horny lance. Still the cartilaginous envelope for the brain in the Cuttlefish is now become in the Tortoise a true osseous cranium. The neck has now seven cervical vertebræ to support it, the two last of which become anchylosed at a certain age. The upper shell or *carapace*, to which we have before alluded, will be discovered on minute examination to be formed by the expansion of eight pairs of ribs, which are anchylosed together by real sutures, and united to a row of square osseous plates which run along the middle of the back, so as to form one solid inflexible piece. These osseous plates are equal in number to the vertebræ of birds, and in fact represent their rings and spinal processes. A circle of other bony pieces, which appear to be analogous to the sternal or cartilaginous portion of the ribs of other animals, surrounds the *carapace*, and unites together all the ribs which compose it. These are cartilaginous and flexible in the genus *Trionyx*. The under surface of a Chelonian reptile is in fact its sternum, and ordinarily composed of nine pieces. So that we see in the extraordinary construction of these animals what Cuvier means when he calls them *animaux retournés;* they are in fact such, having their skeletons on their outside, and the bones and muscles of their head and limbs attached to the inside of this skeleton, contrary to the plan pursued in all the other vertebrated animals. Here then is an astonishing proof, that Nature in one of her own groups adheres always to a particular plan of organization even under the widest dissimilarities of general form, and which plan of organization, could we always detect it, would leave little to be desired in the way of natural arrangement.

The feet of the Tortoise cannot be assimilated to those tentacula which we have termed feet in the *Cephalopoda*. They are not even different forms of the same organ; so that this alone serves to throw a wide distance between the two tribes of animals. To pass therefore from the Tortoise to the *Cephalopoda* by a gradual change, some Chelonian reptile must be found destitute of feet. But we know of none such; yet that the existence of such an animal is not improbable, appears as well from the extreme shortness of the feet throughout the tribe, as from the neighbouring family of *Ophidians* being destitute of them. On quitting a nervous system like that of the *Mollusca,* we ought to expect that the brain will be at first far from voluminous, and that the medullary matter will by no means be very concentrated. In other words, we may be sure that instinct and industry will be extremely low, while muscular irritability and tenacity of life will, on the contrary, be very observable, in the animals which form the transition to the *Vertebrata*. Thus it is then with the Chelonian reptiles, in which the brain is remarkably disproportionate to the size of the animal, and, as was shown by the cruel experiments of Redi, is little if at all necessary to the existence of life. The brain of the tortoise seems to be of no further use to the animal than as a passive sensorium to which impressions are communicated by the organs of sight, smell, and hearing: and the removal of it is said to be attended with consequences to the possessor hardly more important than the loss of these senses. The Chelonian circulation is rather singular; so that it has been said that they seem to have two hearts joining one another, one of which is formed by the two auricles, and the other, though apparently consisting of only one cavity, yet containing two veinous and two arterial ventricles. These four chambers communicate together, so that the black blood which comes from the body into the right auricle, and the red blood which enters the left from the lung, are here always more or less mixed.

M. De Blainville has separated the Batracians* from the other reptiles, on the principle that these come nearer to birds in their organization, and the former nearer to fish. He has therefore called the Batracian reptiles of Brogniart *Ichthyoides*, and the other reptiles *Ornithoides*. This arrangement is excellent, because it is natural; but

* The idea of this class is by no means new, as the propriety of its formation was indicated by Latreille several years ago, and lately again in the new edition of the *Dictionnaire d'Histoire Naturelle*, art. *Entomologie*.

the old names of *Reptilia* and *Amphibia* are so truly unobjectionable that there seems no reason why they should be abandoned. We may, therefore, under the general name of REPTILIA assemble the following groups of M. De Blainville.

1. CHELONIANS or Tortoises,
2. EMYDO-SAURIANS or Crocodiles,
3. SAURIANS or Lizards,
4. DIPOD OPHIDIANS,
5. APOD OPHIDIANS or Serpents.

The extremities of this column appear to meet in the *Emys longicollis* (*Testudo longicollis* of Shaw), and the whole forms a group which may be distinguished from Birds by being cold-blooded; and from the *Amphibia* by having two auricles to the heart, by undergoing no metamorphosis, and, finally, by a different system of generation. For the present we shall consider the Chelonians as their structure leads us to Birds, a transition which, though by no means gradual, is yet effected by affinities so plain as scarcely to have escaped the notice of any naturalist. It may almost be sufficient for our purpose to mention the horny covering of the mandibles of a tortoise, the structure of its limbs and generative organs, as particularly proving the accuracy of this approximation: but, throwing aside all anatomical considerations, the Hawksbill turtle puts the matter beyond doubt. This animal exhibits to the view a rude sketch of the form of a Bird, so distinctly that we can hardly refrain from supposing that Nature must, in a sportive mood, have intended to show us by the union of animals totally dissimilar in habit, what wonders she can perform in the prosecution of her favourite principle of affinity. It is indeed curious, that except in those particular parts of the structure where the general affinity is visible, no two animals can differ so much from each other as a bird and a tortoise. The active tenant of the air and the proverbially sluggish reptile seem, at first sight, to have no quality in common, and indeed, though their connexion is indicated by every zoologist who has written on the subject, there is a broad line of distinction to be drawn between them. We require, for instance, to see some animals of an intermediate construction; and as none such are known, the advocates for absolute divisions will at once conclude that they are not to be found. The safer method, however, would be to content ourselves with the undoubted fact that they have not yet been discovered. Nevertheless, by examining a common turtle, we may obtain the knowledge of some curious points of natural arrangement. Thus we conclude in the first place, that the birds which come the nearest to this animal in structure must be aquatic; that they ought to be covered with scales rather than with plumes; that their sternum ought to be very large, protecting all their viscera; their wings short, of no use for flight, but serving rather as fins to swim with; finally, that their legs ought to be placed so far behind as to render the bird almost incapable of walking. They ought in short to be true reptiles with respect to locomotion. If such then be the sort of bird we are to look for, who does not see the Patagonian Penguin or the genus *Aptenodytes* of Forster in the above description? a bird whose olfactory organs are almost as simple as those of the Chelonians, which, like a turtle dragging itself on its belly along the shores of South America, quits the sea only for the purpose of depositing its eggs in the sand.

It is unnecessary here to describe creatures so well known as birds, the more especially when the place assigned to them by all naturalists between *Mammalia* and Chelonians seems perfectly consonant with the harmony of Nature. Suffice it, therefore, to say that this charming group of animals has perhaps the greatest energy of respiration which is known to exist, and moreover appears to have the organs of sight more perfectly organized for the purposes of vision than any other *Vertebrata*. Some of them, as the *Palmipedes*, are also the most gifted with the power of locomotion, since they command three elements, and can make way equally well on land, in the air, or in water. With the exception of some insects, we are acquainted with no other instance of this in Nature. In many other respects, also, Birds seem to vie with or even to excel the *Mammalia*; from which however they may always be distinguished with ease, whether we attend to their nervous system, their mode of reproduction, their alimentary or secreting organs, or lastly those of locomotion. The organs of sense however, excepting those of sight, appear to be much more complex in structure among the mammiferous animals than with birds, though indeed these last are by no means deficient in the power of smelling, and many are even remarkable for their strong sense of odours.—It has been said, with great justice, by M. Cuvier, that of all the classes of animals that of Birds is the most strongly marked,—is that in which the species resemble one another the most, and which is separated from all others by the greatest interval. In the present state of science it is, indeed, impossible to define accurately how we are to quit Birds in order to enter among the *Mammalia*; and it is right to observe that this difficulty, so far from being employed to separate the two groups as we might have expected it would be, has, on the contrary, been very properly disregarded by naturalists. We have only to regret that the union of *Mammalia* and *Aves* should, ever since the days of Linnæus, have been accompanied by a glaring violation of natural order in the place of the *Cetacea*, which have been supposed to intervene, though certainly few of the *Vertebrata* are wider apart from the feathered creation. Those birds which appear in their internal as well as external structure to approach the nearest to the *Mammalia* belong undoubtedly to the Ostrich family; but then the imagination must be sadly taxed before we can point out any particular quadruped as meeting them.—Among the *Mammalia* we find that the *Monotrèmes* of Geoffroy have an affinity to Birds; but although in these singular animals the rectum, the urethra, and the spermatic canals, have all only one external opening; though there is every reason to believe them to be in some degree oviparous; though they possess the furcate bone of Birds, with many singularities of formation that separate them from the other *Mammalia*, yet no bird is as yet known to meet them. The *Ornithorhynchus paradoxus* possesses the beak of a duck, it is true; but there are grounds for thinking that it would be difficult to prove much further particular affinity to exist between them. Besides, the *Ornithorhynchus* after all is in some respects so true a quadruped, that it becomes almost ridiculous to make it the immediate means of transition; we must therefore leave the problem to be decided by time. Several quadrupeds apparently possess other affinities to Birds, as the Jerboa for instance in its legs, the Bat in its sternum: but it is more than probable that these similarities are only analogical, or, at least, merely necessary consequences of the particular modes of life to which each animal may have been destined. It is certain however that they are quite unsupported by any very important relation, and it may therefore happen that the animal which really connects the *Mammalia* with Birds is now only to be found in the fossil state. Thus for instance, the *Ornithocephalus antiquus* of Soëmmering appears to make a nearer approach to a bird than any mammiferous animal known.

Popular curiosity is almost exclusively confined to the branch of Zoology at which we are now arrived: but notwithstanding that the superior interest universally taken in the history of the *Mammalia* may easily be justified, the naturalist soon learns that it cannot influence him in the study of the creation generally, without being the cause of his losing the sublime effect of the whole temple of nature in a comparatively trifling acquaintance with its details. To be indifferent about the façade, yet with minute and tedious labour to scrutinize the ornaments of a single column, is no great proof of a correct taste; but unfortunately the criterion of taste in natural history is generally taken to be the opinion of the many, and a beautiful science thus dwindles into a collection of anecdotes.

In prosecuting the rugged paths of science the great bulk of mankind have no other object than the gratification of their pride, or the advancement of a temporary interest. Those studies which tend merely to increase our ideas of the wisdom and power of the Deity, and to teach us, on the other hand, our own nothingness, are little likely to have followers. The first question always is, *Cui bono?* and if the answer be such as to make the inquirer believe that neither his cupidity nor his vanity can be gratified, neither his fears quelled, nor his pride elated by the research, he is sure to throw contempt, if not obloquy, on the science. No better example of this truth can be given than the progress of natural history since the period when it, with all other branches of human knowledge, revived from the deathlike state in which they were plunged during the dark ages. It was unquestionably to its evident utility in a chirurgical point of view, that anatomy, for the second time, owed its origin; and when a few men, struck with the wonders it displayed, extended the pursuit beyond what suited the ideas of a barbarous age, ecclesiastical censure, and all the violence of a bigotry which was incapable of looking beyond the province of medicine, prohibited the dissection of the human subject, as the most horrible of impieties. Curiosity was however excited, and this impetus once given necessarily produced its effect; so that while human anatomy was taught in public, by the dissection of quadrupeds, it was often learned in private on the human body. That rational beings should not institute comparisons, and note the differences, between the various specimens of mechanism thus placed daily before them, was evidently impossible; and comparative anatomy, in this manner, arose less from any desire to be acquainted with the works of the Deity, than, in the first case, from a benevolent wish to relieve the sufferings of a fellow creature, and, in the second, from a mixed emotion of pride and curiosity to know in what respects the human structure is superior to that of other animals. The *Mammalia*, however, could not long be examined without the anatomist having his ideas of the corporeal perfection of man, and all the fabric of vanity which was built on such ideas, sorely injured, by perceiving that while some mammiferous animals excelled him in particular points of organization, others, such as the *Quadrumanes*, approached him so nearly as to render it a problem of some little difficulty to draw the line of distinction between them. It is rather amusing now to observe the interest which the older anatomists took in this research, and to mark the tortures to which their *amour propre* seems to have been put, when the internal structure of the Ourang Outang was discovered to be almost the same as that of Man. The fact however could not be disputed; and nothing remained but to throw a veil of importance over the whole study of mammiferous animals, which they neither peculiarly deserved, nor would indeed have ever obtained, had they not interested the self-love of man.

There is no one however, I trust, who from this will believe me absurd enough to imagine that human anatomy is not infinitely the noblest part of natural history, and that the prosecution of it does not contribute as much to the service of true philosophy as to the welfare of our fellow creatures. But its dignity is superior precisely because it is our own structure that is under examination, that is, a frame which has been animated by reason; and I cannot help thinking, that when once we have passed this barrier, and have descended to the other animals, as we can then have little other aim than a general acquaintance with the works of our Creator; so, to attain this purpose, the vilest insect that crawls is as deserving of notice as the Elephant. When therefore we witness that by far the greatest portion of animal life is often regarded with total unconcern by those whose profession it may be to acquire a knowledge of the human frame, it naturally excites regret that so much science and talent should scarcely ever be brought to bear on the discovery of the natural system. An Englishman, on reflecting how much superior our medical schools have ever been in reputation to those of the Continent, must necessarily lament that with such means in our possession we should be so far behind our neighbours in comparative anatomy. Yet if that which has been designed by Omnipotence ought to interest us, how can we obtain more insight into the truth than by tracing organization from its most imperfect sketches up to man? or, even if our curiosity should go no further than to know the nature of material life, how can we hope to master this difficult and most intricate question, unless by watching the first dawn of vitality, and following it carefully to the place where its energies appear to be the most concentrated? It may well then be asked why there are so few persons who, in fact, take any interest in the investigation of the smaller animals. But the answer is simple: Such researches humble the pride, while they do not present any immediate prospect of utility or profit: it were to argue therefore a complete ignorance of human nature, to expect that such studies should be generally cultivated. If an object be small, it is despised, and in proportion to its magnitude it is sure to excite attention. Now when our views relate solely to the humbler concerns of human life no doubt this is perfectly just, but in the contemplation of Nature and of Nature's God it is far otherwise. By Him who is without beginning and without end, infinity of magnitude is comprehended with the same ease as that of minuteness; so that in Zoology we ought never to forget an observation of Madame de Stael, "*le plus foible atome est un monde, et le monde peutêtre n'est qu'un atome.*" In the pursuits of literature, the judgement or imagination of an author reflects a portion of credit on his species that must infallibly interest the reader; nay, in natural philosophy there is enough visible of the work of man, or at least of his sagacity, to keep him in humour; but in natural history he sees nothing but the wisdom and omnipotence of God displayed in his divine works, and his own comparative imperfection and imbecility manifested in his inability to comprehend them.

But though, for the reasons above given, the anatomy of the *Mammalia* and of Birds has had infinitely more attention paid to it than that of all the rest of organized creation put together, it is not too much to say that their natural arrangement is as little or even less known than that of any other part of Zoology. No where, at least, do we find inconsistencies so conspicuous as in the following order, which is that nevertheless of the most learned comparative anatomist in existence:

Felis,
Phoca,
Didelphis,
Mus,
Lepus,
Bradypus,
Dasypus,
Ornithorhynchus,
Elephas,
Sus,
Equus,
Camelus,
Bos,
Manatus,
Balæna,
Accipitres, &c.

Having been warned by the author that we are not to consider this series as a scale of perfection in structure, nothing ought to be said on the subject. It is the order of affinity which is held forth as the merit of this short list; and yet here we have the Seal placed next to the Kangaroo, the Hare next to the Sloth, the *Ornithorhynchus* allied to the Elephant, the Ox to the Whale, and this animal again to the Birds of Prey. In short, the discrepancies are so great and so frequent, that we necessarily pause before we can admit that such can be a series of animals *distributed according to their organization.* Be this however in general as it may, there is one thing very certain, that the *Cetacea* lead us by a very distinct and natural transition from the *Mammalia* to Fishes; and that if their warm blood, their lungs, their viviparous generation and mammæ prove their affinity to the former group, their skeleton and external covering, the imperfection of their olfactory and auditory organs, all show that they approach near to fishes. The viviparous sharks, such as *Selache maxima* Cuv. or Basking Shark, with their ear more perfectly organized than that of other fishes, and their body destitute of scales, the particular disposition of their fins, and their closed branchiæ, all indicate at what place we are to enter among the fishes. With the exception of such sharks, fishes are oviparous animals, whose eggs are fecundated by the male shedding his milt over them. They breathe by branchiæ; and the blood, after respiration, passes into an arterial trunk situated under the spine, and which performing the functions of the left ventricle disperses it throughout the body, from which it again returns by means of the veins. Nothing is as yet known of their natural arrangement; but it is allowed by every naturalist that they are intimately connected with the *Amphibia* or *Batraciens* of

Brogniart. De Blainville indeed, on this account, has called these last animals *Ichthyoides*. They are distinguished from all other *Vertebrata* by undergoing a species of metamorphosis; in their young state being Fish, and breathing by branchiæ; in their adult state being Reptiles, and breathing by lungs. Sometimes indeed, as in the genera *Proteus* and *Siren*, the metamorphosis is abortive; for even in these singular cases the animal does not appear to have remained in its young state, but by some peculiar disposition of Nature adopts a new structure without having entirely lost its old one. The *Proteus anguinus* is a Salamander, which with the usual internal lungs retains the external branchiæ which properly belonged to its larva state. The genus *Siren* has a still more imperfect metamorphosis than the *Proteus*; for here the animal without arriving so near to the perfect form of the Salamander, which may be considered its type, still takes the lungs and those other peculiarities of internal structure which always mark the adult in the *Amphibia*.

Such is the outline of two of the most extraordinary animals in nature, the *Proteus anguinus* of Laurenti and the *Siren lacertina* of Linnæus, the metamorphosis of both which may be termed imperfect or abortive. By this, however, it is not meant that the animal is imperfect, or not fully provided by the Creator with all the organization which it required, in order to retain its place in the scale of nature, but that it has not fully arrived at the structure of the type to which its form ought to be referred, and which in this group is perhaps either the Frog or Salamander. In every group there would seem to be a particular form or structure to which all the animals composing it should be assimilated. In the more circumscribed groups this type of form, being a real existence, is not very difficult to be ascertained; but in the larger assemblages, such as those into which the *Vertebrata* seem to have been distributed by Nature, it is almost impossible to ascertain the type from its being a sort of ideal being, uniting in itself all the various perfections of organization which may in reality be dispersed throughout the group. The physiologist however will be always interested with the study of the *Amphibia*, because it leads him by the most accurate process of ratiocination to establish some fixed points in the group of *Vertebrata*, which he may make the foundation of his more minute investigations. Thus, if that state in which an animal is fitted to continue the species be more perfect than that of infancy, it follows that the tadpole form and structure, which approaches to that of a Fish, is not so perfect as the adult form, which approaches to that of a Reptile. This reptile form is therefore the type or perfection of the group; and as the Salamander is more nearly allied in shape to the true reptiles than any others of the *Amphibia*, we may safely conclude it to be the type to which the *Proteus* and *Siren* tended in the developement of their form, but which they are never able to arrive at from some limits which have been imposed on their metamorphosis by Nature. This metamorphosis then, whether perfect, as in the case of the Salamander and perhaps of the Frog, or imperfect, as in *Proteus* and *Siren*, is the distinguishing character of the group of *Amphibia*, though evidently like most other natural characters not that which may easily be made use of for purposes of arrangement. The *Amphibia* are then clearly situated between Fishes and Reptiles; from the former of which animals they are separated by the lungs and form of the skeleton which they possess in the adult state, and finally, by that remarkable character of Reptiles, namely, that the heart sends to the lung only a part of the blood which it receives from the veins, and that the remainder of this fluid returns into the general circulation without having come in contact with the air. From Reptiles they are even still further distant; for besides the branchiæ of their larva state, which are always more or less analogous to those of fish, and are supported in much the same manner, the circulation is then totally different, as is also the system of generation in the perfect state. The passage however to the Ophidians, by means of the genus *Cecilia*, is so direct and manifest as scarcely to require notice.

Thus we have seen five distinct classes of animals to compose the great group of VERTEBRATA, viz.

1. REPTILIA,
2. AVES,
3. MAMMALIA,
4. PISCES,
5. AMPHIBIA.

There is nothing new in this arrangement, unless it be that the *Cetacea* are not separated from the Fishes by the intervention of Birds, and I hardly imagine that such a novelty is likely to be objected to by those who have more regard for truth of Nature than the authority of an artificial system. But to those who may be inclined to dispute the accuracy of this innovation I will mention, among a thousand which it is possible to produce, one anatomical argument which may be considered as conclusive. On comparing the general structure of a bird, a quadruped and a fish, naturalists find three very distinct essential plans of organization which influence, as Geoffroy St.

Hilaire has shown, not only the accessory parts and appendages of the vertebral column, but also the habits and manner of life of the individual. The Bird for instance has got its trunk, or that sternal apparatus which incloses all the principal viscera of the body, suspended to the hinder part of its vertebral column; the mammiferous animal has the same essential part attached to the middle of its spine, whereas in fishes it is so far placed in front that the sternum may be said to form part of the head. In other words, the quadruped is essentially constructed upon a plan which is intermediate between that of Birds and Fishes. For my part, I can hardly conceive a more conclusive argument in favour of the truth that Birds do not immediately separate the *Mammalia* from Fishes.

Of vertebrated animals the *Mammalia* and *Aves*, but particularly the former, are the most perfectly organized, so far as perfect organization relates to the acuteness of the senses. But perhaps each of the five groups has its own peculiar advantages, since the *Reptilia* seem to comprise the animals which are the most tenacious of life; Fishes, those which are the longest lived; and some of the *Amphibia* are peculiarly gifted with the means of breathing either in air or water. And the whole of the *Vertebrata* forms what Cuvier calls a division, and is distinguished from all other animals by the body and limbs being supported by an internal articulated skeleton. The nervous system of these animals is always more or less concentrated, appearing to be altogether subservient to one great medullary mass, which is contained in a bony case adapted for its reception, and which is called the skull. One of the principal parts of the nervous system is the spinal marrow, which is lodged in the canal formed by the annular nature of the vertebræ which compose the spine. The nerves communicate with this medullary trunk by holes in the vertebræ and skull, and there appear all to unite in a double medullary band, which, after having crossed its filaments, spreads itself in order to form the different tubercles of the brain, and to terminate in the two medullary hemispheres of which the volume generally corresponds with the extent of intelligence.

As the vertebrated spine is the distinguishing mark of these animals, it is evident that the imperfection of this character will always point out the particular species by which we are to leave the group. The bones, as we have seen in the *Cephalopoda* and Reptiles, were at first represented by cartilages; we naturally look therefore for those other vertebrated animals which have their skeleton particularly cartilaginous. The Chondropterygian fishes have the calcareous matter deposited in their skeleton by small grains and not by fibres or filaments. The articulations gradually disappear in these animals, and in the Lampreys we find the spine composed of one solid cartilage upon which the last trace of articulation appears as wrinkles. Fins and every other vestige of limbs or members are here at last totally lost. An elongated body is terminated by a fleshy circular or semicircular lip, and the cartilaginous ring which supports this lip results from the palatines and mandibles being soldered together. The branchiæ, instead of being formed of laminæ as in other fish, have the appearance of purses or bags, resulting from the union of the face of one pair with the opposite faces of its neighbour. We are arrived, in fine, at animals, such as the genus *Ammocœtus* of Dumeril, where the skeleton is soft and membranaceous, or as the genus *Gastrobranchus* or *Myxine*, where no trace of the eye exists, where the maxillary ring itself becomes membranaceous, where the rows of teeth on the tongue are disposed in such a manner on each side as to lose altogether that horizontal position of the organs of mastication, which is so constant throughout the *Vertebrata*, and where they take a structure more analogous to what we shall soon see to be a character of the *Annulosa*.

The common Leech (*Hirudo medicinalis* Linn. or *Hæmopis medicinalis* of Savigny) is a red-blooded aquatic animal, which swims like lampreys with an undulatory motion. Like these animals it has a circulation composed of veins and arteries. It breathes like them by two rows of holes which communicate with branchial pouches. The mouth is still surrounded by a lip proper for suction, and contains three maxillæ, one answering to the solitary upper tooth of the *Gastrobranchus*, and the others to the lateral teeth of its tongue. These maxillæ are minute, compressed, and serrated with very small teeth. The affinity of the leech to the cyclostomous fishes seems to have been first perceived by Linnæus, as appears by the place which he has given to his genus *Myxine*. When moreover we find their habits to be so similar, it may be said that nothing more is wanted to complete the resemblance, than that the wrinkled membranaceous skeleton of *Ammocœtus* should in the leech be supposed to form the envelope for the whole animal.

A great alteration has however now taken place in the internal structure, notwithstanding the above very evident affinities; and in order to develope it we may proceed to consider generally the

ANNELIDES,

Cuv. II. 515

or *Vers à sang rouge* of Cuvier. To this gentleman we are indebted for almost all we know of the internal organization of these animals. Before his works and the publication of M. Thomas of Montpelier appeared, the anatomy even of the Leech was a subject of total ignorance to naturalists. At present we are informed that four great blood-vessels exist in this animal, which extend its whole length and communicate with each other by lateral branches. One of these vessels runs along each side, while of the other two, one is dorsal and the other ventral. These last apparently perform the functions of veins, and the former two of arteries. This then is the general disposition to which the system of circulation, more or less, approaches in the *Annelides,* which are soft vermiform animals with bodies wrinkled transversely or composed of annular segments. They are red-blooded like the *Vertebrata,* but without a heart. It is a singular circumstance attending the natural history of the *Annelides,* that their internal organization should have been understood long before their external structure; in other words, that the usual course of study should have been in them reversed. Now however, thanks to the "*Patientia*" of M. Savigny, the natural arrangement of this subsidiary division is as far advanced as that of any other whatever. But unfortunately for the scientific world the valuable *Mémoires* of this author on the subject have not yet been published, and can be estimated only by the extracts from them given in the 5th volume of the "*Histoire des Animaux sans Vertèbres,*" and by the Report of the Committee appointed by the Institute to decide on their merits*.

* I take this opportunity of gratefully acknowledging the obligation which I am under to the friendship of M. Latreille, who from zeal to aid this attempt to ascertain the natural situation of *S. sacer* sent me the proofs as they came from the press of two *Mémoires*, from which the reader will

Annelides (Linnæ)

Nereidæ Serpula Lumbricus Hirudo

The *Annelides* for the most part are aquatic animals, and are all fond of moisture. They appear to be low in the scale of intelligence, because, with very few exceptions, they want the head and consequently the principal organs of sense. They are destitute of any members or limbs for locomotion except setiferous retractile mammulæ which many possess, disposed in lateral rows, and which serve for feet. Their mouth varies excessively in its construction, being sometimes a proboscis furnished with maxillæ, as in the *Nereidæ* Sav., sometimes presenting the appearance of two lips, as in the *Serpulidæ* and *Lumbricidæ*, and at others, as in the *Hirudinidæ*, forming a prehensile cavity supplied with parts which perform the office of maxillæ. That remarkable character of the *Vertebrata*, the vertical movement of the maxillæ, remains still, in some measure, observable in many of the *Annelides:* but what particularly distinguishes the two groups from each other is the nervous system of the latter, which is very distinct, longitudinal, double and knotted, like that of insects. The *Hirudinidæ* carry this similitude so far as even in general to possess the same number of ganglions. Another remarkable analogy is that which the vesicular branchiæ of some *Annelides* bear to the vesicular tracheæ of many Annulose animals. That the *Annelides* thus lying between the two most perfect forms in Zoology, the Vertebrated and the Annulose, should be so inferior in the senses and powers of locomotion to both, is certainly very

perceive that I have drawn plentifully.—The first is the report of MM. Cuvier, Lamarck, and Latreille to the *Academie Royale des Sciences* on the discoveries of Savigny with respect to the *Annelides*, and the second is a *Mémoire* by M. Latreille on the external organization of articulated unvertebrated animals, and the relation which the *Annelides* bear to the *Myriapoda*.

surprising; but perhaps on further reflection we shall cease to think this anomalous, and may in some measure even expect that the vital powers of these beings ought to be influenced by the circumstance that Nature in them is leaving one plan of construction in order to adopt another which is totally different.

M. Savigny divides the *Annelides* into five orders, three of which are furnished with setiform appendages, the other two being without them. Of these orders the *Nereidæ* possess the most complicated structure, as they have a head, antennæ and eyes. Their eyes however are, in M. Latreille's opinion, only to be compared to the rudimentary ocelli visible in Caterpillars and other larvæ of insects.

Swammerdam, Barrelier, and many of the earlier Zoologists were so struck with the resemblance which some *Annelides*, such as the *Nereidæ*, bear to the Myriapod *Annulosa* as to name them *Scolopendræ marinæ* or *Sea Centipedes*; and M. de Blainville has considered this affinity to be to such a degree natural that in his *Tableau Analytique des Animaux* he places the Setipod *Annelides* immediately after the *Myriapoda*. Linnæus even, by making the *Scolopendræ* and *Juli* the last of his insects, and giving them a situation immediately before *Vermes*, seems to have had a vague idea of the same connexion. The last and in my opinion the most tenable conclusion to which M. Latreille arrives in his report on Savigny's classification of the *Annelides* is moreover as follows: "*Le corps des Annelides appendicées, considéré sous le rapport de la distribution et du nombre de ses segmens, sous celui encore des appendices qui leur sont annexés, souvent aussi quant à l'ordre des organes de la respiration, représente en quel-*

que sorte le corps des Myriapodes ou Mille-pieds, soit avec une tête plus imparfaite, soit privé de cette partie."—This author observes that the distended part of the body or cincture of an earthworm, which contains the organs of reproduction, commences about the 27th or 28th segment, which corresponds with the last of the rings which ever compose the body of a Myriapod. The sexual organs of the male *Juli* occupy the anterior portion of the 7th segment near the second or third pair of perceptible stigmata; a position which corresponds with that of the generative organs in the common Leech. The same limits hold good, according to M. Latreille, with respect to the Setipede *Annelides,* whether it be by the cessation of the subulate setæ or by the changes which take place in the order of the branchiæ. All this the reader will find explained with great ingenuity in the "*Comparaison des Annelides avec les Myriapodes.*" If to these considerations be added the granular ocelli of the *Nereidæ,* their vermicular motion, the form and disposition of their feet, the two last of which are sometimes, as in *Nereis margaritacea,* transformed into filiform appendages exactly similar to those which terminate the body of several *Myriapoda,* we can I conceive have little doubt of our having at length reached the

ANNULOSA,

or those white-blooded animals which are externally articulated. The *Annelides* are all hermaphrodites after the manner of Gasteropod *Mollusca;* whereas there is every reason to believe that the sexes are constantly distinct in the animals upon whose natural history we are now about to enter. The problem becomes therefore at present to ascertain the most natural groups into which the *Annulosa* may be distributed; and having this object in view, the following classes obviously occur to the mind as making a very regular transition from one to the other:

Myriapoda,
Vermes,
Insecta,
Arachnida,
Crustacea.

But however plausible this arrangement may appear at first sight, it must not be forgotten that there are many articulated animals which cannot without great violence be made to enter into any one of these classes. Such for instance are the *Insecta Thysanura* of Latreille, which though considered by all systematists as approaching near to the *Myriapoda* must nevertheless be allowed by every entomologist to be more unlike to these, in some respects, than even to certain Hexapod Insects. Thysanura

On looking back however towards the *Vertebrata* we may perceive that there are few of their external organs so liable to variation in form and number as those of locomotion. Thus, whether our attention be turned towards the *Reptilia, Amphibia,* or Fishes, we see in the same natural class some animals with four feet; some with two, and others, finally, quite destitute of them. In the order of nature the Serpent cannot be far separated from the biped lizard, nor this again from the crocodile; every part of their anatomy demonstrates the truth of their belonging to the same natural class. So far also as my examination of insects had gone, I had always, on looking for natural characters, found those taken from the organs of locomotion, whether wings or feet, to be the most vague of any; since these organs vary in the same genera, nay, even in the same species, after a most extraordinary manner. There was thus no good foundation for believing that entomologists had done wrong in placing the *Thysanura* near to the *Myriapoda*, or that Lamarck had erred in causing them to form one group. But I began to suspect that the real character of this apparently heterogeneous assemblage was to be discovered less in the number of feet, which varied, than in some more striking peculiarity which might be found common to both the *Thysanura* and *Myriapoda*. The most obvious point of similarity between them was that they were both true insects, breathing by tracheal stigmata, and undergoing, if any, at least a very imperfect metamorphosis. But there were other *Annulosa* of this character as well as the *Myriapoda* and *Thysanura* which proved either that such a class, if instituted, was not yet rigorously defined, or that if it was, many other and very dissimilar animals must be assembled together in the same group. Such conclusions could not do otherwise than discourage me, as they showed symptoms of an artificial distribution, and indicated my having thus touched on the very rock which it had been all my endeavour to avoid. It added also not a little to my being convinced that I had not yet arrived at the secret of Nature, to observe that though some of the *Vermes* approached much nearer in general appearance to the genus *Julus* among the *Myriapoda* than did the *Parasita* or *Anoplura* of Leach, yet that these last were very nearly allied to the *Thysanura*.

I had almost despaired of success in my attempts to arrange these various groups, which, though so dissimilar, have an universally acknowledged affinity, and had even commenced a review of my opinions as to there being no true *saltus* in nature, when on looking at the Coleopterous insects generally, and on dividing them into five natural groups taken from their general appearance, and their manner of living, I endeavoured to discover some distinct character for each. For some time I failed in the object of my wishes; but Bonnet's unsuccessful attempt to arrange insects by their larvæ happening to occur to me, I perceived on examining my groups that the larvæ of all of them were very distinct from each other in point of appearance. Of the fifth group indeed I could form but little judgement, as the larvæ of it were but very imperfectly known; but in the other four were to be discerned Scolopendriform larvæ, Juliform larvæ, Apod or Vermiform larvæ, and active Hexapod larvæ. The analogy was evident; and I was thus immediately led to conclude that there was an error in the degree of importance which in the above classical division of the *Annulosa* had been given to the *Vermes*.

Scolopendr
Juliform
Vermiform
Anopluri

M. Rudolphi in his excellent work on the *Entozoa* found it necessary to make two great sections of them, which have by succeeding writers been elevated to the rank of classes on account of the vast difference between their respective organizations. Now, that when thus contrasted with one another they ought to form separate classes will not admit of doubt, as we shall see by the following statement. One of these sections is composed of intestinal worms without any distinct organs, animals whose existence is only proved by the irritability of their soft vesicular substance. The other on the contrary consists of such as are furnished with a nervous system formed by two longitudinal threads terminating in a medullary collar,—worms, in short, which have two apertures to their intestinal cavity, with various other organs, and finally in which the sexes seem always to be distinct. The first of these groups, which is the same with M. Latreille's class of *Monogena*, the reader will recognise as having occupied the situation of a class among the *Acrita*, so that we have only now to examine the second section.

Vin Entomodu

× Vid. Cuv. iii p. 247 Verm

The *Intestinaux Cavitaires* of Cuvier, or *Entozoa Nematoidea* of Rudolphi, are transversely striated worms in which the annulose structure is more or less indistinct, although perhaps never much more so, than we find it to be in certain *Arachnida*. Now having united these "*Vers Rigidules*" with the *Epizoaria* of Lamarck under the general title of *Vermes*, I have ventured to imagine the group thus constituted to be entitled to a place between the *Anoplura* of Leach and the *Chilognatha*. To the latter of these, or *Chilognatha*, they appear to be allied by the cylindrical form, stiff rigid texture, and lateral spinulæ, instead of feet, which some of them possess. In these Cylindrical *Vermes* the organs of respiration are not visible, and it is precisely among the *Myriapoda* that we find the stigmata to become so small as in some species to be imperceptible. The vestiges of Myriapod feet and the cylindrical form however soon entirely disappear in the *Vermes*; and when appendages to the body once again become visible, as in the *Epizoaria*, it is under a quite different appearance, more analogous to that of Hexapod Insects, as may be seen in the genus *Entomoda* of Lamarck, or still better in the *Cecrops* of Dr. Leach. We thus enter among the *Anoplura*, which like the *Epizoaria* are all of a parasitical nature.

Chilognatha Vermes Anopleura

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Ametabola

To some of the Insects which have been just under our consideration Dr. Leach has given the name of *Ametabola*, and I think that no better name can be adopted for this new class. The word however is now taken in a wider and even in a somewhat different sense from that in which my learned friend applied it. For instance, it is not absolutely meant that these animals do not undergo metamorphosis, but that, constructed on the same plan with the larvæ of true insects, they are rendered incapable by Nature of completing their metamorphosis, and are able to perform the offices of adult life in all the various stages of an incomplete change of form. Such a species of imperfection is not unique, nor confined to the *Annulosa*; for the *Ametabola* have their prototypes among the *Vertebrata* in the group of *Amphibia*, where the genera *Siren* and *Proteus* are, to speak analogically, *animals left imperfect in the first stage of metamorphosis*. On taking this view of the subject, the class of *Ametabola* appeared to me to consist of the five following orders, to one or other of which we shall hereafter see that the larvæ of insects may be all assimilated:

Ametabola occur into their Metamorphosis.

!

!

Ametabola & no larvæ of Lepidoptera

Vermes,
Anoplura,
Thysanura,
Chilopoda,
Chilognatha.

From the last of these, or the *Chilognatha*, we proceed by the genus *Glomeris* to *Oniscus*, and thus enter among the *Crustacea*, in some of which we discover a system of circulation and respiration more analogous to that of the vertebrated animals than to any thing among the *Annulosa*. On leaving the *Crustacea* the next group of Annulose animals appears to be the *Arachnida*, which, like some of the former, have the head and thorax united into one piece. The singular genus *Nycteribia* points out the transition of Nature from the *Arachnida* to the *Insectes Suceurs* of Latreille, or *Haustellata* of Clairville, which again by some of Kirby's *Trichoptera* leads us to the *Insectes Broyeurs*, or *Mandibulata* of Clairville. If all these transitions be natural, the real distribution of the *Annulosa* will be readily perceived to advance in order of affinity as follows:

AMETABOLA,
CRUSTACEA,
ARACHNIDA,
HAUSTELLATA,
MANDIBULATA.

It may however be observed, that for the present, and until we shall have seen its remarkable regularity, and its coincidence with those principles of minuter division which I conceive to be indisputable, this arrangement ought by no means to be accounted as proved. Thus it may be asked, Why should the *Crustacea* be so far removed from the vertebrated animals when they possess an organ of hearing, a heart, and a branchial system of respiration, of all which the *Ametabola* and of the two former of which the *Annelides* are totally deficient? Now this is a question that we cannot touch upon without taking some notice of the scientific dispute which has of late agitated the French Institute, with respect to the proper means of transition from the unvertebrated to vertebrated animals, and without considering with that attention which they really deserve the opinions which have been advanced on both sides of this controversy.

M. Geoffroy de St. Hilaire, well known as one of the most able professors in Europe of the Zoology of *Mammalia* and Birds, has in a late very singular work detailed certain analogies respecting the osteology of the *Vertebrata*, which would, if correct, reduce their skeletons to one type, as well with respect to the appendages of the spine as to the spine itself. How far these analogies may be accurate, it is for persons more skilled in anatomy than I am to determine; but the *Philosophie Anatomique* is evidently a book on which it may hereafter be well worth the trouble of those who would develope the natural place of Man, to bestow some attention. In the intoxication however which proceeded from the discovery of so much unity among those animals which he had been in the habit of studying, M. Geoffroy hastily imagined that all those with which he was unacquainted must be vertebrated likewise; and thus gave, with the impetuosity so proverbial in his countrymen, an example to the world of a professor first publishing an assertion on a subject of which he was totally ignorant, and then sitting down to study this subject in order that he might prove his assertion. It is however in justice due to the talents of M. Geoffroy to state, that each succeeding *Mémoire* seems to show, that as he proceeds deeper into the science of unvertebrated animals he gets further from the scope of his original propositions, and approaches nearer to those notions which are more commonly received. Nor ought it to pass unobserved, that some of the secondary positions laid down in the course of his third *Mémoire* are such as require much deliberation on the part of that Entomologist who may be inclined to dispute them. We however, in this place, have only to do with the principal points of his doctrine as they are connected with the subject now in hand.

That every animal is vertebrated is an assumption so contrary to well-established facts, and so demonstrative of the little knowledge its author can possess of the lower tribes of animals, that I almost fear the reader will consider it as trifling with his time to discuss any position which M. Geoffroy may advance on Entomology. He will be the more disposed to form this conclusion, from knowing the decided and cutting remark which Cuvier has made on the entomological debut of his brother professor. But as no less a naturalist than M. Latreille has judged it necessary in one of his most interesting papers to take notice of the first "*Mémoire sur l'Organization des Insectes,*" I cannot have the presumption to disregard it.

When M. Geoffroy says that the external envelope of the body of insects represents the internal articulated column of the *Vertebrata,* he admits that he only expresses an old opinion of an Englishman, Willis, published in 1692; and he has not even the credit of reviving this notion, as he will himself perceive by studying the works of Dumeril and other Entomologists.

It has been well stated by M. Cuvier in his *Leçons d'Anatomie Comparée,* that, whatever their consistence or chemical nature may be, the hard external organs of white-blooded animals should, with respect to their mode of growth, be rather compared to epidermis or horn than to true bones. So that it becomes difficult to discern any analogy which such external organs can have to bones, more close than that which may arise from the circumstance that the muscles are attached to them, as being the most solid parts of the body. But granting, for the sake of argument, the shells of a lobster to be true bones, we thus have less a principle of affinity than one of distinction, which can have no more rigorous meaning than that of its original propounder, "*quoad membra et partes motrices* *non ossa teguntur carnibus, sed carnes ossibus.*" For if we once go the same length with M. Geoffroy, and attempt to prove that the details of this external skeleton are analogous to the details of the internal one of the *Vertebrata,* we must adopt foı truths the wildest visions of fancy, and believe in such startling vagaries as the two following.

"The first thoracic segment of an insect, which carries the two anterior feet, forms the third vertebra of the head, and represents the lower jaw of fishes."

"The elytra of Coleopterous insects correspond with the opercula of Fishes, and the wings with the pulmonary sacs of Reptiles."

In his second *Mémoire,* M. Geoffroy, in attempting rather ingeniously to forsake the bolder parts of his theory, and to slide imperceptibly into the opinions of his opponent M. Latreille, has unfortunately fallen into another error. He supposes gratuitously that the *Crustacea* are divided into two branches, one of which conducts to the true Insects by means of the *Scolopendræ,*—an affinity which no one will deny,—and that the other leads to the *Mollusca* by means of the genus *Cancer!* For this last affinity I cannot divine any one satisfactory reason, unless it be that Aristotle first imagined it, and that the vulgar have constantly adopted the same opinion up to the present day. Nevertheless M. Geoffroy thinks it unnecessary to advance any proof of their connexion, which we are to adopt on his word, merely modified by the observation that "*il conviendra ajouter qu'un hiatus assez marqué tient les Mollusques à distance.*"

We now turn to M. Latreille, who in his *Passage des Animaux Invertébrés aux Vertébrés* has taken the opposite side of the question, and has there assembled together so much science with so much ingenuity and evident zeal for the truth, as must necessarily, on a first reading, dispose every one to adopt his doctrines. The line of argument he pursues is very simple, and perhaps on that account the more seducing. He supposes it to be unquestionable that there are two distinct series of Unvertebrated animals, which each meet the *Vertebrata* at the points where these are the least organized, and where they themselves have the most complex structure. He considers it undeniable that the Cyclostomous fishes are the least organized of the *Vertebrata*, and that the *Cephalopoda* and *Crustacea* are each at the head of a series of unvertebrated animals, and therefore concludes that the *Cephalopoda* and *Crustacea* meet the *Vertebrata* among the Cyclostomous fishes. Thus the great aim of his *Mémoire* becomes to display to the view those analogies which the *Crustacea* in preference to the *Coleoptera* possess with fishes. It need scarcely be mentioned that we have already arrived at several of these positions by tracking closely the vestiges of affinity; we have, for example, ascertained that there are two series of Unvertebrated animals; that the *Cephalopoda* are at the head of one of these, and that the Cyclostomous fishes are among the least organized of the *Vertebrata*. And yet I hesitate in giving full assent to M. Latreille's conclusions, because I find the above facts mixed up with an antiquated notion, which if hitherto seldom questioned has also never yet been proved. Thus it is a mere assumption to say that the *Vertebrata* are met by the Annulose series at the point where this is most perfectly organized. Cuvier and Lamarck both think differently, as appears by the place which they have assigned to the Acephalous *Annelides* before all white-blooded articulated animals; and, as if to disprove the assertion completely, M. Savigny's observations teach us that the most complicated in organization of the *Annelides* are not those which come nearest to the *Vertebrata*, but on the contrary are the *Nereidæ*, which come nearest to the *Myriapoda*. Had it been first shown that the descending scale in the perfection of organization is regular from Man to the *Infusoria*, the truth of the preceding assertion could not have been called in question, because then the most simple vertebrated structure would lead to the most complex unvertebrated animal, and so on; but what naturalist is there in this age who can get rid of the difficulty in this manner? The only argument that I am acquainted with, as having been adduced to prove the junction of the most complex *Annulosa* with the *Vertebrata*, is that the former are gifted with vision. But it so happens that the lowest of *Vertebrata*, such as *Ammocœtus* and *Myxine*, to which they are thus united, are deprived by their construction of this power; and moreover the eyes of the *Annulosa* are totally different in formation from those of the *Vertebrata*. For any argument therefore drawn from the eyes in favour of this affinity to be valid, it is manifestly necessary that the Vertebrated and Unvertebrated animals brought together should possess eyes constructed on similar principles. Now this is the case, as we have seen, with the *Cephalopoda* and Chelonian Reptiles, but not with the *Crustacea* and Cyclostomous Fishes. Indeed, as to the affinity which is stated to exist between these last, it is sufficient for any person to look at a Lamprey and a *Pagurus*, which are mentioned as the most favourable examples of each group, being both endowed with sight, and to ask himself—In how many points do they agree?

But are we sure that the *Crustacea* are the most perfect of Articulated animals? This is a very different question from the former, and one to which an affirmative answer may be so strongly maintained, that I enter upon the consideration of it with no small degree of hesitation. The *Crustacea*, for instance, possess in general four antennæ, at least six maxillæ, a circulation by means of a dorsal ventricle, which distributes the white blood to the branchiæ, whence it returns by a ventral canal; and finally, some few species present vestiges of an ear formed on the plan of some of the lower *Vertebrata*. But if the number of antennæ be any proof of superiority, some *Annelides*, as the *Nereidæ*, have five; if the number of maxillæ be insisted on, some of the same animals have even nine; and as to the sense of hearing, before any argument can be founded on this, it must be proved either that insects do not hear, or, if they betray evident tokens of possessing this sense, that their peculiar construction is inferior both in power and complication of design to that of the few *Crustacea* which display a miserably imperfect trace of the ear of the *Vertebrata*. Indeed, this subject ought not to be dismissed without remarking that Latreille has never attempted, in any of his late *Mémoires*, to maintain the superiority of the *Crustacea*, by the circumstance of some of them possessing a part which resembles the vestibulum of a Vertebrated animal. All then that remains to establish their precedence is the system of circulation and respiration, which in the *Decapoda* at least is so similar to that of *Amphibia* and Fishes.

It can scarcely have been forgotten that of all the animal functions we have yet had to consider, that of circulation appeared to be the most vague and changeable; nor can this moreover have excited much surprise, if we have called to mind how much the nature of the respiratory functions must depend on the medium inhabited by the animal. Among the *Vertebrata*, indeed, circulation and respiration appear to afford the firmest foundation for natural distribution; but the great principle of creation being to combine variety in the means with uniformity in the effect, we find that in the *Mollusca*, on the other hand, the circulation of the blood varies in its manner *ad infinitum*, and has accordingly led to one of the most artificial arrangements which is known. And yet there are no animals in existence which have the organs connected with the circulation more complicated than some of the *Cephalopoda*. In the Annulose animals also, which correspond with one another so remarkably in the nature of their nervous system, we find that of circulation to vary from a singularly perfect one till it altogether disappears. An entirely new method of respiration and of nutrition of the parts apparently takes place, a method indeed so totally distinct from any which we have yet observed in the *Mollusca* and *Vertebrata*, that the most fanciful imagination can never consider them to be modifications of the same. As then these animals are generally constructed on different plans, may we not be permitted, nay is it not absolutely necessary, to suppose that this new and entirely different system of respiration is that which more peculiarly belongs to the group, or in other words is that to which the structure of the animals forming the group tends? What makes this supposition still more probable is, that the *Annelides*, which, according to Cuvier, come the nearest to the *Vertebrata* of all articulated animals, are nevertheless as imperfect in their organization, and as dull in their sensations as any in the Annulose division. Now this could hardly be the case were the *Annulosa* to be considered with propriety as modifications of the vertebrated structure. On the other hand those Annulose animals which respire by tracheæ, and, in short, coincide in no one point of organization with a Vertebrated animal, are nevertheless the most active and industrious of the group, although this activity and this industry appear to be of a totally different nature from what may be observed among the *Vertebrata*. It is difficult, indeed almost impossible, to account for all this, unless we consider every Vertebrated animal to have been constructed by the great Creator with reference to one type, and every Annulose with reference to another; and as the former is more imperfect in its organization according as it approaches to the Annulose structure, so the latter is more imperfect in proportion as it possesses a distinct system of circulation and those other characteristics of the *Vertebrata*. It thus follows that the animals which connect them ought to be extremely imperfect in their organization; and this conclusion is evidently borne out by the stupid, sluggish *Annelides*, in which the organs of sense are scarcely visible, and those of motion are not nearly so perfect as in the larvæ of Insects. Lastly, we shall in this manner be able to account for the many extraordinary violations of natural order which have from time to time been committed by first-rate comparative anatomists; violations indeed so palpable as to render such authors, as is well known, among the very worst authorities for the arrangement of the Unvertebrated animals. If we however attribute their errors to the improper reference they are accustomed to make of all animal structures to one type, namely Man, I think we shall not be far from the true reason why their works ought

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to be consulted rather for the observed facts they may contain, than for the inferences that may be drawn from those facts respecting arrangement.

In comparing animals of the same natural group we always find the terrestrial to be more perfectly organized than the aquatic. Thus in the animal kingdom we have found Insects and *Mammalia* to be removed the furthest from the vegetable kingdom; and again, in observing the vertebrated animals, we have found fishes to be the most imperfect of the group. It may therefore, perhaps, be concluded that though the *Crustacea* have a distinct system of circulation, yet, when considered with reference to the externally articulated animals in general, they are not so perfectly constructed as those insects which are terrestrial. Indeed the system of circulation in the *Crustacea*, being so different from what is observed in Insects, shows that the former have quitted the type of their peculiar group in order to acquire an imperfect sketch of the circulation of the *Vertebrata*; and as to the method of respiration, there is every reason to believe that this depends on the medium in which the animal lives, and that water is the medium which requires the greatest similarity in the structure of the respiratory organs. This hypothesis is supported by the well known fact, that those larvæ of insects which live in water are furnished with branchiæ exactly of the same structure with those of some aquatic *Annelides*, while the remainder of their respective structures are almost at total variance. At all events, though deprived of a distinct system of circulation, insects are the most lively of the *Annulosa*, and the most perfectly endowed with all the five senses.

I would also remark, that all Annulose animals have at some period or other of their lives a greater or less tendency to shed their external covering, and thus to develope a new form; and that there is some reason therefore for arguing, that where this tendency to metamorphosis is most revealed, there the type of perfection at which the whole group aims is the nearest attained. Hexapod insects possess the means of living in the water and on its surface, in the air and on the earth, often combining all these powers in one individual; and with respect to the functions of nutrition and generation, they appear to be quite as perfectly organized as animals which are usually conceived to be superior to them in the scale of being. Yet these functions must not be considered as executed by similar organs or by the same process in the Annulose and Vertebrated animals. There exists a wide distinction between them, so wide indeed that notwithstanding their activity, industry, and ingenuity, insects have in the later systems founded on comparative anatomy been placed beneath the *Mollusca*, only because these last possess nearly the same apparatus of organs for digestion, circulation and respiration as the Vertebrated animals. Two exceptions however to this proceeding are so honourably conspicuous as to deserve mention; I allude to the ingenious authors of the article *Classification* in Rees's *Cyclopædia*, and of the article *Nerfs* in the *Dictionnaire d'Histoire Naturelle*.

It may in fine be observed, that in proportion to the perfection of the structure of the animal, life becomes more concentrated, more confined to a particular part; and various parts, when maimed or amputated, become less capable of being reproduced. The Polype may be divided into as many distinct animals as there are divisions.

Reproduction here appears to be the greatest where the vital principle is the least distinct. A Mollusque is less tenacious of life indeed than a Polype, but more so than a Vertebrated animal. The lazy tortoise moves after having been cut in pieces, and the lizard reproduces very considerable portions of its body when they may have been amputated or in any way destroyed. It is man, and the more perfect animals in this series, that can the worst sustain wounds; to them a member once lost is irrecoverable. In applying this observation to the Annulose animals, we should from analogy conclude that the *Crustacea* are inferior to Hexapod insects, since the former are observed to be capable of reproducing a lost part, and to the latter it is lost for ever. In this manner a Coleopterous or Hymenopterous insect cannot be considered as having its vital principle so much dispersed throughout the common mass of the body as a Crustaceous animal: in other words, it may be accounted to be more perfectly organized. This last is however an argument on which I would not be understood to lay much stress; because, as the reader will perceive in the sequel, the reproduction of the feet in *Crustacea* and *Arachnida* may be accounted for on the mere ground of the nature of their metamorphosis.

But the strongest position of M. Latreille remains yet untouched; namely, that in which he argues from the similarity of their organs of circulation and respiration that there must be some immediate connexion between *Crustacea* and those fishes which come the nearest to the *Amphibia*. He remarks that if the Batracian reptiles, the Cyclostomous fishes, and the *Crustacea* be formed into a series, and the position of their respective branchiæ be studied, it will be discovered that they gradually separate and arrange themselves on two parallel lines; that the decapod *Crustacea* have the same number of branchiæ, that is, seven on each side like some Cyclostomous fishes; but that these branchiæ retreat further and further from the head, until finally in the *Onisci* they reach the tail. The branchial arcs of fish are supported by processes which are articulated with the os hyoides; and M. Latreille thinks that these articulated appendages of the branchial rays represent the four last maxillary feet and the ten feet properly so called, while the os hyoides represents the great sternum of the *Crustacea*. Finally, imagining that "*les Crustacés et les Poissons sont deux classes qui ne souffrent point entre elles d'intermédiaires*," he defines a decapod brachyurous Crustaceous animal, such as a *Pagurus*, to be nothing else than a sort of fish of which the opercular or jugular region is aggrandized into a thorax, shut below by a sternum composed of the os hyoides and covered above by a shell common to it with the head; a fish of which the rest of the body has been divided into segments, and in which the seven rays carrying the branchiæ have gradually retreated towards the tail after receiving articulated appendages; a fish in which the ventral and anal fins have become pseudo-feet, and of which the maxillæ have been divided longitudinally in the middle.

I cannot help thinking, however, that in this ingenious method of making out a *Pagurus* to be a fish, the imagination has been much more consulted than the eye; for, if the single circumstance of the possession of external branchiæ be neglected, in no respect whatsoever does the above description answer to a fish more than to many other animals. We come then to this question, Do not the systems of circulation and respiration, though unsupported by other considerations, form a principle of affinity of sufficient importance to authorize the connexion of *Crustacea* with fishes? I answer that they certainly would be sufficient for the connexion of Vertebrated animals, because we see that the most natural groups into which these can be divided are founded on the system of respiration: but if it be possible to show that the *Annulosa* cannot be naturally grouped and arranged among themselves, by their system of respiration and circulation, then I conceive the case to be altered, and that the similarity in this respect which any Annulose animals, as *Crustacea*, may bear to other animals ought not to be accounted a principle of affinity unless supported by other more important considerations. Now I would ask any entomologist, whether the *Pycnogonidæ* do not connect the *Crustacea* and *Arachnida*. If they do, as Savigny, Latreille and Lamarck are all of opinion, it is exactly a case in point where two groups of animals with a similar system of circulation are connected together by others which possess one quite different from either. And this I venture with deference to submit to naturalists, as the nature of the connexion between *Crustacea* and Fishes which are linked together by the *Annelides* and *Myriapoda*.

It must however be repeated, that much investigation is yet requisite before we can conclude the arrangement which I have ventured to propose to be perfectly natural; and in publishing the foregoing remarks I would willingly be understood to imitate the caution of M. Latreille, who in a supplement to the *Mémoire* which we have just been discussing has expressed himself as follows: "*Mes lecteurs voudront bien ne pas oublier que mon opinion, dans un sujet si obscur, n'est qu'une pure hypothèse, et que je ne la présente qu'avec une extrême réserve, celle qui convient à un* *esprit sage et toujours prêt à revenir sur ses pas, lorsqu'il reconnaitra son erreur. Entre le poisson dont l'organization est la plus simple et le crustacé le plus parfait sous ce rapport, il existe, ainsi que je l'ai dit dans mon mémoire, un hiatus qu'il nous est maintenant impossible de remplir. Quand bien même on admettrait avec moi que les lamproies et les gastrobranches sont les derniers de la classe des poissons, la forme et la situation de leur colonne vertébrale ne pourraient pas être comparées avec la moëlle épinière des Crustacés.*"

But if we agree with MM. Cuvier and Lamarck that the *Annelides* come nearer to the Vertebrated animals than to the *Crustacea* or indeed any *Annulosa*, it may still be asked, how we would account for the singular circumstance of the *Crustacea* possessing a system of circulation and branchiæ resembling those of a Vertebrated animal. Now M. Latreille has given me the answer to this question himself, by bringing these animals into comparison with the *Amphibia*, and by assimilating the *Arachnida* to some of the *Reptilia*,—both analogies, I confess, which I should never of myself have thought of; but the statement of them by so great a naturalist has served to convince me that what in reality is only a relation of analogy has been mistaken for a relation of affinity. This is so common a cause of delusion in the investigation of natural affinities, that I shall be obliged to return to a fuller consideration of it in the following chapter, where the mischief it has occasioned will be more perceptible; and in the mean time shall only observe that the *Crustacea* possess a system of circulation and respiration analogous to that of the *Amphibia*; that like these they are fond of water, but can subsist for some time out of it; that some species even pass the greater part of their life on land, and like some Batracians visit the water only in their season of love.

The more complete developement of the above distribution of the *Annulosa* into five groups, shall also be reserved for a future chapter; and at present I proceed to consider whether we may be able to quit these animals for others, or, in short, to determine whether the chain or series we have hitherto followed so closely must here end.

As in the *Vertebrata* we have seen the internal skeleton both bony and soft, so the external skeleton of Annulose animals is likewise of various textures. In a worm or caterpillar it is soft and membranaceous; in a coleopterous insect it is hard and horny; in most *Crustacea* it is crustaceous, though in some of the *Entomostraca* it is even testaceous. There are few animals so common and so interesting, of which we know less than of these testaceous *Crustacea*, if I may use the expression. Dr. Leach, who is generally understood to be better acquainted with the *Crustacea* than any other person now living, has lately, in a most elaborate paper on the *Entomostraca* of Müller, published in the *Dictionnaire des Sciences Naturelles*, proclaimed the group to be an "*assemblage artificiel d'une portion de la classe des Crustacés.*" Where he has been unable to detect the order of nature I can think it no disgrace to fail. I shall therefore keep together this artificial assemblage, with the exception of the greatest part, if not all, of the *Branchiopodes parasites* of Lamarck, which belong, as I imagine, to the *Ametabola*. For the rest, I shall content myself at present with a brief description of some of the *Monoculi* of

Linnæus; animals that live principally in marshy or stagnant water, where they swim by means of the motion of their antennæ and feet. These projecting from a cleft or longitudinal opening between two scaly or testaceous plates, with which the body is covered, are so placed that they can only move vertically, and not, like the legs of other aquatic *Annulosa,* horizontally. The two testaceous plates form a sort of bivalve shell, to the anterior part only of which the body of the creature is attached. One of these extraordinary animals, which now constitutes the genus *Cypris,* is thus beautifully described by Linnæus: "*Testa semine Brassicæ major, ovata, oblongiuscula, utrinque æqualis, antice gibba et parum retusa, adeoque omnino Conchæ; sed in Conchis apertura est a latere tenuiore et cardo ubi gibba magis est; contra vero in hac; hæc extracta ex aquis tota clauditur ut crederes semen cujusdam plantæ; in aquis dum hiat, jurares concham esse.*" Here then we have a bivalve shell opening and shutting by means of a ligament, and inclosing the animal almost entirely; and yet Linnæus, notwithstanding the great attention which he paid in general to outward forms, perceived that it was not a Mollusque. How unaccountable then it appears that not only Linnæus, but even Cuvier, should consider another animal to be truly molluscous, when it has nothing whatever in common with the *Mollusca* but an external shell or shells enveloping the whole body!

Cirripeda. *Leach.*

"*Nous voici,*" says Cuvier in his *Mémoire sur les Anatifes,* "*nous voici arrivés à des animaux bien différens de tous les Mollusques dont nous avons parlé jusqu' à présent; des membres cornés, articulés en quelque sorte,* *nombreux, susceptibles de mouvemens variés, une bouche garnie de lèvres et de machoires, un systême nerveux formé d'une suite de ganglions, tout annonce que la nature va nous conduire à l'embranchement des animaux articulés; il n'y auroit même rien d'étonnant que bien des naturalistes, d'après la description que nous allons donner, ne pensassent que les cirrhopodes appartiennent déjà à cet embranchement, et nous ne blamerons point ceux qui croiront devoir les y ranger."* Perhaps no passage in the writings of M. Cuvier demonstrates more clearly than this the extraordinary manner, in which he combines accuracy of observation with utter insensibility to the advantages he might derive from the application of his knowledge of facts to the discovery of the natural system. He is too sagacious to blame those who consider a Cirripede to be a Crustaceous animal, at the same time that he persists in placing it among the *Mollusca* because its body is not articulated, because "*nous avons déjà dans le genre des tarets des exemples des membres articulés, comme enfin la coquille des anatifes semble modelée sur plusieurs bivalves.*" Now, though there is no reason to believe that the body of a Cirripede is much less articulated than that of a *Cypris* or *Daphnia,* and though it is even more articulated than the body of many *Acaridæ,* yet it is unquestionably true that hermaphrodites like the Cirripedes are not in reality *Annulosa*; they ought in fact to be considered as leading to less articulated animals, but which are certainly neither *Mollusca* nor *Annelides.* As to the shell being modelled on the same plan with that of the *Mollusca,* so we have seen that of the genus *Cypris* to be: yet neither Linnæus nor Cuvier himself ever thought of this being a Mollusque. "*La coquille,*" says Lamarck, "*n'est pas le* *propre d'animaux d'une seule classe, beaucoup de Mollusques, d'Annelides, et tous les Cirrhipedes en sont munis.*"

There remains therefore no valid reason for arranging the *Cirripeda* with the *Mollusca*, but the circumstance mentioned by Cuvier, that one species of the genus *Teredo,* inhabiting tropical climates, carries on the back of each valve of its shell an articulated process. Neither he nor Lamarck however appears to have ever seen this shell, the *Teredo palmulatus* of Adanson; and Lamarck even suspects that it will be found scarcely to differ from the common shipworm. But supposing this articulated, or, according to Lamarck, this subarticulated process to exist on the back of a shell,—in proof of which existence I believe by the way that there is abundant testimony,—what possible affinity can there be between it and the articulated members of a Cirripede? M. Lamarck, who, while he considers the *Cirripeda* to be Annulose animals, displays as much anxiety to make them approach to the *Mollusca* as Cuvier himself, is too cautious to remark any affinity between a *Teredo* and a *Balanus*. Nay, in alluding to the calamuli of a genus of *Mollusca* bordering on *Teredo,* namely *Fistulana,* he expressly says "*Ce ne sont point des bras articulés analogues à ceux des Cirrhipedes, puisque leur pedicule filiforme, fistuleux, et calcaire est sans articulations.*" And so desirous is this able classifier that he shall not be supposed to have pointed out any affinity as existing between the *Mollusca* and the *Cirripeda,* that when he has made these last immediately to precede his *Conchifères,* he will not commence the description of any true *Mollusca,* until he has laid it down as certain, "*qu'ils ne se lient point aux Cirrhipèdes, malgrè les apparences de rapports qu'offrent les Brachiopodes et les*

Cirrhipèdes pedonculés." Animals, he also says, which have a knotted longitudinal nervous system, articulated limbs with a horny skin, several maxillæ in pairs, moving horizontally, some even palpigerous, can never assuredly be *Mollusca;* neither can white-blooded animals, provided with feet, and having the body enveloped in a mantle or tunic, be *Annelides.* The truth of these remarks is so obvious that I scarcely conceive any person will be inclined to object to them; but M. Lamarck forgets, or at least neglects to observe, that certain *Crustacea* which are destitute of sight, have their head confounded with the trunk, and their body enveloped in a shell. The genus *Pentelasmis* of Hill, if well observed, will appear, according to Cuvier, to be a Crustaceous animal, bent round, and inclosed in a thorax excessively developed. But this is precisely the character of the *Branchiopoda Lophyropa* of Latreille. The shells of neither these nor the Cirripedes are truly articulated like those of bivalve *Mollusca,* but the mantle is only in a manner cleft in front. The body of both a *Pentelasmis* and a *Daphnia* is convex, and ends in a rostriform tube. In both animals the mouth is situated as it were under the head, that is, in the most profound part of the concavity of the body. The antennæ in both are situated at the sides of the mouth; in both they are composed of a thick cylindrical stalk, which branches off into two articulated and ciliated cirri.

The manner in which, according to Degeer, the *Daphnia* uses its feet and tail to direct its food to its mouth is exactly similar to what may be observed in the *Cirripeda.* Each has five pair of feet branching off into articulated fringed cirri. The pyramidal processes which Cuvier considers to be the branchiæ of the Cirripedes, and which are situated on each side of the base of the antennæ, have their analogous and corresponding formation in *Daphnia*, as may be seen in the seventh volume of Degeer, Pl. 27. Fig. 3. n. m. The anus of a Cirripede is placed at the back of the proboscidiform tube, and is protected at each side with a horny spinous process. The tube itself is hollow, and terminates at the point with an orifice serving as an opening for the oviduct, which is represented by some authors as crowned with two or three hairs. Now, all this description applies with equal truth to a *Daphnia*. The eggs have in both animals the same position, being heaped together along the back between the shell and the great intestine. The intestinal canal has two cæcums in one, as well as in the other. Their nervous system is formed on the same general plan, and apparently their organs of manducation. The heart is also dorsal in both, and in short the important question seems to respect the point in which there is any difference between them. This difference however is by no means trifling; for the Cirripedes are deprived of the power of locomotion, and consequently are hermaphrodites; they are likewise destitute of a head, and their body, properly so called, is not accurately speaking articulated. That vegetative quality by which they are rendered incapable of locomotion is truly the natural character of the group; for, as we proceed, we shall find that the cartilaginous peduncle which in the *Pentelasmis* merely served as a cable, by means of which the animal was fixed by the back of the thorax to its anchorage, becomes in the *Balani* the most important part of the whole structure. The Crustaceous animal gradually disappears sinking into the peduncle, which becomes calcareous, and no vestige remains of the Cirripede shells which we have hitherto described, except what is sometimes called the operculum, and at others the teeth of the *Balanus*. The difference in external appearance of this genus from a *Pentelasmis* is so great, that, until the organization of each be carefully examined, no one will ever think of referring them to the same class. The singular genera *Tubicinella* and *Coronula* afford such examples of a new form, both of them being as dissimilar in external appearance from the animals we have been describing, as it is possible to imagine.

Having now established the affinity of the *Cirripeda* to the Branchiopod *Crustacea*, the next question relates to the means by which we are to leave them. Hitherto indeed they have been placed by all naturalists except Dr. Leach close to the *Mollusca;* yet their affinity to *Teredo*, as suspected by Cuvier, is universally denied by other naturalists, and would never have been allowed by himself, had he not found it necessary to assign some reason for placing these animals among the *Mollusca*. His eminent colleague M. Latreille seems on the other hand to be inclined to connect them with *Ascidiæ* by means of Dr. Leach's genera *Otion* and *Cineras;* but this is evidently a last resource, and is carrying the disposition to unite them with the *Mollusca* to so very fanciful a pitch, that I scarcely think many persons will assent to the justness of the affinity, even when backed by that weight of authority which must always be due to the opinion of M. Latreille. The series, which he proposes, leaves *Fistulana* for the *Brachiopoda*, and proceeds to the Cirripedes, thence to the *Tunicata* and *Radiata*, with which last he discovers that the Cirripedes possess an evident affinity.

The arms indeed of the *Brachiopoda*, and their flexible peduncle, afford very powerful arguments for adopting an opinion originally Lamarck's, and for supposing that the *Cirripeda* are connected with some of these, such as the *Lingula anatina*. But on advancing a little deeper into this examination, and finding the total dissimilarity of construction which exists between these two tribes of animals, we acquire the conviction of the relation between them being only one of analogy; since the limpet shape of a *Balanus* might afford as good a reason for asserting its affinity to a *Patella*, as the peduncle of a *Lingula* can possibly give for its connexion with *Pentelasmis*. M. Duméril indeed has placed the *Cirripeda* in the order of *Brachiopoda*, with which he terminates the *Mollusca*; but this could only have been because the true *Brachiopoda* have near the mouth two long ciliated arms, or rather organs of respiration, terminating in a spiral when at rest, together with the abovementioned tendinous cord which sustains the shell.

Not only however are the internal organizations and nervous systems of a *Lingula* and *Pentelasmis* totally dissimilar, but the respiratory arms of the former are nowise articulated; so that, as M. Lamarck observes, "*Les Brachiopodes ne tiennent nullement aux Cirrhipèdes par les caractères de leur organization; leur coquille même n'a aucun rapport avec celle des Cirrhipèdes, quelque variée que soit celle de ces derniers.*" We cannot therefore pass from the *Annulosa* to the *Mollusca* by means of the *Cirripeda*, unless the most fanciful comparisons be employed in order to effect our object; comparisons indeed that are all, more or less, founded on relations of analogy, but which are perhaps unconnected with any principle of affinity. It is however clear that the Cirripedes are on the limits of being truly Annulose, and it is thus therefore demonstrated that they are on the point of assuming some other of the five general forms described in the fourth chapter of this Essay. The close affinity which has been shown to exist between *Daphnia* and *Pentelasmis* may have led us to suspect that, although consisting of pedunculated animals, this last genus approaches the nearest of the known *Cirripeda* to the *Annulosa*. The singularly radiated forms of the sessile Cirripedes are also so completely different from that of any Insect or Crustaceous animal, that we are of necessity induced to look to this radiation as the index of the new form about to be adopted; and the rather, because when the Cirripede has quitted entirely the external form of an Annulose animal, then that distinguishing character of the group, their sessile nature, sometimes disappears as in the genus *Acasta*, where the cupshaped base is not particularly fixed to any foreign body.

Making, then, due allowance for the hiatus which may occur between the *Cirripeda* and the next type of form, we are now to inquire whether any animals have been remarked by naturalists to bear an affinity in general appearance to the sessile Cirripedes of Lamarck. No shell of a Mollusque has the slightest resemblance to a *Balanus*, unless indeed it be that of the genus *Fissurella*. But, to say nothing of the animals, these shells even are totally different in their construction, and the valves of the operculum in the *Balanus* throw a distance between it and every Mollusque, which must be apparent to the most superficial examiner of their respective forms. The authors of an excellent description of British shells, therefore, knew no other way to describe some of the more remarkable of the sessile *Cirripeda*, such as *Coronula*, than by comparing them, after the example of Linnæus, to an *Echinus*. It becomes thus necessary for us, after having repelled the idea of any affinity existing between *Coronula* and the *Mollusca*, to consider the former animal as it relates to the *Radiata*, with which Latreille has allowed the Cirripedes to be evidently connected.

None of the *Mollusca* present a vestige of being truly articulated; for the imbrication of the shells of a *Chiton*, or of the processes of other shells, does not surely deserve this epithet in the sense in which it is applied to the skeleton of the Annulose or Vertebrated animals. Insects and *Crustacea* therefore, the basis of whose structure is articulation, cannot without great violence be connected with the *Mollusca*. The Vertebrated animals have a truly articulated axis; and, as we have ascertained them to be connected with the *Annulosa*, we have now consequently to investigate, what animals of a type of form distinct from either an Annulose or a Vertebrated animal present a vestige of articulation. Every zoologist will at once answer that such are the *Echinoderma* of Cuvier. It did not escape the notice of this anatomist, that the *Radiata* ought immediately to follow the *Annulosa*, so that in this respect there is nothing new in the above observations. The only question that has remained undecided is simply this, Which of the *Annulosa* come the nearest to the *Radiata*? If the order in the *Regne Animal* be the real one, the genus *Nycteribia* comes the nearest to *Echinus* and *Asterias*; but as no reasons are assigned for this arrangement, and as it is not very evident, I shall be allowed to differ from the order there laid down. Nay, I trust even to be excused for hazarding the publication of my opinion, that the *Crustacea* of all the true *Annulosa* come the nearest to the *Radiata*, and that the transition from one to the other is effected by means of the *Cirripeda*. The principal deviation from this line of affinity will be found in the structure of the shell of these last, which, while it differs from that of the *Mollusca*, appears by no means perfectly to correspond with the external covering of the *Radiata*.

Of the method in which the Crustaceous animal disappears, and leaves the structure of *Echinus* only apparent, I am at present totally ignorant; but it will be sufficient for my purpose to prove that the Cirripedes have a nearer affinity to the *Echini* than to any other tribe of animals except the *Crustacea*. The operculum of a *Balanus*, the complicated structure of its valves, and the method by which they are affixed to the radiated cone which contains the animal, have no affinity to any thing in nature, unless it be to what we may witness on examining the mouth of the *Echinidæ*. The porous nature and radiated structure of the outer shells, with the solid calcareous substance of the inner ones, correspond in both the Cirripede and *Echinus*.—Their common hermaphroditism and the peculiar disposition of their ovaries afford additional proofs of their affinity; and it is not a little remarkable that the older naturalists, such as Linnæus, Bruguieres, Klein, and Müller, placed the *Echini* as well as the Cirripedes among the *Mollusca*, although merely, as it would appear, because they have all a calcareous covering. That they had any more profound view is doubtful, from their interposing *Chiton* between *Echinus* and *Lepas*. M. de Blainville indeed considers the genus *Chiton* to form one group with the Cirripedes; but as he then passes from these to Lepidopterous insects, we may be permitted to doubt his having given much attention to this part of natural history.

In assigning however this place between the *Annulosa* and *Radiata* to the *Cirripeda*, I confess that there are many difficulties which, from my being unacquainted with the anatomy of the *Radiata* except from the descriptions of others, I am unable at present openly to encounter. For instance, Cuvier, Lamarck and all the great modern zoologists place the *Echini* at the head of the *Radiata* as possessing the most complicated structure; yet, while Spix and others have been able to detect a nervous system in the *Asterias*, they have utterly failed in observing it among the *Echini*—"*ce que j'attribue,*" says M. Lamarck, "*à des dispositions particulières de ces parties dans les oursins, car je ne doute pas qu'elles n'y existent.*" What apparently adds to this difficulty is, that the nervous system detected in the *Asterias* bears no affinity whatever to that of the *Annulosa* and *Cirripeda*. In the Sessile Cirripedes we may observe the feet and all the other parts of the articulated inhabitant of the calcareous tube gradually to diminish. Now as it is this body which contains the nervous system of a Cirripede, perhaps its absolute disappearance in *Echini* may account in some measure for the impossibility of detecting a nervous system in these. This is an hypothesis it is true, but it corresponds at least with the manner in which great changes of structure are produced in nature. The spinal marrow and the spine itself become gelatinous in the *Gastrobranchus* and the lower tribes of fishes, before we possess in their place the knotted nervous system of the *Annelides*. If the change from the nervous system of the

Cirripeda to the radiated system of *Asterias* be conducted in any manner similar to this, it will then only be necessary to investigate the nature of the chasm that so widely separates them.

I have only one thing more to observe on this subject, namely, that if the radiated disposition of the internal and external parts of the genus *Coronula* forcibly reminds us of the genus *Echinus*, and if Linnæus describes it as "*testa figurâ Echini absque radiis*," it ought moreover to be recollected that the articulated feet of a Cirripede are not absolutely invisible among the *Radiata*. It was even upon this principle that M. Latreille detected their affinity. "*Les Comatules*," says this naturalist, "*et les Euryales, genres de cette division classique* (Radiaires), *nous montrent positivement des parties analogues aux bras des Cirrhipedes, celles qu'on distingue sous le nom de rayons articulés, et quelquefois dichotomes tels que ceux des Euryales. On en voit autour de la bouche dans les Comatules.*"

RADIATA.

The *Echini* deserve attention, as after them no Radiated animal has two apertures to its intestinal canal; they lead immediately by means of the genus *Scutella* to the *Stellerides* of Lamarck, a group which is the same with the genus *Asterias* of Linnæus. Those animals which compose the modern genus *Ophiurus* make the passage very easy and gradual from the true Starfish to *Medusa Andromeda*, and *M. frondosa*, which form part of the genus *Cassiopea* of Peron. This naturalist, who has contributed more than all others together towards our acquaintance with the nature of the *Medusæ*, has so well described the singularity of these animals, that I cannot do better than refer those who may wish to be acquainted with them to the perusal of his description.

The *Medusæ* bring us to the genera *Porpita, Velella,* &c. of M. Lamarck, which compose his *Radiaires anomales,* and which may for greater convenience be designated, as they have already been by M. Cuvier, under their ancient name of *Acalephæ*. The genera *Lucernaria* and *Actinia* lead us from these animals to the *Fistulidæ* of Lamarck. And as M. Cuvier has pointed out the affinity which some *Holothuriæ* bear to the *Echinides* of Lamarck, we may conclude that the chain of radiated animals returns into itself, after presenting the following five principal constructions,

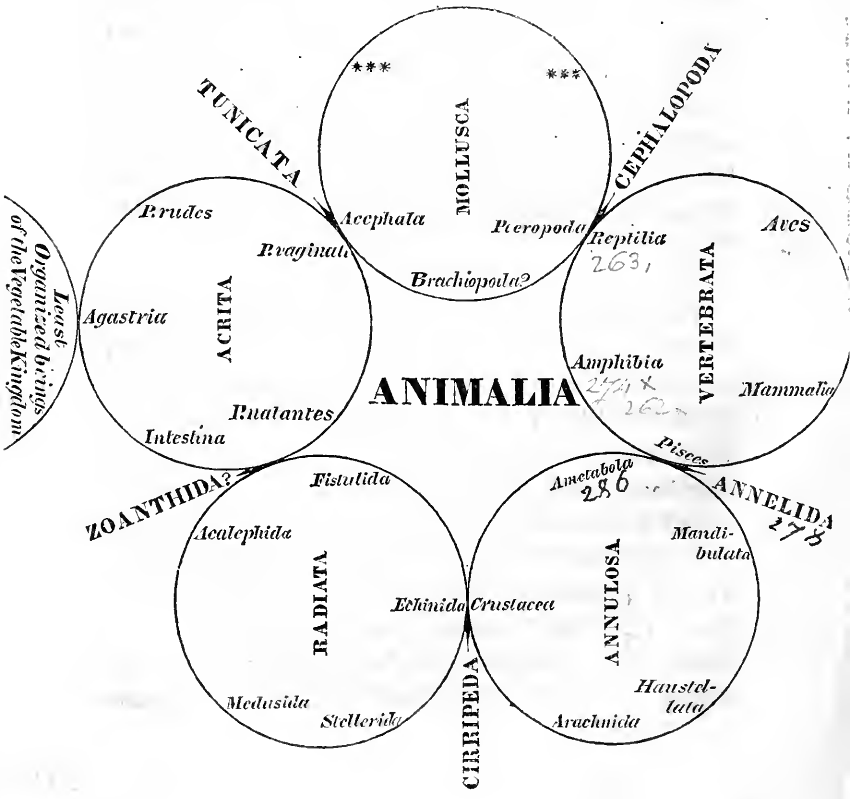
ECHINIDA,
STELLERIDA,
MEDUSIDA,
ACALEPHIDA,
FISTULIDA.

These classes form a group of animals distinguished by the disposition of their parts, internal as well as external, to radiate as from a centre. The Polypes indeed among the *Acrita* have shown vestiges of this disposition; but nowhere is Radiation a regular, nowhere is it a constituent part of the formation, except among the animals with the consideration of which we are at present engaged. The *Radiata* besides are perfectly distinguished from the *Acrita* by the possession of a system of respiration and apparently of a definite nervous system; but this as yet has only been detected among a few. *Asterias rubens* is almost the only species of the *Radiata* of which the anatomy may be said to have been well investigated. Dr. Spix, to whom the honour of this investigation is due, appears to consider the sexes to be distinct. His principal argument however is, that since these animals are always found collected in numbers together, this inclination to assemble cannot result from hazard but from sexual instinct; but were this mode of reasoning correct, Oysters and *Ascidiæ* would not be hermaphrodites. By galvanic experiments he convinced himself of the disposition of the nervous matter, and found it to correspond with the form of the animal. At the lower surface of the body, near the reunion of the two hepatic vessels of each ray, are found for each of these two grayish ganglions resembling an elongated grain of millet, and communicating together by a transverse filament. From each double ganglion proceed filaments to the mouth and stomach, but the principal and longest branch which leaves each ganglion is that which ramifies into each ray. This radiated nervous system, so different from all the others which we have examined, may be considered as the type to which the nervous structure of all the *Radiata* may be referred.

ZOANTHIDA.

The *Zoanthus sociatus* of Cuvier, or *Hydra sociata* of Gmelin, has the same fleshy tissue, the same disposition of the mouth and of the tentacula, as the *Actiniæ*, with an internal organization nearly similar; but it is a compound animal, of which the individuals are united on a common base, which either offers to the eye a broad surface, or in the shape of a fleshy wrinkled tube sticks fast to the rocks, and sends forth other fleshy tubes creeping along in various directions. These singular creatures evidently bring us back to the group of *Acrita* which we left by means of the *Tunicata*, and the classes into which the animal kingdom may be resolved are thus found to return into themselves.

The foregoing observations I am well aware must be far from accurate; but they are sufficient to prove that there are five great circular groups in the animal kingdom which possess each a peculiar structure, and that these, when connected by means of five smaller osculant groups, compose the whole province of Zoology. As for the subordinate affinities, they had better be collected into one tabular view, when it will be found that what, from my imperfect description, may perhaps have appeared confusion in the above detail, becomes order in the general idea obtained of it from the following figure.



On the examination of this sketch, we are at first struck with the analogy which opposite points of the same circle bear to one another,—an analogy sometimes so strong that it has been mistaken for a relation of affinity; and indeed I am still unable to state whether this be not the fact, and that the opposite points of the curve, if I may so express myself, do not meet each other. Thus the resemblance which the intestinal *Acrita* or *Monogena* of Latreille bear to the *Nematoidea* of Rudolphi and the *Annelides,* need not be descanted on, nor the affinity which the *Cirripeda,* according to some naturalists, appear to have with the Brachiopod *Mollusca.* It will be sufficient to state, that as this peculiarity of natural distribution was detected by analysis in the former part of this work, and the use to be made of it was visible among the *Petalocera;* so the discovery of it served to prevent my falling into several mistakes, which I could not otherwise have avoided in deciding between relations of analogy and affinity, as they exist in the more general groups. The quadruped Reptiles may in this way be separated from the *Mammalia* by the intervention of Birds on one hand and of Fishes on the other; and yet Dumeril may possibly not be far wrong in urging that the paradoxical *Ornithorhynchus* bears a nearer relation to Reptiles than to Birds. But my province more peculiarly is Entomology; and this property of a distribution which for convenience only we have considered as circular, will serve to make the hexapod *Acaridæ* approach to the *Anoplura* of Leach, as appears to be the case in nature.

The next observation to be made is on the nature of the five osculant groups, by which we may have perceived the great divisions of animal life to be connected together. These smaller links of the great chain appear to have no very distinct type of peculiar construction. They are all very imperfect beings, and seem in general to be compounded of properties which more peculiarly belong to the two great divisions which they link together; or, if their structure may be referred to any one type, it is undoubtedly to that of the circle of *Acrita*. When a Cuttlefish has been confounded by Gmelin with the *Polypes*, when the intestinal *Acrita* are not even to this day clearly distinguished from Worms, when Savigny and Le Sueur have only just separated the *Tunicata* from other Compound animals, and Lamarck still places *Zoanthus* with *Hydra*; it seems extraordinary that the gregarious disposition of the Cirripedes, their testaceous covering and long arms should not have given them also a place among the *Acrita*. They certainly deserve it better than the *Cephalopoda*, with which they were confounded by no less a naturalist than Poli. But however this may be, it is clear that the type of an osculant group, such as the *Tunicata*, *Cephalopoda*, *Annelides*, *Cirripeda*, and *Zoanthida*, will find its corresponding form rather among the circle of *Acrita* than among any other of the great divisions, unless it be at the points of connexion. A curious exception however to the full force of this remark seems necessary to be made with respect to the *Annelides*; for we have only to cast a glance at the systems in present use, in order to be convinced that the external form and manners of some of these animals announce a certain degree of kindred or analogy with both the *Mollusca* and *Radiata*. But it is possible that what has been already said on the affinity which opposite points of a circle bear to each other, will serve to explain this circumstance.

The third observation to be made is, that on leaving the *Acrita* by means of the *Tunicata*, we immediately have the nervous system directing all its energy to one principal ganglion, which is called the brain, and thus are led to the very great intelligence of some *Vertebrata*; but on leaving the *Acrita* by *Zoanthus*, the vital energy is apparently divided among different ganglions, and we finally arrive at the very great instinct of certain *Annulosa*. The complication and perfection of structure in the animals we meet with in this last path, neither increase so rapidly nor arrive to so great a height as among those animals which possess a distinct brain. The *Mollusca* and *Radiata* are equally distant from the *Infusoria*, but the sluggish *Mollusca* are in general endued with more proofs of life than the most organized of the *Radiata*. Perfection among the *Annulosa* seems always tending to make the animal a complicated machine, guided solely by an instinct implanted in it by its Creator. Perfection in the *Vertebrata* seems to tend to make the animal a free agent, and to render it more independent of fatality.

Fourthly, it can scarcely have escaped our notice, as somewhat remarkable, that each of the great groups appears to be composed of five smaller ones; for while it may be true indeed, that, contenting myself with the ability to pass from the *Acephala* to the *Pteropoda*, by means of the genus *Hyale*, I have by no means determined this disposition to hold good among the *Mollusca*; still, as it is equally certain that this group of animals is as yet the least known, it may be improper at present to conclude that it forms any exception to the rule. It would even seem unquestionable, that the *Gasteropoda* of Cuvier return into themselves so as to form a circular group; but whether

Circular group

the *Acephala* form one or two such, is by no means accurately ascertained, though enough is known of the *Mollusca* to incline us to suspect that they are no less subjected in general to a circular disposition than the four other great groups. It may at first be imagined, that each group resolving itself so constantly into five others, is an effect which can only be attributed to some accident which may have favoured this species of developement; but there are too many conditions to be fulfilled before we can consider this supposition as in the slightest manner probable. The regularity which is conspicuous in the whole distribution of the animal kingdom, as above given, can proceed from no other cause than design. Whether this regularity be in nature, or whether it be merely part of an artificial system, which I now am uselessly proposing to the scientific world for their examination, may not perhaps be very becoming in me to determine: but I can safely say that almost all the groups here laid down have been proposed by others; so that in this respect, at least, there will be some room for remonstrance, if I should be judged to have wrested the animal kingdom to any theory of my own. Indeed, when it is considered that there were so many affinities to be reconciled with this constant use of the number five, it is clearly absurd to imagine that I would have hampered myself needlessly with such a rule. My sole object has been to demonstrate natural affinities; and in doing this I have fallen on a distribution into five groups so uniformly, that where there seems to be an exception to the rule, it appears to be as much the consequence of our little acquaintance with the manifold productions of Nature, as of any other cause whatever. No person, however, can be more reluctant than I am to make any

One Group resolving itself into Five others.

conclusion on this subject precipitately; and therefore, in saying that there is a general tendency, in every natural group of animals, to be subdivided into five others, I would only have this opinion accounted an hypothesis which is not entirely destitute of arguments wherewith we may support its truth. Yet I must acknowledge that it appears to me, even by what we have already seen, to be so far established, that in future, where great chasms occur in smaller groups, I shall consider myself entitled to suppose that these proceed from our ignorance of the productions of Nature.

On surveying with attention the affinities as they are expressed in the foregoing table, it also appears that the animals which compose a circle are few, and that the great bulk of living beings is in some measure to be reckoned out of its circumference. Thus, let any naturalist regard a man, a beetle, a medusa, a monas, and a snail, he will find it impossible to connect them by any solid principles of affinity without reference to some of the intervening animals. Taken alone, they are five different and peculiar pieces of mechanism, which scarcely possess any thing in common but material life and irritability. The course of the real Zoological circle is nearly perhaps as follows:

Tunicata, ...	*Alcyonium*, . . .	*Zoanthida*,
Acephala,		*Fistulida*,
Brachiopoda,		*Echinida*,
Cephalopoda,		*Cirripeda*,
Reptilia,		*Branchiopoda*.
Amphibia,		*Crustacea*,
Pisces, ...	*Annelides*, ...	*Ametabola*.

And all out of the line of this series may be termed eccentric groups, which indeed comprise the most perfectly constructed of terrestrial beings. So clearly does this disposition appear in Vertebrated animals, that if *Ornithorhynchus* be in reality allied to aquatic birds, scarcely more than a dozen animals will be necessary to form the true circle of *Vertebrata;* and all the rest appear to be thrown off from these, in a manner of which I can give no better idea, than by comparing it to the radiation of a star composed of five very eccentric ellipses touching one another.

Such are the principal observations which I have to make on the foregoing table of affinities, which, although a most feeble and imperfect sketch of the truth, will, I trust, be admitted to possess a degree of order and unity hitherto conceived unattainable in the arrangement of animals. This much I venture to say, without the least fear of being charged with vanity, since it must be evident that an arrangement like the preceding, which is nothing else than a simple table of natural affinities, however it may impress us with the idea of Almighty wisdom, can derive no aid whatsoever from human ingenuity. Every discovery of an affinity indeed is, in part, a discovery of natural arrangement; but even in this respect I have done little more than combined in one view the discoveries of others. As for the combination of these affinities, the harmony it may display is the work of God, not of man; and herein it differs from all other systems hitherto proposed, that in admiring their several merits we celebrate the just triumph of one of our own species in simplifying the means of acquiring knowledge; but in admiring the order of the preceding table, so far as it may be correct, we adore our Creator in one of his stupendous works.

If it should excite surprise that this arrangement of animals has not been sooner discovered, let it be recollected that it is founded on knowledge acquired by the study of comparative physiology. There are two methods by which we may arrive at a classification of organized beings, and they may be said to correspond with the ancient and modern methods of natural philosophy. The first is, to make an arbitrary division of Nature, and then, holding it as a law, to view the works of God through this medium of our own creation, by which they cannot fail to be distorted. The second method is, to commence with supposing nothing known but what has originated in actual experiment by the comparative anatomist, and then, by comparing the affinities thus collected, to attempt to gain that knowledge of natural groups which in the first method we started with supposing as already acquired. This last mode of proceeding could only be adopted when comparative anatomy had made great progress as a science; and even now that it is adopted, I shall not be surprised to find it considered as a premature attempt. I will even freely confess, that not merely the object I have principally in view, namely, the place of *Scarabæus Sacer*, but also my little acquaintance with the subjects necessary to be discussed, prevents me from entering more minutely into the investigation of the classes which compose the great divisions of *Vertebrata*, *Mollusca*, *Acrita*, and *Radiata*. To others therefore more skilled in their anatomy I leave these parts of the animal kingdom, once for all stating, that the anatomical observations on which I have founded the preceding arguments are all recorded in the works of the most celebrated naturalists.

How much in particular I owe to the labours of MM. Cuvier and Lamarck, is sufficiently clear. It is a tribute in truth justly due to their patient investigation and accuracy of research, to say that without them the Zoologist would probably have still been accustomed, like our predecessors half a century ago, to confound the true object of Natural History with Nomenclature. He would still have had to wander amid the animated works of Creation with nothing but Linnæan light, or, what is worse, its reflection, to guide his steps.

For skill in anatomical dissection, for accuracy of observation, and reference of means to their respective ends, perhaps no man living can be placed in competition with M. Cuvier. His works present a never-failing fund for meditation; they compose a mine of information, from which the ore is as rich as it is inexhaustible. But the disposition or ability to make use of this ore, to give it the proper form and polish, is not, it seems, a necessary concomitant to skill in extracting it, or to the patience required before it could have been collected for use. At least it is but too visible, and has been too often and too justly remarked, that no person of such transcendent talents and ingenuity ever made so little use of his observations towards a natural arrangement as M. Cuvier. His splendid Geological theories, which, from the particular direction Natural Science has taken in this country, have tended more to make him known here than all his other works taken together, and his Anatomical observations, which occupy so interesting a portion of the History of Science during the last twenty years, are infinitely beyond the feeble praise which it is in my power to bestow on them. And indeed in characterizing his merits as a naturalist, we have less concern with such labours than with his *Regne Animal;* a work which has been is-sued forth to the world as an epitome of his manifold discoveries, as the perfection of the object to which all his operations tended, namely, a natural distribution of the Animal Kingdom. It may not be altogether useless to say of this work, which is at present the text book of Natural History in France, that it is impossible to have read it without being convinced of the importance of the object which the author has aimed at, and of the inadequacy of his endeavours, compared with those of Lamarck, to attain it. At the same time it is but right to add, that no book ever published has comprised so great a mass of zoological information, nor has had it compressed within so small a compass, as the *Regne Animal*. Excellencies of this description render it by much the best work ever published on the subject, and invaluable to those travellers who require a scientific companion to guide their researches in distant countries.

Naturalists, it is said, may be classed like the objects of their study into genera and species; and in this classification places may be found for the comparative anatomist and physiologist down to the mere collector who hoards a shell or pebble, simply that he may be gratified in the possession of that which his neighbour wants. The variety of pursuits embraced in the comprehensive term Natural History, is without doubt multifarious; but it may be questioned whether the title of *naturalist* be merited by the cultivator of any one or two of these pursuits, or indeed by any person who deems even the most ignoble of them unworthy of his attention. A native of this island, whose aim it was to throw light on the organization connected with the great functions of human life by an analogical examination of some of the more perfect animals, has carried off the palm from all who have hitherto attempted to rival him on the same ground. But we are far from being thus assured of his right to be compared as a naturalist with others not blest with half his talents. We learn only that he confined his views to one of the most sublime, but at the same time most limited departments of Natural History. To be pre-eminent in the science requires a much more extensive range of investigation,—no other than that physiology which endeavours to illustrate the system of affinities upon which organs, functions and habits, every thing in brief appertaining to organized matter, were designed by the Architect of the universe. This study includes all the rest; and it is not the least praise of Cuvier that he has tried to impress on our minds a truth so important.

M. Cuvier has been fortunate, inasmuch as his reputation is extended over all Europe, and he is universally admitted to be the first comparative anatomist in the world. But there is another Frenchman, his brother professor, now unhappily oppressed with age and sickness, whose name is in England much less known, and, when known, is rarely cited but in order to exemplify the objectionable tenets held by some of a modern school of philosophers. His peculiar and very singular opinions have never gained many converts in his own country, and I believe none in this; they are indeed only to be understood by those who are already supplied with the means of refuting them: so that, the mischief they may have occasioned being comparatively null, we may be permitted to assign due praise to the labours of Lamarck, as being those of the first Zoologist France has produced, as being those of a person whose merits in Natural History bear much the same relation to those of

M. Cuvier, that the world has been commonly accustomed to institute between the calculations of the theoretical and the observations of the practical Astronomer. I speak not now of Lamarck as a mere *genus-maker*, which with as little trouble as science we can each of us be; nor do I allude to what he has done in Conchology, for it is here perhaps that his arrangement is most artificial; but I would ask those who may have studied his works, whether the reputation of any man for clear arrangement on principles of affinity stands so deservedly high as his? Nay, if we compare what he has effected generally for Natural History with the improvements of others, there is little reason to believe that his claims to our gratitude will be found inferior to those of any of his contemporaries.

Thus much I have considered it to be my duty to say of a man whose scientific labours are now closed in blindness; because his merits are in this country too little known; because his discoveries, though less brilliant, have had little less effect than those of Cuvier in producing the present triumphant state of Natural History; and lastly, because he has done more than any other man that ever existed, towards the natural arrangement of the Unvertebrated animals.

I shall now conclude this chapter with a review of the general distribution of animals, and prove that M. Lamarck, by the first method of reasoning explained in a preceding page, obtained an indistinct view of that arrangement which I have attempted to develope by the second. In the supplement to the first volume of his celebrated work, which deserves to be studied by every naturalist who can divest it of his peculiar theory of organization, he acknowledges that the idea of a simple series constituting the whole of the animal kingdom does not agree with the evident order of Nature; "*car cet ordre est loin d'être simple; il est rameux, et paraît même composé de plusieurs séries distinctes.*" He then presumes that animals offer two separate subramose series; one commencing with the *Infusoria,* and leading by means of the *Mollusca* to the *Cephalopoda;* and the other commencing with the Intestinal Worms and leading to Insects. Now this notion could only have gained a place in the mind of Lamarck, from a conviction by experiment of its being an incontrovertible truth; for be it observed, that no more complete proof of the insufficiency of his theory of formation can be adduced than the existence of two series. Lamarck had unfortunately, from a ready perception of affinities, been induced to confound natural order, by which is meant the actual regularity of disposition which exists in Nature, with that order of formation by which is meant the process of it in time; and this error is more difficult to avoid, than a person who is not deeply versed in the investigation of affinities will be apt to imagine. The consequence however of thus mingling effects of which we are sure, with the means by which these effects have been produced, of which we known nothing, was, that Lamarck adopted the hypothesis of a principle constantly existing in organized matter, by which it as constantly tends to be more organified. The great first Cause had only to create a particle of matter with this principle, and the work of creation as far as it regarded animals was effected. Now, had the series of affinities been simple, we should have had a strong argument for the truth of this hypothesis: but when its author is obliged to confess that Nature "*en donnant l'existence au regne animal, a nécessaire-*

ment commencé par la série des Infusoires," and that "*assez long temps après l'institution des Infusoires et des Polypes elle a commencé l'établissement d'une série nouvelle*," he thus allows that in the formation of animals there were at least two interferences of a foreign principle. Yet, if this weak theory ever had any merit, it was in the supposition that a particle of matter became totally independent on its first creation, and sufficient, in short, of itself, to account for all the affinities and differences reigning throughout the whole province of Zoology. When then that doctrine which its only use was to support is contradicted by Lamarck, the clumsy pillar itself becomes cumbersome; and indeed, from the vague and obscure manner in which its author endeavours to reconcile the existence of two series in Nature with his peculiar theory, I cannot but think that he was aware that he had caused it himself to totter at the very base.

We therefore can have no doubt of the fact of there being two series of animals in nature, each emanating from the *Infusoria*; nor does the observation that these two series meet in the *Annelides* interfere in any manner with this truth, as I hope already to have shown. It may possibly then be considered as a circumstance in no small degree favourable to the character of the remarks contained in the preceding part of this chapter, that I should, by one method of investigation, have arrived directly at a truth which must have been extorted reluctantly from one of the first naturalists of the age, by a continued course of observations in another.

M. Lamarck next observes, that the animals composing these two series differ so much from each other when their nervous matter becomes a little concentrated, that its mode of disposition is wholly different. Now this we have already seen to be the case in the two sides of the Zoological circle, which, as the reader needs scarcely to be told, correspond with the abovementioned two series. But to remove all doubt on this point, let us turn to the tabular view of the affinities of the animal kingdom as given by Lamarck. It is as follows:

Series of Inarticulated Animals.

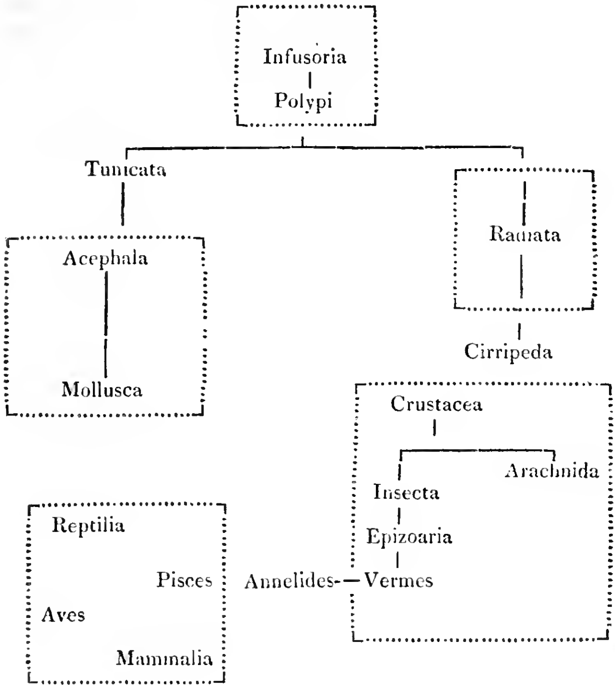
Infusoria
Polypi
Tunicata — Radiata
Acephala
Mollusca

Series of Articulated Animals.

Vermes
Annelides — Epizoaria
Insecta
Crustacea — Arachnida
Cirrhipeda

Pisces
Reptilia
Aves
Mammalia.

Now this table of affinities which is given in page 457, vol. i. of the *Histoire Nat. des Animaux sans Vertèbres,* however confused it may appear, or subramose, as it is termed by Lamarck, coincides with the tabular view which I have laid before the public in the preceding part of this chapter. We have only to join the *Radiata* to the *Cirripeda,* and the *Annelides* to Fishes, for the reasons which I should hope it will now be unnecessary to repeat, and Lamarck's table of affinities, with scarcely any alteration, becomes precisely the same as mine. This is proved by the following distribution, in which squares are used to mark the groupes, but not the progression of affinity.



If any thing could convince me of the accuracy of my method of investigation, it was the coincidence of the result with this double series obtained by what, considering the means he used, was little less than inspiration on the part of Lamarck. His peculiar taste for affinities gave him a glimpse of that order which it was easy for me, or indeed for any person, to obtain, on applying those principles of which the accuracy was first discovered among the *Petalocera*. But is there no such thing in nature as a simple progression of beings? I suspect, not. That a progression of some sort does exist, neither believer nor atheist will deny; and Lamarck justly calls the existence of order in the composition of organized beings "*le plus important fait de tous ceux qu'on ait remarqués dans l'observation des corps vivans.*" Sure enough it is, that we cannot find within all the sphere of human knowledge so beautiful an evidence of the truths of natural religion. How vexing then for naturalists to find their researches into the nature of this progression so constantly foiled! It must be a simple series, say some philosophers, because man is evidently the lord of the creation, and the form to which every other must be referred. But this cannot be a logical conclusion, supposing even the premises to be correct; which however may be disputed, with the bare exception of that indubitable superiority which man holds over all terrestrial organized beings.

It is true that the possibility has been acknowledged, of establishing in the distribution of animals a sort of series which may appear to recede gradually from man, who is thus assumed to be a primitive type to which all other beings are referable. It has been even asserted, that by this process we may be enabled to form a graduated scale of organization, which will be that simple progression the existence of which has so often been assumed by metaphysicians, and taken for granted by naturalists. But supposing the human form to be the type to which all others are to be compared, it is clear that, in endeavouring to establish the simple series, we must either consider each organized being in the whole of its parts, or in only one of them. If we adopt the latter plan, there will be as many different series formed, as there are regulating organs; since every person knows that no two organs undergo an exactly equal and proportionable degradation. Hence, to obtain the simple progression so devoutly wished for, we are under the necessity of making use of the only alternative remaining, that is, of the first method proposed; which failing, I fancy that it will be readily allowed that the truth of a simple progression in Nature is as little to be demonstrated as that of the Ptolemaic system. Now, that the method of referring an organized being to man, by a comparison of the whole of its parts, will fail to produce such simplicity, I think can be proved—In the first place by *experiment*, which has led almost every naturalist to express his inability to obtain a simple series; which has led Lamarck to presume the existence of a double subramose series; and which has induced the reader ere this, I trust, to have little doubt of the existence of a progression which returns into itself: In the second place, by *argument*; for, as Cuvier has most properly said, to form a simple scale of organization, upon the comparison of every organ existing in animals, we ought to calculate the effect resulting from each combination, and then to give each animal its definitive place in the scale according to this calculation. Let us then go so far in our desire to procure the simple series, as to suppose this plan, which is the only one I will venture to say that can be devised, to be practically possible. Let us grant a simple scale to be thus obtained, and there are few so ignorant of Natural History as not to see that it would be the most artificial system that ever was invented. Well does Lamarck observe that such an operation, if practicable, could only be effected by making use of arbitrary data, and that such a result, if obtained, would be totally useless and nugatory. It would no more argue a simple series to exist in Nature, than the possibility of stretching a bow proves that it is always naturally stretched; than the possibility, in short, of forming any sort of scale at our pleasure, proves that the scale thus invented is that according to which we have all been created.

As no naturalist of the present day, as far as I am acquainted, has any doubt of the non-existence of a simple progression in Nature, it may seem to be trifling with the reader's time to take any pains to support a truth which is so generally admitted. When however we observe metaphysicians of no common acuteness, day after day, accounting such a series to be demonstrated, it may be proper to consider their method of demonstration.

No mode of argument, if correct, is so convincing as by syllogism, and there is none in which, if incorrect, the error is so readily detected. We shall therefore now analyze the syllogistical proof of a simple series in nature, which has been given nearly as follows.

1. Species of animals differ from each other in their material structure.

2. Man in his organization is a species of animal.

3. Man is the most perfectly constructed of all known animals.

4. Therefore we ought to refer every species of animal to man, as the type of that perfection from which it more or less recedes;—in other words, there is a simple scale in Nature.

The naturalist is the first to perceive that there must be some error in this reasoning, because he knows by experiment the conclusion to be false. Some first-rate zoologists have therefore supposed the above consequence to be improperly drawn; in which opinion we shall soon see that they were perfectly right. It remains however to be questioned, whether their own conclusion be less exceptionable: for instance, they admit the truth of the three first parts of the argument, and say that, consequently, there is an ascending scale of being from the lowest point of animal life to Man, the king of all, but that this scale is not necessarily simple. Indeed they most ingeniously prove the scale to be not necessarily simple, by supposing it to resemble the surface of a cone, the base of which is composed of innumerable species possessing an infinitely small degree of animal life. These species they further suppose gradually to diminish in number, and increase in complication of structure, as they spirally ascend the cone, till they terminate in unity and perfection at the point,—which is Man. Here we have an ascending scale which is certainly any thing but simple. Before however it is possible to do more than admire the ingenuity of its inventor, we must be fully convinced of the solidity of the base upon which this cone is constructed. Now it is by no means sure that the higher classes of animals, in proportion to the complexity of their organization, always consist of a fewer number of species than the lower. To take the first example that occurs at the top of the cone; the numemerous *Quadrumanes* would thus be widely separated from Man by animals unlike to either. Nay, were it true that the group which comprises the greatest number of species is the lowest in the scale of perfection, there is reason to fear that the *Acrita* would not form the base of the cone, and that I should not be the only person to lament the place which must then be allotted to the innumerable *Annulosa*.

But this is far from being the worst: for it seems moreover to be utterly impossible to draw up any table of natural affinities on the assumption of the truth of this hypothesis; so that, in addition to the difficulty of imagining the existence of this cone, it is useless to the naturalist when imagined. We are thus authorized to go back another step in the review of our syllogism. No one will deny that two species differ from each other in structure; because, were they constructed precisely on the same model, they would form only one species: neither will any one, I think, deny that man is a species of animal. But is it equally certain that the material organization of man, which, for the wisest of purposes, has been made to appear so beautiful and dignified in our eyes, is that perfection of animal mechanism, of which all others are merely modifications? Helvetius, and other materialists, must of course, for the sake of consistency, maintain the excellence of man, considered as a machine, to be infinitely before that of any other animal; because, making as they do the intellectual faculties of man to be the result of his material mechanism, they must either obstinately insist on his superiority in the latter respect, or consent to reduce him to a level of intelligence with the brute. Nevertheless the mechanical superiority of the human frame, although probable, is by no means a self-evident truth; for it has been disputed by those comparative anatomists who are celebrated for their profound knowledge of the *Vertebrata*,—that is, precisely the very division of which all the animals may justly be compared to the human form. Thus says one of them, speaking of the *Vertebrata*, "*Lorsque l'anatomie comparée fait de l'homme son point de départ, et lorsque s'appuyant sur ce principe que les organes de cette* *espèce privilégiée sont plus parfaits, mieux connus et mieux définis, elle examine en quoi et comment ces organes se diversifient, se déforment, et s'altèrent dans tous les autres animaux, mes nouvelles vues me portent à ne donner de préférence à aucune anatomie en particulier, mais à considérer les organes là d'abord où ils sont dans le maximum de leur développement, pour les suivre de degré en degré jusqu'à zéro d'existence."* An anatomist thus informs us, that his observations have not led him to adopt the old opinion on the subject; and we are therefore called upon to prove the truth of the assertion, that the human frame is the most perfect mechanism in the animal kingdom. The process which Cuvier recommends, of calculating the effect of each combination, would, if it were practicable, be of some use here; but unfortunately it is not practicable, und I query much whether there be any other method of proving the truth of the syllogism. We see however that it may be doubted even by those who have best the means of judging; and indeed as the indubitable superiority of man over other creatures depends on something totally immaterial, which throws him out of the group of animals and makes him an insulated being, namely, his mind, I can see no necessity for metaphysicians or naturalists so strongly insisting on what they cannot prove,—the decided superiority in detail of the human mechanism over that of all other animals. Taken as a whole, the human frame without doubt is a most complicated machine, yet perhaps it scarcely possesses any one sense or bodily power in which it is not excelled by some irrational being.

The argument perhaps therefore had better have lain thus:

1. Species of animals differ from each other in struc-

ture; which structure may always be referred to one of two general plans.

2. Man is apparently the most perfectly constructed animal, on the whole, of all those which are constructed on the same general plan with him; and with the others he cannot very logically be compared.

There are few naturalists that will be inclined to dispute the truth of these premises, and we may leave it therefore for the metaphysicians to draw their conclusion.

CHAPTER VI.

ON THE ORDERS OF THE ANNULOSA.

ARISTOTLE appears to have comprehended under the general title of *Ἔντομα* not only true Insects and *Arachnida*, but also some modern *Annelides* and Worms. Now, as they have nothing in common but their longitudinal knotted nervous system, which he cannot be supposed to have detected, and their annular structure, it is manifest that the founder of Zoology must have had an indistinct perception of the natural character of such a group being external articulation. He even expressly says that on this account he gave them their name; yet his perception of the truth I conceive must have been indistinct, because he has separated from these animals the modern *Crustacea*, which are as truly articulated as any of the foregoing. This separation of the *Crustacea* from the other Annulose animals originated in his unfortunately making the first great division of Zoology depend on the medium inhabited; and his reason for continuing in the error becomes apparent as soon as we observe from the name which he gives to the *Crustacea*, (*Μαλακόστρακα* or *Soft-shelled Testacea*,) that he considered them merely, as the vulgar do at this day, to be a sort of Shell-fish whose testaceous covering is softer than ordinary*. Nor indeed do the ancient na-

* As he placed the *Crustacea* between the *Mollusca* (τὰ Ὀστρακόδερμα) and the *Cephalopoda* (τὰ Μαλάκια), he also called them, in opposition to these last, Σκληρόδερμα. They were with him soft-shelled *Testacea* and hard-skinned *Cephalopoda*.

turalists deserve to be condemned severely for this mode of reasoning, since we have seen in modern times, notwithstanding the complete refutation of such notions by the influence of comparative anatomy, that, besides Crustaceous animals, others, such as the *Cirripeda* and *Annelides*, have been confounded with the *Mollusca* for no other reason than because they are all protected by an external shell. Whatever good Linnæus may have done to zoological science so far as it relates to the Vertebrated animals, whatever benefits he may even have conferred on Entomology so far as relates to the subdivision of Hexapod insects, it ought not to be concealed that until the works of Lefrancq de Berkley, Bruguières, Cuvier and Lamarck appeared, our general knowledge of the Unvertebrated animals remained exactly in the same state in which Aristotle had left it, excepting indeed that in the *Systema Naturæ* Crustaceous animals were placed with the other *Annulosa*. Perhaps, also, Redi's discovery of the mode in which insects are generated may form an exception to the perfect justice of this remark, notwithstanding that it is very far from being true that even with this the ancients were altogether unacquainted. It is no stigma on the reputation of Linnæus that he should have left so much undone; but rather wonderful that he should have done so much. In allowing, therefore, that the Aristotelian groups into which, after the example of an Englishman, he divided the winged insects, however badly arranged, are masterly and even natural*,—and in granting that, the entomologist ought never to be considered as the naturalist who owes him the least portion of gratitude,—we

* It is singular that the only order of Hexapod Insects which is of Linnæan invention, namely, the *Hemiptera*, should have been constructed on erroneous principles, as Degeer first perceived.

have another duty still to fulfill, namely, to assign that merit to others which is their due. Now, the Linnæan group of *Aptera* is the same heterogeneous and confused mass that it was in the earliest periods of Natural History, although not merely the science of Entomology, but that of Zoology in general, may be said in some measure to depend on the proper arrangement of Aristotle's Apterous insects. Happy would it have been for the learned Swede if in this department also he had thought proper to follow the track of Ray.

The removal of the chief difficulties attending the investigation of *Aptera* may be dated from the moment when it was observed that a number of animals, of altogether different external appearances, nevertheless agree in the possession of two nervous strings originating in a very small brain placed on the œsophagus, which these strings surround. And when it was further discovered that these two strings, proceeding along the whole length of the subject, are sometimes united at different distances by double knots or ganglions, which disperse the nerves to the limbs and other parts of the body, the externally articulated animal may be said to have been insulated from all others. This nervous system, though it may vary in its details, and particularly in its number of longitudinal ganglions, is singularly conspicuous in the *Cirripeda*, *Annulosa*, and *Annelides*. But as the former of these three groups consists of hermaphrodites, destitute of the faculty of locomotion, with a body not strictly articulated, and as the *Annelides* are hermaphrodite red-blooded animals, the *Annulosa* are not likely to be confounded with either. We have elsewhere seen that the *Annulosa* may be characterized as white-blooded animals having the nervous system above described, with the sexes distinct, and a body visibly articulated on the outside so as to be composed, as it were, of a number of annular segments. Now, as the *Scarabæus Sacer* is evidently such an animal, it becomes necessary, in order to attain the object proposed in the title of this Essay, to investigate the composition of the division of *Annulosa*. In attempting this, I shall commence with the *Crustacea*, not only as being the group which is according to all appearance the nearest to the *Cirripeda*, but because it is that of which I know so little, that I shall be glad to dismiss it in as few words as it is possible to use, consistently with my desire of proving that there is more unity in the plan of Nature than has hitherto been suspected.

Crustacea.

They who may wish to be acquainted with these singularly constructed rather than beautiful animals, must resort to the works of M. Latreille and Dr. Leach, the latter having analytically done as much service to this branch of Natural History as the other has synthetically. My present object will be sufficiently gained by stating briefly that some *Branchiopoda*, such as the genus *Zoe*, have appeared both to Bosc and to Latreille to lead us to the *Decapoda*, or those *Crustacea* which have the head confounded with the trunk. The *Stomatopoda* of Latreille are not allowed by Dr. Leach to be a distinct order, but merely the means of transition from the *Decapoda* to the *Amphipoda*. They are probably an osculant order connecting these: yet, if certain analogical considerations be rigorously attended to, they will find a place rather with the latter than with the former. This besides is a distribution which seems sufficiently authorized by the circumstance, that in both the

Stomatopoda and *Amphipoda* the head is distinct from the thorax. The *Læmodipoda* and *Isopoda* appear to complete the group, and by means perhaps of the genus *Bopyrus* to reconduct us to the *Branchiopoda.*

Although very far from vouching for the infallibility of this series of affinities, I think that the reader will, without difficulty, allow that it is not in absolute contradiction to the disposition of Nature. It is indeed almost the same series as that laid down by M. Latreille in the *Regne Animal,* differing only in its including those affinities which he specifies as having a real existence, but which he nevertheless neglects, or finds it difficult to employ, in his method of arrangement. I shall have occasion also, hereafter, to support the above distribution of *Crustacea* by other arguments; and in the mean time I request it may be understood that it is the disposition of the component parts of the class, and not the limits that may have been affixed to the respective orders,—in short, that it is the chain of affinity, and not the accurate designation of the groups, which I would here propose to entomological notice. Having said thus much to prevent mistake, I may now proceed to state that the general character of the *Crustacea* as an Annulose class consists in their breathing by means of branchiæ, and being in possession of a complete circulation. The blood, after communicating with the surrounding medium, passes into a great ventral vessel, which distributes it over the body, whence it returns to a sort of heart or muscular ventricle situated in the back, by means of which it arrives again at the branchiæ. Now, it is manifest that this is the circulation of a Fish, rather than of a Mollusque, the heart of which is always aortal; and this circumstance might be adduced as conclusive evidence that those naturalists, by whom the *Mollusca* are placed between the *Crustacea* and Fishes, have not properly applied even their own principles. If they think proper to found their arrangement of animals almost entirely on the system of circulation, we have a right to require of their consistency that two classes, such as *Crustacea* and Fishes, having similar systems, shall not be separated by five classes of *Mollusca* which have another system totally distinct. I had before reason to contest the propriety of an application of this principle of comparative anatomists to the arrangement of Annulose animals; and I do not even now regret that they should have chosen to neglect it, since the intervention of the *Ametabola* between *Crustacea* and Fishes has thus a sort of precedent. Indeed, out of the sphere of *Vertebrata*, the system of circulation, taken alone, rarely deserves to have any great importance attached to it; and we accordingly perceive that it has been overlooked even by those naturalists who make it the ostensible principle of their general distribution of animals.

Vestiges of an ear have been detected in some few species of *Crustacea;* but as Hexapod insects,—which appear to enjoy the sense of hearing much more perfectly, although from the difference between the plan of their construction and ours we are unable to discover the organ,—have not the vestibulum of the *Crustacea*, the observation is of little or no use towards determining the relative perfection of the two groups. This is an argument indeed which has been elsewhere urged; but I would rather be taxed with repetition than avoid calling the entomologist's most careful attention to such an extraordinary point of anatomy.

The *Crustacea* are remarkable for having two pair of antennæ, which are classed as *external* and *internal.*

When the external pair becomes null, we approach to the *Arachnida*; and when, on the other hand, the internal pair gets indistinct, we may prepare ourselves for those Myriapod insects which form part of the class

AMETABOLA.

Every author on Entomology having observed the affinity of the *Oniscus Armadillo* of Linnæus to the modern genus *Glomeris*, it scarcely seems necessary to demonstrate here the accuracy of that process of reasoning by which the group of *Ametabola* is united to the *Crustacea*. It may therefore suffice to say, that if the possession of four antennæ constitutes a general and absolute character of the last-mentioned class, the genus *Oniscus* must cease to belong to it on account of its having only a pair of these organs. Now Degeer has observed that the young of *Oniscus Asellus* L. or the genus *Porcellio* of Latreille, on leaving the mother possess no more than six pair of feet, and that as they advance in age they gain a segment to their body, together with a pair of feet additional to those which they possessed at their birth. This our admirable naturalist states to be an observation quite new, and well worthy of attention. Such indeed it was in his time, and even still remains; for we shall perceive it to form one of the many proofs, which, though now overlooked, confirm that axiom which is alone sufficient to immortalize its author, "*Natura non facit saltus.*"

In the first place, the genus *Porcellio* is justly referred to the *Crustacea* by modern naturalists, because it breathes by means of branchiæ; but when the form and the structure of its mouth and of its organs of locomotion only are considered, the Latreillian order of *Chilognatha* instantly occurs to our recollection. These last are herbivorous animals, or at least feed on organized matter in a state of decomposition, like the Crustaceous genera *Armadillo* and *Porcellio*. They differ from them in breathing by stigmata, and having in general two pair of feet for certain segments of their body. It is to be remarked, however, that while these insects have a tracheal system of respiration, their stigmata, as might be expected when we consider that the mode of breathing has just been changed, are often very minute, and sometimes, as in the genus *Glomeris*, almost imperceptible.

Armadillo
Porcellio
Crustacea)
stigm

Glomeris
Julus
Chilognatha
[illegible]

Having thus established a connexion between *Porcellio* and *Iulus*, I would next observe, that in the *Mémoires de l'Academie des Sciences* M. Degeer acquainted naturalists with the fact, that on quitting the egg the young *Iuli* are quite different in appearance from what they are in the adult state; having at first only six feet, and these disposed in one pair for each of the three first annuli of the body. He observed that in this their young state the segments of the body were never more in number than seven or eight, but that by a sort of metamorphosis, no less surprising to him than that of winged insects which have a pupa state, the number of segments and of feet increased with the age of the *Iulus*. This singular discovery is of such importance to Entomology that I shall be excused for transcribing the words of Degeer himself.

Having procured some eggs of *Iulus terrestris* Linn. which the warmth of a few summer days soon hatched, he perceived a small white larva to proceed from each. "*Ces jeunes Iules,*" he says, "*nouvellement éclos me firent voir une chose à laquelle je ne m'attendois nullement. Je savois que les insectes de ce genre ne subissent point de méta-*

morphose, qu'ils ne deviennent jamais des insectes ailés; ainsi j'étois comme assuré que les jeunes Iules devoient être semblables en figure, à la grandeur près à leur mère, et par conséquence je croyois qu'ils étoient pourvûs d'autant de pattes qu'elle. Mais je vis toute autre chose: chacun d'eux n'avoit en tout que six pattes qui composoient trois paires, ou dont il y avoit trois de chaque côté du corps; ils avoient beaucoup de ressemblance avec des vers ou larves hexapodes, telles que celles qui doivent se transformer en insectes ailés."

Four days after, Degeer discovered that his young *Iuli* had gained four more pair of feet, that their antennæ even instead of four articulations had now six, while the number of the annulose segments of which the body consisted had been in an astonishing degree augmented. From the knowledge of this singular fact we perceive the value of our author's other observation on *Porcellio* previously noticed; we see in short that this genus, although truly belonging to the class of *Crustacea*, which, with the exception of some *Branchiopoda*, is generally characterized as undergoing no change of form, has nevertheless a vestige of the same extraordinary sort of metamorphosis which takes place among the *Chilognatha*.

The mouth properly so called of an *Iulus* has no labrum, or at least has it represented by the emarginate clypeus, and is shut immediately behind the mandibles by a sort of crustaceous labium formed, according to Savigny, of two pairs of maxillæ soldered together, and which represent the four upper maxillæ of decapod *Crustacea*. The three first pair of feet answer by analogy, according to the same author, to the three pair of auxiliary maxillæ or pedipalpi of these *Decapoda*. Those segments of the body which in the larva state of an *Iulus* possess a pair of feet, appear to retain them without any addition; whereas the other feet, which are the result of a metamorphosis, are disposed in two pair for every segment. The two or three last segments, however, are quite destitute of any locomotive organ; and the male *Iuli* are said to have only one pair of feet on the seventh segment.

The cylindrical shape, flexible texture, and numerous segments of the body, with the very imperfect structure of the feet of an *Iulus*, have caused several naturalists to imagine that they form the last of the chain of insects. "*On peut remarquer,*" says Degeer, "*que les Iules sont comme le dernier chainon de la chaine qui réunit la classe des Insectes à celle des Vers; car ils ont le corps très allongé et cylindrique, ou presque de grosseur égale dans toute son étendue, et quoiqu'ils ayent un grand nombre de pattes, elles sont néanmoins si courtes, que l'insecte quand il marche paroît plutôt glisser très lentement sur le plan de position, rampant à la façon des vers sans pattes.*"

From the Chilognatha to the Vermes

Adopting this excellent suggestion of Degeer, we proceed, in the manner which I have explained in the preceding chapter, from the *Chilognatha* to the most imperfect of Annulose animals, to wit, those white-blooded *Vermes* and *Epizoaria* of Lamarck which approach so closely to the intestinal worms among the *Acrita*, that is, to the opposite point of the animal kingdom. In this part of the Annulose circle it is possible that the singular animal may be situated, for which, under the name of *Tardigrade,* Spallanzani and Dutrochet have had so much difficulty in finding a place. A figure of it is given in the 19th volume of the *Annales du Muséum,* which, if accurate, sufficiently proves that an animal may exist without

Tardigrade

antennæ or distinct annular segments to the body, while it resembles an insect in form as well as in the possession of two eyes and six articulated feet.

Articulation is not very distinct in some of the *Epizoaria* of Lamarck, but sufficiently so to lead us to the *Caligi* of Müller and the genus *Cecrops* of Dr. Leach, the latter of which by its general form, antennæ, structure of the feet, and want of posterior appendages, prepares us for the *Anoplura*. These are all parasitical insects, which we quit for the genus *Smynthurus* of Latreille, and by means of it enter among the *Thysanura* or Annulose animals possessing peculiar organs of locomotion in addition to six feet.

Anoplura

Thysanura

Some of the *Thysanura*, such as the *Lepismæ* of Latreille, have an elongate form, long setiform antennæ, various small appendages on each side representing false feet, together with articulated setæ terminating the posterior part of the body. And thus we come to the larva state of the *Chilopoda*, or *Scolopendræ* of Linnæus, from which, bearing in recollection the form and structure of the genus *Craspedosoma* of Leach, we return to the *Chilognatha* and complete the circle of *Ametabola*.

Chilopoda

The *Chilopoda* are carnivorous animals, with setaceous antennæ composed of many more articulations than those of the *Chilognatha*. Their mouth comprises a labrum answering to the clypeus of insects, two mandibles, and a quadrifid labium, which may here serve the purpose of an upper lip, although M. Savigny is of opinion that it represents in fact the four upper maxillæ of decapod *Crustacea*. M. Latreille has lately proposed a different theory on this difficult subject; but there are evident objections as yet to both opinions. It is certain, notwithstanding, that the manducatory organs of a *Scolopendra* consist of two small feet in form of palpi, united at their base, and of a lip formed of a second pair of feet dilated and joined likewise together at their base. These last two feet are each terminated by a strong hook, which is said by Leeuwenhoeck to be pierced at the extremity for the emission of a poisonous fluid active enough to kill insects instantaneously. This effect is indubitable, as an observer of no less accuracy than M. Latreille has confirmed its truth; but the existence of a poison in these insects as well as in what are termed the mandibles of *Arachnida* does not necessarily follow from the victim when bitten being instantly paralysed. This effect may equally result from these animals being endowed with an instinct which leads them at once to pierce the most important part of the nervous system of their prey. Nor is the existence of poison proved by the mandibles being pierced, as they undoubtedly are in the *Chilopoda,* since the mandibles of the larvæ of *Dytisci* and other analogous insects have the same structure for suction. This subject, therefore, I am led to think demands further scrutiny, and the rather, because in those spiders I have examined it has been impossible to discover any thing more than a groove in the mandibles; and because neither in the largest species of *Mygale* or *Scolopendra* has there appeared to be any cyst proper for containing poison.

Until very lately, all known of the economy of the *Chilopoda* was comprehended in the fact that they moulted in the manner of *Crustacea,* and that Linnæus had recorded, "*Scolopendræ pulli seu larvæ pedibus paucioribus instruuntur.*" M. Latreille seems to have made the same observation; for in the third volume of the *Regne Animal* he expressly says of his *Myriapoda,* including *Scolopendra* as well as *Iulus*, "*ils naissent avec six pieds, ou n'ont pas du moins dans les premiers instans de leur vie tous ceux qu'ils offriront dans leur état adulte.*" Anxious to verify by personal observation this curious circumstance respecting the history of the young *Scolopendræ*, I took an opportunity of searching for them, and satisfied myself that the *Chilopoda*, like the *Iuli*, have no more than six feet in their youngest state. In spring they are not very uncommon under stones in certain situations, such as the moist shady borders of woods, and in this their larva state will be found very pale, almost indeed white, but quite as nimble for their size as when they possess their full number of feet.

The *Ametabola*, or insects which present the first vestige of metamorphosis without, in any case, being able to perfect it so completely as some of the Winged insects, vary in form as much or more than the amphibious *Vertebrata*, with which they correspond in the nature of their metamorphosis. The general characters therefore of such a group are very few and scarcely decided; I had almost said that the dissimilarity between the several external forms of the orders may be enumerated among the characters of the class. Thus their head is not always distinct; nor do they always possess antennæ or eyes. Sometimes they are provided with maxillæ, and at others only with an haustellum, which however, there is reason to think, will always be found resolvable into maxillæ. The antennæ of *Ametabola* are never more than two in number. These animals have also never more than two eyes, which differ, however, from those of Winged insects in this, that they are never compound, but are either single ocelli or groups of such. The sexes appear to be always distinct; which

Ametabola vid. ab. p. 347, & p. 287

proves the right of the *Ametabola* to form part of the true Annulose division. They seem all to breathe by means of stigmata, or at least have a system of respiration which corresponds more with that of the larvæ of insects than with any other known. They have a thorax also, which, like that of true insects, is composed of the first three annular segments of the body, which follow immediately after the head. When any of the *Ametabola* have true feet they are constantly six in number, and each of the thoracic segments carries a pair. All the other feet, such as those which occur in the *Chilognatha* and *Chilopoda*, are the result of an abortive metamorphosis.

The mouth of the *Thysanura* is constructed like that of a Coleopterous insect, that is, it contains a labrum, two mandibles, two palpigerous maxillæ, and a labium, bearing two palpi. M. Savigny has likewise discovered that the genus *Ricinus* of Degeer possesses a mouth similarly composed, although the palpi are not so much developed. Some of this last mentioned genus, which, from the name of *Ricinus* being preoccupied in Botany, has been lately termed *Nirmus* (perhaps properly, since this is not the signification given by the ancients to the word *Ricinus*), have exactly the shape of a Coleopterous insect destitute of its elytra and wings. The *Ricinus Sternæ* of Linnæus is a good example of this circumstance, as may be perceived on the inspection of Degeer's figure, vol. vii. pl. 4. fig. 12.—With the exception of its being destitute of elytra, it resembles exactly some of the Corticarious *Coleoptera*.

One of the best characteristics of the *Coleoptera* may be founded on the fact of the anterior segment of the trunk, or that which precedes the wings and is called the thorax, supporting the first pair of feet and being much larger than the other two segments. These last seem, on a first glance, to belong to the abdomen rather than to the thorax, and indeed form one portion of the body with the former; their lower side or pectus supporting the other two pairs of feet. Now, among the parasitical *Anoplura* we find the same disposition of the annular segments of the body, and some of the *Ricini* of Degeer have the first segment of the trunk dilated into a thorax in the same manner.

It would be improper to proceed to the Winged insects, or those which undergo a true metamorphosis, without recalling to the reader's recollection the substance of a few remarks which were made in the preceding chapter on the *Ametabola*. The *Annelides*, it will not be forgotten, are destitute of a heart, although their circulation is distinctly effected by the aid of dorsal and ventral vessels. Now the *Ametabola* have the dorsal canal of the *Annelides*, but no distinct circulation; and the *Crustacea* which follow are furnished with a heart and system of circulation more analogous to those of fishes than exist either in the *Annelides* or *Ametabola*. Hence it is plainly to be inferred, that, setting external form and consistence aside, the circulation of itself, were it allowable to argue on it alone, is sufficient to allay every doubt on the point that the *Ametabola* come nearer to the *Annelides* than the *Crustacea*. On the other hand, there is little further similarity between the *Crustacea* and the *Vertebrata* than that which depends on the system of circulation; and if we found our arrangement on such a principle alone, we cannot expect otherwise than to fall into that confusion which is the invariable consequence of reasoning on single or insulated phænomena. Still the system of circulation in *Crustacea* is very interesting, and such as ought to give rise to more general scrutiny, from which we may confidently expect the discovery of some new and highly curious analogies.

Insects

But before we can advance any further in our investigation, it becomes necessary to take a general view of Insects as they are grouped in the best modern works on Entomology.

p 390 Diagram.

MM. Cuvier and Latreille have the merit of first assembling together into one group all the *Annulosa* which do not breathe by means of branchiæ or branchial pouches. If from this assemblage we withdraw the *Ametabola* as forming a distinct circular group, the remaining animals, although affording one of those abstract entomological ideas which occur the most clearly and readily to the mind, will defy the ablest attempts that may be made to insulate them absolutely from the adjoining tribes by definite characters. If, for example, they should be designated as Hexapods breathing by tracheæ, we soon learn that they possess stigmata and six feet in common with many *Ametabola* and *Arachnida*. The composition of the mouth, so beautifully developed by Savigny, is rather what they all tend to have than what they really possess; nay, the component parts disappear in some *Haustellata*, and are on the contrary all visible in some *Ametabola*. If they be characterized as *winged*, hundreds of species which truly belong to the group are apterous; and so far are they from being insulated from other animals, by undergoing metamorphosis, that the *Crustacea*, *Ametabola* and *Arachnida*, all present instances of a difference of form between the infant and adult state. The compound structure of the eyes may perhaps afford the character most easy to be seized, but even the organ of sight itself disappears in some *Hymenoptera*; from all which we may collect that a natural group defies every rule founded on notions of absolute division, and can only be preserved entire and in its proper situation by its contents being referred to some real or imaginary type, as the standard of comparison to which these in a greater or less degree all approach. The tact of the naturalist is shown less by the discovery of such a type than by his knowing when to distrust it. For its accuracy he must rely upon its coinciding with the general feeling of his fellow labourers in the science, since, though every person may not be able to detect an affinity, all ought to feel its truth when it has been detected. But chiefly he must rely on its combining with the other types to form one extensive plan and uniform effect.

The animals with whose history we are at present engaged all undergo a distinct metamorphosis, by which the wings are always developed, and often even the feet. As the type of every Vertebrated animal is tetrapod, so these insects seem all to be tetrapterous, or at least to aim at this type of construction. Vestiges of wings are to be discovered even in the flea, and their place in dipterous insects is supplied by other organs. Wings however do not always exist, since each of the ten principal orders of insects may afford instances of apterous species even after the last metamorphosis. The correct mode of considering insects, therefore, is as referable all to a type which is tetrapterous. The *Coleoptera* indeed are not only sometimes totally apterous, but often have their upper wings or elytra soldered together so as to form a case for the body. Still I conceive the reader will now have little difficulty in comprehending my meaning, when I hereafter may have occasion to speak of the *Winged Insects* or *Ptilota* of Aristotle.

These animals are the perfection of the Annulose type of form; they are in their own division what *Mammalia* and Birds are among the *Vertebrata*. Their perfection however must not be supposed to result from any resemblance which they bear to a Vertebrated animal, but on the contrary depends on their difference from this structure and their greater portion of instinct. They have no true circulation, at least none such has yet been detected. We are even ignorant of any manner in which absorption can be connected with the oscillation visible in their dorsal canal. They breathe by two principal tracheæ extending along the whole length of the body, parallel to each other, and having plexus or centres at intervals, from which ramifications are dispersed throughout the body, and which communicate with the external air by certain orifices or *stigmata*. As in a Vertebrated animal the distribution of the spinal and sympathetic parts of the nervous system bears some analogy to that of the blood in the veins and arteries, so the longitudinal knotted nervous system of a perfect Annulose animal corresponds in form to the disposition of its tracheæ.

The Winged insects appear in their perfect state to enjoy all the senses of the *Vertebrata*, but the organs of sense are entirely different in construction. Their body, which is rarely composed of more than eleven segments, has three very distinct divisions, termed the head, trunk, and abdomen. The head, which is always provided with two antennæ, is composed of one segment, the trunk of three, and the remaining seven constitute the abdomen.

The sexes are always distinct; those insects which are called neuters being only abortive females. Rare instances of hermaphroditism indeed occur, but are invariably to be accounted as monstrous, and as contrary to the ordinary course of nature as the same imperfection when visible among the *Vertebrata*.

The mouth of Winged insects is composed of six principal pieces, of which four, called the mandibulæ and maxillæ, move transversely in pairs, while the remaining two are fixed, and close the mouth vertically. The two maxillæ and the lowest of the vertical pieces are in general all supplied with articulated processes, of various shapes, called Palpi. Such is the comprehensive view which the ingenious Savigny first enabled us to take of the mouths of insects. On examining these animals more closely, it will, however, be noticed that they form two principal classes, since in some orders the four lateral pieces above mentioned, or at least two of them, take the form of teeth, and the two vertical pieces that of lips: in other insects, again, the lateral pieces never serve as teeth, and all the six component parts of the mouth, or certain of them, become elongated so as to constitute a rostrum. The first group must necessarily chew or lick their food; whereas the latter suck theirs, or more properly the fluids of which it is composed seem to mount into the œsophagus of the insect by a kind of capillary attraction.

Conf Diagram p. 390!

Mandibulata

Haustellata

The distinction which exists between these classes was originally detected by Aristotle*. M. Cuvier among the moderns was the first to perceive them to be natural; but he was not then sufficiently acquainted with the subject to characterize either of them accurately, as the works of Savigny

* "Τῶν δ' ἐντόμων τά μεν ἔχοντα ὀδόντας, παμφάγα ἐςί· τά δε γλῶτταν, μόνον τοῖς ὑγροῖς τρέφεται, πάντοθεν ἐκχυλίζοντα ταύτῃ."

[W]inged in[s]ects divided [in]to 2 Classes

have since manifested. MM. Lamarck and Dumeril, together with the author of the *Entomologie Helvetique*, have also been sensible of the necessity of dividing the Winged insects into two classes, distinguished from each other by their manner of feeding. In some countries indeed entomologists have rejected this distribution, at first because it was not to be found in the *Systema Naturæ*, then because it was not well explained in the *Entomologia Systematica*, and lastly, because it is in plain terms contradicted in the *Genera Insectorum* and *Regne Animal*. It is strange that, with this respect for authorities, they should have paid so little deference to the book of nature. They deem it sufficient that in the *Regne Animal* M. Latreille should have founded his general arrangement on the texture of the wings. He has there indeed expressed himself as attaching more importance to the aërial organs of locomotion and to the texture of the body, than to the modifications undergone by those other organs upon which the very existence of the individual depends. "*Ainsi*," says Lamarck, "*les caractères si importans de la bouche ne furent nullement considérés, et cédèrent leur prééminence aux organes si variables de la locomotion dans l'air.*" The propriety, however, of this system is certainly not perceptible in its results, as exhibited in a series where we have *Scutellera* next to *Tetrix*, *Libellula* following *Coccus*, and *Melipona* immediately preceding *Papilio*. Considering that M. Lamarck had already stated the great fault of the system of Linnæus, as it regarded the Winged insects, to be the confusion of the *Insectes Broyeurs* with the *Insectes Suceurs*, such a series is the more extraordinary. It would nevertheless be the height of injustice not to acknowledge that Latreille had good reasons for adopting it, when he found that the opposite method wholly disregarded the nature of the metamorphosis. The question with him was, whether a general distribution, evidently natural, ought to be abandoned when we cannot make it in detail to coincide with the truth. He judged in the affirmative; but being fortunate enough to have taken no other guide for his opinion than nature, he has been the first to remark that he erred in his decision. M. Latreille is too justly celebrated for scientific candour, the greatest possible merit of a naturalist, not immediately to have published to the world his admission of the classes of MM. Cuvier and Lamarck, on being sensible that their accuracy is not necessarily affected by the difficulty experienced in the attempt to reconcile them with other truths. To expect that all his followers will investigate the grounds on which he has altered his opinion may perhaps be going too far; but it is perfectly allowable to hope that they will henceforward adopt this division of Insects into *Mandibulata* and *Haustellata*, now that it happens to be published in the *Nouveau Dictionnaire d'Histoire Naturelle*, art. *Entomologie*, and still more lately also in the excellent dissertation which this great naturalist intends as a preface to his proposed *Species Insectorum*.

Having little ambition to invent new names, and being very reluctant to encumber the science with them unnecessarily, I have made use of the words *Mandibulata* and *Haustellata*, which M. de Clairville first applied to these two classes comprising all the Winged insects. The Fabrician terms *Odontata* and *Rhyngota* might have answered equally well; but having had in the first case a more limited signification given to them by their author, the fear of confusion must be my apology for rejecting them.

The distinction between the *Mandibulata* and *Haustellata* is, I repeat, clearly natural, because it directly affects those habits of the animals upon which their existence immediately depends. It may, indeed, be supposed at first to be in contradiction to the acute observations of M. Savigny; yet, so far is this from being true, that, in his first *Mémoire*, he himself recommends the division of Insects into *Broyeurs* and *Suceurs*. His work in fact affords no more than a happy demonstration of that analogy which neighbouring groups generally, if not always, bear to each other.

When in the distribution of the animal kingdom into classes my efforts to detect any marked relation of analogy were foiled, I contented myself with pursuing those considerations of affinity which served to reconduct me to the point from which I had started. I never can persuade myself, however, that this scarcity of analogical relations between the classes of Zoology has resulted from any other cause than my own inability to detect them. To me their rarity argues nothing more than how much remains to be done, before the order of affinities I have pointed out can be considered as perfectly correct. It is impossible to draw any other inference than this, since in every investigation I have made by analysis, and of the accuracy of which therefore I am most sure, relations of analogy have not failed to be conspicuous. Nay more, when these could be detected, they have always supplied the most convenient testimony of the affinities with which they were connected being real, and thus have given me some reason to suspect that no affinity can be true which is not connected with a relation of analogy.

Suppose the existence of two parallel series of animals, the corresponding points of which agree in some one or two remarkable particulars of structure. Suppose also, that the general conformation of the animals in each series passes so gradually from one species to the other as to render any interruption of this transition almost imperceptible. We shall thus have two very different relations, which must have required an almost infinite degree of design before they could have been made exactly to harmonize with each other. When, therefore, two such parallel series can be shown in nature to have each their general change of form gradual, or, in other words, their relations of affinity uninterrupted by any thing known—when moreover the corresponding points in these two series agree in some one or two remarkable circumstances, there is every probability of our arrangement being correct. It is quite inconceivable that the utmost human ingenuity could make these two kinds of relation to tally with each other, had they not been so designed in the creation. Relations of analogy consist in a correspondence between certain insulated parts of the organization of two animals which differ in their general structure. These relations, however, seem to have been confounded by Lamarck, and indeed all zoologists, with those upon which orders, sections, families, and other subdivisions immediately depend. Now, such can be no other than relations of affinity, since it is clear that the affinity between two neighbouring groups must become greater instead of less, as our ideas of them become less general and more simple. Every person is, I believe, aware that it is a relation of affinity which places the dog next to the wolf, as well as the *Mammalia* near to Birds; but then it is with the same ease perceived that the affinity in one case is much stronger than that in the other.

These various considerations have led me to imagine, how truly I have not yet been able to determine, that the test of a relation of affinity is its forming part of a transition continued from one structure to another by nearly equal intervals, and that the test of a relation of analogy is barely an evident similarity in some one or two remarkable points of formation, which at first sight give a character to the animal and distinguish it from its affinities. As a relation of analogy must always depend on some marked property or point of structure, and as that of affinity which connects two groups becomes weaker and less visible as these are more general, it is not at all surprising that what is only an analogical correspondence in one or two important particulars, should often have been mistaken for a general affinity. That the effects, nevertheless, of this common mistake are by no means trifling, I shall now attempt to show in the case of the Winged insects; and I trust the reader will feel, that because my acquaintance with Zoology may not be extensive enough to enable me to detect the consequences of this error in other places, he ought not therefore to believe that in them it can have had a less baneful influence towards retarding the knowledge of the natural system.

First, It is a fact, I believe, universally acknowledged by those who have paid any attention to Hexapod insects, that a resemblance in certain important parts of their construction may be traced between the *Cimicidæ* and some of the *Orthoptera*. Nay, on account of this similarity being so striking, Linnæus even united them into one order, *Hemiptera*, to which he assigned the following characters: " *Os Rostrumque inflexum versus pectus. Alæ hemelytratæ; superioribus semicoriaceis per suturam rectam mi-*

nimè conniventibus, sed margine interiori impositis." If to this it be added that both groups undergo the same sort of metamorphosis, we shall have little occasion for conjecture to obtain the reason of M. Latreille's having followed the example of Linnæus, and continued to place them together in the *Regne Animal.* At first sight there is certainly sufficient to warrant the supposition of an affinity existing between them; but a more careful examination assures us that there is little similarity either in their organs of manducation or in their internal structure; and above all, that, on placing them together, we interrupt that very evident series of affinities which is composed of insects living by suction. This relation, therefore, which exists manifestly between a *Cimex* and a *Gryllus* is one of analogy, and not of affinity.

Secondly, In the same way many Dipterous genera, as *Musca, Sicus, Volucella, Loxocera,* &c., imitate *Hymenoptera* in certain respects, either of economy or appearance, so accurately as not unfrequently to deceive even scientific observers; and a non-descript and unique hymenopterous insect in my father's possession, is on the other hand well known as having completely adopted the disguise of some Dipterous genus without losing any one of the essential characters of *Hymenoptera.* Thirdly, There is also an evident, though perhaps not so close, analogy between Homopterous insects (as *Tettigonia*) and some *Neuroptera.* This did not escape the penetration of M. Latreille; but, as usual from confounding it with a relation of affinity, he has placed together two groups totally distinct, and by that means broken a very regular transition of affinities. Fourthly, Lyonnet, the most indefatigable of naturalists, made likewise no distinction between analogy and affinity, when, in mentioning the difficulty of assigning a place to certain insects which appeared to him to be anomalous, he said, "*le rapport qu'a la puce à certains égards avec les scarabées la feroit mettre à la fin des animaux de cet ordre.*" The *Suctoria* of Degeer are accordingly situated next to the *Coleoptera* in the *Regne Animal.* We have thus four examples of insulated points of resemblance being deemed evidences of affinity. Now, to close this list with a contrary instance of an analogy being correctly taken for an affinity, I may remark that Mr. Kirby has lately pointed out in the most satisfactory manner, the strong analogy or rather identity of plan which subsists between the manducatory organs of some *Tineidæ*, such as the genus *Aglossa*, and those of Latreille's *Plicipennes*, constituting part of the new order of *Trichoptera*. Indeed, in the cases of *Aglossa* and *Phryganea*, the larvæ of both these genera live in the water by the aid of similar organs of respiration, and conceal themselves from their enemies in tubes, which they form by the agglutination of various foreign substances. Nor do they accord with each other less in structure when arrived at their perfect state. In short, the particulars of analogy become here sufficiently numerous to compose an affinity; and at length the connexion between the *Lepidoptera* and *Trichoptera* is to such a degree manifest, that we find it impossible to do otherwise than make this the point of junction between the *Mandibulata* and *Haustellata*.

From this point then, as the foundation of our fabric, we may arrange the first mentioned four analogies or insulated resemblances, giving them the situation of corresponding ganglions in the two series of Winged insects, which differ in their manner of feeding. But no sooner can this be effected than the reader, if he be an entomologist, perceives that the animals, at these corresponding points, have the same sort of metamorphosis, and moreover that the transition from one form to the other in each series is as gradual as can be expected from our present imperfect knowledge of species. A beautiful regularity, in brief, is visible, which combines those distinctions of the parts of the mouth so much insisted on by Cuvier and Lamarck, those relations of metamorphosis which constitute the leading principle of Degeer, Olivier and Latreille, and finally, those characters drawn from the organs of locomotion upon which the orders were originally founded by Aristotle, Ray and Linnæus.

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MANDIBULATA.	*Relations of Analogy.*	HAUSTELLATA.
1. HYMENOPTERA *Linn.*	Metamorphosis incompleta vel coarctata. Larva apoda.	1. DIPTERA *Arist.*
Strepsiptera? *Kirby.*		Homaloptera *Leach.*
2. COLEOPTERA *Arist.*	Metamorphosis incompleta.	2. APTERA *Lam.*
Dermaptera *Degeer,* 3. ORTHOPTERA *Oliv.* Dictyoptera *Leach.*	Metamorphosis semicompleta.	3. HEMIPTERA *Linn.*
4. NEUROPTERA *Linn.*	Metamorphosis subsemicompleta.	4 HOMOPTERA *Degeer.*
5. TRICHOPTERA *Kirby.* Tenthredina.	Metamorphosis obtecta. Larva pedibus membranaceis. Imaginis os mandibulis abbreviatis incompletis, labio et maxillis ad basin saltem coalitis.	5. LEPIDOPTERA *Linn.*

x v. Kirby & Sp: iii p. 242 Pupa obtecta.

The first reflection to occur on the inspection of this table* will probably be, that Savigny has, in his "*Tableau des organes de la Bouche des Insectes Hexapodes Masticateurs et Suceurs comparés,*" given a proof that these relations of analogy may extend even to the organs of manducation. He has the rare merit, moreover, of using no expression which would induce us to suppose that he considered them as proofs of direct affinity, although certain authors, whose arrangement was founded on his observations have since reckoned them to be such.

Our thoughts will next be directed to the inequality which is so apparent in the contents of the orders. The order of *Diptera*, for instance, comprises an almost innumerable quantity of species, whereas those of Apterous insects are well known to be remarkably few. Yet the order of *Aptera* has been admitted as natural by every eminent entomological writer since the days of Degeer. Why then this disparity of contents in two adjoining groups? Such is truly a question well worthy of investigation, but more particularly when we know that this disparity is the strongest argument in favour of a saltus that can be adduced. I have, however, designated the great intervals which sometimes separate two such adjoining groups as chasms or hiatus, rather than as saltus; in the first place, because they never appear to proceed from the series being interrupted by any thing known; and then, because I cannot help thinking, from analogy, that if they never should be filled by living animals, they may have, at some time or other,

* The relations of analogy refer of course to the types of the corresponding orders, rather than to all their contents; and the proper name annexed to the order is that of the person who applied first the technical word, rather than of him who has the greater merit of having detected the group. Of the ten principal orders we owe four to Aristotle, one to Ray, one to Linnæus, and four to Degeer.

been occupied by species now extinct. These chasms are indeed in some cases very wide; but, on the other hand, we often see the orders passing gradually into one another, as the *Hemiptera* and *Homoptera*, the *Coleoptera, Orthoptera, Neuroptera* and *Trichoptera;* so that, where any void occurs, it is difficult not to imagine that it must result rather from the imperfection of our knowledge of created species than from any other cause whatever.

We shall now return to the *Coleoptera*, which, previously to this general dissertation on Winged insects, we left connected with the *Ametabola;* and thus we may endeavour to trace those circumstances of affinity which the column of

MANDIBULATA

evidently displays.

The *Coleoptera* are universally admitted to be connected with the *Orthoptera*, by means of the *Forficulæ*, which, though now placed by Latreille and others in the latter order, formerly with Linnæus brought up the rear of the *Coleoptera*. The mere aspect of the genus *Mantispa* is sufficient to satisfy us that the *Neuroptera* ought never to have been separated from the *Mantidæ*. And so truly is a Trichopterous insect connected with the *Neuroptera*, that it is only within the last few years that Mr. Kirby has revived the opinion of Degeer that it belongs to a distinct order. Thus far our path has been smooth; but now we have to determine to which of the other *Mandibulata* the Trichopterous insects lead. An evident hiatus is visible in this place; but we cannot do better, perhaps, than follow the example of such entomologists as Linnæus and Latreille, and pass at once to the *Tenthredines*. Hence to the *Hymenoptera* the passage is easy;

and these closing the column of *Mandibulata*, it only remains to be seen whether the series here terminates, or whether it returns back to the *Coleoptera*. Several circumstances that have occurred within my own observation, relative to the systematical arrangement of Ants, have, I confess, led me to suspect that there is an approach made by these *Hymenoptera* towards the *Coleoptera*. The absence in some ants of the wings, sting, and ocelli, all such remarkable characteristics of the *Hymenoptera*, has served to strengthen this belief. No one can doubt that a powerful alteration from the Hymenopterous type has taken place in some of these insects; and their whole shape, as well as the gradual disappearance of their ocelli, shows that this new tendency is not towards the *Tenthredines*. How the question may in the end be settled, I know not; but it is very certain that Mr. Kirby, by means of his new order of *Strepsiptera*, has opened a vast field for speculation, as to the means of connecting the *Coleoptera* with the *Hymenoptera*. The true place in nature of the singular genera *Xenos* and *Stylops* is indeed very difficult to determine; and what remarks, therefore, I am now about to offer on them ought to be received by the reader with great caution, as well because it has hitherto been out of my power to become acquainted with them, except through the medium of the works of Kirby, Latreille, Savigny and Lamarck, as because the total variance in the statements of these authors respecting them demonstrates that their true nature is, as yet, by no means ascertained.

Professor Peck and Savigny, however, have both most satisfactorily shown that the *Strepsiptera* are provided with true mandibles and palpigerous maxillæ; and therefore have completely set aside the opinion of MM. Lamarck and Latreille, as to their affinity with the *Diptera*. Proceeding then on the fact that they belong to the *Mandibulata*, which, by the by, appears at last to be admitted by Latreille, we necessarily make inquiry as to the particular part of this class in which they ought to be placed. Now, the only chasms of importance, which we have noticed in the column, are one between the *Trichoptera* of Kirby and the *Tenthredines*, and the other between the *Hymenoptera* and the *Coleoptera*. The deficiency of ocelli, the structure of the whole insect, but particularly that of the wings, prove that the *Strepsiptera* cannot occupy any vacancy near the *Trichoptera*. It therefore only remains for us to place them between the *Hymenoptera* and *Coleoptera*. But this appears to be nearly the situation originally given to the *Strepsiptera* by Mr. Kirby; for in his very remarkable paper on these insects, in the 11th volume of the Linnæan Transactions, he says, "With respect to the place of *Strepsiptera* in the system, it seems to me that this order should follow *Coleoptera*; for its metamorphosis being different from that of *Orthoptera* and *Hemiptera*, and nearer to that of the *Coleoptera*, this seems its most natural station considered as an elytrophorous order; especially since, if it be inserted between *Orthoptera* and *Hemiptera*, with both of which it has some affinity, it would interrupt the series of semicomplete metamorphosis, by which, besides other characters, those two orders are so closely united." He had previously noticed a circumstance which at once distinguishes them from all *Coleoptera* and *Orthoptera*, and gives them an affinity with the *Hymenoptera*, namely, a narrow collar instead of an ample thoracic shield. And it is worthy of remark that Rossi, in the work which first informed naturalists of their existence, placed them among the *Hymenoptera*, induced to this, as Mr. Kirby supposes, by the economy of their larvæ. Such, then, is in all probability their true place in nature, though certainly my opinion on the subject, for the reasons already stated, ought to be received, as it is advanced, with great caution. The *Xenos* beyond a doubt is, with the *Stylops*, the most puzzling insect to place naturally that we know; it is truly an "*animal animum excrucians;*" and no better proof of this can be given than that when Lamarck and Latreille make the *Strepsiptera* a division of *Diptera,* they seem absolutely to have pitched on the most artificial situation for them which they could have chosen. Latreille has remarked that the body of the *Strepsiptera* bears a striking relation to that of some *Homoptera;* and to judge from the descriptions given by Mr. Kirby of these insects, their wings are folded like those of *Orthoptera,* while the form of their head resembles that of some *Neuroptera.* To the *Diptera* they have no visible affinity, and scarcely any analogy, except such as we might expect from their proximity to the *Hymenoptera.* How far I am right in adopting Mr. Kirby's opinion as to their real affinities, remains yet to be seen; but it is no weak argument in support of its accuracy, that they possess the very precise kind of metamorphosis, which insects in the hiatus between the *Coleoptera* and *Hymenoptera* ought to have from analogy.

The *Strepsiptera* ought probably to be considered as an osculant order; and they undoubtedly form a group which is apparently of much greater importance, and is marked with much stronger characters, than the *Dictuoptera.* These can scarcely be said to afford a type of any very peculiar construction, and may therefore, perhaps, with more propriety be viewed as an annectent tribe falling into the extensive order of *Orthoptera.*

Having now obtained a general notion of the *Mandibulata*, our thoughts ought to be employed on the best method of quitting them. For this purpose we must be guided by the excellent observations of Mr. Kirby, with respect to the similarity of the organs of manducation in the *Trichoptera*, or *Mouches Papillonacées* of certain writers, and the *Lepidoptera;* those of Baron Degeer as to the correspondence between the forms of their wings, and between the internal organizations of their larvæ; and finally by those of Reaumur as to the affinity visible in the general appearance of the insects themselves. In this manner we shall enter among the

HAUSTELLATA,

or *Insectes Suceurs* of M. Cuvier. In all his various works M. Latreille assigns a place to the *Lepidoptera* immediately after Hymenopterous insects, and immediately before the *Diptera*. He has thus differed entirely from Linnæus, with whom the Lepidopterous insects are situated between his orders of *Hemiptera* and *Neuroptera*. If, however, it be asked what direct affinity the French entomologist was able to detect between a butterfly and the *Hymenoptera*, or what direct affinity, on the other hand, Linnæus could have detected between it and the *Libellulæ* (the insects which he places nearest to the *Lepidoptera*), I fear that the patience of the inquirer will be exhausted long ere he can obtain any satisfactory answer. The maxillæ indeed of certain Hymenopterous insects form a proboscis or trunk, having some similarity to that of *Lepidoptera;* but this solitary character might with equal propriety be used to connect the latter order with certain *Coleoptera*, as the genera *Nemognatha* and *Gnathium*. Upon the whole, therefore, the celebrated Swede has the advantage here over his successor in the science; for while it is impossible to connect *Melipona* with *Papilio*, or indeed any Hymenopterous insect directly with the *Lepidoptera*, it is undoubtedly true that these last have their natural situation between the Linnæan *Hemiptera* and *Neuroptera;* due regard being always paid to the manner in which these orders were originally defined. Unfortunately for Linnæus, however, the arrangement he pursues in detail does not give us the least reason to suspect that he merits any praise for this position of the *Lepidoptera*. At the period when his work was published the *Trichoptera* formed part of the *Neuroptera*, and the *Homoptera* part of the *Hemiptera;* if therefore in the *Systema Naturæ* we could find *Phryganea* the first genus of the *Neuroptera*, or *Cicada* nearly the last of the *Hemiptera*, we might conclude that Linnæus had discovered the natural affinities of these insects. But there is not even a semblance of such disposition in his work, and to all appearance it was by the merest hazard that he pitched the *Lepidoptera* on the place which they occupy in his system.

On examining the characters given in the *Regne Animal* to the Lepidopterous insects, we are informed that they present to the eye two peculiarities which belong to them exclusively. The first is, that "*les ailes sont récouvertes sur leurs deux surfaces de petites écailles colorées, semblables à une poussière farineuse et qui s'enleve à toucher;*" the second, "*une trompe à laquelle on a donné le nom de langue roulée en spirale.*" We ought to commence our investigation, therefore, by inquiring whether there are any other tetrapterous Insects among the *Haustellata*, which have their wings covered with a farinaceous powder; and if there should be any such, it is clear that they possess a peculiarity by which Latreille thought proper to distinguish the *Lepidoptera*. Yet any person the least versed in Entomology will at once put an end to this research, by replying that certain Homopterous insects correspond with the description proposed. It is true that the shape of the head, the position of the eyes, the indistinctness of the antennæ, and the presence of ocelli, all separate what may be considered the type of an Homopterous insect from the *Lepidoptera:* instead of the triangular dilated forehead, by which the true *Cicadæ* are distinguished, we require one that shall be destitute of ocelli, truncated in front and contracted at the sides; instead of the minute antennæ, we require them to be remarkably developed. It happens then that such an insect is found at Sierra Leone, and is described by Fabricius under the name of *Flata limbata*. It is indeed so singular an example of the commencement of a relation of affinity between the *Lepidoptera* and *Homoptera,* and so distinct withal from its present congeners, as to excite our surprise that so little attention should have been paid to it.

affinity betwe…
Lepidoptera
Homoptera
Diagram 3

But in truth the whole genus *Flata*, as it exists at present, bears manifestly a distant affinity to certain extreme *Lepidoptera,* which must be apparent not only from its having been connected by Linnæus and Fabricius with such trivial names as *Phalænoides,* but from the admission of Latreille himself. "*Les Fulgores dont la tête n'a point d'avancement rémarquable composent dans Fabricius divers genres. Ses Flates ont les élytres et les ailes très larges, et ressemblent à de petites phalènes, ou mieux encore à des pyrales.*" The immediate means of transition from Homopterous insects to the Lepidopterous,—in other words, the osculant order,—is exemplified probably in the genus

Aleyrodes of Latreille, the *Tinea proletella* of Linnæus, and the *Phalène culiciforme* of Geoffroy. The history of this minute insect is the subject of one of Reaumur's most interesting *Mémoires;* and when we learn that it undergoes an obtect metamorphosis, that in its pupa state it is inactive and in its adult is covered with a farinaceous powder, we are as little surprised that this great physiologist should have considered it to be Lepidopterous, as that Latreille, reasoning from its articulated rostrum, should have pronounced it to be Homopterous. We are only astonished that the latter should have adopted any arrangement, which would lead us to fancy that he believed his observations on *Aleyrodes* contradicted those of Reaumur. It is thus that these great naturalists are so often right and wrong at the same time with respect to the same animal, and that a person in search of natural affinities has generally reason to conclude himself to be perfectly correct, when he has combined all their positive observations and rejected their negative inferences.

That the *Homoptera* are directly in conjunction with the true *Hemiptera,* or *Heteroptera* of Latreille, I believe no one will be inclined to dispute. At least this affinity cannot be disputed without a distortion of some of the most evident facts in Natural History, being accompanied by an utter disregard for the authority of all entomological writers. The transition is effected through the medium of the *Notonectidæ* and other *Hydrocorisæ* of Latreille, which coincide with the Homopterous insects in the small developement of their antennæ, and conical rostrum, and with the true *Hemiptera* in their rostrum being frontal, their elytra coriaceous, and their body generally depressed. It would at present be very blameable in me to pretend to determine whether these insects come nearest to the Hemipterous or Homopterous type; but I may observe that probability is on the side of the latter supposition, since the genus *Ranatra* bears a strong analogy to the *Ephemeræ*. We perceive, however, the wings of the *Hydrocorisæ* becoming gradually more coriaceous, or rather corneous, and opaque; we perceive them crossing one another more and more, in order to make room for the enlargement of the scutellum, which, with the two ocelli and quadri-articulate rostrum, is the typical character of the true *Hemiptera*.

On account of the similarity in the structure of their mouths, but particularly in consequence of the sheath of the rostrum in both orders being articulated, Fabricius, Lamarck and Latreille have all admitted the proximity of the *Suctoria* of Degeer to the *Hemiptera*. "*En divisant*," says Latreille, "*comme l'a fait M. de Lamarck, les insectes qui subissent des métamorphoses en deux grandes coupes, ceux qui ont des mandibules et des machoires, et ceux où ces organes sont transformés en un suçoir, l'ordre de Suçeurs semble être entremédiaire entre les Hemiptères et les Diptères.*" Yet, notwithstanding the justice of this remark, notwithstanding that M. Latreille mentions this affinity of the common flea to the *Hemiptera* in all his works, it is very singular that in his arrangement he never acts wholly upon its truth, and in the *Regne Animal* even totally disregards it. This inconsistency without doubt arises from his not having been able to make his observation accord with his system; and unfortunately, rather than disturb this, he is often apt to overlook the advantages to be derived from his discovery of an affinity. Nothing, however, stamps such a value on his works as the candour with which he always, on its detection, mentions an affinity at the moment even when it directly contradicts the accuracy of his distribution.

In the *Genera Insectorum* M. Latreille reckons that the *Suctoria* of Degeer, as the last order of the Hexapod insects, immediately follow the *Diptera*, and even in the *Regne Animal* he allows this to be their natural place. In good truth, however, this is to be accounted only half the situation which the order ought to possess. Fabricius was more bold and less correct; for he placed the genus *Pulex*, not even at the end of the *Systema Rhyngotorum*, but between *Zelus* and *Aphis*, with which last it certainly has some remote affinity. But it is to M. Lamarck, who united these opinions of Fabricius and Latreille, that we are indebted for the knowledge of its true place in the scale of creation, and therefore the very least return we can make is to adopt his name *Aptera* for the order. I am the more disposed to insist on this point of nomenclature, because it is a classical denomination, which, owing to the later improvements in the science, would otherwise be lost. But it must not be understood that every insect which belongs to the group is therefore of necessity Apterous; this is perhaps no more true than if, in adopting Degeer's word, we should therefore conclude that the order contains every insect which lives by suction.

The *Aptera* contain undoubtedly the type of a very distinct order; for they are the only animals in the class of *Haustellata* which have a bivalve articulated sheath to their rostrum. "*La puce*," according to Lamarck, "*tient beaucoup aux Diptères par la métamorphose**, *car sa larve*

* Leeuwenhoeck claimed and has acquired all the honour of this discovery; but in fact it was half known in the days of Aristotle, who observed not only that the *Pulices* had distinct sexes, but that they produced σκώληκες ᾠοειδεῖς. From not following the metamorphosis further, he fancied this

est apode, et sa nymphe inactive est renfermée dans une coque; mais son bec en forme de trompe est éminemment articulé, et rien de semblable ne se montre dans les Diptères." The structure of the *Aptera*, in short, conducts us from the *Hemiptera* to the *Homaloptera*, which comprise such Dipterous insects as have the sheath of their rostrum in like manner bivalve, but without articulations.

The Dipterous insects are by Latreille connected with the *Lepidoptera;* and against the opinion of those who may doubt the truth of this affinity he can always appeal to certain *Diptera*, as the *Psychoda phalænoides*, forming the genus *Tinearia* of Schellenberg, or to certain *Lepidoptera*, such as the *Pterophori* Latr. which are named *Phalènes-tipules* by Degeer. Unless therefore these observations are so many idle fancies which have deceived some of the most acute of naturalists; and unless it be conceivable that these various idle fancies occurring to different persons, can have fortuitously combined into a regular order of affinity corresponding analogically with the adjoining group of *Mandibulata* ; unless, I repeat, we can arrive at such conclusions, there is no other resource left than to allow the series of *Haustellata* to be natural; and one, moreover, which in pursuance of a design returns into itself.

[illegible] Diagram 390

In all this I have scarcely touched on the metamorphosis, because I am sure that the foregoing table, showing the analogical relations that exist between insects provided with a rostrum and those furnished with mandibles, will more forcibly express to entomologists the regularity

progeny, however, to be something *sui generis* and imperfect, the parent being generated spontaneously in the earth. It is always either at the egg or pupa state that Aristotle loses sight of the metamorphosis, and in absence of experiment has recourse to his fancy.

of the transition which here takes place, than any other argument in my power to advance. Nay, if a person should object to the foregoing detail of affinities, it would in my opinion be perfectly allowable to refer him to the attendant analogies, as amounting to a demonstration of its general accuracy.

There are certain Dipterous insects, however, which before we quit the *Haustellata* deserve a few moments of particular attention. It is easily seen that allusion is now made to the *Pupipara* of Latreille, or *Mouches-araignées* of Reaumur and other French naturalists. The structure of their mouth and organs of locomotion, the nature of their metamorphosis, the texture of their body, but particularly the gradual manner in which the head becomes united to the thorax, and at length almost forms one piece with it, all distinguish these animals from the ordinary type of *Diptera*, and have lately occasioned their being formed into the osculant order of *Homaloptera*. Analogy seems to indicate that they ought to occupy that situation among the *Haustellata* which, to all appearance, the *Strepsiptera* occupy in the circle of Insects provided with mandibles. The safest way therefore, in the present state of our knowledge, will be to account it an auxiliary or osculant order like the other. The singular genus *Nycteribia*, or *Pthiridion* of Hermann, well known as infesting bats, closes the series of Pupiparous insects, and must satisfy every person that we are arrived among the

ARACHNIDA,

of which Leon Dufour has just said that the history is scarcely yet sketched, while our knowledge even of their species is extremely imperfect, notwithstanding the labours of Lister, Homberg, Clerck, Degeer, Olivier, Walkenäer, and Latreille. On entering this class we find animals still parasitical and still hexapod, even when the type of the *Acaridea,* as well as of the other Arachnide orders, is undoubtedly octapod. In the genus *Siro* we are led by an easy transition from the Mites to the *Phalangidea,* hence by *Galeodes* to the *Scorpionidea* and *Araneidea.* From these last we may possibly be able to return to the *Acaridea* by means of genera like *Trombidion.* This is a series of affinities, all of which, excepting the last, have been noticed by the modern French entomologists; so that for the present I shall refer to their works for the proofs requisite to substantiate the accuracy of the progression. As to the manner in which the series is here divided, it must on the other hand be considered as barely an approximation to the truth; so that, having thus chalked out a mere outline of the distribution of the *Arachnida,* I may be permitted hereafter to correct it in proportion as its inaccuracies shall be detected. It may, however, with more confidence be stated that the *Arachnida* are connected with the *Crustacea,* by means of the *Pycnogonida,* because the observation and the consent of all the first entomologists of the present day unite in confirming this affinity.

The *Arachnida* differ from *Crustacea* in having their respiratory organs always internal, and opening on the sides of the abdomen and thorax to receive the air. These lateral apertures are common to them with Insects, and are known to physiologists by the appellation of Stigmata. When these stigmata communicate with pulmonary pouches, there is a circulation effected by means of a dorsal and muscular heart, from which two great vessels pro-

Stigmata

ceed and communicate with every respiratory cavity, ramifying over its membrane. When the stigmata, on the contrary, are tracheal, there is no circulation; but in its place we have alternate contractions of a dorsal vessel, which, from its not throwing off any branch whatever, appears to deserve the name of heart no further than as it occupies a situation in these animals, which corresponds to that of the heart in Pulmonary *Arachnida*. Nevertheless the *Arachnida*, whether breathing by pulmonary pouches or by tracheæ, form but one class, as we perceive from the union of their head and thorax into one piece, and from the concentration of their viscera into the abdominal portion of the body. It is needless to repeat in this place the arguments that have been already adduced to show, that the division of the organs of respiration and circulation is not to be depended on in the classical arrangement of the *Annulosa*. If these arguments should not have been deemed satisfactory, perhaps the opinion of M. Lamarck on the subject may influence the reader to believe, that their only weakness has consisted in my manner of enforcing them. "*Lorsqu'il y a de grandes analogies d'ensemble, les diverses particularités d'organization que l'on observe quelquefois ne permettent cependant pas de séparer classiquement les objets qui les offrent. Qu'y a-t-il, en effet, de plus voisin des araignées que les faucheurs, les galéodes, &c.! Cependant les premières respirent par des poches évidemment branchiales, tandis les autres ne respirent que par des trachées.*" The tracheæ, however, of the *Arachnida*, when they exist, differ from those of Insects in being disposed in a solitary ramifying series, which may almost be termed radiated; on the other hand,

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Insects, under which denomination I include the *Ametabola*, are well known to have their tracheæ disposed in a double longitudinal series.

Linnæus does not appear to have allowed the existence of antennæ in Spiders or Scorpions, although he assigns this name to certain organs in *Nymphon*, *Phalangium* and *Chelifer**, which evidently correspond with those organs in Spiders, which he terms their Palpi. The separation of the class of *Arachnida* from other Annulose animals originated with Lamarck, who nevertheless made it comprehend the *Ametabola* under the name of *Arachnides antennées*, as well as the true *Arachnida*, which, adopting the opinion of Degeer, he entitled "*Arachnides exantennées*." M. Latreille in the *Genera Insectorum* made these latter the third legion of his *Insecta*, under the name of *Acera*, and at last, in the third volume of the *Regne Animal*, comprised them all in a class entitled *Arachnides*, which he says "*se distingue au premier coup d'œil des deux classes voisines, les Crustacés et les Insectes, parcequ'elle n'a point d'antennes*." Still more recently however, in a very singular *Mémoire* presented by him to the Institute, he has advanced several curious speculations on the external organization of Winged Insects, as compared with that of the *Arachnida* and *Crustacea*. Among these theoretical novelties we find that he now considers the old opinion of Lamarck, to wit, that the *Arachnida* are destitute of antennæ, to be an error which he acknowledges to have himself propagated from not having sufficiently examined the subject. He observes that the mandibles, maxillæ and maxillary palpi, or the organs which correspond to these

* This genus, or rather *Obisium*, is so well described by Aristotle, under the epithet of *Scorpodes*, that I think he has the right of priority to the name.

in *Crustacea*, exercise a function so secondary, that after gradually becoming modified in those genera, such as *Cyamus*, which come near to the *Arachnida*, and after almost even disappearing, as in the genus *Phyllosoma*, they may be considered as being altogether null in the *Araignées palpistes* of Lamarck. Nevertheless my readers, whom I suppose all to be entomologists, need scarcely to be informed that the last mentioned animals possess organs which are commonly termed mandibles, organs which Linnæus, in the Spider, named "*ungues seu retinacula*," and which in the Scorpion he regarded as "*Palpi chelæformes*." Now, it will be asked What organs among the *Crustacea* do these two mandibles, ungues, or cheliform palpi of the *Arachnida* represent? Savigny was of opinion that they took the place of the second pair of pedipalpi; but Latreille answers the question in quite a different manner. He refers to the changes which the two intermediate antennæ of the *Branchiopoda* undergo, and finds a resemblance even between these organs in the brachyurous decapod *Crustacea*, and the mandibles of *Phalangium*. He further observes that these organs in both the tribes,—that is, the internal antennæ of *Crustacea* and the mandibles of *Arachnida*,—have a similar situation, namely, above the labrum and entrance of the œsophagus, together with a similar mode of insertion, being parallel at their base, and only taking an oblique or curved direction at their extremities;—whereas, on the other hand, all true pedipalpi are situated below the labrum, and are inserted immediately above the breast.

M. Latreille then adopts the remark of Lister, that all Annulose animals have a distinct head, and that the head of Spiders and Scorpions is that part of the thorax which contains the eyes, together with these cheliform or unguiform antennæ, and which is generally distinguished from the true thorax by an angular impression, the point of which faces the abdomen. There is, it is true, only one method of setting this matter completely at rest, which is, to ascertain whether it be really with nerves answering to the antennal nerves of *Crustacea* that those organs, commonly called the mandibles of the *Arachnida*, are supplied: but in the mean time I confess that I am much inclined to adopt M. Latreille's theory, because it reconciles many circumstances which had hitherto appeared to me anomalous. To give only one example: M. Savigny considered that the *Pycnogonida* connected the *Arachnida* with *Cyamus*, but thought it evident that *Nymphon* has lost not only the compound eyes and masticatory organs of *Cyamus*, but also the antennæ. He thus makes the two pairs of organs, which proceed from the head of *Nymphon grossipes*, to be the first and second pairs of true feet in Amphipod *Crustacea*; or, in other words, he accounts the first and second pairs of feet in a *Squilla*,—that is, according to his theory, the second and third pairs of feet in an Insect,—to be nothing else analogically than the mandibles and maxillæ of a Spider! There is little enough of rule in this, it may be said; but there will appear still less, when we find that in other *Pycnogonida* the pair of feet which is most apt to disappear is not, as might have been expected, the first, but the second. Hence, proceeding on this theory, we find the principal appendages of the body of a Crab to be disposed in a male *Phoxicholus*, as follows:

1. *Antennæ, mandibles and maxillæ,* none.

2. *Second maxillæ and first pair of maxillary feet,* a vestige.

3. *Second pair of maxillary feet,* present.
4. *Third pair** *of maxillary feet,* none.
5. *First pair of true feet,* none.
6. *Second pair of true feet,* present, &c.

This irregular appearance and disappearance of organs, so contrary to the very object of M. Savigny's excellent work, is, however, entirely removed by M. Latreille's hypothesis, as is likewise the violence done by M. Savigny's theory to that uniform principle of nature, which places the eyes constantly in the head of an animal. Those who have well weighed the admirable *Mémoire sur les Animaux sans Vertèbres,* which first called the attention of naturalists to these anatomical analogies, know that the author's theory, with respect to the *Pycnogonida,* would place their eyes in the thorax, or at least in that segment of their body which corresponds with the thorax of insects. Now, only suppose, with M. Latreille, that what Savigny accounts to be the first ring of the body is nothing else than the manducatory organs soldered together, or a prolongation of the pharyngean region, and that the mandibles and palpi represent the four antennæ of the *Crustacea,* and the above anomalies will in a great measure disappear. Even although the four antennæ may become all null in *Pycnogonum,* we may perceive that those which seem the most readily annihilated are the lateral pair, as in *Phoxicholus.* Thus the only locomotive organs which we may regard as totally lost in the *Pycnogonida,* are such as may be reckoned immediately connected with the system of manducation

* Dr. Leach has confined the name of *Pedipalpi* to this pair of maxillary feet. I have thought it best, however, until we know more of the structure of the mouth in the *Apiropodes* of M. Savigny, to term this, with the two preceding pairs, *pedipalpi,* or *maxillary feet,* discriminating them merely by their place. By this mode of proceeding their true nature remains *adhuc sub judice.*

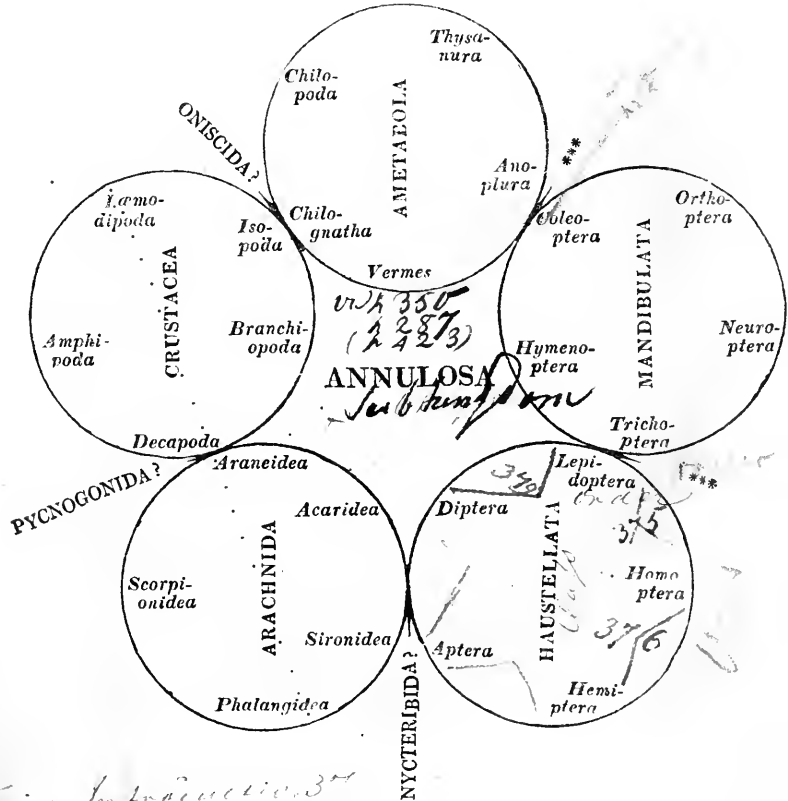
among the *Crustacea,* and which are replaced in the true *Arachnida* by organs of a totally different construction.

But, granting this doctrine of M. Latreille to be agreeable to nature, it may next be urged that the greatest argument for the necessity of distinguishing the *Parasita* or *Anoplura* of Dr. Leach from the *Arachnides trachéennes* of Latreille is thus done away with, since both possess a pair of antennæ. Nay, M. Latreille seems to have himself judged that it ought to have this consequence; for in his last general distribution of the *Annulosa,* published in the *Annales du Muséum,* he places the parasitical *Ametabola* in the class of *Arachnida* under the name of *Arachnides pédiculaires.* Some persons, however, may be disposed to think that in doing this he too hastily abandons his old arrangement, which the new theory, once admitted, instead of weakening will serve to establish beyond a doubt. Thus it has not escaped him that the two antennæ of his *Arachnides pédiculaires* represent the lateral pair of antennæ in *Crustacea:* now, these are the two which remain in the *Onisci,* but absolutely become null in the true *Arachnida.* So that, in following the changes which the antennæ undergo in the Annulose animals, a most beautiful regularity presents itself to the view. A Decapod Crustaceous animal has, for instance, four antennæ, the middle pair of which disappears in *Oniscus;* from which circumstance, in the circles of *Ametabola* and Hexapod insects we have only one pair of antennæ, which answers to the lateral pair of *Crustacea,* and finally disappears in *Nycteribia.* If again, on the other side, we quit the *Crustacea,* by means of the *Pycnogonida,* it is the external or lateral pair which is most ready to disappear; and among the *Arachnida* we discover only the intermediate pair, until this also disappears about the confines of this group and Winged insects. In this manner M. Latreille's doctrine becomes an argument for proving the *Crustacea* to be naturally interposed between the *Arachnida* and Parasitical insects, which indeed are only connected by that property which the opposite points of a group always possess of approaching to each other.

The true *Arachnida* have no lateral antennæ, but only a pair answering to the intermediate pair of these organs in *Crustacea*, and which in the former animals is always connected with manducation. Their head is always in some degree confounded with the thorax; the stigmata occupy only a part of the body, and even in those species which breathe by means of tracheæ communicate with a simple tracheal cord, which, from its ramifications, may almost be termed radiated. The Parasitical insects, on the other hand, have no intermediate antennæ, but only a pair which represents the lateral pair in *Crustacea*, and which in these animals is never used for purposes of manducation. The head is always distinct from the body; and the stigmata, which are disposed over almost the whole length of each side, communicate with a bifurcated tracheal system.

Having now described, as briefly as I conveniently could, the natural connexion of those orders into which the *Annulosa* are resolvable, it may not be improper to give a summary view of the affinities as they may be expressed by a table. In this table, however, the distribution of the *Crustacea* and *Arachnida* is presented to the reader with much diffidence of its accuracy, and that chiefly on the following account.

If we establish a chain of organic gradation solely upon the relations of affinity as above detailed, so that the circles of *Crustacea* and *Arachnida* shall touch at the points *Læmodipoda* and *Phalangidea*, with the mere intervention of the *Pycnogonida* as an osculant class, then it will be perceived that the analogies which the two classes, possessing a distinct circulation, bear to the contiguous circles having no circulation, are reversed in order. If, on the contrary, we pay attention, as in the subjoined table, to the relations of analogy as well as of affinity, we have the analogies between contiguous circles always observed in their proper order; but then the *Araneidea* and *Decapoda* will be found near the osculant point of the classes of *Arachnida* and *Crustacea*, while *Cyamus* and *Phalangium*, which I perfectly agree with M. Savigny in thinking connected together by *Pycnogonum*, are at the opposite although analogous points of their respective circles. The only method by which at present I can explain this remarkable circumstance, is by the affinity which opposite points of a circle always bear to each other. As *Phalangium* approaches near to *Aranea*, and female *Læmodipoda* in some measure to *Decapoda*, the reader will perceive how the *Pycnogonida* may form a point of union for the four groups; in other words, may be the centre of that affinity which exists between an *Aranea*, *Phalangium*, *Cyamus* and *Pagurus*. Although I am unable to come to any final determination on this curious and (if it may be judged by the trouble it has given me) even abstruse point, yet I request the attention of entomologists to the fact that one of the most singular characteristics of the *Pycnogonida* is their possession of only one segment to the abdomen; in which they wholly differ from *Phalangium*, but agree with *Aranea* and *Pagurus*. Nay, there is a nondescript genus of Spiders from India, of which the abdomen is as minute, in proportion to the other parts of the body, as in *Pycnogonum;* so minute indeed as to have occasioned one of these *Arachnida* to be mistaken by a naturalist for a Coleopterous insect, of which the head and elytra were represented by the abdomen and antennæ of the Spider! But before we proceed deeper into the discussion of analogies, the annexed table of affinities ought to be examined with care.



One of the first properties of this compend of affinities which will excite attention is, that the *Annulosa* appear therein to be naturally divided into two great groups; one composed of three circles distinguished by a tendency to metamorphosis and a bifurcated tracheal system of respiration, the other of two circles characterized by the possession of internal antennæ and a tendency to a system of circulation. The only animals indeed of these last groups, which are subject to any remarkable change in the primitive and essential form of their body, are a few Branchiopod *Crustacea*; that is, the opposite points of the circle of *Annulosa* correspond intimately with each other. It is not a little singular that this correspondence, or perhaps more properly this affinity, which exists between the *Branchiopoda* and the Hexapod Insects should be founded on the nature of their metamorphosis. Some credit is due to Müller if he ever had this connexion in view, and it is probable that he really had, from his having bestowed on these *Crustacea* the appropriate appellation of *Entomostraca* or *Testaceous Insects*. Even if he meant no more by the word than that they are articulated testaceous animals, it is well known that their disposition to metamorphosis, so contrary to the usual habit of the *Crustacea*, did not escape him.

I have already made an attempt to draw the attention of naturalists to the relations of analogy existing between corresponding points of the two contiguous circles which pass through a perfect change of form; and now I shall content myself with indicating, by position, those analogies which apparently hold good between the corresponding points of all the five groups of *Annulosa*. While, however, at this part of my subject, I must express regret at knowing comparatively so little of the *Crustacea* and

Arachnida; convinced, as I am, that it is my duty to warn the inexperienced reader of the circumstance before he enters on the study of the following columns.

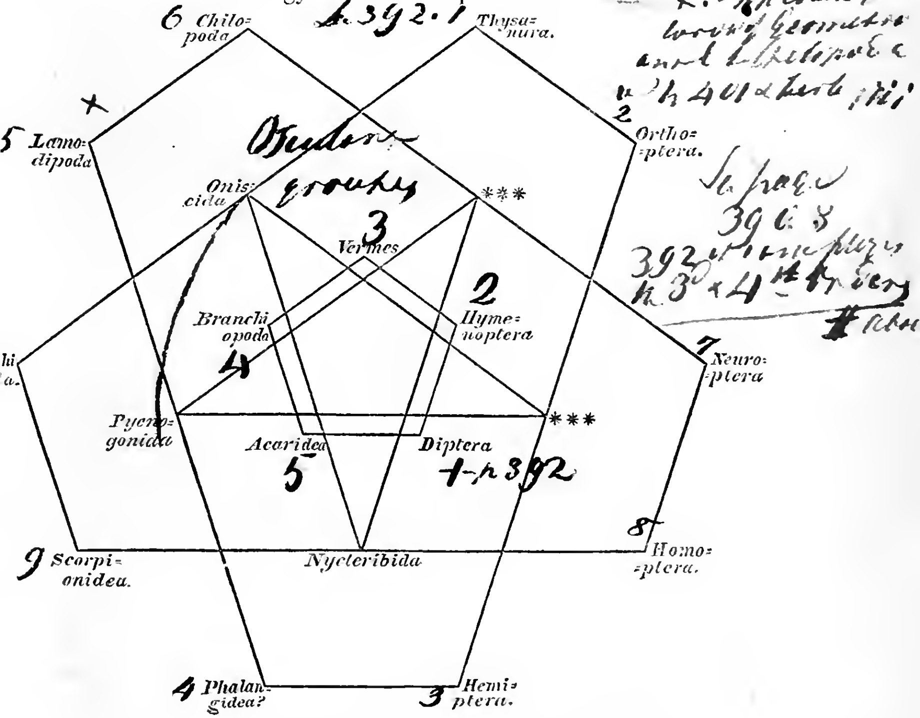
1.	2.	3.	4.	5.
HAUSTELLATA.	MANDIBULATA.	AMETABOLA.	CRUSTACEA.	ARACHNIDA.
1. Diptera	Hymenoptera	Vermes	Branchiopoda	Acaridea
2. Aptera	Coleoptera	Anoplura	Decapoda	Araneidea
3. Hemiptera	Orthoptera	Thysanura	Amphipoda	Scorpionidea
4. Homoptera	Neuroptera	Chilopoda	Læmodipoda	Phalangidea
5. Lepidoptera	Trichoptera	Chilognatha	Isopoda	Sironidea?

Of these five columns I consider the three first to be distributed not very inaccurately, and to deserve much more confidence than the fourth and fifth. Unfortunately, from not having studied the affinities of these last with the care required by analysis, I have been unable to detect the principle upon which their analogies are graduated. There are naturalists, I well know, who will object to the supposition that these are graduated on any other scale than that which we are certain of, such as the external appearance. But as, independently of their form, the analogical characters of the groups of *Mandibulata* and *Haustellata* are founded on the variation of metamorphosis; so there is reason to believe that some principle of analogy, unconnected with their general appearance, may hereafter be found to exist between every other two contiguous columns. Sure enough it is, that, with respect to external form, these analogies are remarkably conspicuous, and as usual have been mistaken for affinities. Thus it was that Linnæus, Müller, and others, came to confound the *Calygi* with true *Epizoaria;* and that Latreille says of his *Branchiopoda,* "*Plusieurs de ces animaux sont de véritables suceurs, et se rapprochent à cet égard des Arachnides,*" such as the *Acaridæ* for instance. Nay, if this train of reflection on the nature of relations of analogy be pursued, we also perceive why Pallas was induced to give the trivial name of *Scolopendroides* to a species of *Caprella*,—why the *Amphipoda* have been characterized by the setaceous appendages of their abdomen,—why these *Crustacea* leap,—why the genus *Thalassina* imitates the form of a Scorpion,—why naturalists, conversant with this branch of Natural History, have, since the days of Aristotle, all compared the genus *Pagurus* to Spiders,—why some species of the genus *Epeira* resemble Decapod *Crustacea* so much as from them to have borrowed their name. These, and a thousand similar cases, are all relations of analogy, which may be explained by the bare inspection of the above columns.

But it will be said that the *Arachnida* and *Haustellata* are according to the table of affinity contiguous circles, and yet the corresponding points in the columns do not coincide analogically. This struck me at first, I confess, as something unaccountable; but a very little attention to the subject served to show that it could not be otherwise, as these columns only represent half the course of the analogies which appear on the inspection of the preceding table of affinities. By a reference to that table, the entomologist will perceive that the corresponding points of these contiguous circles have an analogy, which, I doubt not, would be even more conspicuous if the groups of *Arachnida* were only more accurately defined. Even assuming their accuracy as they have been described in the foregoing pages, surely we may consider the faculty of spinning, which is common both to Spiders and Lepidopterous larvæ, to be one of analogy. Surely the *Nepa* or *Ranatra*, with its cheliform anterior feet, its caudal appendage, its habit of carrying its progeny on its back, deserves the title of *Water Scorpion*, which it has acquired in almost every European language.

We may add that an analogy of form and manners is visible also between the *Phalangidea* and the larvæ of *Hemiptera*, between the *Acari* and the parasitical larvæ of the corresponding group of *Haustellata*.

But granting that the analogical relations between these two classes are not so visible as those which exist between the *Arachnida* and *Crustacea*, (although the above examples, in my opinion, amount to a perfect demonstration of their having a real existence,) it is to be observed, that relations of analogy are sometimes disguised in such a manner that they are only to be remarked by the ordinary observer when pointed out to his notice. In the eyes of any person at first sight, few groups can be more dissimilar than the *Ametabola* and *Mandibulata*; yet they are contiguous, and therefore ought, according to what has been said, to have relations of analogy between their corresponding types. Now, if such can be pointed out as existing under a disguise, and as being particularly curious when unmasked, it is perhaps a fair inference to suppose that two contiguous circles, like those of *Haustellata* and *Arachnida*, which differ as much or even more than the former two in general structure, may likewise have these analogies depending upon some secret of Nature. It is obvious that the analogies will thus be rendered less liable to detection than those which depend on the external appearance simply. Another argument in favour of this conjecture is, that in both cases we are leaving insects which undergo a perfect metamorphosis for those which are subject to an imperfect one, or which only shed their external envelope. But we must leave inferences for facts; and, in the first place, have to explain why the above-mentioned analogies of external appearance, between the corresponding groups of *Arachnida* and *Haustellata*, are not distinguishable in the columns as above disposed. For this purpose I shall lay before the reader a table, expressing all the analogies which have been now given in detail, premising only that it is carefully to be kept separate from any notion of the progression of affinity, such as is expressed by the other figure. It results, however, as may easily be discerned, merely from the corresponding points in those five circles being joined together*, every line expressing the existence of an analogy between the points it connects.



* Nothing in Natural History is, perhaps, more curious than that these analogies should be represented by a figure so strictly geometrical. One is almost tempted to believe that the science of the variation of animal structures may, in the end, come within the province of the mathematician.

Now, if the line of analogy, beginning at the *Orthoptera* for instance, and setting out for its corresponding group of *Thysanura*, be followed, when the five circles have been traversed analogically we arrive at the *Homoptera*, and not at the *Hemiptera*, which order is only attained after the circles have been twice analogically traversed. This may serve to explain a circumstance to which I may hereafter have occasion to allude, namely, that an external order* seems always to have an analogy to the two external orders in the contiguous circle, but with this difference, that to the one it is direct and very conspicuous, while to the other it is indirect and barely visible. An example will best explain what is meant. The *Orthoptera* bear a relation of analogy to both the orders of *Hemiptera* and *Homoptera*, but to the former it is much more conspicuous than to the latter. The same appears to hold good with all the other external orders.

To follow up these speculations at present would be losing sight of the principal object which it was originally our purpose to keep in view. It need only, therefore, be stated, that when we shall have once attained a knowledge of the accurate series of affinity, the study of relations of analogy seems calculated to throw light on almost every general and specific notion, that may have been or can be entertained on the nature of these animals. To those who may have a taste for this investigation it must, for the present, be left, while our attention shall be more closely con-

* By an *external* order is meant any one situated in the greater segment of a circle of affinity, when divided by a line joining its osculant points. There are ten such, viz. *Orthoptera*, *Neuroptera*, *Homoptera*, *Hemiptera*, *Phalangidea*, *Scorpionidea?* *Amphipoda?* *Læmodipoda?* *Chilopoda* and *Thysanura*. We may name the five orders, *Vermes*, *Hymenoptera*, *Diptera*, *Acaridea*, and *Branchiopoda*, *internal*, and the ten remaining *inosculant*, from their communicating with osculant groups.

fined to the Insects breathing by tracheæ, and to the analogies which they in particular may display.

It has been already hinted that a very beautiful analogy, although disguised, reigns between the corresponding columns of *Ametabola* and *Mandibulata*. To prove that there was ground for the assertion will now be my aim. The subjoined columns represent part of the preceding table of affinities.

Branchiopoda	Vermes	Larvæ of Hymenoptera
Isopoda	Chilognatha	Larvæ of Trichoptera
Læmodipoda	Chilopoda	Larvæ of Neuroptera
Amphipoda	Thysanura	Larvæ of Orthoptera
Decapoda	Anoplura	Larvæ of Coleoptera.

There is so strong an affinity in general structure between *Ricinus* and certain *Coleoptera*, that it has disposed me to believe that the circles of *Ametabola* and *Mandibulata* must here meet; a further proof of which may be, that the larvæ of *Coleoptera*, as being the nearest to the *Ametabola*, do not imitate any one group in particular, but the whole five, in precisely the same order in which they occur in their own circle. But if there should be any doubt on the subject, I am sure that the perusal of the 26th and 27th pages of Savigny's first *Mémoire* must remove it entirely. When the reader has well weighed the comparison therein made and the nature of relations of analogy, he will perceive that these two pages support not only the affinity of the *Coleoptera* to *Ricinus*, but many also of my other observations. The Hexapod larvæ of *Orthoptera*, with the setiform appendages to their tail, meet with their prototypes among the *Thysanura*; the flat carnivorous larvæ of Neuropterous Insects, furnished as they are with suctorious mandibles, bear an obvious analogy to the *Chilopoda;* the form of an *Iulus* is easily discoverable in the cylindrical eruciform larvæ of the *Trichoptera,* while the apod larvæ of the *Hymenoptera* are described by the first zoologists as resembling an intestinal worm in form as well as manners*. I shall leave the analogy between the *Coleoptera* and *Ametabola* to be discussed in a future chapter; only stating, for the present, that so far from the other analogies being fanciful, it can be proved by citations from the works of the best entomologists that they have been severally noted by them, although without any view to arrangement, or indeed any object beyond the mere mention of the fact. Compare Lamarck's descriptions of the genera *Blatta* and *Lepisma,* and it will be seen in how few circumstances some *Thysanura* differ from the larvæ of the first mentioned genus. I mean few circumstances according to the description, for there is enough of dissimilarity evident to show that the relation between them is only one of analogy. Let any one read Latreille's description of the larva of an *Hemerobius* or *Raphidia,* and, except that it is hexapod, he may easily believe that a *Scolopendra* is meant. Nay, the greatest part of the aquatic larvæ of *Neuroptera* have false feet or branchiæ, which complete their Scolopendriform appearance. The similarity between an *Iulus* and the larva of a *Tenthredo* is carried even to such a pitch, that the number

* M. de Humboldt's Anatomical Account of the worm *Porocephalus Crotali,* which he discovered adhering to the œsophagus and pulmonary sac of a South American Rattlesnake, affords us an interesting example of the relation of analogy between intestinal worms and the larvæ of the internal orders of insects. Nothing is more remarkable in the metamorphosis of these last, than their propensity, when larvæ, to secrete fat for the absorption and nutrition of the insect during the period when it is unable to eat. Now, M. de Humboldt says of the abovementioned intestinal worm, "*Tout le corps de l'animal à l'exception de deux extremités est rempli de fils vermiformes d'un blanc laiteux, qui paraissent avoir de l'analogie avec les lambeaux graisseux* (epiploons) *qui flottent dans l'intérieur des larves des insectes, et surtout avec les ovaires pelotonnés des Ascarides.*"

of feet shall be here increased above the usual number in a Winged insect; in which case we must bear in mind a maxim of the *Philosophia Entomologica*, "*Ubi plures quam sex pedes adsunt, anteriores sive pectorales tantum veri pedes, reliqui omnes spurii et mutici.*" Finally, M. Latreille, in describing the *Hymenoptera*, says "*Leurs larves ressemblent à un ver, et sont dépourvus de pattes.*"

But if the entomological reader can divest himself of the notion of absolute divisions, and if he will recollect the great difference there is between a tendency towards any construction and the actually attaining it, I would recommend, in preference to being guided implicitly by such examples, his studying the figures and descriptions of larvæ given in the works of Reaumur and Degeer, and then judging for himself.

Relations of analogy, however, are not rigorously confined to contiguous circles, but may sometimes be carried on to the corresponding points of others widely distant. Thus, on referring to the table of analogies, a comparison may be instituted between the larvæ of the *Mandibulata* and the corresponding orders of *Crustacea*, though we must expect that the force of the resemblance should be here much weakened by the intervening distance. Nevertheless, between the *Amphipoda* and the larvæ of *Orthoptera* it is particularly striking; for, if we take no account of the leaping *Talitrus Locusta*, which bears such a general resemblance to the *Gryllidæ*, we have the larvæ of *Mantes* and even of *Phyllia* represented most closely by some of these *Crustacea*. Such forms being far from distinct among the *Ametabola*, it would appear that Nature was resolved that they should not be lost, but be reproduced in the next circle and in their proper analogical place. Thus, M. Latreille, in describing the genus *Phyllosoma,* which was one of the results of the unfortunate Congo expedition, expresses himself in the following words: "*On a donné à une Squille de la Mediterranée, genre de la même famille que la précédente, le nom de Mante, parceque ce crustacé a quant à la forme de ses serres des rapports avec les Orthoptères qui ont reçu cette dernière dénomination. Il semble que la Nature ait voulu, à l'égard des Phyllosomes, étendre ce parallèle, et réproduire le type de forme qu'elle a adoptée pour d'autres Orthoptères rangés avec les Mantes par Linnæus, et qui composent aujourd'hui le genre Phyllie.*"

Turning also to the other side of the insects furnished with mandibles, we may distinguish those relations of analogy, which have an existence between the corresponding ganglions of *Mandibulata* and *Ametabola,* to be still visible between these last and the corresponding groups of *Haustellata.* Thus says Degeer, in describing the larvæ of the Latreillian genera *Erycina* and *Polyommatus,* "*Celles sont les Chenilles-Cloportes, ainsi nommées parcequ'elles ressemblent en quelque manière aux Cloportes, ayant le corps très applati, mais large, et portant ordinairement la tête cachée sous le premier anneau du corps: elles marchent aussi très lentement en glissant pour ainsi dire sur le plan de position.*" And if Lepidopterous larvæ sometimes thus imitate the more eccentric forms of the corresponding order of *Chilognatha,* every one knows that their ordinary shape is that of an *Iulus.* Nay, the rule of analogy between corresponding groups is so strictly observed, that we may even trace vestiges of it all the way from the *Lepidoptera* to the analogous point of the *Crustacea,* although they become at last very vague. No animals, for instance, are so singular in appearance as the geometrical larvæ of the *Phalænidæ**; and the only place where we shall again meet with this mode of progression among the *Annulosa* is at the corresponding point of the *Crustacea*, that is, between the types of the *Læmodipoda* and *Isopoda*, as the geometrical Caterpillars occur between the types of the *Lepidoptera* and *Homoptera*. !! v. p. 395

A natural series of affinity is such as, taking the majority of characters for our guide, shall be found uninterrupted by any thing known, although possibly broken by chasms occasioned by the absence of things unknown. Thus the series of the *Systema Naturæ* and of the *Regne Animal* is not natural when the *Cetacea* intervene between the *Mammalia* and Birds, but is perfectly consonant with Nature when the Tortoises are made immediately to follow these last. In the first case there is an intervention disagreeable to the eye and contrary to the opinion of the naturalist, as well as of the ordinary observer; in the other there is only a chasm which the discoveries of a future day may fully occupy. I rest therefore the general accuracy of the above arrangement of the *Annulosa* much less on the presence of every link in the chain of affinity, than on this being uninterrupted by any thing known, while it beautifully coincides with relations of analogy. Still it is but a shadow, a pitiably faint shadow of the truth. "*Animadverti immensum opus Dei non possè hominem assequi quamvis laboriosè quærat.*" And as it is an advantage to a person aware of his fault to be the first to acknowledge it, I shall now show wherein I consider the above observations to be most imperfect.

* Aristotle describes their motion well: "Γίνονται δὲ καὶ τὰ πτηνία καὶ τὰ ἄπτερα ἐκ τινῶν καμπτῶν τοιούτων, αἳ κυμαίνουσι τῇ πορείᾳ, καὶ προσβᾶσαι τῷ ἑτέρῳ κάμψασαι ἐπιβαίνουσιν."

We shall return, for this purpose, to the relations of analogy visible between the circles of *Mandibulata* and *Haustellata*, where I take it for granted that the two series are perfectly natural according to the foregoing definition, that is, because they are only broken by chasms and not interrupted by unnatural interventions. But it is far from being a necessary consequence of the series being natural, that the specification of the five orders which compose each series should also be correct. I make this remark, because a fluctuation of the line of analogy is often visible; for which I cannot see any sufficient cause unless the circumstance, before noticed, of every external order bearing an analogy to the two external orders of the contiguous class, may hereafter prove to be such. As we have heard so much of the distortions and dislocations of natural order, and as so many of these have now disappeared, it is my firm belief that Natural History scarcely knows what is truly an anomaly. There is, at least, a possibility of these apparent fluctuations being hereafter in like manner reduced to a regular principle. But whether it be owing to the above circumstance, or to some cause of which as yet we have no idea, or whether it results from our orders being badly constructed, the effect is undoubtedly visible. To explain what is meant: a Dipterous insect resembles a Hymenopterous one in appearance as well as metamorphosis; the genus *Pulex* also resembles the *Coleoptera*, and the *Lepidoptera* imitate the *Trichoptera* in these same points: consequently, as to the accuracy of the position of three groups in each series there can be no doubt. Yet, although the analogy of metamorphosis remains unobjectionable, that of external appearance and even of economy appears not to follow

Vid analogy
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Tribe of Lepid
to the [illegible] of
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exactly the same rate of progression. Looking at the *Hemiptera*, we necessarily must compare some in their aspect to *Coleoptera*, others to *Blattæ*, but few to the true *Grylli*. Nay, these have more similarity in the form of their head and external structure to *Homoptera* than to *Hemiptera*, and the Homopterous insects, which resemble most in their perfect state the *Neuroptera*, are perhaps those which compose Latreille's second family. To be brief, but I fear more abstruse, it may be said that in that space of the series of *Haustellata*, which intervenes between the *Aptera* and *Lepidoptera*, the analogy of external appearance with the *Mandibulata* commences a little nearer to the *Aptera* than that of metamorphosis. A circumstance, however, which makes me almost sure that there is some rule in this, is to observe that in the other Annulose columns symptoms of the same apparent irregularity are visible, and always in the corresponding space, that is, between the second and fifth orders, as they are disposed in page 392. What also deserves remark is, that this space nearly, if not altogether, coincides with half the column, and its extremities are the opposite points of the class, which, according to what has been said of such circles, always approach to each other, if they do not even meet. This we see in the disposition of *Cocci* and other Homopterous insects to come in between the *Aptera* and *Diptera*, and likewise in the relation which holds good between Termites and Ants; or still better perhaps between *Psoci*, the larvæ of *Coleoptera*, and *Anoplura*, which, by the by, appear to afford a parallel for the relation between *Aranea*, *Pycnogonum*, and *Phalangium*.

The greatest fault, however, of the tabular view above given is my uncertainty, not only with respect to the natural limits of the osculant classes, but even as to their types and those points of the classes which they accurately meet. I deem it preferable, however, to express this uncertainty by notes of interrogation or asterisks, rather than pretend to that acquaintance with the truth, which can only be obtained by analysis.

In conformity with the prevailing disposition of naturalists to generalize anatomical facts, and their anxiety to reach the *simplex duntaxàt et unum*, it may now be expected that I should endeavour to give the reader an abstract idea of an Annulose structure, that I should enter, in short, upon one of the most difficult and obscure provinces of Natural History. Unfortunately, however, little more progress has been made in this direction of the science than such as may be summed up in the recital of a few vague conjectures, and one or two probable hypotheses, which their authors are still only preparing the proper means to substantiate. It may, therefore, be somewhat bold in me to attempt criticism on a question beset with so many difficulties; but as this species of inquiry is, if not the first, at least one of the best steps towards a right understanding of those animal constructions which are framed on a plan different from that of Man, a great object will be attained if I do no more than explain in what these difficulties consist.

In all his demonstrations of a peculiarity in the formation of Unvertebrated animals, the naturalist is under the necessity of referring constantly to the more generally understood structure of the *Vertebrata*; not, however, that he would reduce every living creature to the Vertebrated type of form, or even insist upon any direct affinity between plans so fundamentally different, for this would be a great mistake;

but, in order that those analogical principles, which may have served so well to connect Vertebrated animals together, may be transferred to the arrangement of the multitude of heterogeneous forms which are included under the comprehensive title of *Animals without Vertebræ*. Now, on looking at the circle of *Vertebrata*, undoubtedly the first and most general idea we can obtain of them is afforded by that bony articulated axis which gives support to their whole body. Our second and much less general notion of them arises from the principal bony and articulated appendages which are attached to this axis. Every Vertebrated animal may, for instance, be considered as a quadruped, or at least as tending to have four appendages to the vertebral column, which, whether modified into hands, feet, wings, or fins, are always in some degree referable to one general model for their structure. Man has usually been accounted to be this model; but the great aim of Geoffroy St. Hilaire, in his *Philosophie Anatomique*, is to show that every tribe of Vertebrated animals, perhaps every species, has some organ or some portion of an organ in a maximum state of developement, and consequently that the model to which we ought to refer every vertebrated structure is not a real existence, but an abstract idea made up of all the various excellencies that may be dispersed throughout the group. One being may indeed come nearer to this perfect model than another, by possessing more of these perfections; yet, on the other hand, not only is there no being in the group absolutely destitute of all these characters of the model, but there is every probability also that there is no being which has not some advantage of structure to boast over every one of its fellow species.

Reptiles afford us examples of the partial or even total absence of feet; and while we know, from the doctrine of analogy, that these organs of locomotion are represented in fishes by their fins, yet, in the case of such substitutions, a new form is often adopted, in which the original type is no longer recognisable. Nor ought it to surprise us that these appendages of the axis should disappear, still less that they should differ from their original type, when we perceive that the vertebræ themselves may become obscure, as in the Chelonian reptiles, or may be nearly annihilated, as in the Cyclostomous fishes. Any attempt, from such considerations, to define the particular living animal which is or even comes nearest to the model of the *Vertebrata* were clearly absurd; we can do no more than endeavour to ascertain what animals possess the least number of those characters which distinguish the type of the group. Thus we learn to consider Reptiles and Cyclostomous fishes as the two paths by which the vertebrated model is abandoned for others, and at last, finding this chain interminable, are induced to confess that there is no strict rule of absolute division by which a Vertebrated animal may be defined. The line cannot be drawn without our either leaving this division imperfect, or encroaching in some respect on the others. Still it must be confessed that this uncertainty only relates to the verbal definition or rule which we may choose to institute; for we are seldom in danger of mistaking a Vertebrated animal either for any *Cephalopoda* or *Annelides*. The type of the *Vertebrata* is indeed, without being limited by words, an idea much more definite, and therefore more easily conceived, than that of an Annulose animal; for if, as M. Latreille has observed, we compare the organs of locomotion in the *Annulosa* with each other, such enormous discrepancies are to be remarked, that we are, on a slight view of the subject, almost tempted to believe that the torch of analogy throws little light on the anatomy of such organs out of the circle of *Vertebrata*.

Not content with the group of *Annulosa* being held together by their nervous system and external articulation, characters which they possess in common with the *Cirripeda* and *Annelides*, M. Savigny was the first who undertook to reduce this uniformity to more definite principles, and thus to afford us a more distinct and precise perception of the Annulose model. For this purpose he directed his attention to the construction of the mouth in Hexapod insects undergoing metamorphosis, and appears to have succeeded in reducing this astonishing variety of mechanism to one general type. It was then reasonably expected that the same theory, carried a step further on to the *Crustacea* and *Arachnida*, would produce similar effects, and that the entomologist would be able to understand the general plan upon which those organs are formed, which principally contribute to the life of an Annulose animal. So far, however, is this just expectation from having been realized, that the chief information to be drawn from the second *Mémoire* of M. Savigny relates to the individual construction of those species of *Apiropoda* which he has examined, and indeed does little more than explain the gradual adaptation of their feet to purposes of manducation;—a fact certainly of the most interesting kind, but which can only by analogy be directly connected with the object he had in view. I have no hesitation in saying, for my own part, that, notwithstanding M. Savigny's industry and wonderful talent for generalizing facts collected by the most sound experiments, I am not only still unable to refer the construction of the mouth of his *Apiropoda* to any one type, but cannot even form an abstract idea of the organs of manducation in the circles of *Crustacea*, of *Arachnida*, or *Ametabola*, taking each class separately.

M. Latreille indeed, in his late *Mémoire*, read before the Institute, on the formation of the Wings of Insects and their external organization considered with reference to that of the *Arachnida* and *Crustacea*, has attempted to remedy by a new theory the anomalies so apparent in that of M. Savigny; but he has only made more manifest the extreme difficulty of the investigation, and the futility as yet of all endeavours to surmount it. This *Mémoire* of M. Latreille, although unsuccessful in its attempts towards a general theory of the mouth, is nevertheless full of most interesting speculations, in the illustration of which by anatomy every friend to natural science must be gratified in learning that he is now busily employed. His opinion with respect to the antennæ of *Arachnida* has already been discussed, and, if correct, goes a great way towards our obtaining a definite notion of the type of the *Annulosa*. But, in addition to this, M. Latreille makes a daring attempt to substantiate the accuracy of an hypothesis which I believe, with the exception of the late M. Jurine's approach towards it, is quite new and entirely his own. He argues, that as the Vertebrated animals offer so striking a correspondence in their organs of locomotion, the probability from analogy is, that Nature in the structure of the *Annulosa* may, notwithstanding her deceitful exterior, be found on accurate examination to be equally consistent with herself. Now, to prove the justness of this position, he states that in some species of *Caligus* he has observed the feet to be fan-shaped, divided at the extremity into two branches, which are adorned with plumose subdivisions ranged parallel to their axes. Then comparing this structure with the wings of the *Pterophori*, a small family of *Lepidoptera*, of which the wings are composed of feathers somewhat similar to those of a bird, he concludes that the feet in the *Caligus* are the substitutes of wings, and that the wings in the *Orneodes* occupy the place of feet. Without prejudice to the validity of his conclusion, it may however be properly objected to this mode of reasoning, that the general construction of the *Orneodes* being so distant from that of *Caligus*, we cannot place much faith in any affinity between the details. M. Latreille seems to perceive this, and therefore adopts a closer but scarcely more solid comparison, in assimilating the tracheal fins of the larvæ of *Ephemeridæ* to the wings of the perfect insect, that is, abdominal to thoracic appendages, and then appeals to the observations of M. de Blainville, which prove that the wings of Insects are a sort of tracheæ*. On these loose notions of resemblance he founds his opinion that the wings of a Hexapod insect are nothing else than tracheal appendages, which occupy the place of tarsi in certain feet. The articulations of the wings which correspond to the *coxa*, *femur*, and *tibia*, are, in his judgement, so far rudimentary that he hesitates to give these names to the three or four callosities, termed *osselets* by M. Jurine, which, although nearly concealed in the thoracic cavity, are visible at the root of a wing. M. Latreille was doubtless carried a great way towards this conclusion on still more solid ground than has been just cited, namely, a *Mémoire* on the Wings of Insects,

* This discovery ought not to be attributed to M. de Blainville, but to the late M. Jurine, who in the introduction to his work on *Hymenoptera* has admirably explained the structure of their wings.

read before the Physical Society of Geneva in 1805, and in which M. Jurine has explained the analogy which these organs bear to the wings of birds, a subject of late still more rigorously and almost mathematically investigated by M. Chabrier.

It is obvious, nevertheless, that such a basis for a theory is sufficiently flimsy, and would scarcely deserve much attention, were not the theory itself susceptible of many happy applications to fact. But as this is one of the great tests of the worth of any new opinion, and is only inferior to a sound deduction of it from actual experiment, I shall now indicate the use to which M. Latreille's theory may be converted.

Boas Johansson, in the *Amœnitates Academicæ*, summed up the character of Annulose animals in these words: "*Hæcce denique, ad unum omnia, animalia suis vestita ossibus cataphracta et quasi loricata, mirifice incedunt;*" and the foundation of M. Latreille's theory may be said to rest upon this fact, that the *Annulosa* ought to be considered as *clothed in their bones*. Arguing therefore from the established truth of the skeleton of the *Vertebrata* being referable to one model, he conceives that the Annulose type may be discovered by a strict attention to the segments which compose the external envelope of such animals.

The body of an Amphipod Crustaceous animal is, as our author observes, formed of fifteen articulations, the three first of which, having the manducatory organs attached to them, constitute the head, the five following the thorax, and the remaining seven the abdomen. In Decapod *Crustacea* and the majority of the *Arachnida*, the upper covering of the thorax is united to the head, forming one piece with it. These three segments in the *Myriapoda* become more connected together than they are in *Crustacea*, and when at length they become in a manner compressed into one piece with the three pairs of pedipalpi which are affixed to them, there seems to him reason for supposing that we have before us the head and organs of manducation of a Hexapod insect. This doctrine, however, in as far as it regards the mouth, I cannot consider to be yet established, notwithstanding the ingenuity of some of the arguments by which it is supported. It is particularly hard to discern, for instance, in what respect this opinion, as it affects the second pair of pedipalpi in a *Scolopendra*, is less objectionable than that of M. Savigny on the same subject.—But we proceed with the more essential part of the theory.—The head, then, being thus formed of three segments in the *Crustacea*, and becoming gradually compressed into one, it follows that the body of an insect must be composed of thirteen segments, that is, still allowing five for the thorax and seven for the abdomen. All this Latreille has admirably elucidated, as well as the correspondence of this number of segments with those of Caterpillars and larvæ in general. The only objection to it is, the difficulty of accounting for the circumstance of the thorax of Winged insects consisting of no more than three segments. M. Latreille considers that the remaining two become the two first of the abdomen,—an idea which it is impossible to adopt without giving up his theory altogether. For, in the first place, on looking at any Coleopterous insect we find only seven segments to the abdomen, three to the thorax, and one to the head, eleven in all; from which it appears that some two segments which existed in the same insect when a larva are now apparently lost. M. Latreille thinks with justice that these two are thoracic, that is, are such as would bear feet in *Crustacea:* the question therefore is, how he can assign them to the abdomen. If he supposes that these two as they exist in the larva of an *Oryctes* are transferred to the abdomen of the imago, it is neither true in fact,—since no more than its proper number, seven, can be found in the abdomen,—nor would it, if true, coincide with the theory which he wishes to establish, and which makes the wings take the place of the feet that are deficient.

The segment which is usually termed the thorax of a Coleopterous insect, is evidently only one, and bears the first pair of feet. We have next four pairs of locomotive organs attached to that part of the trunk which is commonly considered to consist of only two segments. Now, for M. Latreille's theory to stand, it is absolutely necessary to resolve these two into four, which, although it has not yet been effected, I confess I think by no means impossible. The surest guide, however, in this research, will be the dissection of an insect in the pupa state, with reference to the larva and imago.

The reader will observe, that if ever this hypothesis should be substantiated by such or equivalent experiments, a Coleopterous insect, in addition to what is termed its thorax, will have four thoracic segments in the trunk, or that part of the body which forms the front of the abdomen. It requires explanation, perhaps, how segments united to the abdomen of a Hexapod insect ought to be accounted as appertaining to the thorax; and for this purpose we return to the *Crustacea.* The five thoracic segments of *Lycista furina* Eg. have perhaps no other character to distinguish them than that each carries a pair of true feet. And this seems the proper definition of the thorax of an Annulose animal, namely, that it consists of those segments which carry the true organs of locomotion; a rule which, if applied to Coleopterous insects, will evidently make us account those articulations, apparently the first of the abdomen, to be in reality the last of the true thorax. The abdomen, therefore, of a Coleopterous insect is in reality composed of only seven segments, of which the last is often retracted from its forming part of the sexual organs. M. Latreille observes, that this retraction of segments is still more remarkable in Hymenopterous insects, since the genus *Chrysis*, for instance, has apparently only three or four abdominal articulations, the remainder being in fact internal and composing a sort of tube. He also remarks that the position of the sexual organs in the *Apiropoda* of Savigny will always be sufficient to mark out the true thorax, except in the genus *Scolopendra:* but the best method is, as before mentioned, to consider the thorax as consisting in all insects of those segments to which the true organs of locomotion are attached. I say the true organs of locomotion, because by this expression the false feet of *Crustacea* and *Myriapoda* are excluded.

But if the thorax of Winged insects should consist of five segments, corresponding to five in *Crustacea*,—and the inspection of the trunk of a *Cetonia* or *Buprestis* gives some credibility to the supposition,—then the substitutes of the two pairs of feet wanting can only be found in the wings, which, in the pupa state, are disposed like the feet, and which have a situation, so far as relates to the thoracic segments, exactly suitable to what we should have expected. Nor do these wings differ more in appearance from the feet of which they occupy the place, than the fins of Fishes do from the organs of *Mammalia* which they represent. Nay, there are certain Annulose animals which afford us indubitable examples of this analogy between wings and feet. The *Cyamus*, for example, is a Crustaceous animal with ten feet; yet, for the purposes of locomotion, it has only three pairs, the remaining two pairs being organs which M. Latreille has termed branchial feet, and which indeed undoubtedly serve for purposes of respiration. Again, when wings are deficient in any great division of Hexapod insects, we always find them replaced by the vestiges or semblance of wings, or, finally, by other organs having even a greater appearance of being tracheal feet, as, for instance, the *halteres* of the *Diptera* occupying the place of the two under wings which in this order are null.

It is, however, sufficiently obvious that, so far from this theory being confirmed by incontrovertible proof, it is as yet little more than enunciated: but as I know no fact directly in opposition to it, and many by which it is indirectly favoured, no course of proceeding would in my opinion be more blameable than hastily to reject the hypothesis before we have seen the result of M. Latreille's present labours. Undoubtedly those persons who are unacquainted with the conformity of Nature to certain general principles, will have great difficulty to understand how the wing of an Hymenopterous insect can be one of its feet; yet they are not so dissimilar perhaps as the fore foot of a quadruped and the wing of a bird, which often agree almost to the number of *digiti*.

My chief reason for entering on this subject so fully, was, that it appeared to me of all the theories yet invented the most likely to serve in the end to effect the reduction of the *Annulosa* to a general plan of construction, analogous to that on which the *Vertebrata* are now known to be framed.

But I had also another reason, connected in no small degree with the chain of affinities, which I have attributed to the class of *Mandibulata*. It is, that, if the theory of M. Latreille be true, there can remain no further doubt as to the accuracy of Mr. Kirby's opinion on the natural situation of the *Strepsiptera* being close to the *Coleoptera;* for then those appendages to the thorax which he terms elytra, may really be such, or at all events be the substitutes of wings. MM. Lamarck and Latreille have indeed both declared themselves against this doctrine, and have consequently accounted the genera *Stylops* and *Xenos* to be Dipterous; a conclusion peculiarly harassing to the entomologist, who may wish to adopt it, from no insects whatever being more unlike than these to the common type of the order of *Diptera*. Assuming, however, the *truth* of M. Latreille's theory as to the tendency in the thoracic segments to have each a pair of appendages, the elytra of a Coleopterous insect are wings, serving indeed as a case for the shelter of the other pair, but not the less answering to the place of true wings in other Hexapod orders, or of two feet in *Crustacea*. But this is not only the exact case with the elytra or thoracic appendages of a *Xenos*, but the insect would be theoretically imperfect without such organs, since it has neither *halteres* nor *squamulæ* to take the place of a pair of wings as in the *Diptera*. Here then, to mention nothing of the more solid arguments to be drawn from the construction of the mouth, is a reason founded on a most ingenious speculation of M. Latreille, why we should believe his opinion of the natural situation of the *Strepsiptera* to be less correct than that of the distinguished naturalist, who first attempted to decide with precision on their affinities.

But to return: It may be remarked that while the thorax of a Crustaceous animal has in reality ten feet, we find a pair of these to disappear first in the males of such insects as recede from the Crustaceous type. Thus the female *Nymphon* is decapod like the *Crustacea*, while the male has only four pairs of feet, like the *Arachnida*,—a mode of change to which Nature appears to be partial in the structure of Annulose animals, when leaving one form for another, and of which I have given an instance on a smaller scale in the change of the *clypeus* of the genus *Anoplognathus*, described in the first part of this volume. Savigny perceived that the male *Nymphon* prepares us for the Arachnide form, in which we have never more than eight feet. M. Latreille indeed imagines that vestiges of a decapod structure are visible even in some *Arachnida*, such as the Scorpion, whose *pectines* he fancies to represent a pair of feet or wings; nor does he seem aware that his theory is supported by the opinions which Redi and Amoreux formed, on observing the use which the animal makes of these processes in walking. But, however this may be, it is very sure that the less perfectly organized animals of this class lose still further a pair of feet and become hexapod, thus preparing us for the apterous and parasitical *Diptera*, which again are among the least perfect of the *Haustellata*. The tendency, however, of an Annulose animal to a decapod structure is soon again visible; for at first we have a minute pair of wings, as in *Hippobosca*, which afterwards become of a powerful size in the *Muscidæ*, besides being assisted by a pair of thoracic appendages termed *halteres*, which finally themselves become wings in other more perfect orders.

A more troublesome office of the learned author of this hypothesis will probably be to explain the conformity of Myriapod animals to this Decapod construction, or at least to show how they have gone beyond it, like those fishes which apparently have overshot the tetrapod mark of the *Vertebrata*. But as this leads us into speculations of a very extensive nature, and not immediately connected with our subject, I shall, for the present, merely state my inclination to adopt the following opinion of M. Latreille, viz. *That every Annulose animal has a tendency to be Decapod, or, more properly, to have five pairs of thoracic appendages answering to the five thoracic segments;* and thus, although Nature may make particular exceptions to her plan, it may eventually be necessary to describe that imaginary being, the Annulose type of form.

CHAPTER VII.

ON THE TRIBES OF MANDIBULATA.

In tracing Nature from the root into any of the ramifications, it may be expected that our comprehension of the various objects which present themselves to the mind, ought to become at once less difficult and more strong as these diminish in number. In climbing this tree, the firmest grasp is not at the broad trunk, but among those slender branches where, in fact, we have the least support. There are persons, therefore, who may perchance think that in proportion as our scrutiny becomes gradually confined within narrower bounds, and we come more particularly into the province of the entomologist, there ought to be less doubt attached to his positions and greater credit given to his arrangement for accurate conformity with Nature. Nor could any objection be brought against this reasoning, if it were only possible for the naturalist, in the prosecution of the plan adopted for this inquiry, to proceed at once to the analysis of species and of artificial genera. But as we at present are advancing towards our object synthetically, I am under the necessity of warning those who may be inclined implicitly to follow me, when arrived on comparatively familiar ground, that they can scarcely indulge any opinion more erroneous in entomology, than to confound the present species of investigation with the analytical nicety of a Monograph. It is to be recollected that we are now distributing animals into various groups upon principles of knowledge, which the reader is supposed to have already acquired by analysis. For this analysis, in so much as it was necessary for the establishment in outline of the primary groups, he has been presumed to be indebted to the assiduity and skill of comparative anatomists. But that still more minute and tedious examination, which is requisite ere we can esteem the subdivisions of these groups to be natural, remains yet to be attempted. Until therefore we resort again to minute analysis, and perhaps until this analysis shall have been extended to all the beings which compose the group of *Mandibulata*, little that is positively certain ought to be concluded with respect to its subdivision. Nay, the safer way will be to account much of the remaining synthesis in this Essay as somewhat hypothetical. It is a misfortune which I foresaw would be the consequence of the plan of this investigation being rather premature. And it is therefore my intention, if any of the foregoing notions should be deemed likely to promote the interests of Natural History, to investigate, at some future period, this same ground in detail by the inverse method. It is sufficient, for the present, if my aim should be perceived from the arrangement of the following few crude facts, to which I was led in the course of collecting materials for an *Analytical Essay on the Developement of Annulose Forms.*

Tribes.

These preliminaries being settled in order to prepare entomologists for many mistakes that will no doubt hereafter be detected in this and the following chapter, by means of future analysis, I may proceed to make a few remarks on the

Coleoptera.

The metamorphosis of these Insects is technically termed incomplete; by which is meant that the change of form from the larva to the imago state has taken place through the medium of a third or nympha form, which is wholly different from the two others, besides being inactive and incapable of taking nourishment. Now, if in addition to this be taken the circumstances that the larvæ have all a constant form, in which, while the thorax is rarely distinct, there is always a corneous head furnished with mandibles and maxillæ; if it be remarked that the nymphæ have the upper wings much thicker and larger than the two lower, we shall probably have stated every thing that is known to apply generally to the undeclared state of the *Coleoptera*. But although there be little in this that will separate them on a first glance from some other *Mandibulata* of the order of *Neuroptera*, yet their perfect or *imago* state is so peculiar that perhaps no order of insects is better defined than that of the *Coleoptera*. The total absence of ocelli, the enlargement of the second segment of the body, and the peculiar manner in which the wings of the most part are folded under the elytra, render a mistake with respect to the contents of the order quite impossible. Whether this particularity be natural, or whether it results from the imperfect state of our knowledge of species, is a question only for time to resolve; but analogy would persuade us to assign the latter alternative as the cause of these insects forming what, if we adopt the ordinary expression, may be termed so very *natural* an order. The accident, however, of a group o animals being in a manner insulated is very advantageous for those who may be in search of a natural method of distribution, because the most general ideas which can be formed of it are thus confined within certain limits, and the greatest evil of generalizing is thus *in limine* counteracted.

It was from such reflections that I had much less reluctance to confide in the accuracy of my eye in seizing the natural affinities of the *Coleoptera* than I should otherwise perhaps have experienced, being convinced that the peculiarities of the order made it equally impossible to insert any thing in it which ought not to be there, as to withdraw from its just province any insect which might be truly Coleopterous. Thus, I threw the whole into the great groups which occurred most obviously to the sight, leaving out of consideration all genera with respect to whose affinities there was the least reason for doubt. It then became necessary, in pursuance of that elementary maxim of Natural History, "*Character non est ut genus fiat, sed ut genus noscatur,*" to seek for general characters wherewith the divisions thus obtained might be defined; and for some time I could discover none that were in any manner applicable. Some satisfaction, therefore, was experienced when, on happening at length to think of their larvæ, I discovered that each of my groups had, as far as my knowledge of them went, a peculiarity of character. This, however, like all other natural peculiarities which distinguish groups, can only be described by an enumeration of the types to which the animals composing each group more or less approach; or in this case rather by a classification of the types to which the larvæ of each group may, in a greater or less degree, be assimilated. Of

Chilopodomorphe
Scolopendre

Chilognathe
Julus

Vermiform
or Apod

Anopluriform

Thysanuriform

Such types we have, First, a Carnivorous Hexapod larva, with an elongate, linear and flattened body, having a large head armed with two sharp falciform mandibles, and furnished with six granular eyes on each side. Example: *Carabus* or *Dytiscus*. Secondly, A Herbivorous Hexapod larva with a long and almost cylindrical body, so fashioned that the posterior extremity being curved under the breast, the animal, when at rest, necessarily lies like an *Iulus* on its side. Example: *Petalocerous larvæ*. Thirdly, Apod larva, having scarcely the rudiments of antennæ, but which is furnished instead of feet with fat fleshy tubercles, which, when continued along the back and belly, give the animal a facility of moving in whatever way it may be placed. Example: *Curculio* or *Cerambyx*. Fourthly, Hexapod and distinctly Antenniferous larva, with a subovate rather conical body, of which the second segment is longer and of a different form from the others, so as to give the appearance of a thorax. Example: *Coccinella* or *Chrysomela*. Fifthly, Hexapod Antenniferous larva of an oblong form, having like the former vestiges of a thorax, besides two or more articulated or inarticulated setaceous or corneous appendages to the last segment of the abdomen. Example: *Meloe?*

Every Coleopterous larva which I have had the opportunity of observing may be assimilated to one or other of these types, which it was scarcely possible to look at without being reminded of the *Ametabola*. Indeed, it occurred to me almost immediately, that I had Chilopodiform, Chilognathiform, Apod or Vermiform, and Anopluriform larvæ, together with a fifth form, of which I even now know little except from the examination of two or three larvæ collected by myself, together with the almost marvellous descriptions of Goëdart and Degeer. Such a distribution of the *Coleoptera* may be said to be founded on relations of analogy, which, on comparing the young *Ametabola* with the larvæ of the corresponding groups of *Coleoptera*, will be found as strong as those which exist between the classes of *Mandibulata* and *Haustellata*. The distinction, however, between affinity and analogy, is perhaps no where in Entomology more necessary to be attended to than here; since in terming larvæ *Chilognathiformes* or *Chilopodiformes*, it is not meant that they are *Scolopendræ* or *Iuli*, or even near to them in affinity; but only that they are so constructed that certain analogical circumstances attending them strongly remind us of these *Ametabola*. !!

The only author who has to my knowledge placed the order of *Hymenoptera* next that of *Coleoptera* is M. Cuvier. How he came to discover this affinity I know not; but I suspect his reasons for it to have been founded on very general considerations, since at the time his work was published the *Strepsiptera** had scarcely been thought of, much less studied.

If further observations should prove Savigny to have

* If the word *Strepsiptera* is in these pages invariably used in preference to *Rhipiptera* and *Rhipidoptera*, names given to the same group by the French entomologists, it is because the former word has the right of seniority, because it is the name bestowed on these insects by the person who first gave us any definite notion of their place in nature, and in short because it appears to be free from fault. M. Latreille indeed says, that the etymology of his name *Rhipiptera* rests on an incontestable fact; but so does also *Strepsiptera*, as will appear from the *Mémoires* both of himself and M. Jurine on these insects. They both acknowledge that the organs which have occasioned so much dispute among entomologists are used in *flying*, and every person agrees that they are *distorted*. I therefore ask whether, according to the rules of the science, it be not our duty to adopt the name originally given to the order by our learned countryman? For my part, until a fault shall be distinctly proved to affect it, I shall always adopt that name, whether French or English, which is supported by the right of priority.

erred in his analysis of the mouth of these last animals, they must then no doubt take a situation near to the *Diptera*. But at present, all who confide with me in the consummate accuracy of this gentleman's microscopical dissections can only consider the resemblances which the *Strepsiptera* bear to certain *Haustellata* as so many relations of analogy. M. Latreille seems to have been induced originally to form his opinion of their affinity to Dipterous insects, from an idea that the head of their larvæ is soft and changeable in form; which, if correct, would indeed have been conclusive evidence in his favour. I can perceive nothing, however, either in the figure or slight description given of the larva of *Xenos Peckii*, by professor Peck, or in the more detailed and scientific history of the larva of the *Xenos vesparum* of Rossi by the late M. Jurine*, that warrants any other opinion on the subject than that the head is covered with a hard scale, and is constant in form like that of *Hymenoptera*. M. Latreille is at last sensible of this, and says, "*Outre que les larves des Rhipiptères ont une véritable tête munie de deux yeux; qu'elles ressemblent d'avantage aux larves apodes de la plupart des Hyménoptères, elles conservent leur forme primitive, ou n'éprouvent point le changement que Réaumur nomme forme de boule allongée.*

I have elsewhere shown that Mr. Kirby considers these insects as close to the *Coleoptera*. Better authority, therefore, for this affinity I need not. It only remains to demonstrate their affinity to the *Hymenoptera*. From their comparative anatomy and metamorphosis, Jurine was the first to prove this, the opinion of Rossi, with respect to

* It was one of the last papers read by this lamented naturalist before the society established at Geneva for the promotion of Natural Science.

them, to be correct. M. Latreille, in consequence of a late most elaborate examination of them, comes to the following conclusion: " *Les Chalcidites et les Chrysides, tribus de ce dernier ordre (Hymenoptera) sont les seuls insectes dont le thorax, par l'ensemble de ses rapports puisse être comparé à celui des Rhipiptères. C'est encore vers les hyménoptères pupivores que nous ramènent d'autres caractères de ces derniers insectes, leur manière de vivre et l'habitude de sautiller.*" A naturalist, therefore, judging, as I now do, of the situation of an insect which he has never had an opportunity of examining, cannot be far wrong when he in this manner unites the opinions of three persons so distinguished in the science as MM. Jurine, Latreille and Kirby.

M. Latreille, however, reviving another of the neglected observations of Degeer, finds two epaulettes, as he calls them, attached to the anterior and dorsal extremities of the second segment of the thorax in *Lepidoptera*; and on account of this *solitary resemblance* deems the *Strepsiptera* to be situated between the *Hymenoptera* and *Lepidoptera*. There is certainly every reason to think him right in imagining the elytra of *Xenos* to answer to these epaulettes in *Lepidoptera*, and to the tegulæ in *Hymenoptera*; but as *Neuroptera, Diptera, &c.* appear also to have similar thoracic processes, although under different forms, we may perhaps be enabled to set its proper value on this as a single character sufficient to establish an affinity. No other character, I may venture to say, will ever bind a Strepsipterous insect to the *Lepidoptera*.

I have little doubt, moreover, of the elytra of *Coleoptera* being still the same epaulettes or tegulæ under a different form; and this belief is grounded on the fact that the upper wings of *Lepidoptera* are articulated at their base, and then communicate with these epaulettes, which are themselves not articulated any more than the elytra of *Coleoptera*. The last mentioned organs, therefore, I am inclined to consider as the basal process of a wing, of which the subsequent articulations are obsolete, but of which a vestige may be traced immediately under the base of the elytra. It is certainly curious that the elytra of *Coleoptera* should not have articulations at their base, but that their wings should; and it is rather singular that it should escape the notice of M. Latreille, that if these epaulettes of *Lepidoptera* were organs *sui generis,* all his theory of the thorax must fall to the ground. There would then be one more pair of thoracic appendages in a Butterfly than there are thoracic segments.

These remarks, however, I offer merely as hints, contenting myself with the certainty that the organs which Mr. Kirby calls the elytra of *Strepsiptera* answer to the elytra of *Coleoptera,* and requesting those who may doubt it to reflect whether any other conclusion can be drawn from the following description, which M. Latreille himself gives of these organs in his late *Mémoire sur quelques Appendices du Thorax de divers Insectes:* " *Jurine, qui a assisté à la naissance du Xenos des guêpes, nous apprend qu'il agite vivement ses balanciers dès le premier instant de leur apparition. Leur tige est selon lui composée de deux parties bien distinctes; l'une antérieure, ronde, solide, et cornée, l'autre postérieure et formée d'une légère membrane blanche. Ces organes sont dès lors creux ou tubulaires; l'insecte les meut avec une grande rapidité lors qu'il vole, et souvent même lorsque ses ailes sont en repos. On ne peut donc guère douter qu'ils ne l'aident à voler. Sans leur secours,* *les ailes n'auroient pu, à raison de leur ampleur extraordinaire, de leur grande ténuité, de l'obstacle que leurs plicatures opposent continuellement à leur extension, vaincre la resistance de l'air. Elles sont annexées au mésothorax ou au second segment du tronc, et correspondent ainsi aux ailes supérieures des autres insectes.*"

Thus I consider it to be established that we are to pass from the *Coleoptera* to the *Hymenoptera* by means of the *Strepsiptera**. As yet, however, I am ignorant of the Coleopterous insects which we ought to quit directly for them. Judging from their *facies*, I know no *Coleoptera* which approach them closer than the genus *Atractocerus*. Were I from theory to describe the Coleopterous insect which ought to come nearest to the *Hymenoptera*, it would be nearly as follows: Larva apod, Imago with the thorax small, and the remaining segments of the trunk forming a mass not liable to be confounded with the abdomen. The wings ought not to be folded transversely, and the elytra should perhaps be very minute, since we know no instance among Coleopterous insects where they become at their full size membranaceous. It is possible, nevertheless, that the transition from a Coleopterous to a Hymenopterous form is effected on another principle, namely, the affinity which some *Hymenoptera*, in their perfect state, may be found to bear to imperfect *Coleoptera*. Thus, in the Australasian genus *Myrmecodes* we observe many of the distinctive characters of *Hymenoptera* to disappear. Until the truth be ascertained by analysis, it will perhaps be most prudent to

* If I express myself with more confidence on this head than in the preceding chapter, it is because the receipt of M. Latreille's *Mémoire* has confirmed me in the opinion which I there advanced with some hesitation.

adopt the middle path between these two hypotheses, holding it for certain, nevertheless, that some of the first *Hymenoptera* we can approach, when keeping close to the path of affinity, must be such as are destitute of ocelli.

HYMENOPTERA.

On looking at the *Hymenoptera* generally, and endeavouring to fix on the most distinct types of construction, I made choice of *Formica, Chrysis, Apis, Sphex* and *Ichneumon*. In such cases, Linnæus is a guide almost infallible, from his wonderful facility in discovering the minor natural groups. If he could but have combined these as well as he has defined them, he would still be in legitimate possession of that rank in Entomology, of which he has been so long only the usurper, to the prejudice of Degeer and others. Now, besides the Hymenopterous genera before mentioned, which I have chosen as types, Linnæus has no more than five, to wit, *Cynips*, which comes so close to *Ichneumon* that Latreille refers them both to the same group; *Tenthredo* and *Sirex*, which differ so much from true *Hymenoptera*, that it is difficult to imagine them to belong exactly to the order; *Mutilla*, which is now with propriety referred to the *Formicidæ* as containing its type; and finally *Vespa*, which from its form and manners seems not to be a peculiar type, but only intermediate between *Apis* and *Sphex*. M. Latreille indeed has founded his family of *Diploptera* upon the Linnean genus *Vespa*, and apparently with much reason; but the simple circumstance of the upper wings being doubled longitudinally is not sufficient, in the opinion of M. Lamarck, to constitute a primary division of the order. In short, if we consider those *Hymenoptera* of

Linnæus which have apod larvæ (the *Larvæ subvermiformes* of Latreille) to form one group, it seems not impossible to refer them all to one or other of the following subdivisions. 1. *Anthophila* Lat. 2. *Rapacia* of Lamarck, excluding his second division. 3. *Pupivora* Latr., with such modifications as will make the group consist only of those insects which have a plurivalve fissile appendage to the abdomen. 4. *Heterogyna* Latr.: and 5. *Tubulifera* Latr., which last appear to approach in habit, organs of manducation, and structure of wings, to some brilliant Indian bees, allied to Latreille's parasitical family of *Nomadæ*.

It is undoubtedly through the medium of certain *Pupivora* of Latreille that we ought to quit the *Hymenoptera*. If we look to external structure, the genus *Aulacus* of Jurine will probably be fixed upon; and if we resort to theory, and ask which of the true *Hymenoptera* have phyllophagous larvæ presenting vestiges of feet, it may be answered that certain species of the Linnæan genus *Cynips* correspond with this description. The truth may possibly be found hereafter to lie between these two supposed means of arriving at the genus *Tenthredo* of Linnæus. Sufficiently certain, however, it is, that the *Urocerata* of Latreille, composing the genus *Sirex* of Linnæus, come nearer than *Tenthredo* to the *Hymenoptera*. The abdominal appendage of *Sirex* is constructed on the plan of that of the *Ichneumonidæ*, and the larva has only six feet; whereas in the true *Tenthredines* the oviduct is composed of four pieces, of which the two internal are serrated and sheathed by the two external, and the larva at last has from eighteen to twenty-two feet, of which all after the first six are membranaceous.

We now look for *Mandibulata* which have cylindrical larvæ with membranaceous feet, and the genus *Phryganea* appears to the view.

Trichoptera.

That the *Urocerata*, with their hexapod larvæ, form an osculant order between these and the true *Hymenoptera*, cannot be doubted; they may, in pursuance to the custom of naming orders from some peculiarity of the wings, be called *Bomboptera*, in allusion to the unusual noise which they make in flying, and from which they borrow their French name of *Ichneumons-Bourdons*. The important question, however, is, Whether the genus *Tenthredo* of Latreille, which is evidently further removed from the true *Hymenoptera* than the genus *Sirex*, ought to be esteemed osculant with it, or as constituting a ganglion of the same order in which *Phryganea* is placed? I confess that I am rather inclined to adopt the latter alternative, however contrary to the general opinion, and that for the following reasons.

The *Perlariæ* of the *Genera Insectorum*, or M. Lamarck's family of *Phryganidæ*, is evidently a natural group formed of those insects whose larvæ, admirably described by Aristotle under the name of *Xylopthori*, are aquatic and live in tubes or sheaths, which they have the instinct to make for themselves. This group is lately divided by Latreille into *Perlides* and *Plicipennes*, the last of which constitute Mr. Kirby's order *Trichoptera*. Such a name, thus founded on too trivial a character for an order, is perhaps objectionable not only as inapplicable to all *Phryganeæ*, but because it places the genus *Perla* in another order, when the larva, the metamorphosis, the antennæ, the mouth and wings, all manifest their close affinity*. Yet, if the *Perlides* of Latreille fall into the same group with the *Phryganeæ,* such an order presents a singular discordance in the external appearance of the *imagines*. For instance: some, as *Nemoura,* have the corneous mandibles of the *Hymenoptera*; others, as *Phryganea,* have them scarcely developed like the *Lepidoptera*; some have a broad head and the first segment of trunk large, others a small head, setaceous antennæ, and the first segment of trunk as small as in the *Hymenoptera*. There are some with caudal appendages, others with none; some with opaque, deflexed, trichopterous wings, the upper larger than the under, others with them horizontal, membranaceous and transparent, the inferior exceeding in size the superior; some with two ocelli, others with three; and perhaps no solid character can be found for Lamarck's group of *Phryganidæ,* but the circumstance that while the perfect insects are Gymnopterous, and vary excessively in external organization, the larvæ are all cylindrical with membranaceous feet, and undergo that metamorphosis to which Linnæus has applied the epithet *obtecta*. But, if this be the character of an order of *Mandibulata,* it is difficult to exclude from it the *Tenthredina*; and indeed it is very singular that even the genus *Cephaleia* of Jurine scarcely possesses a leading character, in the external organization of its perfect state, which may not be found either in the *Perlidæ* or *Phryganidæ*. It conse-

* We may hope that the learned entomologist who has revived this order will change its name on another account, namely, that Meigen has applied the word *Trichoptera* to designate certain *Diptera*. On *Phryganea* being indicated as a distinct order by Degeer, his commentator Retz gave it the name of *Elinguia*. But, besides the necessity which, for the sake of uniformity, there is for naming the orders from some character of the wings, this, the original name of the order, is even still more objectionable on other accounts, as must be sufficiently obvious.

quentlyis not improbable that the Linnæan genus *Tenthredo* may hereafter be ascertained to constitute a type of that order for which, until a better shall have been invented, we must retain the name *Trichoptera*. This type seems to be intermediate between the *Perlidæ* and *Phryganidæ*, although separated from each of them by a tribe of insects, of which as yet I know nothing except from theory *.

The genus *Sialis* comes so close to *Nemoura* in external appearance, that nothing perhaps will exclude it from the order of *Trichoptera*, except the circumstance of its having neither an eruciform larva nor a truly cased metamorphosis. It is therefore osculant, having a Neuropterous scolopendriform larva and a Trichopterous imago. Hence, if we retain for such insects M. Latreille's name of *Megaloptera*, the order of

Neuroptera

may be entered at the genus *Chauliodes*, which may be referred to *Corydalis* as the type of its tribe. The principal forms among the *Neuroptera*, or those to which all in the order appear referable, are probably, 1. *Termes*, 2. *Corydalis*, 3. *Myrmeleon*, 4. *Libellula*, 5. *Panorpa*.

* Scarcely had the above been written, when Dr. Horsfeild, by a rather singular coincidence, inquired of me where he could procure any information with respect to a larva found on plants and trees at Java. It covers itself with a tube of straws glued together longitudinally, from which it occasionally protrudes a head like that of a Caterpillar. He kept it alive in a box for months, without being able to ascertain its perfect state. This is clearly something allied to *Phryganea*, although not aquatic. Can it be the larva of any insect which will occupy a place in one of the chasms which I have indicated between *Tenthredo* and the aquatic *Trichoptera*? I may here observe that M. Latreille has just announced a new Trichopterous genus (*Sericostoma*) resembling the *Lepidoptera* in the form and direction of its labial palpi, but of which "*la larve est terrestre et logée dans un tuyau en spirale*." These circumstances show that it is not the same genus with Dr. Horsfeild's Insect, but at the same time establish the important fact that the larvæ of *Trichoptera* are not necessarily aquatic.

Hence may be derived the following tribes :

Termitina	Metamorphosis semicompleta
Corydalina	Metamorphosis incompleta
Myrmeleonina	Metamorphosis obtecta
Libellulina	Metamorphosis subsemicompleta
Panorpina	Metamorphosis . . . . . .

Although these groups are laid down in the *Regne Animal,* I have no great confidence in their accuracy on account of our knowing so little of the exotic *Neuroptera*. The metamorphosis even of the common *Panorpa* is still unknown; and therefore it is entirely from theory that I conclude it, in the above arrangement, to be intermediate between that of a *Termes* or *Psocus* and that of a *Libellula.* If we consider indeed the extraordinary general resemblance which *Nemoptera* bears to the *Ephemeræ,* and which the *Panorpa hyemalis* of Linnæus bears to *Raphidia* and *Termes,* this idea seems not improbable. But even if it should be erroneous, this can never affect the truth of the principal fact we have to establish after the suggestion of M. Latreille, namely, that the essential character of the *Neuroptera* is a varied metamorphosis. Their larvæ undergo either incomplete, obtect, subsemicomplete or semicomplete metamorphosis, in opposition to the *Orthoptera,* which are subject only to semicomplete metamorphosis, or to the *Trichoptera,* which have it only obtect. But although the *Neuroptera,* like their corresponding order among the *Haustellata,* vary so much in their metamorphosis, the *Libellulina,* which are the types of the order, are subject to one which is peculiar. We proceed, however, with our affinities.

Linnæus gives the following singular description of an

How are these forms [illegible] in the other tribes of Lepidoptera
Papilionidae [illegible]
Sphingidae,
Bombycidae.
Noctuidae,
Phalaenidae.

insect, which seems to occupy nearly the same place among the *Mandibulata*, as a *Thrips* among the *Haustellata*, and which he calls *Panorpa hyemalis: "Antennæ corpore breviores. Rostrum corneum cylindricum thorace longius. Thorax teres rugosus. Alæ maris* 4. *abdomine breviores apice incurvo subulato fuscæ. Abdomen maris muticum; feminæ ense terminali."* The next time we have an original observation on this insect is in Panzer's *Fauna Ins. Germ.* under the title of *Gryllus proboscideus! "Singulare admodum insectum, quod ad Gryllos* Fab. (*Acridina* Lat.) *propter antennarum situm atque fabricam habitumque pene cum Gryllis convenientem relegavi. Mira* fabrica *oris, quippe proboscide ad instar Truxalidum instructa!"* We then find it in the French *Encyclopédie* again under its original name, Olivier concluding his description of it with the following words: *"Cet insecte n'appartient certainement à ce genre* (Panorpa); *il paroit en former un qui devra être placé peut-être parmi les Orthoptères."* Lastly, we have it as the Neuropterous genus *Boreus* of M. Latreille, of which the characters are, the first segment of the trunk enlarged into a thorax, and the abdomen of the female terminated with an ensiform appendage; in both which respects it evidently leaves the true *Panorpæ* for *Raphidia*. We are now very near, if not already arrived at, the osculant point of the circles of *Orthoptera* and *Neuroptera*.

Another insect, forming the modern genus *Mantispa*, which with Linnæus and Scopoli was a *Raphidia*, but which Fabricius and Pallas esteemed a *Mantis*, an insect which M. Latreille, in the *Genera Insectorum*, made Orthopterous, in the *Considérations générales* Neuropterous, which in the *Regne Animal* he again restored to the *Or-*

thoptera, and lastly, in the *Dictionnaire d'Histoire Naturelle*, seems inclined to consider Neuropterous, must without doubt have been as difficult a subject for naturalists to place as the *Panorpa hyemalis*. The theory of osculant groups, however, removes this difficulty; and in reckoning *Mantispa* to be nearly osculant between the orders of *Neuroptera* and *Orthoptera*, we have the satisfaction of adopting as correct all the above-mentioned opinions, which to appearance are so discordant. The construction indeed of the mouth, thorax and feet of a *Mantispa* differs not essentially from that of *Mantis*; while the transparent, reticulated and deflexed wings are truly those of a Neuropterous insect.

As we have now ascertained that an insect exists, leading from *Panorpa* to *Truxalis* or *Proscopia*, and another from *Raphidia* to *Mantis*, it follows that, accurately speaking, the orders must touch one another at some point, among the *Neuroptera*, between *Raphidia* and *Bittacus*.

ORTHOPTERA.

If there was reason for hesitation with respect to the types of the *Neuroptera*, there is not the least with respect to the principal forms of *Orthoptera*. Every entomologist seems to have been sensible of these forms, and often from their dissimilarity has been disposed to consider what are only tribes to be so many orders. Indeed no forms that are within the limits of an order can be more distinct from each other than those of a *Phasma*, *Truxalis*, *Locusta*, *Acheta*, *Blatta*, and *Forficula*; and we accordingly find that they have been considered as the types of so many groups by Linnæus. The affinity of *Blatta* to *Mantis* is acknowledged in the *Regne Animal*. The genus *Proscopia,* lately instituted by professor Klug of Berlin, one of the first entomologists of the present day, proves the proximity of *Phasma* to *Truxalis*; and no entomologist is ignorant that the chain of connexion from *Acridium* to *Locusta,* from *Locusta* to *Acheta,* and from this to *Blatta,* has been long since detected, and is now perfectly established. Hence some notion may be obtained of the contents of the Orthopterous circle, if we reckon the above-mentioned five genera as the types of the following tribes:

1. Phasmina
2. Acridina*
3. Locustina
4. Gryllina
5. Blattina.

But as this series returns into itself, and the Linnæan genus *Forficula* cannot be inserted therein without disturbing its regularity, we must agree with Degeer and Mr. Kirby that it belongs to a distinct order. That this order can only be esteemed osculant between the *Ortho-*

* The types of this family are the *Acrides* of Aristotle, and present one of the rare instances of an ancient name being properly applied in Entomology. Perhaps it is too late now to extend this plan; yet a greater service could not be rendered to Natural History than an edition of Aristotle's *Historia Animalium* from the hands of an able zoologist. That excellent work has been a sealed one to modern entomologists, principally because the founders of our present nomenclature opened it not for the purpose of study, but in order to save themselves the trouble of inventing new names. They seem to have taken the old Aristotelian words at a venture, without either considering their meaning or the context, and thus to have applied them to the first insects that came in their way. Among innumerable instances of this it may be stated that the true *Attelabi* were Orthopterous insects, and probably the same with our tribe *Gryllina,* including perhaps the Apterous Locusts. The *Tettigometra,* instead of being a distinct genus, was, as its name implies, the *Mother of the Cicada,* in other words the pupa: the Coleopterous insect, to which Aristotle applied the name of *Carabus,* was the modern *Lucanus*: *Spondylis,* or rather *Spondyle,* was the name given to the smaller *Staphylini* allied to *S. olens*: the *Clerus* of the ancients was the larva either of the *Galleria cereana* or *Tinea alvearia*: their *Bostrichus* appears to have been some male *Lampyris,* and their *Necydalus* the hairy larva of some *bombyx!*

ptera and *Coleoptera* the reader will perceive by referring to its place in the *Systema Naturæ*. The *Dermaptera*, for so they are termed from its having been the name originally proposed for the *Orthoptera* by Degeer, are in fact Coleopterous insects, with the metamorphosis and caudal appendages of true *Orthoptera*.

In the course of these various details I have taken little notice of the relations of analogy which may exist between the corresponding groups of adjoining circles. Indeed, my confidence in the accuracy of the foregoing tribes has not been great enough to induce me to give much time to this part of the subject, although relations of analogy are visible even from the simple position of the different groups in their series of affinity. I shall therefore content myself with laying this position of the series before the reader, to whom the investigation of such analogies may perhaps afford some amusement. In the present as well as in the similar table before given the order of affinity is represented vertical, and the order of analogy horizontal.

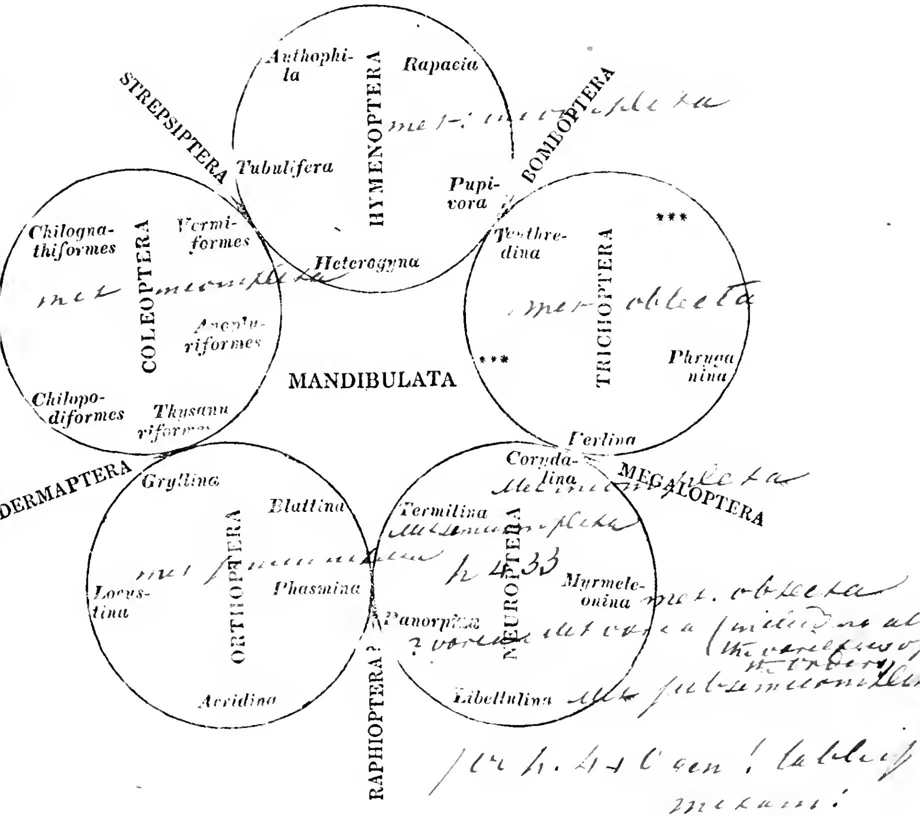
I. ORTHOPTERA.	II. COLEOPTERA.	III. HYMENOPTERA.	IV. TRICHOPTERA.	V. NEUROPTERA.
1. Phasmina	Larvæ Vermiformes	Tubulifera	Perlina	Corydalina
2. Acridina	L. Chilognathiformes	Anthophila	Phryganina	Myrmeleonina
3. Locustina	L. Chilopodiformes	Rapacia	* * *	Libellulina
4. Gryllina	L. Thysanuriformes	Pupivora	Tenthredina	Panorpina
5. Blattina	L. Anopluriformes	Heterogyna	* * *	Termitina.

If a diagram of these analogies be constructed on the plan of that given in the preceding chapter, the reader will perceive the same general order and the same apparent anomalies. But if we only recollect that the two extreme columns have their analogies inverted, the bare inspection of this table is sufficient for my purpose, which is to call attention to the vermiform appearance of the larvæ of a *Phasma*, *Raphidia*, *Tenthredo*, and *Ichneumon*,

—to the curious partiality which certain carnivorous insects, such as *Ammophila*, *Cicindela*, the Apterous Locusts of Africa, and the Myrmeleon, all possess towards a sandy soil,—to the gregarious omnivorous disposition of *Termites*, *Blattæ*, Ants and *Coccinellæ*,—and to the caudal appendages which give such a peculiar aspect to an *Ichneumon*, *Gryllus*, *Perla*, *Tenthredo* and *Panorpa*. The most satisfactory point, however, to observe, is the relation of analogy which connects Bees with *Phryganeæ*, and consequently with *Lepidoptera*. In this manner we perceive the real value of that similar structure of the maxillæ, from which M. Latreille has conceived an affinity to exist between two insects so different in general structure as *Melipona* and *Papilio*. If such be a few of the analogies brought immediately into view by an approximation to the truth so imperfect as the foregoing detail of affinities, what infinite order and beauty may we not expect on the developement of the Natural System!

The relations between *Panorpa* and *Myrmeleon*, between the *Mutillæ* and the *Ichneumon-Wasps* of Latreille, between *Silpha* and *Cassida*, *Gryllus* and certain *Acridina*, all show that the opposite points of the orders approach each other as usual*. With this consideration premised, we may now venture to exhibit the preceding details of affinity, as they may be collected into one summary view. The chief difficulty in this attempt is to discover the exact points of the Coleopterous circle, which communicate with the contiguous orders of *Hymenoptera* and *Orthoptera*. I could therefore wish this part of the figure to be regarded with distrust.

* It is perhaps by the circumstance of Anopluriform larvæ meeting the opposite point of the circle, and resembling Chilognathiform larvæ,



In this diagram I have marked the place of *Sirex*, *Sialis* and *Boreus*, as belonging to osculant orders, to which I have ventured to give the usual terminations in *ptera*, although ignorant of the just limits of such groups. If indeed

that we may account for the singular analogy which the larvæ of certain *Blattæ* bear to *Glomeris*. Some interesting examples of this may be seen in the collection with which Dr. Horsfield has lately enriched the Museum of the East India Company.

the above three insects should eventually prove to be the types of their respective osculant orders, they may in conformity to the method in common use be styled *Bomboptera*, *Megaloptera* Lat., and *Raphioptera*. As for *Mantispa*, I can scarcely conceive it to offer any type of form distinct from *Mantis*, from which indeed it only differs in having the wings of a Neuropterous insect. It is therefore an insect in the tribe of *Phasmina*, close to the osculant points of the orders of *Orthoptera* and *Neuroptera*. I shall only here add, that while from the inspection of this chain of affinities several deductions may be drawn, that particular one which seems to be of paramount importance to Natural History, is the artificial nature of the term *Order* as usually applied in an insulating sense. In Entomology, at least, an order can only be called natural when the epithet is assigned to a certain group, which, without being insulated, has in it one principal ganglion, whose character is in some degree imprinted on the whole of the contents. Thus the types of the five orders of *Mandibulata* may be represented by a *Carabus*, *Pompilus*, *Phryganea*, *Libellula*, and *Locusta*.

We have now completed a hasty sketch of the tribes into which the *Mandibulata* may hereafter with more certainty be subdivided. The review of them, however, affords a simple method of designating the orders, which hitherto I had only indicated by their analogical relations.

COLEOPTERA	*Larvæ variæ* . . .	Metamorphosis incompleta
ORTHOPTERA	*Larvæ hexapodes* .	Metamorphosis semicompleta
NEUROPTERA	*Larvæ hexapodes* .	Metamorphosis varia ✗ p 433.
TRICHOPTERA	*Larvæ cruciformes*	Metamorphosis obtecta
HYMENOPTERA	*Larvæ apodes* . . .	Metamorphosis incompleta.

The beauty of this natural disposition is, that the above three columns are so many chains of connexion, the vari-

Neuroptera &c p. 433. This Order exhibits types of all the Metam.: of the different Orders of the Mandibulata. ~~So~~ likewise does the Tribe of Diurna (Papiliones) exhibit types of all the various metam.: (or larvæ) in the Order Lepidoptera (and of the Ametabola) ation of which is perfectly regular. The metamorphosis, for instance, which is incomplete in *Coleoptera*, becomes semicomplete in *Orthoptera*, subsemicomplete in the types of the *Neuroptera*, obtect in *Trichoptera*, and then once more again incomplete. As for the orders themselves, we have seen them to pass most regularly into one another, excepting, however, the chasms which occur between the *Coleoptera* and *Hymenoptera*, and between the *Tenthredina* and the *Phryganidæ* of Lamarck.

These several remarks, which appear capable of very great extension, together with a recollection of the preceding statements respecting the *Haustellata*, must, I think, sufficiently evince the truth of Metamorphosis being the chief principle upon which the natural orders of Aristotle's *Ptilota* have been constructed. We observe that the table of affinities, inaccurate and superficial as it may be, turns out in the end to be also a table of the variation of metamorphosis. Hence it may increase the conclusiveness of our principal affinities, if, in the first place, it can be proved that metamorphosis is in these animals the maximum state of a general law of Nature, by which the whole organization of the being is gradually developed and made fit for reproduction; and if, secondly, we can show that the most distinguished among naturalists have united in expressing their conviction that considerations founded on metamorphosis must ultimately produce the most natural plan of entomological arrangement. Now, that neither of these propositions ought to be deemed incapable of demonstration, may, I think, be inferred from the following slight sketch of some of the most remarkable truths in Natural History.

It was perfectly in unison with the innate propensity

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of the human mind towards the marvellous, that the change of a caterpillar into a butterfly, when first noticed, should have been considered by the ancients as a true transformation irreconcileable with the ordinary course of nature. Even on the mystery being in a great degree cleared up by the discoveries of Libavius, Redi, Malpighi, and Swammerdam, the phænomenon continued to be termed metamorphosis; and perhaps it is even still a little owing to such circumstances that a natural process, neglected in other branches of Zoology, has always excited so much curiosity among entomologists. Metamorphosis, however, has been taken of late in a very general point of view, and rendered synonymous with that species of organic decomposition which, by means of continual shedding of the external envelopes, or even of the various integuments which may compose these envelopes, occasions that extraordinary characteristic of a living body, namely, that it never remains in a constant state or identically the same, but is continually assimilating new particles of matter as it throws off the old. And since no metamorphosis can take place except in consequence of these integuments being shed, perhaps it may not be altogether improper to survey the subject in this light. What I mean is, that we ought to regard the metamorphosis or change of form which certain animals undergo at various periods of their life, as an attendant upon, if not a variety of, the *ecdysis* or moulting, to which all organized beings are subject. There is, however, a great distinction to be made between the *ecdysis* of the *Vertebrata* and *Annulosa*; for in the former we observe little more than that the animal has quitted a sheath in which it was inclosed; whereas in the latter, the change is nothing else than if the skeleton were shed; for this name is surely deserved by those hard and solid parts which in so many cases afford support to the muscles. It is clear that such a process must occasion a crisis in the life of an Annulose animal incomparably more decisive in its effects than what can be produced among the *Vertebrata*, by merely being set free from an integument. All the marvellous, however, of *ecdysis* was with the earlier naturalists comprehended in the change of form, and consequently the shedding of the envelope only excited attention where it regarded a few of the *Annulosa*. Hence it was a great discovery of Linnæus that every Annulose animal ought to be considered as subject to metamorphosis. It may indeed have led to his more artificial notion of every externally articulated being having a nympha state; but even this helped Fabricius to give, although with a faulty nomenclature, a much more convenient division of metamorphosis than he could otherwise have devised.

Ecdysis, by which term is signified generally every change in the identity of the envelope of a living body, may either be complete or incomplete. If it be incomplete, or, which is the same, if the integuments scale off piece by piece, we have that mode of change which is peculiar to the most perfect of the *Vertebrata*, and to the least perfect of the *Annulosa*.

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εκδυσις.

Complete ecdysis is the shedding of the whole external envelope at once, of which we have examples among the vertebrated as well as annulose animals. It is of three sorts; First, where the external envelope is shed without producing any essential change of form, except inasmuch as may relate to the increased size. In those larvæ of insects which become inactive in their pupa state, such a process may always be distinguished from the true metamorphosis; but in Apterous Hexapods having active nymphæ they are necessarily confounded. It is also visible in reptiles and spiders, where such appendages of the trunk as have been lost may be reproduced by continued moulting. When the various envelopes are all cast as it were in one mould, it is to be expected that the proper form of the animal should reappear as these continue to be thrown off. The return therefore of a spider or crab, after having lost a limb, to its original form, may be in some measure understood as depending on the manner in which such animals shed their envelope; but that the limbs thus shot forth should be furnished with muscles and nerves, is, I conceive, what cannot be accounted for, except by referring to that polype nature of the cellular substance which is perhaps, in the opinion of some persons, the foundation of all ecdysis. If perfect Hexapod insects cannot reproduce their members, this inability may probably proceed from a cause which appears to have produced the same effect among *Mammalia* and Birds, to wit, that these animals in their perfect and final form are all subject, if to any, at least to a very imperfect ecdysis.

The second sort of complete ecdysis is that where the under envelope has been cast in a somewhat different mould from the upper; so that in the course of the moulting certain new parts become gradually developed without the general form being in any material degree altered. This is observable in every Annulose class, as well as in Humboldt's Axotl among the *Vertebrata*, and is the first species of change which merits the name of Metamorphosis. It includes the *Metamorphosis inchoata* and *Metamorphosis dimidiata* of Latreille, and is the same with the *Métamorphose partielle* of Lamarck.

The third sort of complete ecdysis is that wherein by some two or three moultings, generally the last which the animal has to undergo, the form is entirely changed, as well as the number of appendages more or less increased. This is clearly a true Metamorphosis, and includes the other two sorts of complete ecdysis; for we have here combined a total casting of the integuments, a developement of additional appendages, such as feet or wings, and finally an entire change of form. Such a combination may be witnessed among the *Vertebrata* in Frogs, and among the *Annulosa* in certain Hexapod insects. Hence, in confining ourselves to plain and open ecdysis, there will be no great error in stating that the most imperfect takes place in the highest *Vertebrata* and the lowest *Annulosa*; while the most complete ecdysis is that which is seen to prevail in the highest *Annulosa* and some of the lowest *Vertebrata*.

In strict accuracy, however, it appears that we ought to acknowledge the existence of complete ecdysis throughout the circle of *Vertebrata*. Nay, some physiologists have attributed insect Metamorphosis itself to a shedding of an envelope analogous to that which contains the fœtus of the more perfect *Vertebrata*. As every embryo, whether animal or vegetable, is inclosed in a tunic more or less solid, which is its chorion, so, proceeding with the analogy, they conceive that there must be some condition for every animal, similar to the state of the fœtus of the more perfect animals when surrounded by the amnios; and this state in Batrachian reptiles and Hexapod insects they hold to be the larva. The only danger of this reasoning is, that while we find the birth of an animal to be attended with complete ecdysis, we may be apt to imagine that every complete ecdysis betokens a true birth. It would however be truly absurd to consider the casting of their shell by *Crustacea*, or the periodical moulting of the serpent, in this light; yet no one can doubt the fact of both of these being cases of complete ecdysis, only differing from that of *Lepidoptera* because in the former animals the internal envelope is always of the same form as that of which it is to take the place. The truth perhaps is, that we ought only to allow two states to every animal, a perfect and an imperfect state. Then, by the reflection that no animal out of the circle of *Acrita* can ever arrive at its perfect state except by means of Metamorphosis, and that when perfect it can never again be subject to this change of form, though it may still moult or shed its external envelope, we may be able, if not to comprehend the cause, at least to know the effect of some of the most puzzling phænomena in nature. The true criterion of animal as well as vegetable perfection is the ability to continue the species; hence some of the *Vertebrata*, as well as *Annulosa*, gaining this faculty before they have arrived at their proper type of form, metamorphosis ceases, and they preserve the shape of larvæ.

But if a complete ecdysis may sometimes create a total change in the external appearance of the animal, the fact, however astonishing, is nothing in comparison with the internal metamorphosis which accompanies it, and of which as yet no philosopher has been able to give any satisfactory explanation. The generalization indeed by which we have reduced the moulting of a bird's feathers and the metamorphosis of a butterfly to one principle, may appear to be strained beyond its proper limits; yet if we contemplate the regular gradation from one to the other, how truly for instance the inactive pupa of a Beetle corresponds with the agile nympha of a *Gryllus*, how this ecdysis in an Apterous *Gryllus* corresponds with the sloughing of a spider; and this again with the annual renovation of the serpent, we must be sensible that however dissimilar the extremes may be, all these changes are modifications of one principle. But what more particularly deserves remark is, that these extremes should often be visible in neighbouring groups; nay, in the same order; that, in short, metamorphosis should differ so much in degree even where the animals are near in affinity. An Orthopterous insect may preserve the same form and habits from the instant it quits the egg up to the period of its death, the only qualities obtained by ecdysis being an augmentation of size and an aptitude to continue the species. But if we turn to the order of *Coleoptera*, which is contiguous in affinity, it is truly wonderful that by metamorphosis not only the form but the nervous and digestive systems may be altered, and the organs connected with these primary functions may all be of a construction different from that which they originally possessed.

Those changes in the instincts of the same insect which every person must have observed to result from metamorphosis being considered, it is to be expected that the nervous system of the larva and imago will prove different on dissection; but the difficulty is to understand how any such complete alteration in the nervous system can be effected while the identity of the animal is preserved. The larva of an *Oryctes nasicornis*, for instance, has, proceeding from the lateral and somewhat posterior lobes of the brain, two nerves, which having embraced the œsophagus constitute what may be termed its *medulla spinalis*, which is here a large fusiform ganglion formed by the agglomeration of smaller ganglions, from which the nerves diverge to supply the various organs. Another pair of nerves which proceeds from the brain, on uniting above the œsophagus forms a small ganglion, which is the origin of a single nerve called the *recurrent*. This supplies the coats of the stomach and intestinal canal. In the perfect insect, on the other hand, the double knotted longitudinal cord of the *Annulosa* is very distinct, and the animal would seem to have changed a *spinal marrow* for a *sympathetic nerve*.

Similar changes to a greater or less amount take place in other insects. Nor does the system of nutrition undergo a less extraordinary transformation by metamorphosis; for, to take again the larva of the said *Oryctes*, we find that not only the structure of its mouth, but the whole form and disposition of its intestinal canal are undiscernible in the perfect insect. The same circumstance holds good in the Frog, which in its perfect state has the short narrow intestine proper for an animal destined by nature to feed on insects; whereas while a tadpole, it possessed a long spiral intestine, such as better suited its herbivorous disposition.

If, finally, the alterations developed by metamorphosis in the organs of respiration and generation be taken into view, we must be absolutely convinced that the Naturalist cannot neglect the particulars of ecdysis in his arrangement of the *Annulosa*, without resorting to artificial principles in their stead. From the study of Metamorphosis, indeed, we may be said to learn every circumstance of the lives of such animals as are guided solely by instinct; and just as a knowledge of the whole life of an insect must make us better acquainted with its nature than a mere description of one of its forms, in the same proportion ought Metamorphosis to outweigh every other principle of arrangement.

There is perhaps no maxim in the *Philosophia Entomologica* more sound or more worthy of notice than the following: "*Larva alimento proprio nutrit imaginem latentem in adultiorem ætatem.*" And indeed when we trace the natural history of a *Libellula* from the egg to its perfect state, no clear idea of the truth can be formed, except by conceiving one animal to be so inclosed in another, that the imago is in some measure distinct from the larva, and is only declared to view by the death of the latter. Hence a system unconnected with metamorphosis may be reckoned to take no more notice of half the number of true insects, than if they never had existed. It is the defect both of the artificial system in Entomology, and of the sexual system in Botany, that they become useless, except when the objects of the respective sciences are before us in one particular state, which is often the most transitory of their life. Unless this condition be fulfilled, such systems lose their sole and peculiar merit of being dictionaries by which natural objects may be named. There are thousands of organized beings, to the history and knowledge of which the disciple of Linnæus or Fabricius has no clue whatever; although perhaps they are in that state of their existence which most directly affects the interests of man. Plants not in flower, and insects not in their declared state, constitute an ocean of difficulties in which the most skilled in Linnæan nomenclature will founder, unless he have other beacons than such momentary considerations as are afforded by the number of stamina or the form of antennæ.

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There is surely, therefore, reason to think that it would be an immense improvement on a *Species Insectorum*, and would, as much as any thing whatever, benefit the philosophy of the science, if larvæ were classed on artificial principles. Rather than that they should be totally neglected as at present, it were better with Aldrovandus and Mouffet to consider them a separate tribe of animals, or even to return to the classification of Aristotle, and place them with worms. Little matters it to say that they are not distinct animals from others duly classified, and therefore deserve not a separate description. Such an argument might be admirable, if the natural system were in question, as this would be sure to take some notice of them; but is wholly inapplicable to an artificial system, which is defective whenever we are not enabled by its means to discover the scientific name for any object that may fall in our way.

The natural system, when discovered, will doubtless combine a view of every property and peculiarity of species, with a certain perception of the manner in which these characteristics vary. Now in Entomology, every approach to this *beau idéal* must evidently be inconvenient—nay, unintelligible to persons commencing the study, because it pre-supposes a knowledge of animals, which they have on the contrary to acquire. And this is the objection that Reaumur made to the system of Swammerdam, in a passage of his *Mémoires sur les Insectes,* which, by the way, notwithstanding the acknowledged faults of Swammerdam's system, induces me to suspect that he himself was insensible to the full value and drift of those facts which he has so ingeniously compiled. To deem Entomology only as a science, by the help of which insects may be named with the least possible trouble, was a bitter satire on his own invaluable labours, as they respected true philosophy.

The following passage of Degeer will show us how different a view of the matter was taken by a better naturalist, and scarcely less celebrated physiologist.

"*Swammerdam a établi les classes sur les métamorphoses des insectes, et M. Bonnet a donné l'ébauche d'une division générale des insectes, fondée également sur leurs métamorphoses. De tous les plans de division celui-là paroit assurément la plus naturelle; car, comme dit M. Lyonnet, La diversité qu'ont les insectes, savoir que les uns changent de forme, et que les autres conservent toujours celle qu'ils ont reçue en naissant, cette diversité suppose en eux une disposition d'organes, une construction intérieure, un méchanisme si différent, qu'on peut dire, que rien ne les distingue plus essentiellement les uns des autres.*" Degeer nevertheless felt as strongly as Reaumur, a truth which escaped the notice of Swammerdam, that an artificial system ought never to be founded on metamorphosis; but he had more sublime notions of nature, than to suppose that metamorphosis must therefore be totally independent of system. That however which is most singular, and which shows that Reaumur's opinion must have arisen from any other cause than an incapability of perceiving natural affinities, is, that he almost invariably adopts metamorphosis for his guide, whenever he pays any regard to arrangement. This is, as if he had said, I do not place much faith in systems, still less in the existence of a natural system; but if any such should exist, Metamorphosis must be the leading principle upon which insects have been constructed.

The English naturalist therefore experiences no small satisfaction on reflecting, that Ray*, the expounder of

* Rarely can England be accused of being taught by foreigners to do justice to the merits of her sons. There are however instances of her ingratitude in this respect, and no where is it more manifest, than in the case of John Ray. Whether his views were too profound both for the age in which he lived and for that which succeeded him, or whether true science was forgotten in what the late Dr. Gordon termed the pleasure of expounding riddles, cannot now be determined; but certain it is, that the services

those orders of *Metamorphota*, which Linnæus did little more than name, and the founder of that classification of *Ametamorphota*, which the other did no more than adulterate, was one of the original advocates of a maxim which does honour to Fabricius: "*Metamorphosis insectorum ad ordines naturales viam pandit, ideoque semper observanda et distincte tradenda.*" If to the authority of Ray that of Lister and Willughby be added, I suppose we shall have cited the three greatest names in Zoology of which England can boast; and if I should err in considering Metamorphosis the key to the natural arrangement of the *Annulosa*, it will always be some consolation to think that I have erred with such men. But it is impossible that I can have much deceived myself in this respect; it is incredible that such footsteps can have led me far astray from nature, when the consequences of following them manifestly produce an uniformity of plan, a general harmony of one part with another, which afford the best proof that any fault which may be discovered in the preceding remarks, ought not at least to be attributed to the method of investigation.

It is but too true, however, that the Linnæan school, and more lately that of Lamarck, have been led into error by observing that the methods of Swammerdam, Lister,

of this admirable philosopher have never in this country been properly appreciated. To say that he was a great naturalist, is not enough; we ought to add that in Zoology at least he was the master of Linnæus, and that but too often the depth of his views appears to have been beyond the comprehension of his pupil. The only advantage over him which Linnæus enjoys, is not in the general conception of the animal kingdom, but in the clearness of details; not so much in the power as in the facility which the latter acquired of communicating knowledge by means of his unrivalled artifice of nomenclature. At last the cloud which has so long eclipsed the reputation of Ray passes off; but they are not his countrymen who can claim the credit of having dispelled it. M. Cuvier styles him "*le premier véritable méthodiste pour le regne animal, guide principal de Linnæus.*" How far the latter has acknowledged the obligation, his various works testify.

Ray, Reaumur, Roesel, Bonnet, Lyonnet and Latreille, which are all in some measure founded on Metamorphosis, have become useless, both as dictionaries and as tables for displaying those affinities which exist in nature. The cause of their thus being inconvenient as artificial systems, while they do not fulfill the object of the natural system, is, that their inventors have all proceeded on the notion of the existence of absolute divisions in nature, and moreover have all confounded relations of analogy with those of affinity. To understand this, let us return to the classification which I have attempted to give of Ecdysis. It has in this chapter been divided and subdivided, and the division may perhaps have helped to diminish the obscurity which may possibly ever attach itself to the nature of metamorphosis. Yet if any person, fancying that his ideas on the subject are become more clear, should apply this classification of Metamorphosis to the classification of insects, a system from his attempt will arise, confused and artificial to a degree which is almost incredible till seen. For instance, if we class together all *Annulosa* which undergo that change of form which I have made the second division of complete Ecdysis, that is, the *Métamorphose partielle* of Lamarck, a group is formed in which the *Myriapoda*, certain *Branchiopoda* and *Arachnida*, the winged *Orthoptera* and *Hemiptera*, are all combined. Again, taking the first division of complete Ecdysis as the character, another group in like manner consists of the majority of *Crustacea*, *Arachnida* and *Ametabola*, with the apterous *Orthoptera* and *Hemiptera*. However manifest these two divisions may be, and however well grounded on the classification of Metamorphosis, of which we have seen the importance in Annulose economy, they give origin to a chaos of confusion at utter variance with nature and her affinities. Yet such a system is nearly the same with that proposed by Swammerdam and Ray, who, after smoothing down its contradictions as much as was really possible, left spiders and worms in one group; *Orthoptera, Hemiptera* and certain *Neuroptera* in another; and *Lepidoptera* and *Coleoptera* in a third. On looking at such a scheme, I think we cannot wonder much at naturalists rejecting it, both as an artificial and a natural method of entomological arrangement. Whether they have been equally right in rejecting along with it Metamorphosis itself as a principle of distribution, is quite another matter, and will depend on the opinion of the scientific world, as to the accuracy of those authorities I have cited, in order to establish my details of affinity. Grant that only one fourth part of these authorities may happen to be in the right, then it must be further allowed, that a classification of insects in admirable harmony with nature may be constructed on Metamorphosis, not indeed on its division or differences, but on its method of variation. And this perhaps may be held to be the compend of a *Philosophia Organica*,—that it is an error to confound the distribution of the works of our Creator with our own method of dividing a subject into heads for the sake of perspicuity. In other words, I imagine it to be proved by the whole of the preceding chapters, that *when a system depends on the division of organs or properties, it is artificial; when it depends on their method of variation, it is natural.* This truth, which seems not without its use even in metaphysics, I had a great wish to place among my definitions, but was deterred by feeling that it is too contrary to certain old established maxims to pass at first sight unquestioned.

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A more appropriate example of the consequences of not knowing what has just been explained, cannot be given than the system of Fabricius. That he was an acute man is testified by the *Philosophia Entomologica*; that he was well versed in the knowledge of species appears from his other works; and the reader must have witnessed in several of these pages, unequivocal marks of his not having been by nature incapable of perceiving an affinity. Indeed it would be very extraordinary if he should have been but little above the ordinary level, whose memory is honoured in Germany as that of the greatest naturalist it has produced. Yet there is no hazard whatever incurred in asserting that the system he invented, although originating in considerations of the first importance, is one of the most artificial of the multitudes that have been proposed for Entomology. Of this, although the cause escaped him, no one was more aware than himself, as he shows by a total disregard at times of the most essential parts of his method. The Linnæan school has therefore condemned the adoption of any such principle as the structure of the organs of manducation, just as Swammerdam's failure drew down their invectives on metamorphosis, without occasioning on their own part the production of any much less objectionable arrangement. Indeed it appears impossible that there should be a great distinction between any two of all their systems in value, since the generality of Entomologists have split on the same rock, and regarded only the actual difference between the structures of animals, and not the manner in which this difference takes place. If Fabricius even had bestowed half the attention on the method in which the organs of manducation vary, that he has on his own division of them, and this is not much, the *Systema Entomologica* would have been nearly as consonant with nature as it is now the reverse. Any principle of distribution, whether wings or tarsi, antennæ or maxillæ, though perhaps not always convenient, is in itself good; the difference in the effect consists wholly in the method of using it, and there is no principle so good as not to become worse than useless by being applied improperly. Relations of analogy themselves seem to be of little use in prescribing exact limits to a group. Nay, when we employ such relations as absolute characteristics of all the contents of a group, then the most natural of characters become artificial. Thus Metamorphosis constitutes the basis of the analogy which reigns between the corresponding orders of *Mandibulata* and *Haustellata*. Yet if it be used to circumscribe these orders with precision, the extremity of some of the most natural groups, such as the *Diptera*, will be divided from those types to which they evidently are referable. Hence we may conclude that the variation of Metamorphosis is only an index of the series of affinity, and not a principle by which the orders have been strictly circumscribed.

Notwithstanding the importance in Zoology of this maxim of variation, it has never that I know of been clearly expressed; and, as it has certainly never been acted upon, we may doubt that it can have been distinctly understood. The only author in whose works I have been able to trace a vestige of it, is that great philosopher whose merits I have occasionally canvassed with severity, both for the sake of benefit to science and of justice to Ray,—most assuredly not from any unworthy wish to detract from his just meed of fame*. Botany is the true province of Linnæus; there he claims the prize of pre-eminence, and there he must stand or fall according to the judgement of those philosophers who in the cultivation of that charming science are able to carry their ambition beyond ascertaining the name of a plant. But the most original of the botanical works of Linnæus, belongs in certain respects as much to the zoologist as to the botanist; and there are some even who think that, with an exception in favour of his powerful instrument of Nomenclature, he never conferred such a benefit on Zoology as by the publication of his *Philosophia Botanica*. Here we find that what by his

* It cannot be supposed, however, that my partiality for a science, injured as this has been by a belief in the infallibility of Linnæus, should have excited any great anxiety to conceal his faults. In every attempt to serve the cause of Natural History, my rule has been "*fari quæ sentiam.*" Had there been in this country any regular and efficient school of Zoology, such remarks would not have been left for me to make; but unfortunately in those classic scenes which derive no small portion of their fame from a Ray, and a Lister, the existence of Zoology as a science is in these days scarcely suspected. Well may the foreigner who beholds our learned establishments so splendidly endowed, note, among the most remarkable circumstances attending them, that in none whatever should there be a zoological chair. It is not for me to enter into the causes of this, else it were desireable to know why plants should have been deemed worthy of attention, while animals have been utterly neglected. I can only acknowledge with regret, that such has been the case. If it be said that lectures on natural affinities are included in some course of comparative anatomy, I am truly glad to hear it; but if it be urged that the knowledge of comparative anatomy implies that of the animal kingdom, I deny it totally, since comparative anatomy is only the instrument of Zoology; and while no man can be versed in natural affinities without some acquaintance with comparative anatomy, examples may easily be specified of comparative anatomists who know nothing of Natural History. It is true, that there are professors of Natural History in three of our Northern Universities: and indeed the zeal, the liberality, and justly celebrated acquirements of one of these gentlemen are likely to produce the most beneficial effects to science at large, as well as to the learned body which he adorns. But we must not conceal the fact, that a professorship of Natural History is necessarily charged with duties that give ample employment in Paris to thirteen professors with their numerous assistants. I have ventured to give this humiliating picture of the state of zoological instruction in Great Britain, because there are persons who affect surprise, that in that science which relates to the animated works of God, France should take precedence over a nation incomparably more religious.

disciples have, in pursuance I suppose of an expression in the *Classes Plantarum,* been always called Natural Orders, he himself with admirable caution also named *fragments of a natural method;* by this implying that the intervals which separate them are not natural, but the consequences of our ignorance of species. Hence we have the observation, "*Plantæ omnes utrinque affinitatem monstrant uti territorium in Mappâ Geographicâ,*" which, to be sure, is sufficient evidence of his never having suspected much regularity to exist in the creation. Still more to the purpose therefore is the remark which follows, "*Defectus nondum detectorum in causâ fuit quod methodus naturalis deficiat, quam plurium cognitio perficiet; natura enim non facit saltus.*"

Now, although no where can I find it positively expressed, and although the Linnæan definition of genera appears even in opposition to it, I conceive this idea, that absolute divisions do not exist in nature, to lead directly to that which is still more important, namely, that the only probability of our ever understanding the great scheme of the creation must depend on studying the method in which the organs and properties of natural beings vary. All true knowledge of Natural History hinges on this—*Ordinis hæc virtus erit et venus.*

CHAPTER VIII.

GENERAL REFLECTIONS ON THE SYNTHETICAL METHOD.

In the first Chapter of this Essay, it is stated to be my firm belief, that one plan extends throughout the universe, and that this plan is founded on the principle of series of affinities returning into themselves, and forming as it were circles. The time is at length arrived, when the reader has the means of deciding whether this presumption was warranted by facts, or whether it ought to be considered as the mere offspring of an ardent imagination under the bias of a favourite theory.

In the first part of this volume, I discovered by analysis three instances of progressions of affinity returning into themselves; namely, in the circles of Saprophagous and Thalerophagous *Petalocera*, and of Thalerophagous *Rectocera*. Still more minute analysis enabled me to perceive the same rule of progression in the genus *Phanæus*, which is so singularly characterized by the want of ungues to the tarsi.

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In the present essay, on the other hand, the opposite method has been adopted; and while we make use almost entirely of the observations of others, the same effect is uniformly seen to be produced. A degree of order, unity and harmony appears to prevail throughout a great portion

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of Nature, far, I confess, beyond what two years ago would have been by me conceived possible to exist amid such infinite variety of form. This order, thus deduced in the first case from experiment, and then confirmed by the observations of the most celebrated naturalists, became by

Analysis

analysis apparent in the plan upon which a genus of South American insects has been constructed, and by synthesis is now seen to extend to those primary groups which compose the whole of the animal kingdom. Can we then suppose that the collateral branches of Nature present nothing

Synthesis

but confusion, when, in that which we have happened to investigate, there appears a design so consummate as to have no limit except in our power of understanding it? In one part of Nature we discover affinities and their attendant analogies all combining to one sublime effect, intricacy upon intricacy, yet apparently capable of being reduced to the most simple regularity of plan. Is it then possible to suppose that the rest of organized beings constitute a chance-medley map of reticulation, as some seem to think, or offer to the view a few scattered fragments of a temple now in ruins, as others have esteemed them to be? Or, if it be granted that order of some kind does exist in those collateral branches, which have not fallen within the scope of our investigation, is it credible that one plan should have been uniformly adopted for that vast and essential part of the universe which has been the subject of the preceding pages, and another plan for the rest? These are questions which must be left for the reader to answer. I shall merely observe, that he who can readily assent to such opinions has undoubtedly the right, but he alone, to give his verdict against me for having too hastily formed a general hypothesis with respect to nature. I do not however fear that such a verdict founded on such grounds can ever be the verdict of the majority; and at all events less blame must fall to my share than was incurred long since by the ingenious author, who, without the same reasons for it, has expressed the same sentiment. "*Dans ce qui appartient à la nature tout est lié, tout est dépendant, tout est le résultat d'un plan commun constamment suivi, mais infiniment varié dans ses parties et dans ses détails.*"

Indeed, had it not been that now the belief of one general plan extending throughout the universe seems justifiable, it might be doubted whether the preferable course of proceeding would not be to omit the present chapter altogether. We might question whether it would not be better to have immediate recourse to analysis, rather than to pursue any further the synthetical plan, while destitute in so great a degree of the information necessary to support it. Thus every interruption to the synthetical method of investigation is not only inconsistent with the particular path traced out for this essay at the commencement, but is moreover losing sight of its very object and sole use. On the other hand, again, the accurate designation of the more minute groups of *Coleoptera*, in the actual state of our acquaintance with them, is quite an impossibility, and every attempt at it, unless founded on analysis, deserves to be considered as little better than vague speculation. Objections thus presenting themselves to each alternative, I have resolved to sketch slightly the leading affinities of the *Coleoptera*, in order to preserve as much as possible the plan originally laid down, while at the same time, to prevent the possibility of great errors creeping in, I shall abstain from offering at present all remarks, the tendency of which may be to define by synthesis the subdivision of this order.

The chief cause of our being placed in this dilemma, is the almost total ignorance which prevails with respect to Coleopterous larvæ. It is true, indeed, that names and general characters, drawn from the analogy which these larvæ [illegible] bear to the five different types of form which compose the circle of *Ametabola*, have been bestowed in the preceding pages on the leading groups or tribes into which the order of *Coleoptera* may be divided. But these characters are by no means to be understood as rigorously exact. If it be possible ever to assign such, it can only be after a series of minute observations, and a much more accurate examination than any to which the larvæ of insects have yet been subjected. Now, however, that the science of Entomology is so nearly relieved from the ignorant prejudices which have prevented its cultivation, there is reason to hope that this branch of the physiology of insects will no longer be overlooked. It is very sure that the economy of the greatest part of these animals is most calculated to excite curiosity, and most connected with the interests of man, while in the first stage of Metamorphosis; and moreover that they would, while in this state, have undoubtedly engaged particular attention from the observers of Nature, had their forms been but more attractive to the eye.

In the researches here recommended to entomologists, great advantage is in my opinion to be derived from a careful consideration of larva forms with reference to the *Ametabola*; for of these we may see even the more singular and eccentric genera represented by the larvæ of *Coleoptera*. The larva of *Anthrenus*, for instance, bears a strong likeness to a *Polyxenus*, while that of the genus *Gyrinus* resembles a *Scutigera*. Thus does every step we take in the study of nature, unfold to the view new instances of her attachment to certain general principles of form, amid a variety in the details which truly appears to be inexhaustible.

The following indications, which relate rather to the contents of the tribes than to the order of affinity in which these contents are distributed, will be found useful, not as being the truth itself, but as being guides to the truth. It must be well understood, however, that the designation of some of the contents of a tribe is not synonymous with the designation of the distinctions and affinities affecting the groups which compose it. The latter I do not aim at; and even in the specification of the probable contents of a tribe, there are many chasms yet to be filled up, particularly in the circles of Apod, Anopluriform, and Thysanuriform larvæ.

Tribes of Coleoptera

Chilopodiform

The types of the tribe of Chilopodiform larvæ are certainly those carnivorous insects which have four maxillary palpi. These form two great groups, one of which consists of the genera *Carabus* and *Cicindela* of Linnæus, and the other of the *Hydrocanthari* of Latreille. To the same tribe the genus *Hydrophilus* of Geoffroy ought to be ascribed; from which, by means of *Sphæridium*, we enter among the Chilognathiform larvæ. The type of this tribe appears to be the genus *Scarabæus* of Linnæus, or those insects to which, after the example of Dumeril, I have given the name of *Petalocera*. The tendency of Chilognathiform larvæ is herbivorous; and among them we have the Linnæan genera *Lucanus*, *Ptinus*, *Byrrhus*, *Hister*, *Elater*, *Buprestis*, and part of *Tenebrio* and *Dermestes*. By means probably of the genus *Bostrichus* of Geoffroy, we quit the

Chilognathiform

Apoda Vermiform Chilognathiform tribe for that of Apod or Vermiform larvæ. To this belong the Linnæan genera *Bruchus, Curculio, Attelabus, Cerambyx, Leptura, Necydalis,* and part of *Dermestes,* and *Tenebrio.* With the help of *Donacia,* so nearly allied to *Leptura,* we quit this tribe for that of Anopluriform larvæ, where we find the Linnæan genera *Chrysomela, Cryptocephalus, Coccinella, Cassida* and *Hispa.* These last lead us into the tribe of Thysanuriform larvæ, where we have *Meloe, Mordella,* with many *Heteromera** of Latreille, and perhaps *Clerus.* I suspect also that some

Anopluriform

Thysanuriform,

* I have lately come to the knowledge of the larva of the *Xylita buprestoides* of Paykull, the *Elater Buprestoides* of Fabricius, which ought not to be confounded with the genus *Serropalpus* of Hellenius. The *Xylita* belongs to the group of Thysanuriform larvæ, although not central, but approximating to the Iuliform larvæ, which are opposite. This is a proof of the acuteness of my friend M. Latreille. Although the affinity is not so close as to be readily remarked, he has said of the *Melandryadæ,* "*Ces Heteromères se rapprochent des Cantharis et des Meloe de Linnæus.*" As Thysanuriform larvæ are but little known, and as no confusion was ever greater than that which affects the genera *Serropalpus, Melandrya, Dircæa, Orchesia, Mystaxis, Xylita* and *Hypulus,* it may be of service to describe this larva. I shall merely premise that I have had no opportunity of dissecting it. *Larva* whitish, elongate, scaly, with few hairs, except about the last segment of the abdomen; body thickest at the middle and tail, upper side rather convex, under concave. Head semiglobular, with vestige of eyes. Antennæ triarticulate, short, with the first joints greatest. Mandibles short, strong and sharp. Maxillary Palpi acute at point, and labial excessively minute. Second segment of the body large, subthoraciform, and composed apparently of two segments. Anterior feet large, compressed, hooked, extending nearly to the top of the head; the two posterior pairs of the same shape, but so short as scarcely to reach beyond the coxa of the first pair, besides being in some measure hid in the concavity of the body. The third segment of the body is shortest, and the others lengthen gradually to the 12th, which is convex, and marked with strongly impressed points. But the singular part of the body is the tail, or 13th segment, at the base of which is the anal aperture. This segment is slightly convex above, and flattish below, but armed at the extremity with two sharp horny appendages, curved upwards. In colour and appearance, this forked process resembles the caudal appendage of certain *Forficulæ.* I am indebted for a knowledge of this larva to Mr. Samouelle, a gentleman as well versed in insects, as he is assiduous as a collector. He found it with the perfect insect in the solid wood of an old oak in Hampshire, and thus at the same moment added a new genus to the British Fauna, and an important fact to entomological science. M. Waudouer has found several of the same species at Nantes, in the same situation. It has little connexion with *Elater,* except by that property which opposite points of a circular group have of approaching each other in affinity.

of Latreille's *Malacoderma* will ultimately find a place in this group; but however this may be, the Linnæan genus *Staphylinus* certainly reconducts us from these insects to the Chilopodiform tribe of larvæ.

The opposite sides of the Coleopterous circle appear to meet in the cases of *Silpha* and *Cassida*. But here I must desist, as there is reason to fear that I have already gone more minutely into this subject, than my knowledge of it warrants. Some modern groups, indeed, I scarcely dare venture upon, particularly the *Melasomes, Taxicornes,* and *Stenelytres* of Latreille. These, as their names import, are so many magazines, which it will cost the Entomologist no small labour to elucidate.

Pentamerous insects seem chiefly to belong to the tribes of Chilopodiform and Chilognathiform larvæ. Apod larvæ seem almost all by metamorphosis to become Tetramerous Insects; Anopluriform larvæ either Tetramerous or Trimerous; and Thysanuriform larvæ either Heteromerous or Pentamerous. The nature of this variation in the number of joints in the tarsi, ought not to escape our notice.

If my observations had been sufficiently extensive to authorize the determination of the following problem, namely, whether the *Rectocera* and *Petalocera* ought to be considered as referable to one type of the subdivisions of the tribe, or to two, I might have ventured to designate the Stirpes into which the Iuliform larvæ may be divided, and consequently from analogy might have obtained more definite ideas of the composition of the tribe. To say the truth, however, I am inclined to think that the three Linnæan genera *Scarabæus, Lucanus,* and *Hister,* may be discovered hereafter to be all referable to one peculiar type. But this is mere matter of suspicion, or at least I can give no better proof of it, than what is to be found in the first Essay, and I therefore am unwilling at present to speculate on the assumption of its entire accuracy.

I may state however my belief, that future investigation will produce a table expressing the affinity of the Stirpes of *Coleoptera*, exactly on the same plan as those we have already seen. For if the groups of Iuliform larvæ be directly divisible into families such as those into which the *Petalocera* were resolved in the first Essay, then the uniformity hitherto so observable in the distribution of the animal kingdom no longer holds good, or at least the difficulty of reconciling such an hypothesis with this uniformity seems at present to me to be insurmountable. But the strongest argument in favour of my opinion, that there is an intermediate class of groups between those which in the last chapter I termed tribes, and those which in the first Essay were called families, is, that every Entomologist has acknowledged that the Linnæan genera *Scarabæus*, *Curculio*, *Cerambyx*, &c. are natural groups; and these would evidently be lost, did we proceed at once to divide the Chilognathiform larvæ into families, such as the *Melolonthidæ*, *Rutelidæ*, &c.

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This intermediate class of groups may, as before stated, perhaps be named STIRPES; and had they been properly determined, our next object would probably have been to resolve them into FAMILIES, unless indeed we can suppose that there exists still another intermediate class of groups. Here, however, unusual difficulties present themselves; for the *Lamellicornes* of Latreille appear to be decomposable into two distinct divisions of two circles each, which seems irreconcileable with what we have seen, unless we can imagine the *Rectocera* and *Petalocera* to be Stir-

Stirpes

Families

pes, and one of the two circles, into which each of these groups is divisible, to be osculant. This however is too violent a supposition, and besides, to say the truth, does not entirely destroy the anomaly; and therefore I am obliged to confess myself at present ignorant of the means by which the Iuliform larvæ are to be resolved into families. Nor do I see any other means of extricating ourselves from the obscurity in which this part of my subject is involved, than by an investigation of the Linnæan genera *Ptinus, Buprestis, Elater,* and *Dermestes,* upon the same principle as that which I have pursued in the analysis of Latreille's *Lamellicornes.* The deficiency of our information as to the subordinate affinities of the above-mentioned Linnæan genera, is so great that I do not feel myself authorized to proceed further by the synthetical method. But from the contents of this volume, I think the reader must be convinced that the *Scarabæus Sacer* is situated in nature nearly as follows:

1. *Animalia.* Ann: Sav:
    2. *Annulosa.* . . . . Subkingdom
        3. *Mandibulata.* . . . . Class.
            4. *Coleoptera.* . . . . Order.
                5. *Larvæ Chilognathiformes.* . . . . Tribe.
                    Acanthopoda? (Here occurs an uncertainty as to the groups from a deficiency of proper analysis.) Stirp Famil Genu
                        6. *Petalocera Saprophaga.*
                            7. *Scarabæidæ.*
                                8. *Scarabæus.*

Its place as a species in the genus *Scarabæus,* shall appear in the next chapter, when, with the exception of the investigation still requisite to show the relation which the

Petalocera, as a group, bear to the Chilognathiform larvæ, the object of this Essay will in some measure be fulfilled.

It would be wrong, however, to close thus, without alluding to a subject most important to the advancement and general interest of human knowledge, and intimately connected, as I conceive, with reflections that cannot fail to rise in the mind of every person who may believe with me, that one principle of arrangement extends throughout nature. It has been said, that a contempt for the exertions of intellect under forms different from ours, is as sure a mark of a narrow mind as that hostility, almost to be called hatred, which is sometimes betrayed by men of talent against those sciences which they are incapable of learning. Such is a sentence lately written by one of that school, of which, as he himself observes, it is the peculiar character to view all the sciences with an equal eye. Indeed it would be difficult to find within the whole compass of modern philosophy, a remark in which more true learning is displayed, or a maxim, I regret to say, more necessary than this to be impressed on our minds. That we should place the highest value on whatever we may have judged worthy of employing our time, is clearly to be expected; but that we should therefore not only despise but throw obloquy on what others may esteem a proper exertion of their intellect, can only be attributed to ignorance the most bigoted. "We content ourselves," says the excellent author of the *Wisdom of God in the Creation*, in the quaint but forcible style of his age, "we content ourselves with the knowledge of tongues, or a little skill in philology or history perhaps, and antiquity, and neglect that which to me seems more natural, I mean Natural History and the works of the creation. I do not discommend or derogate from those other studies; I should betray my own ignorance and weakness should I do so; I only wish that they might not altogether jostle out and exclude this. I wish that this might be brought in fashion among us; I wish men would be so equal and civil as not to disparage, deride, and vilify, those studies which themselves skill not of, or are not conversant in." In this respect perhaps no branch of science has had so much right to complain as Entomology; it has, within the recollection of many, been spurned as useless, condemned as trifling, and laughed at as foolish. Yet, as if to demonstrate the excessive absurdity and wickedness of judging any thing organized by the hands of Omnipotence to be unworthy of human notice, it so happens that of all branches of natural history, without exception this is the one in which we can best study that interesting scheme by which our own structure, as well as that of every other terrestrial being, has been regulated. This may seem a sweeping proposition; but the almost infinite number of species contained in the group of *Annulosa*, of which certainly more than a hundred thousand now exist in collections—the consequently easy gradation of affinity from one form to another, will always, in preference to any other branch of natural history, render this the field for investigating the nature of those general rules which may have governed the distribution of the universe. They may without doubt be also detected in other branches of Natural History, but no where so easily as in this; since the chasms are here not only narrower, but less frequent. In contemplating the otherwise unaccountable profusion of Annulose species, their diversity of manners, structure, and ornament, we almost fancy with Ray, that it was in order to teach us the Wisdom of God in the Creation, that they were called into being. Botanists and Zoologists, we are all in full pursuit of the same sublime object, the natural system. Now, without pretending to any extraordinary foresight, I think it may be asserted that we shall never owe so much knowledge of it to any branch of Natural History, as to Entomology. Time only can show whether this surmise be false; but if it should prove true, I cannot perceive how it should be in opposition to what we already know, that the despised worm has been employed to teach us our present material nature.

Man, however, is an animal whose ideas can reach beyond matter. And from this high privilege and peculiar characteristic it is, that in all ages he has been enabled to make his sentient principle the chief object of his interest and inquiries. There are sequestered moments, I believe, in the life of every person when the mind turns anxiously to the contemplation of its own nature. Whether we ought to look for much information on this perplexing subject from the future discovery of the natural system, it is at present impossible to say: but I cannot refrain from stating, that every step hitherto taken in the investigation of natural affinities, has afforded me additional ground for thinking that there are certain leading rules of connexion which extend beyond the limits of matter.

Under the head of Definitions, I have already attempted to give briefly those opinions on this momentous question, which seemed to me as indisputable in themselves as they were necessarily connected with a discussion on forms of matter. I may have stated there several propositions that required proof, but none, I verily believe, that may not in some degree be proved. An endeavour has constantly been made, to rest contented with a simple exposition of those principles which every naturalist admits to be incontrovertible truths,—such as the omnipotence of God, and the unity of our sentient principle. That mind must be lamentably warped by scholastic prejudices or sceptical theories, which can doubt such facts as these. The only assumption, with which I am likely to be taxed, is that of the existence of secondary operative causes distinct from matter, or at least not of necessity dependent upon it. As a promise was held forth that I should resume this subject, my reasons shall now be given for having taken that much disputed position, the defence of which will inevitably lead me to consider the true distinction between man and other animals. On a question so hackneyed nothing new ought to be expected here, and I feel that it would be ridiculous in me to attempt any thing of the kind. Nay, this point, so often debated, would never have been handled by me, had I not been sensible that many expressions in the preceding pages are liable to misconception. My aim therefore is not to launch forth any novel system of Metaphysics, but only to explain briefly,

First, my chief reasons for adopting, with a firm conviction of its truth, the doctrine of the immateriality of all operative causes.

Secondly, my chief reasons for believing that whatever relates to the sentient principles of the lower animals must ever in this world be seen, as through a glass, darkly. With these objects in view, I shall simplify, as much as I possibly can, the metaphysical nature of an inquiry so contrary to the usual researches of Entomologists, by comprehending it in a classification of the chief hypotheses that have been proposed on the sensations of animals. The word *hypotheses* thus applied to all of these theories must not startle, for it is unquestionably true that no opinion has yet been advanced, or perhaps ever can be advanced on the nature of the distinction between man and the brute, that does not involve some open or concealed assumption of what it is impossible for us to prove. The merits of the hypothesis must rest entirely on the probability of this assumption, and the following classification shall not therefore be according to the order of time in which these theories have been started, but as nearly as possible according to the apparent probability of the assumptions they involve. As this plan will show the connexion which exists between these several opinions, every shade of them that has been or may be formed, will more easily be comprehended.

It were needless to enumerate every obstacle that impedes our progress in this branch of Natural History. There are a few, however, which must not escape us; of which the chief indubitably is, that little, except the fact of its future immortality, having been positively revealed to us on the physical qualities of the sentient principle, we find materialists and immaterialists with equal zeal applying scriptural texts to the support of the most opposite doctrines. We ought also to take into consideration the fact that the majority of our ideas, even those of reflection, are during this life in some measure dependent upon the influence exercised by matter on our material organs. Hence it becomes peculiarly difficult for immaterialists to preserve their ideas of spirit and matter separate. The purity of the one is generally contaminated by certain lurking notions, which a little analysis of our thoughts soon convinces us to have been derived from the other. Another prominent difficulty is, that, whatever be the nature of the sentient principle, we can only be acquainted accurately with our own individual feelings. Uncertainty thus attending our knowledge of what really operates in the minds of others of our own species, it is little to be wondered at, if all our speculations on the perceptions of animals of a structure different from our own should be shrouded in comparative darkness. In the examination of the sentiments which agitate or appear to agitate such bodies, analogy ceases to be of much use, and we are obliged to rest content with no better guide than conjecture.

The last, but by no means the least obstacle to these researches, which we shall take notice of, is the absolute inability of the human soul to comprehend perfectly in what manner a being can be omnipotent. Nothing is so manifest as that the Primary Cause must be omnipotent; yet it scarcely seems possible, in the imperfect state of our faculties, to imagine a divine attribute without at the same time limiting almighty power. Few persons are aware how much this subject was formerly connected with Natural History, or how much injury was formerly done to the science by erroneous notions of omnipotence. The older philosophers, whether materialists or not, seem all to have entangled themselves in a maze of difficulties, when they took up the most useless and hopeless of all researches, and laboured to discover what works were compatible with omnipotence. Their inquiries were directed not to the actual state of the creation as it appears to be formed, but to the means by which it has arrived at its present state. Hence came those subtle scholastic questions relative to final causes, which as long as this world exists will afford matter for disputation. Few thought of ascertaining what things do exist, still fewer of the manner in which they exist; but all were anxious to know by what means they were created. Almost the only question was, whether God ought to be considered the immediate cause of the effects we daily witness, or whether he has employed mediate agents, such as λόγοι σπερμάτικοι, settled laws, plastic natures, and a host of other instruments; of which, granting them to exist, as possibly they may, we have equally clear notions. Every decision on this subject has however been futile. The most cogent argument, for instance, which Cudworth advanced in favour of his *plastic nature*, was founded on the apparent errors of organization, those *lusus naturæ* which argue the agent, as he fancied, to be imperfect. One does not, however, easily see why he should have taken it for granted that these are imperfections which frustrate the particular, as well as what we suppose to be the general views of the Creator. Nor is it very clear how the choice of an erring agent in the creation, can be less derogatory to omnipotence than direct error. But, after all, the most singular argument of the advocates of mediate agents has been, that the Divine Being must necessarily be distracted among the mean, trifling and infinitely numerous things which demand his attention, on the supposition that he acts directly. I think I need cite no more examples to prove that it does not follow because a man calls his maker Almighty, that he believes him to be omnipotent.

Having thus mentioned a few of the principal difficulties which will ever throw some doubt and mystery round even the most probable of the hypotheses which follow, we may now refer to a subject which appears in itself indeed more comprehensible than Omnipotence, but of which nearly as little appears with certainty to be understood,—the nature of sentient principles, other than the human soul.

We may pass over those who pretend to disbelieve the evidence of their senses, and to doubt the existence of matter. No man of this way of thinking, can rationally take up a book on Natural History, much less can he have studied it; and we turn therefore to the equally absurd dogma of those, who on the contrary deny the existence of every thing but matter.

1. This, which is the most simple kind of materialism, was the celebrated system of Spinoza, so ably refuted by Clarke and Cudworth. There is nothing in the universe, says Spinoza, but matter, which is the universe or Deity, and has cogitation among its other attributes. It is sufficient to observe, that by this impious, if intelligible proposition, time and space were denied existence, since they are clearly distinct from matter, and therefore could have no place in the universe of Spinozists!

2. Next therefore come those who acknowledge the existence of something in the universe besides matter, and who even believe in the immateriality of the Deity, but insist that the sentient and cogitative principle in man is not distinct from the body, but the result of its organization. With such persons sensation is nothing else than a variety of material life, and reason little better than the conflict of various appetites.

The advocates of this opinion may be ranged under two heads:—viz. those who believe in the authority of revealed religion, and those who do not. Both proceed to a certain point on the same reasoning, and argue, that as the powers of perception and thought have never been found but in conjunction with a certain organized system of matter, therefore those powers necessarily exist in, and depend upon such a system. But this is clearly the same assumption as that made by Spinoza; namely, that no sentient beings exist, but such as we perceive; and would, if necessarily true, make the Deity material.

They who have been so unfortunate as to renounce revelation, generally consider utter annihilation to take place at the termination of material life. They hold, that the combination of actions to an end, is more complete in proportion to the complexity of the material organization of the agent. In order therefore to maintain the intellectual superiority of man over other animals, they are obliged to assume his positive superiority in mechanism; and as this assumption is demonstrably false with respect to the majority of his bodily powers, they are obliged to centre the light of reason which characterizes him, in some favourite part of his structure. Helvetius accordingly placed it in the human hand, and came to the monstrous conclusion, that the flexibility of the human fingers produces that intelligence, which is to direct them to useful purposes. Others, composing what may be styled the school of Bichat, vest their reason in the substance of their brain, by the organization of which they hold perception as a latent property of matter to be called into activity. The nerves with them produce the mental faculties, in the same manner that the various secretions of an animal are generated by the secretory organs. Here is clearly an assumption of what can never be proved; for while they assert that the brain and nerves constitute the mind, all we really know of the subject is, that during life the exercise of the sentient principle is connected with medullary matter. But why this medullary matter should be an operative cause rather than an operative instrument, no one can tell, particularly when it is more consonant with what we positively know of matter, that it should be an instrument.

That inevitable conclusion, however, of materialists, which is in direct opposition to the conviction of the commonest understanding, is the divisibility of the sentient principle, or, in other words, the doctrine that it is the instincts of a person which compose all that he can call his being. To say the truth, this denial of the unity of the sentient principle, is not only in perfect harmony with materialism, but even absolutely required by it; for matter, to which our perception is said to belong, being demonstrably divisible *ad infinitum*, it follows that, instead of each of us being one sentient being, we are each an infinite number!

And this amusing conclusion must be equally arrived at by those who, conscientiously founding their belief upon a particular interpretation of certain texts of scripture, adopt the above notion of the materiality of the soul, but suppose that with the particular species man, it is to be revived after dissolution by death to future immortality. They assume, like the former, that matter is neither impenetrable nor inert, and consequently different from what we have every reason from experiment to believe it to be. They assume, moreover, that after the dissolution of the body by death, the material particles which composed it remain essentially distinct, and are never assimilated by other bodies; for if they are, there ceases to be any identity, and the resurrection of the material soul as a distinct being from other souls, and independent of them, becomes physically impossible. Even if we grant the second body to be identically the same with that which died, another singular consequence of this doctrine presents itself, which is at complete variance with the experience of every Zoologist. It is, that a material body during life is always composed of the same identical particles. Now mind being supposed a property of matter, if this point were not rigidly insisted upon, a short interval of life would destroy all responsibility with our identity.

It was in order to get rid of such impossibilities and contradictions, that in the first chapter I admitted the existence of secondary operative causes, distinct from matter. My conviction of this truth, is of the same nature with that derived from an *ex absurdo* proof in geometry. Some however go much further, and argue on the pre-existence of immaterial beings to their union with the body, or speculate on their necessary immortality. Such subjects I could not venture to discuss, since all that can be stated with certainty is, that whatever has had a beginning may have an end, and that the necessary immortality of the human soul is a dogma as much in opposition to the idea of divine omnipotence, as its necessary mortality. Without the assurances of revelation, the immortality of the soul could never have been ascertained; nay, perhaps might have been reasonably doubted. The truth, however, of a future state, rests on different grounds, and may be clearly deduced from our being to a certain degree free agents. The doctrine of free agency is perhaps not demonstrably true; but, however theorists may say to the contrary, it is one of those truths in which our conduct and our laws show that we have as much belief as in our existence. One thing very certain is, that the denial of the possibility of a creature being a free agent, is a denial of the omnipotence of the Creator, and an advocation of the doctrine of his attributes being independent upon his will. If the free agency of man be admitted, responsibility for our actions ensues as a necessary consequence, unless we can fancy that the Deity should have in this instance acted directly contrary to those principles of order by which we observe the universe to be governed. Free agency without responsibility is an attribute of the Deity; and to invest a naturally imperfect being like man with it, is as contrary to our notion of divine justice, as that he should be made responsible without being a free agent. With Omnipotence, it must be equally possible to trace out our future actions as to give us perfect freedom of thought and deed; our disbelief therefore of necessity in human actions, must rest solely on the consciousness implanted in us, that we are to a certain degree free agents, and therefore responsible. Revealed religion, however, shows in what a wretched state of misery and despair we should be involved, had we only to abide by the consequences of this responsibility.

Being in this manner convinced of the immateriality of the sentient principle in man, and firmly believing in its existence after the dissolution of the body by death, I placed these truths among my definitions. To those who may believe with me in one plan reigning throughout the universe, I need not say how essential to its uniformity is the existence of secondary immaterial causes, as connecting matter with spirit. I shall therefore proceed to enumerate the leading hypotheses which have been published on the subject of comparative psychology, by persons who believe in the immateriality of the human soul.

3. The nearest of these theories to materialism, is that which has for its fundamental position, that the other ani-

mals are all distinguished from man, by having no immaterial agent connected with their bodies. This opinion has two branches, the most improbable of which has been adopted by no less men than Bacon, Locke, Gassendi and Willis. It is that the sentient principles of brutes are wholly material. As Willis was the only one of these celebrated persons who had any pretensions to be a Zoologist, he is the only one that can be charged with inconsistency. When he admitted the existence of an immaterial soul in man, he must have considered the medullary matter to be an instrument, or medium only. Now if nerves be the instrument or medium in one case to produce certain effects, it is almost inconceivable, and certainly in opposition to the established rules of philosophy, that they should be the causes of the same effects in another. If medullary matter in man be acted upon by an immaterial agent, and brutes be allowed the faculty of perception, the nerves of these must also be acted upon by an immaterial agent, unless indeed we make all the lower animals, as materialists apparently make man, to consist each of an infinite number of sentient beings.

In order to avoid this absurdity, Descartes and Malebranche denied to animals the faculty of perception. This is the second branch of that theory which allows no immaterial agent to act on the nerves of the lower animals. It is said to have been borrowed by the Cartesian school, from Vivez and Pereira, but it is probably still more ancient. Descartes was too good a catholic not to make the human soul an immaterial being, attendant during this life on the body; and too proud probably of the powers of his own mind to believe in the existence of any similar principle in brutes. He thus came to view them as mere material machines put in motion by simple mechanical laws. In denying perception to animals, he certainly avoided the singular consequence of materialism, which, by investing matter with that power, denies the unity of the percipient. There is also no impossibility in the same actions of a man and a brute resulting by the same medium, nerves, from different causes. But that a uniform mechanical law should produce effects varying according to circumstances, as we perceive them in the generality of animals, is perfectly unintelligible, and has occasioned the Cartesian hypothesis to be generally regarded as one of the most revolting assumptions of philosophy. If any zoologist, however, be an advocate for the necessity of human actions, I do not see how he can consistently maintain the superiority of man over other animals, without being either a materialist or a Cartesian.

4. We proceed, as often happens in matters of belief, from one extreme to the other, and now have to state, that by some persons every animal has been accounted not only to be acted upon by an immaterial sentient principle, but to be endowed with free agency as well as man. If, indeed, nervous matter be necessarily indicative of the presence of an immaterial free agent, no line can well be drawn to separate one part of the animal kingdom from the other; and we must thus, with free agency, allow responsibility and a future state even to that principle which animates the gelatinous pulp of an ascidia or polype. Yet this conclusion, which to me is even more disagreeable than that of Descartes, has been entertained by some of the most acute philosophers that have ever existed. It appears also to lead inevitably and directly to a ridiculous idea of Krause, who has seriously asserted, not only the presence

of a soul in the most minute of animalcules, but that the souls which are thus attendant upon the simplest forms of matter, and which seem so little affected by material injury, ought to be of a more refined and perfect nature than those others which are affected by the slightest derangement of a complicated piece of machinery. In other words, the soul of a polype ought to be accounted a more refined and perfect being than that of a man!

5. We shall now return to the ordinary doctrine, or the opinion of Locke on this subject, in order that we may understand, or rather endeavour to understand, a new theory which has been of late advanced with a degree of confidence in its accuracy, that argues any thing but acquaintance with this obscure subject*.

The opinion of Locke seems to have been that there are three kinds of souls, 1. *A vegetative soul,* which is common to all organized matter, and which seems to be nearly the same with that phænomenon which in the preceding pages has been named material life. 2. *A sensitive or irrational soul,* which is common to the whole of the

* The writer referred to announces a number of discoveries in natural history; for, as he does not state his authority, and the facts appear to be quite new, we must give him the credit of their discovery. I shall state a few of them for the amusement of naturalists. He says, the first process which distinguishes the animal from the vegetable, is digestion; and that this peculiar characteristic is observable even in the lowest degrees of animal life: hence we learn, either that the *Agastria* of De Blainville are plants, or that our author has discovered their digestive organs. He says that an animal is distinguished from a vegetable by its power of changing the absolute position of the whole of its parts. No wonder therefore that naturalists should have such a difficulty in deciding the place of the Sessile Cirripedes, since it appears now that they are plants. A piece of information also, for which our farmers can never be sufficiently thankful to him, is, that the *Uredo frumenti* draws positive nutrition only from earth. The animal, he says, appears to derive positive nutrition only from organized matter, or rather from that which has previously been alive; while the vegetable draws the supply from earth, and other unorganized substances. —My reason for noticing these things is to show, that in certain studies a little more attention to zoology, than is at present bestowed in this country, would not be misplaced.

animal kingdom, and which is material. 3. *A rational immaterial and immortal soul,* in which the intellect and will are conceived to be seated, and which is peculiar to men and angels. Now the consequence of admitting that any sensitive principle can be material, has already been seen; and it was in order to avoid it, I suppose, that a new version of this unauthorized compound of Alexandrian philosophy, and Jewish tradition, was devised. Whether this new version be more satisfactory, it is for the reader to determine from the following abstract. For my part, I shall be sorry if it cannot be doubted without incurring the charge of heresy.

Man, as we are now told, has three lives, viz. the life of vegetation; the life of volition; and the life of understanding. These are termed three *degrees* distinct in themselves. I trust, however, that species are meant, as it savours rather strongly of materialism, to make the understanding a degree of material life; we shall therefore consider them as distinct species. We easily discern, that the chief alteration that has been here made on Locke's system, consists in the sensitive soul being furnished with will. It is, however, besides, made immaterial and mortal; so that each man has two distinct species of immaterial beings in him, a mortal and an immortal being. It is not specified how this squares with Mr. Locke's notions of identity; indeed never was the unity of the sentient principle more distinctly denied. But we are also told, that while the plant is endowed with organic life alone, the animal enjoys the life of volition. "It is this," we are informed, "which gives it the power of voluntary motion, of sensation, perception, and of that sagacity which, though it may sometimes rise to a very high degree, is nevertheless totally distinct from the understanding in man." We have here to learn, either that "the understanding which constitutes the human soul" has no will, and therefore no responsibility, since I suppose it cannot be contended that the soul is responsible for what it has not willed; or that every man is endowed with two wills, that of his understanding, and that of his life of volition. It must be an important, if not a pleasant speculation, for our author to know which of his two wills is implicated in his faults, since, if he can contrive to fix them all on the principle of volition, which is mortal, his understanding will come well off. It deserves remark, that Mr. Locke was afraid that persons would fall into this very mistake, although he had distinctly shown that intellect and will are only powers of the mind. "These powers of the mind," he says, "viz. of perceiving and preferring, are usually called by another name; and the ordinary way of speaking is, that the understanding and will are two faculties of the mind; a word proper enough, if it be used, as all words should be, so as not to breed any confusion in men's thoughts by being supposed (as I suspect it has been) to stand for real beings in the soul that performed those actions of understanding and volition." But the whole of the new theory seems hastily got up; for we have volition sometimes a power, sometimes an immaterial principle, while in general it is supposed to mean the act of willing. From all which I know not what inference to draw, unless that we are to believe the principle that wills, the power to will, and the act of willing, to be all one and the same thing.

6. The reader has now doubtless had sufficient of this improvement upon Locke, and will not be sorry to have another theory set before him, which, although I scarcely

think it will have many advocates, is neither utterly inconsistent with natural history nor in opposition to revealed religion. It rests on the belief, that no active energy can be imparted to nervous matter, except by the volition of an immaterial spirit. Thus an immaterial soul, placed here in a state of probation, is held to act by volition directly on the brain of man. But the brain of other animals or the ganglions which obtain that name, are supposed to be acted upon by the volition of the Deity. This opinion can only have one foundation, which is far from being weak or easily subverted. It is, that this planet and its contents were created for the sole use and instruction of man, who thus is the end of the terrestrial creation. "*Principio ipse mundus Deorum hominumque causâ factus est: quæque in eo sunt omnia, ea parata ad fructum hominum et inventa sunt.*" The common objection to the theory now under discussion is, that if the Deity be really the direct cause of the actions of animals, they ought never to err in their instincts, as we know that they do. Such reasoning, however, is as erroneous as that of Cudworth in favour of a plastic nature. It is surely presumption to talk of errors in nature, as if they were faults or imperfections that had taken place in opposition to the will of the Deity. All we can mean without impiety is, that they are departures from a general plan or rule, which very departures are perhaps proofs of some interference.

A more powerful obstacle to our belief in the divine volition being the only agent on the nerves of animals other than man, is their possession of organs of sense. We can perhaps conceive that the Deity should be the cause of their actions; but what can be their passive principle? The Deity cannot surely be the percipient. If the eyes of an animal, for instance, be put out, it is evident from his actions that he has lost a power. Yet we cannot be absurd enough to suppose that the Deity should have lost any power by this process; and if we say, on the other hand, that the loss has only been experienced by the body, we fall into the exploded notion of a material sentient principle.

To me, such an argument appears insurmountable; but I confess its force is very much weakened by the reflection, that the basis of the opposed doctrine is, that every thing we see is intended for our instruction, either with respect to the divine nature or the human. Now it is manifestly possible to place to this account, not only the apparent consequences of injuries in animals, but all the phænomena they may present. Nevertheless, assumption, I repeat, crowds so fast here on assumption, that, although not any one by itself may be improbable, all together render it very difficult, if not impossible, to credit the maxim, "*Deus est anima brutorum.*" In consequence of a remarkable but not very explicit paper in the second volume of the Spectator, Addison is generally supposed to have been of this sentiment. When talking of the energy which acts in animals he says, "To me it seems the immediate direction of Providence, and such an operation of the Supreme Being as that which determines all the portions of matter to their proper centres." The latter part of this sentence, however, seems to correspond rather with the Cartesian hypothesis, which supposes animals to be acted upon by some mechanical force; and the whole makes me suspect that Addison had not exactly made up his mind as to the distinction between the two theories.

7. I now come to the last hypothesis which I have to

mention. In this, as in the cases immediately preceding, man is imagined to consist materially of one of the most complicated pieces of mechanism which the animal kingdom contains; but his corporeal superiority and perfection appear to consist in his nervous system, which is conceived to be acted upon, during the life of organification, by a conscious immaterial being endowed with a sufficient degree of free agency to render it morally responsible to its Creator. The medullary matter of such other animals as possess the life of organification, is supposed to be acted upon likewise by conscious immaterial beings; but these are infinitely inferior to the soul of man, inasmuch as, their actions not being sufficiently free, they are destitute of the powers of reflection, discharged from responsibility, and therefore from the necessity of a future state. The principle of necessity is carried to its utmost limits in the annulose circle, as may be exemplified in the laborious economy of *Scarabæus Sacer*. The principle of liberty, on the contrary, predominates in the *Vertebrata;* and although no animals in this last circle, except man, are sufficiently free to be morally responsible, we see the whole contents of the group tending towards this point of perfection. We have seen that nature appears to abhor absolute division in the arrangement of organized matter, and something of the same kind is observable here in characterizing spirit. Vestiges of instinct may be traced in man; and a will faintly dawns in those insects which are most enslaved to their peculiar economy.

But there are animals, as we have seen, which possess only that simple degree of material life, which allows merely of their being propagated, like plants, by scission; and for the sake of uniformity we were obliged to assume that such animals are capable in some degree of sensibility. The very reverse of unity is however visible in their irritable principles. Here, therefore, if the presence of an immaterial conscious being be admitted, it must be in infinite number; an idea so absurd, that we are forced to believe that the *Acrita*, or those animals which possess not the life of organification, have no sentient principle acting on their nervous matter. Their irritability no more proves it, than the convulsion by galvanism of the muscles of a dead frog is sufficient testimony of its suffering pain.

The latter notions with respect to the nature of the sentient principle in animals, are in strict unison with zoological phænomena. I am indeed ignorant of any better explanation of these, than by such an hypothesis, which must be acknowledged, however, to involve, as well as the other theories, assumptions of the truth of which we cannot be certain. Perhaps some opinion, preferable to any of the preceding, may yet be devised, and the search for it must give us an additional zest for that science, which affords the only sure data upon which similar investigations can ever be founded. I despair, indeed, of positive certainty on the point being in this world ever attained; but surely the subject is one of the most interesting upon which the mind can speculate, and must fully repay the trouble of thought. At all events, we ought not on a philosophical question, as it has most truly been said, *to take assertion for proof, obscurity for depth, or perplexity for argument.* Neither the authority of office, nor the weight of name; neither the elegance of style, nor the purity of motive, can be any sufficient reason for doing ourselves so little justice. Or, to cite a passage of Ray which is most apposite, "Let it not suffice us to be book-learned, to read what others have written, and to take upon trust more falsehood than truth; but let us ourselves examine things as we have opportunity, and converse with nature as well as books. Let us endeavour to promote and increase this knowledge, and make new discoveries, not so much distrusting our own parts, or despairing of our own abilities, as to think that our industry can add nothing to the invention of our ancestors, or correct any of their mistakes. Let us not think that the bounds of science are fixed like Hercules's pillars, and inscribed with a *ne plus ultra*; let us not think we have done when we have learned what they have delivered to us. The treasures of nature are inexhaustible; here is employment enough for the vastest parts, the most indefatigable industries, the happiest opportunities, the most prolix and undisturbed vacancies."

CHAPTER IX.

ANALYSIS.

"*Verus botanicus genera naturalia assumit, nec erronea ob speciei notam aberrantem conficit.*" After duly weighing this expression of Linnæus, the full force of which certainly long escaped me, I am inclined to think that when we find him declaring genera to be natural, it may be of use to recollect that he confounds two sorts of genera:—the one, the genus as he most philosophically conceived it ought to be constructed; the other, the genus as he was only able artificially to construct it. The first of these, which perhaps he constantly aimed at, was truly a natural group, not liable to be injured by any slight aberration from the leading characteristics by which he imagined it to be distinguished in nature. Before, however, he could carry this idea into execution, he was obliged, as he unfortunately thought, to choose some principle or principles of division, by the application of which his genera might be formed; and herein lay his error. He chose in Entomology to make the antennæ the keystone of division, as he might have made any other organ or property of insects. Fabricius, by a parody on his words, said, on the other hand, "*Genera tot sunt quot similiter constructa instrumenta cibaria proferunt diversæ species naturales,*" a rule than which scarcely any more false could have been devised. The *instrumenta cibaria* are indeed as useful indices of a natural arrangement, as any other organs whatever; but absolute rules of generic distinction, founded on their minute differences of structure, are not only faulty in themselves, but calculated to blind us altogether to those beautiful groups which the Entomologist has so often occasion to remark in nature.

In a tribe of insects feeding on dry food, every species shall perhaps present a slight variation in its organs of manducation from the nearest to it in affinity; and in a tribe feeding on juices, and therefore provided with membranaceous mandibles, insects the most opposite in external appearance, shall present scarcely any difference in the structure of their mouth. So also with the antennæ: the "*clava fissilis*" makes the Linnæan genus *Scarabæus* one of the most natural in Entomology, while the "*clava perfoliata*" and "*antennæ moniliformes*" make the genera *Dermestes* and *Tenebrio* of the *Systema Naturæ* groups worthy only of Mouffet. Nay, this very adoption of one principle of division—this prescription of a rule to nature, was a cause moreover of the Linnæan and Fabrician genera, even when natural groups, having an insulated character about them, utterly inconsistent with the abstract idea which Linnæus, from the above botanical aphorism, appears to have had of a genus. There is no appearance, indeed, in the works of Fabricius, that this naturalist ever had any abstract notion of a genus, or indeed any belief, but that every division he in his good pleasure thought proper to propose was a law of nature. Linnæus, on the contrary, undoubtedly had both a theoretical and a practical genus, the latter of which was the invariable result of his attempts to carry his idea of the former into effect, upon the erroneous basis of preconceived characters for division. So that, because his philosophical idea of a genus was perhaps natural, he considered his genera, as he has instituted them, to be the same. Yet if this great naturalist, instead of commencing with any rule from the antennæ or other solitary organs, had placed together in a group all those insects which agreed in a majority of characters and habit,—if he had then endeavoured to discover that character which was common to them all, he would probably have had a group which might have been called a natural genus without much error. Far from leading him to indulge any idea of absolute division, the "*notæ aberrantes*" would then have rendered such species as they distinguished the most valuable of all, as tending to point out to his notice the neighbouring genus. And this Linnæus appears indirectly to have perceived; for when he says that it is no argument against the validity of a genus, that some species should gradually quit its type, there seems reason to believe that his theoretical notion of genera may, without any inconsistency, be reconciled with his maxim, that no saltus exists in nature, which is positively contradicted by his genera, as they are instituted.

An example was given in the appendix to the former Essay, of a genus containing five types of form, the progression of which returns into itself. This genus, *Phanæus*, was there proved to be distinguished by a peculiarity of geography, as well as of construction and appearance, while the genus *Scarabæus*, as there developed, was considered to be probably artificial, like almost every other that has hitherto been instituted in Entomology. Now to show, if possible, by analysis, that there were grounds for this suspicion; to show that *Phanæus* is by no means a solitary example of generic regularity in the distribution of nature, and that in both *Phanæus* and *Scarabæus* the theoretical genus of Linnæus appears to be exemplified, will be attempted in the present and concluding chapter, of which the leading object is to ascertain the place of *Scarabæus Sacer* in the smallest group to which it can be referred.

With respect to the Saprophagous *Petalocera*, but particularly to the three Coprophagous families, it may be said that they walk not on their tarsi, but on the extremities of their tibiæ. We may observe this so well in *Geotrupes stercorarius,* that, excepting in certain cases where the insect hangs by the ungues of the tarsi, we are utterly unable to imagine the use of them. In the genus *Phanæus,* where the ungues themselves are deficient, it is particularly difficult to determine the use of the tarsi, although it is very easy to conceive them to be a great inconvenience to the animal. Indeed, on this very account the tarsi in Coprophagous insects become often obsolete, and their use as organs of prehension is in some measure supplied by one or two *calcaria* fixed at the extremity of the tibiæ. It is on these that, accurately speaking, the animal walks. After the discovery of the principle upon which the natural group of *Phanæus* was constructed, I turned my attention to the true *Scarabæi,* in the hope of being able to apply a similar plan to these more celebrated insects. But every attempt failed, because, although my series of affinity was to a certain degree very distinct, I had no point about which my group could centre. It was in this state of doubt that I received a letter from the Rev. Mr. Kirby, to whose discoveries I have so often already alluded, announcing a new principle of arrangement, founded on the comparative number of tibial calcaria in various insects. This he conceived of sufficient importance to entitle *Scarabæus* H. E., *Gymnopleurus* Illig., together with *S. Æsculapius* Oliv., to the rank of a family, because they all possess two calcaria less than other Coprophagous insects. To me the observation appeared to afford the generic character for which I had hitherto been fruitlessly seeking—a character by which it was possible to group these insects together in much the same manner as the *Phanæi* had already been assembled, on account of all wanting ungues to their tarsi. The arrival also in England of an extraordinary insect, forming a type intermediate between the *Scarabæus Sacer* and *S. Æsculapius* of Olivier, enabled me to descry not only the limits of the genus, but its series of affinity such as I now present it to the Entomologist, instead of the genus *Scarabæus* of the first part of this work, which proves to be only a *typus formæ* or subgenus.

Fam. SCARABÆIDÆ. *H. E.*

Genus. SCARABÆUS. *Linné.*

Genus Mundi Antiqui proprium, tibiis omnibus apice unicalcaratis.

Scarabæi spec. LIN. DEG. Actinophori spec. CREUTZ. STURM. Ateuchi spec. FAB. LAT. Scarabæus et Gymnopleurus. H. E.

Antennæ articulis novem, primo cylindrico apice basique paulo crassiori, secundo tertio quarto et quinto obconicis, secundo minimo, tertio quarto et quinto, tertio præsertim, longioribus, sexto breviori pateriformi; reliquis clavam irregularem subcompressam formantibus, septimo maximo octavum tenuem in sinum excipiente, ultimo subtrigono seminis citrini ad instar acuminato.

Instrumentis in cibariis haud valida patet distinctio.

Confer *H. E.* vol. 1. p. 134. et *Sturm Ent. Hand.* tab. iii.

Caput subtrigonum vel rhomboidèum nunquam cornutum; clypeo radiato bidentato vel emarginato. Thorax ellipticus marginatus puncto sæpe indistincto utrinque impressus, abdomine semper latior, lateribus marginatis. Pectus irregulare. Pedes validi. Tibiæ trigonæ ad apicem spinâ unicâ instructæ; anticæ tri- vel quadri-dentatæ tarsis plerumque obsoletis; posticæ conicæ ad apicem oblique truncatæ tarsis gracillimis setaceis unguibus duobus munitis.

Obs. Color plerumque niger haud raro metallicus.

Hoc in circulo quatuor formæ typos adhuc solùm vidi.

With respect to the geography of this genus, I may mention that out of 43 known species, 27 may be found in Africa.

The first type extends from the Atlantic Ocean to Thibet, and from Austria to the Cape of Good Hope. The second type, however, appears to be confined to the north of Africa, and the third to the south. The fourth type has not yet been found; and the fifth inhabits all that tract of country which extends from the Atlantic Ocean to the Chinese sea—from Paris to tne Cape of Good Hope.

Creutzer, in his *Entomologische Versuche,* a little work published in 1799, and containing many excellent observations on the science, has stated, that *S. sacer, laticollis, impius, semipunctatus, variolosus,* and *morbillosus,* do not possess that character which Illiger had assigned to the genus *Copris.* In other words, they have not the middle feet distant at their base. On the contrary, it is remarked by Creutzer, that their middle coxæ are as near to each other as those of the first and last pair of feet. This circumstance, therefore, with their different habitus, induced him to set apart, under the name of *Actinophorus,* the abovementioned insects in his cabinet, and to add to their number *S. pilularius, Geoffroyi* and *Schæfferi.* "It is true," he observes, "that these three species, and particularly the last, in which the middle coxæ are wide apart, quit in some measure the habitus of *S. Sacer* and its affinities; yet they appear to me to be better placed in this genus than in any other."

In the year which followed the publication of the *Entomologische Versuche,* appeared Sturm's *Entomologisches-Handbuch,* in which the genus proposed by Creutzer is adopted, and scientific characters are assigned to it. Sturm, however, adds *S. volvens* and *sinuatus* to the species specified by his predecessor, merely observing that *volvens* and *Schæfferi* quit in some degree the general habitus of the others. He therefore divides his genus *Actinophorus* into two families; the first consisting of those species which have the middle feet near to each other at the base, and the second containing those which have them widely apart. The first family is the earliest, and indeed the only distinct specification of the genus *Scarabæus* as here given, that I have met with. When we consider the small number of species with which these two Germans were acquainted, it is really surprising that they should have acquitted themselves so well. They certainly are the first discoverers of the present natural group, of which I shall now indicate the construction.

☞ *Species vel varietates quas obelo distinxi in Musæo Mac-Leayano non hospitantur.*

TYPUS I. Antennæ articulo tertio quarto quinto et sexto, his ultimis præsertim, brevibus, quinto pateriformi, septimo trapeziformi octavum et nonum in sinu fere includente et capituli ovati transversi irregularis basin formante. Clypeus radiatus, sexdentatus, vel potius subtrilobus, lobo medio emarginato utrinque bidentato. Abdomen truncatum depressum elytrorum margine externo post humeros acutos nec profundè nec abruptè sinuato. Mediosternum oblongum elevatum fere porrectum. Pedes villosi coxis basi æquè dissitis. Tibiæ anticæ extus quadridentatæ intus rariùs serratæ; posteriores quatuor calcaribus fixis. Tarsi anteriores nulli; posteriores tibiæ pone apicem inserti unguiculis brevibus.

OBS. Caput anticè scabrosum. Elytra striata vel substriata.

HELIOCANTHARUS. *Antiquorum.*

1. SCARABÆUS ater, occipite bituberculato, elytris sublævibus punctis aliquot inter sex lineas obsoletas impressis. *Sacer.*

♂ Abdomen sæpius tam longum quam latum.

♀ Abdomen sæpius quam longum latius.

Scarabæus sacer. *H. E. Pars.* 1. p. 185.

Scarabæus crenatus. *Degeer Ins.* vii. p. 638. n. 36. t. 47. f. 13.

Scarabæus lævis. *Osbeck. Iter.* p. 51.

Habitat in Europæ australioris, Asiæ occidentalis et Africæ borealis aridis, pilulas e stercore bovino volvens, ovisque impositis denique sepeliens.

α VAR. S. tibiis anticis intus bidentatis. *Mus. Brit.*

β VAR. S. elytris subsulcatis. *Mus. Kirby.*

γ VAR. S. atronitidus; tibiis anticis haud intus bidentatis.

——— *Schæffer Icon. Ins. Ratisb.* t. 201. fig. 3.

Scarabæus sacer. *Panzer Faun. Germ.* fasc. 48. fig. 7.

S. Var. sexualis. *Lat. Gen. Crust. et Ins.* vol. ii. p. 70.

Habitat in Rossiâ meridionali, in regione Caucaseâ.—*D. Steven.*

δ Var. S. *impius* Fab. atronitidus; clypei dentibus tuberculisque inconspicuis, tibiis anticis extus serratis vix dentatis, intus inermibus.

Dufresnii. 2. SCARABÆUS ater, clypeo cruce elevato, thorace tuberculis confertissimis scabro: lineâ longitudinali lævi, elytris haud punctatis.

In honorem viri amicissimi, Entomologi acuti, nominatur species præcedenti nimis affinis.

pius. 3. SCARABÆUS atronitidus, clypeo cruce elevato, thorace tuberculis scabro posticè lævi: medio subdepresso, elytris punctis irregularibus impressis.

Scarabæus sacer. *Don. Ind. Ins.* tab. 1.?

Actinophorus sacer. *Sturm. Ent. Hand.* 1. p. 74. t. 3.

Ateuchus lævigatus *in Catalogis Germanorum.*

Habitat in Austriâ. *DD. Dejean. Dahl.*

β Var. S. ater hirsutior; clypei tibiarumque dentibus longissimis acutis, thoracis punctis rarioribus.

Habitat in Hispaniâ. *D. Pavon.*

γ Var. S. inter varietates α et β intermedius.

Bonellii. 4. SCARABÆUS ater, clypei lineâ transversâ elevatâ: medio tuberculato, thorace tuberculis scabro: lineâ dorsali lævi, elytris granulatis, tibiis fere tridentatis.

α Var. S. clypei tibiarumque dentibus acutis. *Mus. Brit.*

β Var. S. clypei tibiarumque dentibus obtusis rotundatis.

Habitat ad Cap. Bon. Spei.

Historiæ Naturalis sagacissimo interpreti, Musæi regalis apud Taurinenses Præsidi, sic meritas grates persolvo.

Hottentottus. 5. SCARABÆUS ater, clypei cruce elevatâ, thorace punctis impresso: anchorâ dorsali elevatâ lævi, elytris punctorum striis impressis punctisque minutissimis granulatis aliisque raris vix impressis.

Ateuchus Hottentottus. *Lat. in Cat. Mus. Gall. Reg. MSS.*

β VAR. S. anchorâ dorsali inconspicuâ thoracisque punctis obsoletis.

Habitat ad Cap. Bon. Spei. *Mus. Brit.*

6. SCARABÆUS ater, clypeo trituberculato, thorace anticè vix scabroso, elytris punctis minutissimis granulatis. ***impius.***

Scarabæus impius. *Herbst.* col. 2. p. 302. n. 196. t. 20. f. 1.?

Habitat ———. *Aut exemplar Herbstianum, aut unum illud singulariter simulans in Mus. Mac-Leayano hospitatur.*

This species answers so exactly to the description and figure of *S. impius* given by Herbst, that I have little doubt of its being the same. It is clear that the above specific character does not at all answer to *S. Sacer*, and the only circumstance in which it positively differs from that of Herbst's insect is in the clypeus having three tubercles, whereas this author says that in the middle of the clypeus there is an elevated line, "*die in der mitte getheilt ist, so dass sie das ansehen zweyer stumpfer erhöhungen hat.*" It was owing probably to this opinion, which may have resulted from a careless examination, as well as to the specific character given by Herbst, which rests on a variation apparently common to every species of the type, that Fabricius made it a variety of *S. Sacer*. From this, however, Herbst's figure and the sculpture of the elytra as above given sufficiently separate it.

7. SCARABÆUS atro-æneus, clypeo tuberculato: lineâ utrinque ad occiput connivente, thorace anticè tuberculis scabro, elytris punctis minutissimis granulatis paucisque majoribus vix impressis. ***Lamarckii.***

Habitat in Senegalliâ.

Insectum Artis Zoologicæ magistro dicatum.

8. SCARABÆUS ater, clypeo medio vix cornuto: lineâ transversâ ***Cuvieri.***

elevatâ, thorace tuberculis scabro, lyrâ dorsali lævi tricuspidatâ, elytris punctis minutissimis granulatis paucisque majoribus vix impressis.

Habitat in Africâ.

In honorem Anatomes Zoologicæ principis, Entomologi apprimè docti, nomen dedi.

sanctus. 9. SCARABÆUS viridi-cupreus, capite thoraceque scabrosis, thoracis cruce dorsali elevatâ lævi inconspicuâ, elytris punctis plurimis impressis, tibiis vix quadridentatis.

Ateuchus Sanctus. *Fab. S. Eleuth.* 1. p. 56. n. 6.

Copris Sanctus. *Fab. Suppl. E. S.* p. 34. n. 209-10.

β VAR. S. elytris cupreis.

γ VAR. S. totus viridi-nitens.

δ VAR. † S. totus atro-cæruleus clypei dentibus obtusioribus. *Mus. Brit.*

Habitat in Indiâ orientali. *Mus. Brit.*

This species approaches to *Gymnopleurus* in marking, tridentated anterior tibiæ, colour, vestige of sinuated elytra, and of impressed puncture on each side of the thorax. It is the only insect of the type which is known not to inhabit Africa.

Palæmon. 10. SCARABÆUS ater, clypei lineâ dorsali elevatâ vix lævi, thorace punctis impressis numerosis, elytrorum striis elevatis undatis.

Scarabæus Palæmon? *Oliv. Ent.* 1. 3. 237.

Ateuchus morbillosus. *Fab. S. Eleuth.* i. p. 56. n. 7.

Habitat in Senegalliâ. Ad Caput Bonæ Spei.? *Mus. Brit.*

intricatus. 11. SCARABÆUS ater, clypei lineâ dorsali elevatâ lævi, thorace punctato: lineâ dorsali parùm elevatâ, elytris punctis elevatis quadratis lineatis.

Scarabæus Palæmon. *Oliv. Ent.* i. 3. n. 237. t. 27. f. 234.

Ateuchus intricatus. *Fab. Syst. Eleuth.* i. p. 56. n. 9.

Habitat ad Caput Bonæ Spei. *Mus. Brit.*

Notwithstanding Schönherr's excellent work, the greatest confusion still prevails with respect to the two preceding species; and it has arisen entirely from Fabricius, when publishing his *Systema Eleutheratorum*, having forgotten the insect which he had described in his *Systema Entomologiæ* under the name of *morbillosus*. The *S. morbillosus* of his *Ent. Syst.* is a German insect, ("*Habitat in Germaniâ,*") and is evidently the species found in Malta and the south of Europe, and described by Panzer, *Ent. G.* I. p. 17. n. 69. This is so dissimilar in form and sculpture from *A. intricatus* of the *Syst. Eleuth.*, that it could never have been confounded with it on comparison. It would appear, therefore, that Fabricius, when about to publish his *Syst. Eleuth.*, saw an African insect, which answering nearly to his description of the true *S. morbillosus*, the form of which he had forgotten, he thought proper to alter the habitat from *Germania* to *Guinea*, and the "*Elytra striis punctisque numerosis exarata*" to "*Elytra striis elevatis undatis,*" without taking any notice of the difference. They are blunders like these which render Natural History such a drudgery, although their rectification is by some esteemed to be the whole of the science. The insect, however, which Fabricius describes as *A. morbillosus* in the *Syst. Eleuth.* has truly so great an affinity to his *A. intricatus*, that, when he suspects them to be varieties of the same species, ("*Statura, magnitudo et summa affinitas A. morbillosi, cujus forte mera varietas,*") I am inclined to think him in the right. Olivier appears also to have been of the same opinion, for he says of *S. Palæmon*, "*Il se trouve au Senegal, au Cap de B. Esperance.*" The species are only to be distinguished by *Palæmon* being rather smaller than *intricatus*, besides being more punctated, wanting the elevated dorsal line, and having the elevated points of the elytra irregular, so as to give the striæ the appearance of being waved. From *S. morbillosus* they may easily be distinguished by their anterior tibiæ being more distinctly quadridentate.

S. intricatus and *Palæmon* both come very near to *Gymnopleurus* in marking and form, in vestige of sinuation in *Palæmon*, and of impressed points on each side of the thorax of *intricatus*.

puncticollis. 12. SCARABÆUS atronitidus glaberrimus, capite anticè scabro posticè lævi convexo, thorace punctis minutis rarissimis anticè impressis, elytris vix striatis.

β VAR. † S. thorace punctis duobus dorsalibus vix impresso. *Mus. Brit.*

Ateuchus puncticollis. *Lat. Mem. sur les Ins. Sac. d'Egypte.* p. 7. t. 18. fig. 14.

Habitat in regione Tripolitanâ. *D. Ritchie. Mus. Brit.*

This species approaches excessively close to the Spanish variety of *S. pius* before described. The rectangular shape of the abdomen distinguishes this at first sight from *S. semipunctatus*, which has it rather circular.

Species quæ Scarabæum Bonellii *affinitate attingunt.*

Spencii. 13. SCARABÆUS atronitidus, capitis lineis duabus curvis antrorsum in vertice concurrentibus, thorace tuberculis scabriusculo, elytrorum striis sub lente vittæformibus.

β VAR. S. rufus.

Habitat ———. *Mus. Brit.*

Hæc Species Monographiæ de Cholevis acutissimo auctori dicatur.

Degeeri. 14. SCARABÆUS atronitidus, capite posticè punctato: medio tuberculato lineâque transversâ elevatâ mucronatâ, thorace anticè tuberculis scabro, elytrorum striis inconspicuis.

Habitat ———.

In memoriam Entomologorum principis.

15. SCARABÆUS atronitidus, capitis lineâ transversâ interruptâ convexâ, thorace lævissimo: tuberculo utrinque elevato. *Savignii.*

Habitat ———.

Illius oculatissimi tot res mirandas explicantis nomine merito insignita prodit species profecto distincta.

Species osculantes quæ S. Sanctum *affinitate attingunt.*

16. SCARABÆUS atronitidus, corpore convexiusculo, capite medio lævi posticè punctato: puncto medio apertiori, thorace elytrisque punctis raris latis subconicis æqualibus variolosis impressis. *morbillosus.*

Scarabæus morbillosus. *Fab. Ent. Syst.* 1. p. 63. n. 210.

Scarabæus variolosus. *Panz. Faun. Germ.* 67. n. 7.

Actinophorus variolosus. *Sturm. Ent. Hand.* 76. n. 66.

Habitat in Insula Melitensi et Dalmatiâ. *D. Dejean.*

β VAR. S. fere duplo minor elytrorum striis indistinctis.

Scarabæus morbillosus. *Panz. Ent. G.* I. p. 17. n. 69.

Habitat in Melitæ Insulâ. *D. Ritchie. Mus. Brit.*

γ VAR. S. parvus, thoracis dorso utrinque gibboso.

Panzer certainly was in error when he referred the insect he has figured as *S. variolosus* to the *S. variolosus* of the *Entomologia Systematica.*

17. SCARABÆUS atronitidus, thorace punctato elytris sulcatis. *laticollis.*

β VAR. S. duplo minor, thoracis punctis indistinctis.

Scarabæus laticollis. *Linn. Syst. Nat.* p. 549. n. 38.

——— pilularis. *Raii Ins.* p. 105. 4.

Copris serratus. *Fourcroy Ent. Par.* 1. p. 13. n. 2.

Le Hottentot. *Geoff. Ins.* tom. 1. p. 89. n. 2.

Habitat in Europâ meridionali, Africâ boreali, insectum fœtidissimum. *Mus. Brit.*

18. SCARABÆUS ater, corpore depressiusculo, capite medio lævi posticè punctato, thorace elytrisque punctis con- *variolosus.*

fertissimis confluentibus inæqualibus variolosis impressis.

Scarabæus variolosus. *Fab. Ent. Syst.* 1. p. 63. n. 208.

——————— *Fab. Syst. Eleuth.* 1. p. 56. 4.

Habitat in Europâ australiori et Africâ boreali.

β Var. S. minor. *Fab. Mantissa*, p. 16. n. 161.

Obs. Species S. *morbilloso* valde affinis, at abdomine subcirculari distincta.

semipunctatus.

19. SCARABÆUS atronitidus, capite posticè punctato, thorace punctis latis impresso, elytris substriatis.

Scarabæus semipunctatus. *Fab. E. S.* i. p. 63. n. 207.

Scarabæus variolosus. *Oliv. Ent.* 1. 3. p. 151. n. 184. t. 8. f. 60.

β Var. S. duplo minor, elytris striatis.

Habitat in Europâ meridionali, Africà boreali. In Sardiniæ sabulosis vulgatissimus. *D. Arnold.*

These are all the species which I have seen of that type of form which, as emblematic of the sun, was held in such reverence by the Egyptians. In thus endeavouring to distribute them in a natural order of affinity, taken from their general structure and individual sculpture, I find that we may account nine at least of the species above described, to constitute part of a series which returns into itself, and of which the opposite points meet, as appears by the affinity of form which *S. semipunctatus* bears to *S. Sacer*. Of the economy of these insects, although so common in the south of Europe, we know scarcely more than what may be found in Aristotle's *Hist. Animalium.* M. Disderi, however, in the third vol. of the Turin Transactions, has given an entertaining paper on the manners of the insects inhabiting the vicinity of Saluzzo; and this, perhaps, contains the most able history of *S. Sacer* to which the reader can refer.

M. Disderi observes, among other circumstances, that "*Scarabæus noster non urget pectore globulum antrorsum eum trudendo quod faciunt alii; verum longioribus pedibus suis posterioribus globulum stringit atque retrogrado non directo incessu volvit.*" Which admirably coincides with a remark communicated to me by Mr. Kirby, to wit, that the hinder tibiæ of *Heliocanthari* are of the same form as the fore tibiæ of *Onitis*.

In addition to various Egyptian sculptures of this type of form, the artists of which perhaps strictly intended the imitation of no particular species, I have seen good representations from Egypt of *S. sacer*, *semipunctatus*, *morbillosus*, and *laticollis*. Latreille appears also to have seen an image of *S. puncticollis*. These five species therefore, with *Copris Midas*, which was emblematic of Isis and the moon, and is well described by Pliny, may be held among the most celebrated insects of antiquity. Although the explanation of Horapollo's mysticism, and the cause of the *Heliocantharos* being the Egyptian symbol of generation, are subjects which more properly belong to the antiquarian, much curious information may be derived from M. Latreille's *Mémoire sur les Insectes sacrés d'Egypte*, which has been lately read before the French Institute.

TYPUS II. Antennæ articulo tertio longiori, quarto et quinto brevibus septimo, trigono pateriformi, capituli subquadrati transversi basin formante. Clypeus radiatus subtrilobus, lobo medio emarginato utrinque bidentato, adeoque sexdentatus. Abdomen rotundatum subdepressum circuli segmentum majus sistens, elytrorum margine externo post humeros vix acutos nec profundè nec abruptè sinuato. Mediosternum breve elevatum triangulare vix porrectum. Pedes villosi coxis intermediis adjunctis et tibiarum calcaribus cum tibiâ articulatis seu mobilibus. Tibiæ anticæ extus quadridentatæ intus serrulatæ tarsis nullis.

MNEMATIUM *mihi.*

Ritchii †. 20. SCARABÆUS nigronitidus, capite punctato vertice depresso, thorace lævissimo punctato, elytris atris subsulcatis.

Habitat in Africâ boreali. Mourzouk. *D. Ritchie. Mus. Brit.*

M. S. Perlustratoris intrepidi, zoologiæ peritissimi, amici nunquam nimis deflendi, JOSEPHI RITCHIE, *qui labore et curis defessus sub sole Africano juvenis occubuit die Octobris vicesimo* 1819.

The only specimen known of this interesting insect is now in the British Museum, and formed part of a curious collection sent home by my lamented friend, the late Mr. Ritchie, who, amid the versatility of his genius and knowledge, was particularly devoted to the science of entomology. The *Scarabæus Ritchii* is one of the most convincing arguments that can be adduced for the probability of the chasms which now occur in entomology, being all in due time filled up by the discoveries of travellers. Until this insect was detected, there was a wide distance between the *S. sacer* and *S. Æsculapius* of Olivier; but now the chain of connexion is complete, as we have here the clypeus of one species, with an approximation towards the singular form of the other. Mr. Kirby long since observed to me, that *S. laticollis, semipunctatus,* and *variolosus,* quit the character of their type in having the fore tibiæ serrulate on the inside, the calcaria distinctly articulated with the tibiæ, the four hinder tarsi inserted in the middle of the tibiæ, and the ungues rather long. Now these are all characters which, to say nothing of the subcircular form of their abdomen, show us how these insects lead from *S. sacer* to this type—*Mnemation*—which is probably confined to the north of Africa.

The inequality of the number of species in natural groupes, I have before stated as perhaps one of the most curious facts in natural history. On looking therefore at such groupes as the present, the entomologist should bear in mind that an *hiatus* ought not to be confounded with a *saltus*, however fashionable of late the synonymy of the words may have been.

TYPUS III. Antennæ articulis tertio quarto et quinto longioribus, at paulatim longitudine decrescentibus, septimo octavo et nono subsimilibus capitulum subglobosum formantibus. Clypeus triangularis apice bidentato. Abdomen convexiusculum circulare, thoracis margine pilis longis ciliato, elytrorum margine externo post humeros rotundatos nec profundè nec abruptè sinuato. Mediosternum subtriangulare fere impressum. Pedes villosissimi coxis intermediis basi adjunctis et tibiarum calcaribus cum tibiâ articulatis vel mobilibus. Tibiæ anticæ extus quadridentatæ tarsis nullis; tarsis posticarum quatuor apicibus insertis unguiculis longis.

PACHYSOMA. *Kirby MSS.*

21. SCARABÆUS ater, thorace punctato, elytris punctatis vix striatis, tibiis anticis intus lineâ elevatâ instructis. *Æsculapius.*

Scarabæus Æsculapius. *Oliv. Ent.* 3. 187. Pl. 24. f. 207.

Ateuchus Æsculapius. *Schönherr. Syn. Ins.*

Habitat ad Cap. Bonæ Spei. *Mus. Brit.*

22. SCARABÆUS atronitidus, thorace punctato, elytris striatis vix punctatis, tibiis anticis intus tuberculorum serie instructis. *Hippocrates.*

Pachysoma Hippocrates. *Kirby MSS.*

Præcedente duplo major habitat ad Cap. Bonæ Spei. *Mus. Kirby.*

In this, as well as in the last type, the coxæ of the intermediate legs touch each other at their base; yet Latreille (*Hist. Nat. des Crust. et des Ins.* X. p. 92.) gives the following character to his genus *Ateuchus*, as distinguishing it from *Aphodius*, "*Pattes intermédiaires plus écartées entre elles à la naissance que les autres.*" If, however, this character be held only as the structure to which the *Scarabæidæ* have a general tendency, it is without doubt perfectly correct; and in this sense alone it has been adopted in the general description of the family given in the preceding Essay. Another proof of the futility of absolute rules of division in natural history is, that in the work above quoted, Latreille separates *Ateuchus* from *Onitis* by the latter having no anterior tarsi. We perceive, however, that these organs are equally deficient in *Heliocantharus*, *Mnematium* and *Pachysoma*, which all formed part of his genus *Ateuchus*.

In a letter recently received from Mr. Kirby, he states to me that he has perceived in *Pachysoma* an approximation towards the *Gymnopleuri* of Illiger. In this opinion I perfectly coincide with him, on account of the globular form of the clava of their antennæ among other considerations. But then the hiatus between them is so great, that it becomes absolutely necessary to suppose the existence of an intermediate type.

TYPUS IV. *Nondum detectus.*

From theory, the clava of the antennæ of this type ought to be globose, aud the clypeus bidentate. The remarkable propensity which the other four types of *Scarabæus* have to make Africa their habitation, renders it probable that this unknown type still exists in the interior of that vast peninsula. Mr. Ritchie's late discovery of the second type of the genus fully warrants the supposition. It is at all events remarkable, that whenever a groupe does not contain five minor groupes, some chasm in the series of affinity should thus be apparent. In stating so curious a fact, it becomes very desirable that it should be supported by the *argumentum ad verecundiam*, but I can find no observation resembling this in any author but Linnæus. In that part of his Diary which relates, not to natural history, but to medicine, he says that nature is balanced by contraries, and acted upon "*numero quinario.*" The whole passage is curious, but at the same time, I confess, beyond my comprehension, as it seems to have been also beyond that of his learned biographer, who, in allusion to it, says—"It was his opinion that Nature acts *numero quinario,* as he informs us in his Diary; but he has no where explained himself on this abstruse subject; and the hypothesis seems to be one of those eccentric excesses of imagination in which ingenious minds are apt to indulge, without the possibility of being followed." *Tempus ducamus, et dies alteri lucem afferent.*

TYPUS V. Antennæ articulo tertio longiori, quarto et quinto pateriformibus, septimo maximo subhemisphærico capituli globosi basin formante. Clypeus rhomboideus apice sexdentatus quadridentatus bidentatus vel emarginatus. Thorax puncto parvo utrinque impresso. Abdomen truncatum subdepressum, elytrorum margine externo post humeros acutos profundè et abruptè sinuato. Mediosternum oblongum elevatum retusum vel subporrectum. Pedes pilosi coxis intermediis subdistantibus, femoribus anticis sæpius intus unidentatis et tibiarum calcaribus mobilibus. Tibiæ anticæ triquetræ extus tridentatæ, tarsis minimis instructæ; posticæ elongatæ subarcuatæ triquetræ angulis serrulatis, interiori duplicato.

GYMNOPLEURUS *Illiger.*

OBS. Quibusdam Cetoniadarum speciebus Australasicis elytrorum margo post humeros profundè sinuatur; et analogia, affinitas haud ulla, *C. punctatam*, Don. inter Petalocera Thalerophaga quasi *Gymnopleurum* facit.

* *Clypeus anticè rotundatus quadridentatus fere sexdentatus, dentibus intermediis longioribus. Corpus supra læve nitens. Thorax posticè punctis duobus impressus. Elytra margine parum sinuato. Tibiæ intermediæ subbicalcaratæ.* Insecta Africana.

azureus. 23. SCARABÆUS nigro-cyaneus, clypeo bilineato, elytris sub lente striatis, pedibus cyaneis.

Ateuchus azureus. *Fab. S. Eleuth.* 1. 57. 15.

Scarabæus profanus. *Fab. Syst. Ent.* 1. 64. 211?

Ateuchus profanus. *Fab. S. Eleuth.* 1. 56. 9?

OBS. Statura omnino *Scarabæi sinuati.*

Habitat in Guinea.

It is so usual with Fabricius to describe in one work, under a new name, an insect which he has already described in another, and forgotten, that my only doubt as to the propriety of affixing the synonym of *profanus* to *G. azureus,* arises from the epithet *parvus* being used in his description of the former. If this word be employed in a general sense, and not in comparision with *S. sacer,* the *profanus* of Fabricius must be the *cærulescens* of Olivier. The laxity of the description in the *Entomologia Systematica* renders it almost impossible to decide the matter.

nitens.† 24. SCARABÆUS cupreus, antennis nigris pedibus cupreis.

Scarabæus nitens. *Oliv. Ent.* 1. 3. 159. 195.—T. 7. 55.

Elytra sub lente fortasse striata?

Hæc Species mihi adhuc invisa habitat in Senegalliâ.

mundus. † 25. SCARABÆUS nigro-olivaceus, clypeo trilineato, thorace punctato, elytris subtilissimè granulatis: striis punctatis.

Gymnopleurus mundus. *Leach MSS.*

Habitat ad Cap. Bon. Spei. *D. Burchell.* *Mus. Brit.*

** *Clypeus bidentatus vel emarginatus lateribus haud undatis. Corpus læve, sericeum vel scabrum. Thorax foveolâ posticè haud impressâ.* Insecta plerumque Europæa.

26. SCARABÆUS lævis supra nigro-æneus, antennis flavescentibus, clypeo bilineato, thorace vix punctato: angulis posticis acuminatis, elytris septem-striatis, femoribus anticis serratis. *sinuatus.*

Scarabæus sinuatus. *Oliv. Ent.* 1. 3. 160. 196.—T. 10. f. 93.

Ateuchus sinuatus. *Fab. S. Eleuth.* 1. 60. 28.

Scarabæus Leei. *Don. Chin. Ins.* T. 1. 4.

Actinophorus sinuatus. *Sturm. Ent. Hand.* 1. 76.—T. 3. 1.

Habitat in Chinâ et in Indiâ Orientali. *Mus. Brit.*

β Var. S. ater, clypeo emarginato, tibiis anticis arcuatis extus vix crenulatis.

Scarabæus Mopsus. *Pall. Icon.* p. 3. A. 3. T. A. 3.

Obs. Apud Olivierum figura 189. tab. 21. in omnibus præter clypeum *S. mundum* simulat.

I agree with Sturm in thinking that Pallas had this species in view when he described *S. Mopsus*, although it is also clear that he was acquainted with the *pilularius* of Fabricius. The truth, perhaps, may be, that he confounded two species; the one taken in Daouria, near the Selenga, being a variety of *G. sinuatus*; and that taken on the banks of the Wolga, being *G. pilularius.*

27. SCARABÆUS obscuro-niger, subtus nitidus, antennis nigris, clypeo trilineato, elytris inter strias tuberculis aliquot minutissimis instructis, tibiis anticis calcare obtuso. *pilularius.*

Le Bousier à Couture. *Geoff. Hist. Ins.* 1. 91.

Scarabæus pilularius. *Fab. Syst. Ent.* 29. 118.

Ateuchus pillularius. *Fab. Syst. Eleuth.* 1. 60. 27.

Scarabæus Geoffroyæ. *Panz. Ent. Germ.* 18. 71.

Gymnopleurus Cantharus. *Illig. Mag.* 2. 201. 2.

Actinophorus Geoffroyi. *Sturm. Ent. Hand.* 1. 78.

Ateuchus pilularius. Var. β. *Schönnher Syn. Ins.*

Habitat in Europâ meridionali *magnitudine admodum varians. Vix ipsi accedis, plerumque statim avolat clausis elytris, Cetoniæ ad instar, ita ut minuti spatio ex* 100 *qui simul convenerint vix unus maneat.* Vide Laur. Ponza in Act. Taur.

β Var. S. clypeo inter lineas duas concurrentes tuberculato, elytrorum striis valde conspicuis.

γ Var. S. clypeo bilineato: lineis concurrentibus, thoracis lineá dorsali elytrorumque striis inconspicuis.

Scarabæus Mopsus. *Pall. Icon.* p. 3. A. 3.

No species is more common, or less distinctly known, than *G. pilularius,* as the above synonyms testify. Linnæus was never able to distinguish it from *A. volvens,* an American insect, which belongs to the neighbouring genus, and has a strong relation of analogy with this. Fabricius has carelessly copied, into all his works, the Linnæan habitat of *pilularius,* even after he had distinguished the two species; and has thereby made a great mistake in the geography of insects, since no true *Scarabæus,* as the genus stands in this Essay, is to be found in the new world.

Sturmii. 28. SCARABÆUS ater lævis vix obscurus, clypeo trilineato, elytris inter strias granulatis femoribus anticis obtusè dentatis, tibiis anticis inter dentes haud crenulatis: calcare acutissimo.

Actinophorus pilularius. *Sturm. Ent. Hand.* 1. 79. t. 3.

Præcedente minor convexior.

Habitat in Europâ australiori; in Greciâ. D. *Woods.*

β Var. S. elytrorum striis et granulis inconspicuis, tibiis anticis bidentatis.

Habitat in Lusitaniâ.

γ Var. S. elytris sublævibus.

Sturm was the first who pointed out the distinction between this species and the former. So many excellent observations on the subject are to be found in this Naturalist's *Verzeichniss*, that Schönnher certainly appears to have been too hasty in rejecting the notion of their being distinct species. As, however, Sturm unfortunately gave the name of *Geoffroyi* to the common species, and indeed to the only one that could have been confounded with *A. volvens*, I have thought proper to return to the Fabrician synonyms, which he has cited erroneously.

29. SCARABÆUS atro-nitidus, clypeo bilineato: lineis obliquis haud confluentibus, thorace elytrisque lævissimis. *atronitidus.*
Habitat in Greciâ, *D. Woods.* Præcedenti nimis affinis.

30. SCARABÆUS niger, supra confusè variolosus: variolarum centro sub lente eminente, clypeo bilineato: lineis ad nuchum concurrentibus, elytris substriatis. *flagellatus.*
S. flagellatus. *Fab. Mantissa*, 1. 17. 168.
——————— *Oliv. Ent.* 1. 3. 162. 199. T. 7. 51. a. b.
S. stictopterus. *Linn. S. N. Gmel.* 1. 4. 1558.?
S. coriarius. *Herbst. Col.* 2. 309. 199. T. 20. 4.
Ateuchus flagellatus. *Fab. Syst. Eleuth.* 1. 59. 22.
Gymnopleurus flagellatus. *Illig. Mag.* 2. 201. 1.
Habitat in Europâ australiori et versus Septentrionem usque ad Lutetiam pertingit, magnitudine varians. *Mus. Brit.*
β Var. S. variolis omnibus confusis.
Habitat in Hispaniâ, *D. Dejean.*
γ Var. S. thoracis variolis minimis, elytrorum variolis et striis valde conspicuis.
Gymnopleurus flagellatus, var. *D. Gebler in literis.*
——————— conflagratus. *D. Steven in literis.*
Hanc varietatem sub lente pulcherrimam, e loco prope Sees

von Saisan in Tartariâ magnâ misit *D. Gebler;* e Cherso-neso Taurico *D. Steven.*

The nomenclature of this species is a singular instance of the habitual carelessness of Fabricius. In the *Species Insectorum* he described a Cape insect *thorace lævi,* under the name of *S. flagellatus*. In the *Mantissa,* he gives the same name to an insect of the South of Europe, *thorace elytrisque scabris*. In the *Systema Entomologiæ* he confounds them both, having evidently forgotten the original *flagellatus* so much, as not to know it on its reappearance, since we find it in the appendix to the last-mentioned work, described as *S. scabratus*. And thus they stand in the *Syst. Eleutheratorum,* where the first *habitat* of *flagellatus* ought consequently to be expunged. Schönnher first perceived this blunder, but has himself erred in taking any synonym for *scabratus* from the *Mantissa*.

humanus. 31. SCARABÆUS atro-olivaceus holosericeus lævissimus haud punctatus, clypeo bilineato: medio lævi, elytris sub lente forti substriatis.

Gymnopleurus humanus. *Leach MSS.*

Habitat ad Cap. Bon. Spei. *D. Burchell. Mus. Brit.*

*** *Clypeus apice bidentatus, lateribus undatis. Corpus metallicum, sericeum vel nitidum. Elytra striata vel substriata.* Insecta Africana.

Leei. 32. SCARABÆUS rubro-cupreus holosericeus, subtus atroviridis, clypeo thoraceque lineâ longitudinali nitidâ dimidiatis, elytris subgranulatis, tibiis posticis æneis.

S. Leei. *Fab. Ent. Syst.* 1. 65. 215.

Habitat ad Cap. Bonæ Spei. *D. Burchell. Mus. Brit.*

The reader will perceive that this species differs from the *Ateuchus Leei* of Fabricius, in the under side being of a dark-green instead of black, and its habitat being the

Cape instead of India. Still I have no doubt of the species being one and the same.

33. SCARABÆUS rubro-olivaceus holosericeus, thorace elytrisque pulcherrimè rugulosis versicoloribus. *Bufo.*†

Habitat ad Cap. Bonæ Spei. *D. Burchell. Mus. Brit.*

34. SCARABÆUS rubro-cupreus metallicus, clypeo lineâ mediâ nitido, thorace rugoso nitidè sculpto, clytris ad latera rugosis nitidè granulatis ad suturam elevatam nitidam undatis. *fulgidus.*

S. fulgidus. *Oliv. Ent.* 1. 3. tab. 22. 199.

Ateuchus Leei var. *Fab. Syst. Eleuth.* 1. 58. 16.

Habitat in Senegalliâ. Insectum pulcherrimum.

Schönnherrio et Fabricio non obstantibus, a *Scarabæo Leei* prorsus distinctum.

35. SCARABÆUS atro-cæruleus metallicus, clypeo lineâ mediâ nitido, thorace ruguloso: sculpturâ dorsali nitidâ, elytris pilis albidis canis, suturâ elevatâ latè nitidâ undatis, lateribus rugulosis. *cærulescens.*

Scarabæus cærulescens. *Oliv. Ent.* 1. 3. 189. 240. t. 27. 231.

Habitat in Senegalliâ. *Mus. Brit.*

36. SCARABÆUS viridi-cæruleus, clypeo lineâ mediâ nitido, thorace ruguloso: sculpturâ dorsali nitidâ, elytris granulatis piloso-canis: suturâ elevatâ. *affinis.*

Obs. Præcedenti nimis affinis.

* * * * *Clypeus apice bidentato. Corpus subtus nigro-nitidum. Thorax foveolâ posticè impressus. Elytra striata vel substriata.* Insecta Asiatica.

37. SCARABÆUS atro-cæruleus nitidus, clypeo trilineato: lateribus undatis, thorace varioloso, elytris valde rugosis. *cyaneus.*

Copris cyaneus. *Fab. Ent. Syst. Suppl.* 34. 211.

Habitat in Tranquebariâ.

38. SCARABÆUS niger, clypeo lineâ mediâ elevatâ, thorace punctis sex sicâque dorsali atronitidis elevatis, elytris sulcatis: unctis lincaribus canis ordine duplici impressis. *Kœnigii.*

Scarabæus Kœnigii. *Fab. Syst. Ent.* 1. 29. 114.

Scarabæus scriptus. *Pall. Icon.* p. 7. A. 7. T.A. f. 7.

——— guttatus. *Linn. S. N. Gmel.* 1. 4. 1558.

Ateuchus Kœnigii. *Fab. Syst. Eleuth.* 1 58. 19.

Habitat in Indiâ orientali. *Mus. Brit.*

β Var. S. atro-æneus, thorace punctis quatuor elevatis.

Obs. Speciem simillimam circa Lacum salsum Inderiensem Deserti Tatarici legit D. Pallas.

The *Ateuchus squalidus* from Brazil, which Fabricius characterizes as "*Affinis A. Kœnigii,*" does not belong to this genus, although to one immediately contiguous. The mistake is analogous to that of Linnæus in confounding *pilularius* with *volvens*. Gmelin has described the *S. Kœnigii* twice under different names; and his work, "*tout indigeste, denué de critique et de connaissance des choses,*" as usual, justifies this character given to it by Cuvier.

granulatus.

39. SCARABÆUS niger supra cinereo-pubescens, capite maculis nitidis duabus, thorace sedecim, elytris basi octo; medio unâ undatâ; apice tribus, abdominis lateribus albo-guttatis, ano albo.

S. granulatus. *Fab. Ent. Syst.* 1. 65. 217.

S. Kœnigii. *Don. Ind. Ins.* t. 2. f. 3.

Hæc species, à præcedente omnino distincta, habitat Tranquebariæ. *Mus. Brit.*

Illiger has observed in his Magazine i. p. 318, that Fabricius was wrong in citing the S. *granulatus* of Olivier as a synonym to this species; but he little suspected the real extent of the evil. It is indeed among the most curious circumstances attending the history of this unfortunate genus, of which scarcely a species has escaped an error of nomenclature, that the *S. granulatus* of Olivier is no other than *Ateuchus scabratus* or the original *S. flagellatus* of

Fabricius, to which we before have had occasion to allude. This, although a native of the Cape, belongs not to the present genus, but is an osculant insect apparently connecting *Gymnopleurus* with that genus to which *Ateuchus volvens* belongs.

40. SCARABÆUS atro-viridis supra cinereo-pubescens, thorace maculis nitidis octo, elytrorum basi septem, medio unâ magnâ, apice duabus. *parvus.*

Habitat in Indiâ orientali. *Mus. Brit.*

Obs. Thoracis foveola postica parum conspicua.

***** *Clypeus sexdentatus. Corpus supra cinereo-pubescens maculis nitidis, subtus nigro-nitidum. Elytra striata.* Insecta Asiatica.

41. SCARABÆUS atro-viridis, thorace maculis duodecim, elytris margine nigris; basi maculis quinque; medio quatuor; apice tribus. *miliaris.*

S. miliaris. *Fab. Syst. Ent. App.* p. 817.

——— *Oliv. Ent.* 1. 3. 167. 206. t. 18. 164.

Habitat in Indiâ orientali. *Mus. Brit.*

β Var. S. pubescentiâ cinereâ subobliteratâ.

γ Var. S. ater.

42. SCARABÆUS atro-viridis, capite trimaculato, thorace canaliculato maculis tredecim, elytrorum basi octo, medio quatuor, apice tribus; maculis aliis minoribus inter strias seriatim dispositis. *spilotus.*

Habitat in Indiâ orientali.

43. SCARABÆUS atro-viridis, thorace decem-maculato, elytris maculis multis irregularibus subseriatim dispositis. *maculosus.*

Habitat in Indiâ orientali, præcedente duplo major. *Mus. Brit.*

β Var. S. tibiis anticis intus emarginatis. An Sexus alter?

Obs. *Heliocantharus Palæmon* et *Gymnopleurus azureus* hac specie quodammodo attinguntur.

I have thus attempted to find characters for the natural groups which appear on disposing the *Gymnopleuri* according to their affinities; but the proper method of considering them all is, as referable to one or other of forms which may be expressed by the five following species:—

1. *azureus.*
2. *flagellatus.*
3. *cærulescens.*
4. *Kœnigii.*
5. *miliaris.*

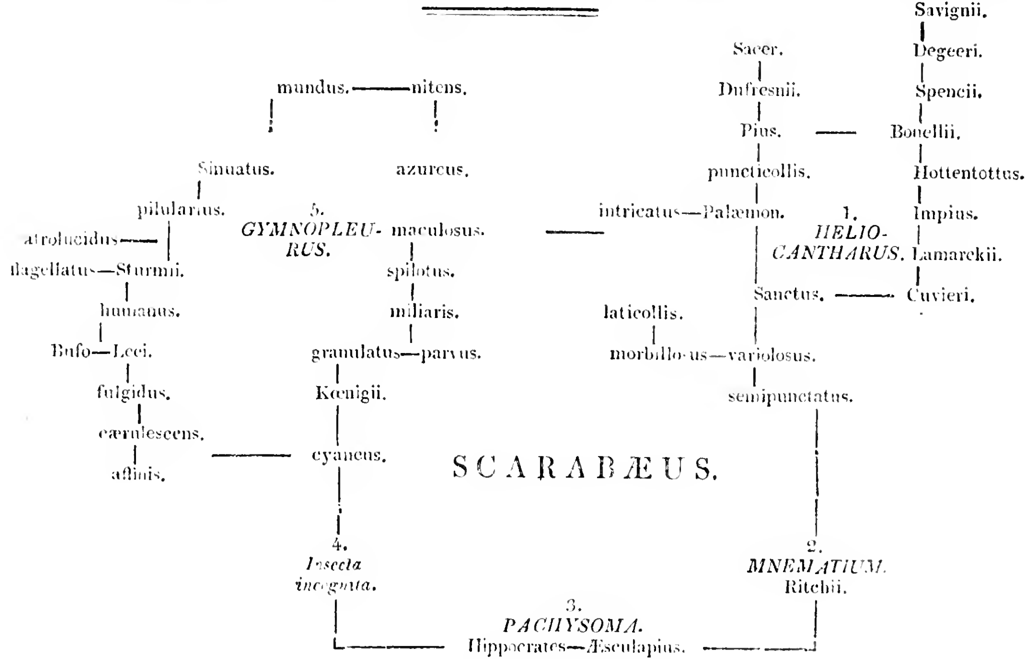
In almost every group which has been set before the reader, he must have perceived that one of the five minor groups, into which it is resolvable, bears a resemblance to all the rest; or, more strictly speaking, consists of types which represent those of each of the four other groups, together with a type peculiar to itself. This is visible in the composition of the *Acrita*, among the divisions of the Animal kingdom; in that of the *Ametabola*, among the classes of *Annulosa*; and of the *Coleoptera*, among the orders of *Mandibulata*. It is a disposition also which can scarcely have escaped our notice on examining the genus *Phanæus*, the fifth type of which contains insects resembling all the other types, together with *P. Carnifex*, which has a form peculiar to this fifth type. What this fifth type is to *Phanæus, Gymnopleurus* is to the genus *Scarabæus*; that is, while it has a form peculiar to itself in *G. flagellatus*, it contains insects varying in the structure of those parts which remain constant in the other sub-genera.

To minds that delight in tracing design amidst those circumstances which seem in our eyes the least to require it, it will always be interesting to observe the limits by which nature has circumscribed the locality of animals.

That plants, which have no means of changing their place, except by foreign agency, should be confined to certain districts, is perhaps to be expected. At least, this circumstance is not calculated to excite our astonishment so much as, that beings endued very perfectly with the powers of locomotion, should never wander beyond certain definable limits. Whether, indeed, the species be thus in a manner imprisoned within an invisible wall, or whether their non-appearance beyond certain degrees of latitude be owing to the circumstance that those which may have strayed so far from their assigned region immediately perish,—in either case, no more convincing instance of the geography of animals being definite, can be advanced than *G. pilularius*. We find this insect in the north of France, and, according to Schæffer, at Ratisbon; also, according to Pallas, in that tract of country which separates the Don from the Wolga: and again, if this celebrated naturalist be right as to the identity of the species, it occurs in the north of Chinese Tartary, on the banks of the Selenga. A learned Entomologist, M. Gebler, whose residence in the heart of Siberia is rendered tolerable by the study of Natural History, has also sent me the *G. flagellatus* from Barnaul. Latreille, therefore, appears perfectly accurate when he fixes the northern geographical limit of *Gymnopleurus* at the 50th degree of latitude, since this parallel is so strictly the boundary of that species which comes the furthest north. But do the minimum and maximum heights of the thermometer remain constant throughout the old world on this parallel of latitude? If they do not, we may suppose that the geographical distribution of these animals has been regulated by some other principle besides warmth. Our knowledge of the economy of the *Gymnopleurus* assures us also, that this line of locality cannot depend either on its food or on the soil. On what circumstances it really does depend, is a question perhaps difficult to decide, but which I would here propose as well deserving the attention of Entomologists.

A review of the preceding analysis will enable the reader to construct a Table of the affinities of the genus *Scarabæus*. He must not, however, imagine himself in a state to form any correct notion of the comparative distance of the species from each other, until many more species than are here described shall be known. It is sufficient if he be aware that a table, however rude, will always have the advantage of expressing affinities more clearly than a linear series. With such a table I shall conclude this attempt to discover the rank and situation which *Scarabæus sacer* holds among organized beings; certain that, whatever errors may be detected in it, they have not arisen from any want of anxiety to ascertain the truth.

Sketch of the Affinities which appear to connect the described Species of the Genus Scarabæus.



ADDENDA ET CORRIGENDA.

PART I.

Page 97.—By a letter received from General Dejean, I learn that *Pholidotus lepidosus* had previously to the publication of this part, been described by Schönnher in the third volume of his *Synonymia Insectorum*, under the name of *Lamprima Humboldtii*. Not having yet seen this volume, I can only give the name as a synonym, and make use of it as a satisfactory proof that the insect in question may safely be attributed to the family of *Lamprimidæ*.

P. 98.—Mr. Swainson, who was urged by his zeal for Natural History to make a voyage to Brazil, has assured me that my suspicions were correct with respect to the insect I have named *Casignetus* being the female of *Pholidotus*.

P. 111.—General Dejean is convinced, from actual observation, that *Dorcus parallelipipedus* and *D. tuberculatus* are sexes of the same species.

P. 143.—It is the female of *Amblyterus* which is here described; but it has been remarked by Mr. Brightwell of Norwich, that the other sex has the last joint of the maxillary palpi much larger, and also furnished with the same longitudinal incision which is so conspicuous in *Pelidnota*. An additional proof is thus offered to our view of the affinity between these two genera.

P. 154.—The organs of manducation in *R. pulchella* are described from Mr. Kirby's dissections, published in the 12th vol. of the Linnæan Transactions. On this subject I have since received the following letter from him:—"Dear Sir,—I beg that in your next part you will correct an error into which I have been the occasion of leading you. The *Instrumenta cibaria*, figured in the 12th vol. of the Linnæan Transactions (tab. xxi. fig. 10. *a*, *b*, *c*, *d*.), are not those of *Rutela pulchella*, of which I had only a single specimen, but they are those of *Macraspis tetradactyla*, which I then regarded as a *Rutela*. This oversight arose from the MSS. and drawings being sent separately to town, so that the circumstance escaped my treacherous memory before the explanation of the plates was made out. I am, &c. W. K."—The Entomologist will therefore perceive, that the character is erroneous which I have given to *Rutela pulchella* in the first part of this work.

PART II.

P. 194.—Perhaps no animals are more worthy of the Physiologist's attention than Heteromerous Insects. Their singular properties have afforded objections to the second character of distinction between the Vegetable and Animal kingdoms, which may seem opposed to an expression in p. 192. But we ought not at present to lay any great stress on such objections, since Mr. Baker's curious experiments on the *Blaps Mortisaga*, which he has detailed in the Philosophical Transactions, and which appear to have been only repeated by M. Biot, prove no more than that this annulose animal can exist in air extremely rarified. M. de Humboldt has also shown in the *Mémoires de la Société d'Arcueil*, that the air-bladder of fresh-water fishes contains from four to seven per cent. of oxygen. Hence, all that can be said of those intestinal worms which have been cited as the most striking examples of the power of an animal to live without oxygen, is, that the minutest particle of this air is sufficient for their existence.

P. 230, l. 15, for *Thethya* read *Tethya.*

P. 258, l. 12. I have here adopted the French word *Batracien*, which would have been more correctly *Batrachien.*

P. 261, last line but one, for *family* read *class.*

P. 278, l. 8. When this was written I had only seen M. Latreille's report, since which M. Savigny's work has itself appeared. From this it seems, that now, in order to occasion as little violence as possible to nomenclature, he has altered his first intention, and given the name of *Sanguisuga* to the common leech, assigning the generic appellation of *Hæmopis* to the horse-leech.

P. 288, l. 4, for *leads* read *lead.*

P. 351, l. 5, for *the* read *some.*

P. 367, l. 8, before *Cuvier* insert *Fabricius.*

——, l. 18, for *apoda* read *apus.*

P. 375, l. 7, after *antennæ* erase the words *the presence of ocelli.*

——— l. 11, after *be* erase the words *destitute of ocelli.*

P. 436, l. 5.—Panzer in the *Fauna Germanica*, fascic. 68. n. 24, has given a figure of an insect found in ant-nests, and which he terms *Blatta acervorum.* Respecting its affinities he merely observes, "*Ambiguum insectum! an hujus generis? quamvis maxime Blattis affine, an jam declaratum?*" Never having seen the insect myself, I could not venture to express any decisive opinion on its natural situation at the time my sentiments with respect to the connexion existing between the *Blattina* and *Gryllina* were written. Since then, however, I have had the satisfaction of seeing in the 16th vol. of the *Biblioteca Italiana*, a very interesting paper entitled "*Osser-*

vazioni sopra la Blatta acervorum di Panzer del Dottor Paolo Savi assistente al Prof. di Botanica nell' Imp. e R. Università di Pisa." This Entomologist fully states the several respects in which its construction agrees with the true *Blattæ*, but also observes "*che questo insetto certamente non e una Blatta, ma piuttosto un' Acheta di Fabricio o Grillo di Latreille,*" and he accordingly names it *Gryllus myrmecophilus!* It is not easy to imagine a more complete confirmation of the truth of the affinity here stated to exist between the *Gryllina* and *Blattina.*

P. 457, note line 12, for *desireable* read *desirable.*

P. 497, l. 17. Although in conformity to the plan of the *Regne Animal*, I have assigned names to the subgenera of *Scarabæus*, I am not without apprehension that confusion will thus arise between *genera* and *subgenera*, or types of form. It may indeed be a question for Entomologists to determine, whether it be preferable to give names to types of form, or to designate them only by their number, reckoning always from some particular type. As every natural group seems divisible into five others, perhaps the latter mode is the least objectionable, particularly if we were always to account that type of a group to be the first, which contains representations of the four other forms, as well as the form which is peculiar to itself. On this plan the type of *Phanæus* which contains *P. Carnifex*, and that of *Scarabæus* which contains *S. flagellatus*, would be the first of their respective groups.

END OF VOL. I.

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