# CHAPTER VII.

Classification ; Nature and mode of—"Natural" and "Artificial" systems — Morphology and Physiology the two factors of Classification — System and Mode of Arrangement of the Animal Series : the Type or Sub-Kingdom ; Class ; Order ; Family ; Genus—Species—Nature of "Species"—Variation in Species—Recent Opinions regarding the significance of the term—Provisional Definition of "Species"—Illustrations of Classification.

THE introductory matter which has formed the subject of the preceding chapters prefaces, in a very convenient manner, the important section, upon the consideration of which we now enter. The ultimate aim of the principles of biological science, and of the recognition of those relations which exist between living forms, is the due arrangement of these forms in a certain system, and according to a scientific mode. Such a system of arrangement we denominate "classification;" and this latter, in turn, is a necessary preliminary to the systematic and careful examination of individual organisms, or groups of organisms.

The early history of almost every science may be said to begin with a scheme of classification. The beginnings of a scientific method will generally be found to have taken origin in a rude attempt to arrange the objects or subjects of which the method proposes to treat. As might be expected, such initiatory attempts at systematic arrangement present us with very varied aspects, so far, at least, as the features from which the principles of the classification were drawn are concerned. These features are found to be essentially those derived from external configuration, or from characters which a mere superficial examination might furnish. And the characters thus

ascertained result in the formation of a so-called "artificial" system of classification; since in its construction the deeper and more reliable features of structure are neglected for the "artificial" characters drawn from chance resemblance or configuration. A system of classification, on the other hand, founded on the characters furnished by a consideration of the entire *structure* of the organisms it is proposed to classify, and which system accordingly includes all the natural details of form, is in contradistinction termed a "natural" classification.

No great amount of thought is needed to perceive that the earlier classifications were eminently "artificial" in character; and such systems find their existing prototype in the arrangement which we might suppose a savage to make of the living things by which he is surrounded. Thus he would classify together birds and bats, from the fact that both indulge in the habit of flight. The whale he would classify with fishes, because it resembles them in external appearance and habits. And he would group frogs, newts, lizards, and snakes together under the term Reptiles, thereby including under this single term an immense variety of heterogeneous forms. And, finally, if we can suppose sufficient intelligence to guide the savage in his work, he would tend to arrange the animal kingdom in a linear series, to form an unbroken and continuous line of beings, commencing in detail with the lowest organisms, and capping his series with the highest form. Now in each case the primitive taxonomist has seized on purely external characters and resemblances; and as a result he has formed certain "artificial" groups, including individuals which may have, save perhaps in form or habits, no community of type and no "natural" affinities.

Conversely, let us suppose the scientific taxonomist, with the knowledge which he has derived from his study of Morphology and Physiology, to be placed in the position of the primitive savage. His mode of classification would be essentially and exactly opposite to that of the latter. He would, by a thorough investiga-

tion of the structure and functions of the various forms he might meet with, first demonstrate the existence of distinct types or plans of structure; and he would thus construct great primary groups, into which the entire series would be divided. Fixing definitely the characters of these primary groups, he would be enabled to refer to them any subsequent forms which might fall under his notice; and then his further labours would consist in the assorting and parcelling out of his primary groups into subordinate divisions. And, so far from his system partaking of the nature of a linear or continuous series, he would find that the construction of any such arrangement would be unnatural and impossible; since in his labours he would demonstrate that there are forms of essentially different nature, which it would be impossible to arrange one above another in point of organisation, and that, in short, the very nature of the case does not admit of any such arrangement being made.

The labours of the primitive savage, therefore, exemplify for us the formation of an "artificial" arrangement of the organic series. The labours of the scientific morphologist show us on what principles we construct a "natural" classification, which thus brings together organisms or groups of organisms allied to each other by all the essential points of structure. This latter, as we shall have occasion to observe, is the only system which can be said to perfectly fulfil all the conditions required of a truly scientific arrangement.

To trace from the standpoint of a historian the progress of the system of classification from its rude outlines and imperfect details to its establishment upon a sure basis, is a task which, however interesting and instructive it might prove, falls without the boundaries of the present work. I have already sufficiently indicated the starting-point of such a history, and the student will find no difficulty in obtaining from appropriate sources an interesting sketch of the progress of this department of biological science.

A truly philosophical system of classification has been

defined as "an expression, in a convenient form, of the facts and laws of Morphology and Physiology." And the statement thus enunciated expresses the grand fact that it is from a correct appreciation and idea of the differences and relations which the study of structure and function reveals, that we are enabled to construct a truly "natural" system of classification of either animal or plant series. The full knowledge of structures and functions is therefore the sole aid which we require in the task of arranging either kingdom.

We have already seen that the ultimate object of all classification is the arrangement of objects or forms into defined groups, chiefly for the purposes of ready identification, and detailed examination of their structure and relations. This, shortly stated, is the aim of every system of arrangement, on whatever conditions or by whatever means the system may be constructed. We arrange or classify a library for the express purpose of enabling us to select and obtain, without trouble, any particular volume we wish to consult. And there are, it is obvious, many methods by which our end may be attained. We may arrange our books alphabetically, or we may assort them according to the subjects of which they treat, or we may even employ the characters afforded by size or appearance, to enable us to place them conveniently for access and purposes of consultation. And if we follow out a little further the simile of the library arrangement, we shall find that we may gain a general idea of the motives which, at various stages in the history of Biology, have prompted the scientific taxonomist in his labours.

The process of classifying books by size or appearance requires no great knowledge or methodical power. A person who could neither read nor write, but who possessed some idea of colour and size, might undertake to arrange the library at once tastefully and harmoniously; but, at the same time, such a classification would be entirely destitute of any literary value, and clearly of no service to any one unacquainted with the library. It would be, in short, of no universal or convenient application. Such a

process is imitated, then, in the earlier and artificial systems of the classification of animals and plants. Conspicuous characters may be said to constitute the basis of these earlier methods, just as it forms the basis in grouping together the books after this first method. Alphabetical classification, in the second place, whilst requiring a certain amount of knowledge, may yet be wholly inadequate to fulfil the ends of a perfect system of arrangement; and the superficial classifications which existed in such numbers in the later stages of the progress towards taxonomical perfection, very closely correspond to this latter arrangement of the library. Lastly, to classify our library according to the subject-matter of the volumes requires a great amount of knowledge and discrimination; but the result of this latter arrangement would be the assorting of the books in a manner corresponding in detail to that in which the principles of Morphology and Physiology serve to arrange the animal and vegetable series in the present day. Leaving superficial distinctions and artificial characters, we fix on the evidences of structural type and the degree of physiological perfection, as affording us the requisite power to marshal the varied forms of life into their natural places and rank in the scale of being.

Recognising the presence in the organisation of animal and plant forms of two great factors or principles —the morphological factor and the physiological factor —we are prepared to regard every animal or plant as depending for its place in the scheme of classification, firstly, upon the fundamental plan or type on which its body is constructed; and, secondly, on the degree of perfection to which the processes or functions of life are carried within the organism. And if, in addition to these primary facts, we consider the existence, in most instances, of the "law of correlation" of forms and structures, by means of which we ascertain the invariable co-existence of certain characters, we obtain a comprehensive, natural, and accurate synopsis of the form itself; and also of all forms with which the same modes of investigation prove our typical form to be related.

But, further, the "natural" system of classification takes into account not merely the present features of the organism as a fully-formed being. It also traces its life-history backwards by aid of development, and thus derives its special characters from a review, not of a mere part of its existence, but of its entire life-history.

Having thus gained an idea of the extent and aims of the subject before us, we may next observe how the foregoing principles are put to a practical use. Bringing before us as taxonomists the entire animal kingdom or series, we first look about us for certain broad and general features, by means of which we may parcel out our kingdom into definite districts, susceptible each of further subdivision. Such primary groups Morphology provides us with in the form of the six great "Morphological Types," which, as previously remarked, figure in the system of classification as "sub-kingdoms." These sub-kingdoms are based, as we have observed, on the existence of six distinct types or plans of fundamental structure recognisable in the animal world. Each sub-kingdom has thus an entity of its own, and the remembrance of this fact will serve to facilitate our appreciation of the difficulties, and indeed impossibilities, which lie in the way of the construction of a "linear system" of classification. These sub-kingdoms are divided into subordinate groups called "Classes;" the "Classes" are in turn subdivided into "Orders;" the "Orders" are broken up into "Families;" the "Families" into "Genera;" and the "Genera" into "Species."

We thus descend from a universal to a particular quantity. We begin with the entire kingdom, and at last arrive at those units of which the series in its entirety is composed. A tabular view of the system of classification might be rendered thus:—

KINGDOM divided into { SUB-KINGDOMS divided into { CLASSES divided into { ORDERS divided into { FAMILIES divided into { GENERA divided into { SPECIES.

Let us next exemplify this process of progressive analysis in the scheme of classification. Having before us the entire animal series, we find that Morphology divides it for us into the six types. Each type includes a large number of forms, which agree in having their bodies built up on the same fundamental plan of structure. So far Morphology alone assists us. The division, so far as it has proceeded, is founded on purely structural grounds. We know, for example, that the Vertebrata are distinguished by the peculiar division of the body into two distinct regions, as we have already observed and illustrated (Figs. 16 and 17). Then we find subsidiary characters in the relative positions of the neural, hæmal, and digestive systems, in the presence of a notochord or vertebral column, and in other and minor structural features. All these characters belong to the Vertebrata as a *type*—that is, every member of the sub-kingdom *Vertebrata*, must agree with its fellow Vertebrates in the possession of the special features which are distinctive of them all.

But if we examine, even with a superficial glance, the various forms to which, in virtue of this community of type, the term *Vertebrate* may be applied, we at once detect very many and important modifications of the same structural plan; and a study of the more intimate homologies of the group, as also of the degree to which the "specialisation of functions" is carried out in the various Vertebrate economies which we may examine, serves to show us that the members of a type or sub-kingdom exhibit among themselves certain broad variations of the structural plan. These broad variations are determined by the degree of perfection in which the "specialisation of functions" exists; and the characters adduced from these latter considerations suffice to constitute large groups subsidiary to the sub-kingdoms, and known in our system of arrangement as "Classes."

As Professor Agassiz expresses it, classes are divisions which include forms built up on the same morphological type or plan, but exhibiting variations in the manner

according to which the plan is executed. This may be expressed in another way by saying that classes are groups of forms subsidiary to a morphological type, and which derive their special characters from physiological variations, and from the structural and "correlative" modifications dependent thereon.

A cursory examination of the *Vertebrata*, then, from a conjoint morphological and physiological standpoint, would result in the elimination of certain subsidiary groups or "classes." The first series of forms which we could differentiate would exhibit an adaptation to an aquatic existence. The limbs would appear in the form of fins; the breathing organs would be similarly modified to suit an aquatic life; the physiological perfection of the digestive and circulatory functions would be respectively noted; and in this way a "class," that of the *Pisces* or Fishes, would be formed, distinguished thus by a certain physiological status, and by a corresponding and special morphology. At once, therefore, we not only express the characters common to the members of any "class" or group, but also those characters by which it is distinguished from every other group. The statement of these characters, in fact, "constitutes the definition of the group."

Similarly, we can distinguish a second "class" evincing a higher degree of physiological specialisation than the preceding group; this latter "class" showing us a greater perfection of the skeleton; the presence of lungs in the adult in addition to the gills of early life; an advancement in the structure and functions of the heart; and a "metamorphosis," or certain series of changes, through which the young embryo passes in its progress towards adult and mature existence. These characters, expressing a functional state higher than that of the fishes, and necessitating a more perfect morphology, map out for us the "class" *Amphibia*.

The *Reptilia*, or Reptiles, forming the third class, lead us to a still higher degree of specialisation. The presence throughout life of lungs only; of a compound lower jaw and "quadrate bone;" of limbs (when present) suited

generally for terrestrial progression, and of other functional peculiarities, define the class before us.

Then the *Aves*, or Birds, are defined by their warm blood; the peculiar structure of their lungs; the character of the body-covering; the modification of the anterior limbs for flight; and by corresponding physiological characteristics. Whilst the *Mammalia* are known by their simple lower jaw; their two "occipital condyles;" their non-nucleated red blood-corpuscles; and by the possession of mammary glands.

The division of the *Vertebrate* type in this way, will suffice to exemplify the mode in which the physiological principle of "specialisation of functions" primarily aids us in subdividing a sub-kingdom. It must be borne in mind, however, that the morphological distinctions are not always subservient to or dependent upon the physiological ones. On the contrary, it is sometimes exceedingly difficult to detect any differences on physiological grounds, whilst the morphological conformation may at once assist us in distinguishing between forms, or, on the other hand, aid us in maintaining their relationship. And further, the "law of correlation of forms," which, as we have seen, lies at the foundation of many definitions, exists independently of any physiological differences. Whilst thus the presence of "correlative" structures forms the most stable element in many definitions, we are unable, as already observed, to trace any causal connection between the correlated organs or parts. Apart from these latter considerations, however, we must recognise the conjoint value of Morphology and Physiology in serving to determine the relations between any two organisms or groups of forms.

The next division which we notice is the "Order." This term is applied to those subsidiary groups into which the "class" is divided. In the differentiation of "orders" the morphological differences become less apparent, whilst the physiological ones become better defined than before. An "order" thus retains the morphological features of its "class," just as a "class" retains those of

its "type;" but the various "orders" of a "class" generally vary greatly in the degree of physiological perfection to which they may severally attain.

The "order" is divided into "Families." These latter divisions are not to be regarded of primary importance, and in most cases serve as convenient stepping-stones from the "orders" to the "genera," where the number of forms included in an "order" is very great.

The "Genera," into which the "family" or "order" is divided, bring us to the consideration of characters which very nearly approach those of the individual; and accordingly we find the circle of physiological distinctions growing gradually more contracted, until in the "species" we reach the characters which are specially distinctive of the *individual* organism, and which are accordingly more localised and susceptible of determination than those of the larger groups. "Species," in this view, and without prejudging the remarks to be presently made on the origin and limits of species, may therefore be held to be "the most limited group of individuals which can be defined and separated from all other groups by a common character."

The process of classification is therefore essentially one of differentiation, or of the separating out firstly of groups, and through the groups of the "specific" individual. With "species" we reach the unit of classification, or that quantity, from and through combinations of which the entire scheme of classification is made up. To obtain a satisfactory idea of the terms we have just examined, in reference to "species," it will be necessary to review them in an opposite order from that in which we have just been considering them. We shall therefore begin with the consideration of the term "species," which in more ways than one has been the bugbear of classification, and concerning the nature of which our ideas have, within the past few years, undergone a remarkable change.

In considering the nature of the term "species," and also the views regarding it which recent observations and theories have promulgated, it will be at once the easiest

and most satisfactory course, if we turn our attention, in the first instance, to the consideration of the opinions formerly held with regard to the limits and meaning of the term; then to the more modern views concerning species; and, incidentally, to a brief summary of the arguments *pro* and *con* the opposing doctrines.

At the outset of our inquiry we are led to consider a few of the many definitions which have been given of "species." A "species" has accordingly been defined by Forbes as "an assemblage of individuals presenting certain constant characters in common, and derived from one original protoplast or stock." Martin says that "species are distinct forms, originally created, and producing, by certain laws of generation, others like themselves." Cuvier defined species as "the collection of all the beings descended the one from the other, or from common parents; and of those which bear as close a resemblance to these as they bear to each other." Müller tells us that species "is a living form, represented by individual beings, which reappears in the product of generation with certain invariable characters, and is constantly reproduced by the generative act of similar individuals." Buffon maintains that "species is a constant succession of individuals similar to and capable of reproducing each other." De Candolle says that a "species" comprises "all those individuals which mutually bear to each other so close a resemblance as to allow of our supposing that they may have proceeded originally from a single being or a single pair." Woodward explains that a "species" is constituted by "all the specimens or individuals which are so much alike that we may reasonably believe them to have descended from a common stock." And, lastly, we find "species" by other writers to be defined as "an assemblage of individual animals which are supposed all to have descended from the same parents, and exhibit the closest resemblance in all parts of their structure;" or as "a number of animals so closely resembling each other that they all might be supposed to be the offspring of the same parents, and in turn

to give birth to progeny exactly resembling themselves."

Now, the list of definitions just cited, serves admirably to show the chief and essential ideas which the use of the term "species" involved at a period comparatively recent in the history of biology. And these points were, firstly, the recognition of a certain degree of "resemblance" between the forms of which a "species" was composed; and, secondly, a community of descent, or that the members of a species must have descended from a single pair, or from pairs of individuals of exactly similar nature. We thus see that the scientific term "species" is one which, according to the former views, might be adequately and correctly enough rendered by the commonplace word "kind." And accordingly the fact of two animals belonging to the same "kind," popularly speaking, necessitated, firstly, a close resemblance between them; and, secondly, the supposition that their progenitors were also similar to one another. Such were the ideas formerly involved in the use of the term "species;" and it will be well to bear these ideas in mind, in order that we may observe more clearly the nature of the sweeping changes which of late years have taken place in opinions regarding the limits and significance of the term.

But if we more carefully consider the foregoing definitions, or if we investigate the further opinions of naturalists in the past regarding "species," we find that they attached to "species" a very constant and fixed degree of stability in form and relations. They admitted that "species" might, and very often did, vary; and that changes in form, size, colour, or general appearance, might, from the operation of external conditions, be produced. And they further allowed that the changes so produced in certain individuals of the species might even be transmitted to the progeny of such individuals, and that these alterations might in this way become more or less of a permanent nature. Such individuals, or their progeny, in which "variations" became thus perpetuated, were known as "Varieties." These "varieties," however, in most cases,

showed a disposition to return to the likeness of the "species;" but when a "variety" became to all appearance permanent, it constituted a "race." "Races," in other words, are permanent or perpetuated "varieties."

Now, it is chiefly from the admission of this greater or less degree of possible "variation" in species that the modern significance of the term has assumed so wide a difference from that in which it was formerly held. And it is around this point that the heat and fury of the battle of the theories appear to rage. Hence the issue at large appears to assume the form of the question 'whether or not "species" is variable without the limits which former opinions set; and, if so, what are the causes or conditions which determine the variations, and to what degree may such variations extend?' Is Forbes's dictum, that "every true species presents in its individuals certain features, specific characters which distinguish it from every other species, as if the Creator had set an exclusive mark or seal on each type," consistent with facts as they now stand? And can we maintain, in the face of recent investigations, the community of descent and primitive origin of species commonly insisted upon in the older definitions? Such are the questions which the biologist has inevitably to meet and answer, and such is the bent of the observations to which we must next direct attention.

Taking origin from the admission that the individuals of a "species" exhibit among themselves variations in form and structure, we find that modern theories assign to such variations not only a far wider range than was formerly accorded, but the variations are also held to possess very intimate relations with the "origin" and ultimate development of the particular "species" in which they are perceived, and with that of neighbouring or distantly connected species also. This statement leads us, then, to notice the first part of the question which we enunciated above—namely, "whether species is variable without the limits which former opinions set."

Naturalists, as we have observed, have long admitted the existence of variations in "species;" and it is these variations, and the estimation in which they are held, that have caused so much dissension as to the universal recognition of many animal and plant forms as true and undoubted "species," on the one hand, or as mere "varieties" of a "species," on the other. And in certain species, the existence of so-called "dimorphic" or "trimorphic" forms—that is, forms included in a single "species," but exhibiting differences among themselves of insufficient value to constitute "varieties"—has but rendered the task of accurately limiting or defining such "species" all the more hopeless and confusing. Then, even among the individuals composing most normal and perfectly ascertained "species," there is no immunity from variation to a greater or less degree, but, on the contrary, a marked tendency towards alteration and variability.

If the existence of this variation in "species" be admitted—and we apprehend that it will now be universally allowed—it remains yet to be shown whether or not this variation exceeds the ordinary limits which are commonly assigned to it. We have seen that the variation first becomes definable to form the "variety," and that the variety becomes perpetuated to form the "race." Now, if we admit that the "race" is subject to the same variations to which the species is liable, then the "race" in turn becomes an unstable and mutable quantity. The influences affecting the individuals of the "species" may equally well affect the individuals of the "race." The conditions which vary the "species" may, in the order of a logical sequence, be supposed, and are, capable of effecting "variation" in the "race" also; and if we conceive that variation may thus be illimitable, we are prepared to admit that the divergence may proceed almost *ad infinitum*.

Such are the effects which are now well ascertained, through the researches of Mr. Darwin and others, to be produced among the constituent individuals of a "species" by the external and modifying influences of climate, food,

domestication, and by other causes allied in nature to these latter; or even, in many cases, without the operation of any apparent or defined cause.

The question of the variation of "species" beyond the limits which former opinions set, may, I think, be thus settled by the confirmation that these limits are exceeded to an extent for which the older theories and definitions would be quite unprepared. The question so far has been a morphological one. We have, in other words, been considering "species" relatively to variations in form, appearance, and structure.

Physiology appears in the next stage to answer the question as to "community of descent," and as to the degree to which such variations may extend. The supposition that "species" may have sprung from a single pair, or from pairs of similar individuals, we have observed to underlie, in a greater or less degree, all the definitions of "species" which have been given. And accordingly we find this idea of a common and similar descent to be embodied in the generally accepted notions—namely, that the power of propagating and producing a progeny which shall be equally capable with the parents of perfectly reproducing their like, is confined to the individuals of each "species" or of each "race," as the case may be. In other words, the so-called "physiological species" is constituted by "groups of individuals which breed freely together, tending to reproduce their like." The offspring of the true physiological species, therefore, normally tend to resemble their parents, and in turn to reproduce their like.

And such an admission or statement is merely tantamount to asserting that individuals belonging to different "species" do not generally breed together; but that, if they do breed together, the progeny, known as "crosses" or "hybrids," will be sterile, or incapable of reproducing their like. But "hybrids" are not universally sterile. On the contrary, very many instances might be adduced to show that whilst "hybrids" have been perfectly fertile, the progeny of

admitted and true "varieties" of a species may be sterile. And, in the face of these and allied facts, the rigidity and unexceptionable nature of the "physiological species" would appear to share no better fate than that which befalls the morphological aspect of the term. The test of "infertile hybridism," therefore, as distinctive of the "physiological species," is not of universal application. Whilst we admit its general truth, we must protest against its universal correctness. And when we add to the foregoing considerations, that in many cases the hybrid "races" so produced seem to be more or less perpetuated, and to continue to produce among themselves fertile progeny, we shall have said enough to convince the reader that "species," in the light of a "physiological" quantity, must present to our modern ideas a very different aspect from that in which it was regarded of old.

The following conclusions, therefore, seem fairly deducible from our considerations :—

Firstly : That "species" is of two kinds, or may be regarded as involving two distinct yet connected aspects —"morphological species," meaning the most limited group of individuals distinguished by the possession of a common character, and separated from all other groups by such a character ; and "physiological species," denoting those groups of individuals "which breed freely together, tending to reproduce their like."

Secondly : That neither "morphological" nor "physiological species" are constant quantities, but are, on the contrary, subject to greater or less degrees of variation and change.

Thirdly : That the test of "infertile hybridism" is rendered invalid in many cases by the recognition of the facts, that whilst certain individuals may be even more fertile with individuals of another species than with those of their own, and whilst true "varieties" of a "species" may be sterile when interbred ; so, on the opposite side, the individuals of separate and entirely distinct "species," and the hybrid progeny resulting therefrom, may be perfectly fertile when "crossed."

Fourthly: The fertility or sterility of "hybrids" is subject to so great variation, that no great dependence can be placed upon deductions drawn from this latter source. The power of reproducing their like among "hybrids" appears to be affected by conditions and causes different, in degree at any rate, from those which affect the "species" as a whole. And

Fifthly: So far as research has proved, the fertility of "hybrids" tends to become lessened in time—this fact to be taken consistently with the progress of experimental study and research.

The term "species" therefore possesses, in these days, a significance widely altered from that in which it was formerly held. It no longer expresses an immutable or fixed quantity, neither does it possess an absolute meaning; and recognising the shifting nature of the question as it now stands, we may, most consistently with the demands of scientific accuracy, regard "species" in the light of an abstract term, of service to us in embodying an idea and starting-point in our system of classification. The term may therefore be now taken to mean 'a group of individuals possessing a general likeness or resemblance to one another, which, in the usual order of circumstances, produce new individuals; these latter exhibiting among themselves the same general resemblance, but liable in themselves, and in the case of their progeny, to greater or less variation from the distinctive characters of the species.' We thus entirely, for the present, shun the question of "community of descent," from its more theoretical and less tangible aspects at least. This consideration will more appropriately occupy us when treating of the theories regarding the origin of living forms in general. And it is also needful, by way of conclusion, to remark, that the "variation" mentioned in the latter part of the above definition of species is to be regarded, like the term "species" itself, as somewhat of an abstract term, embodying the recognition of certain phenomena, but at the same time admitting the necessary imperfections of the data on which the existence of such phenomena or con-

ditions is founded—imperfections these, which time and research will undoubtedly go far to remedy and improve.

Accepting, then, this provisional idea of "species," we have no difficulty in readily recognising the existence of many and familiar "species" of living forms in the world around us. We familiarly talk of the various "species" of animals or plants; employing the term popularly, as already remarked, in the sense of the word "kind." In this abstract sense, therefore, any one animal and its progeny may constitute the type of a "species;" and into such a group, all forms related to it by that nearness of relationship expressed by the term "kind" will be placed. For example, the "domestic" mouse and all its "kind"—that is, all other "domestic" mice—constitute, in this light, a distinct "species" of mice. The essential of which statement lies in the patent fact, that all "domestic" mice exhibit certain characters, generally of constant nature, and by these characters they are distinguished from all other animals, and primarily from all other mice. Thus we find certain characters in form and habits, by which we distinguish the "domestic" mouse from other "kinds" of mice, such as the "harvest" mouse and "field" mouse. And we have in these latter forms, examples of two other "kinds" or "species" of mice, and further research would, in all probability, bring as many more "species" to light. So with the differences between horses and asses, or between many other forms, which a cursory glance throughout animal or plant worlds will detect and exemplify.

A step upwards in the taxonomical ladder brings us to the "genus," which is defined as a group embracing a number of "species," closely allied to each other in all essentially structural peculiarities, but which may be subject to minor differences in form, colour, size, and general appearance. There is, therefore, a closer resemblance and relationship between "genus" and "species," than between any of the other groups, in the scale of classification. The Rats thus form a group of sufficient nearness and resemblance to the Mice, to be included in

the same "genus" with the latter. The Rat may, on ordinary grounds, be considered a larger kind of mouse—*specifically* distinct, but *generically* the same with the mice.

In scientifically naming animals and plants, we use what has been termed the "binomial system" of Linnæus, in which we give to every organism two names; the first being indicative of its "genus"—its *generic* name, and the second denoting its "species"—its *specific* name. Thus, the "Domestic" mouse would scientifically be named *Mus domesticus;* the "Harvest" mouse, *Mus messorius;* whilst the common or Brown Rat would similarly be termed *Mus decumanus*, and the Black Rat *Mus rattus.* The typical species of the Horse is known as *Equus caballus;* whilst the Ass, Zebra, and Quagga, are respectively known as *Equus asinus*, *Equus zebra*, and *Equus quagga.* A glance at the scientific appellations of living forms may, to the naturalist, therefore reveal much concerning their nature and relations with each other. The "generic" term *Mus*, as above used, indicates that the Rats and Mice belong to one and the same "genus;" and similarly the common term *Equus* informs us that the different "species," Horse, Zebra, Ass, and Quagga, are included in that "genus."

The "family" may be defined as a group embracing genera, which are all nearly related to each other, but which, at the same time, may exhibit slight differences in structure and appearance. The widening of "generic" characters serves to constitute the "family;" just as the broadening of "specific" characters collates the forms included in a "genus." This group is not of much practical or theoretical importance. It serves, as already remarked, as a convenient stepping-stone between the "order" and the "genus," where a large number of genera have to be collated and arranged before including them in the "order." Thus the rats, mice, and other genera, might be arranged to form the family *Muridæ;* the Hares and Rabbits might similarly be included in the family *Leporidæ;* or the Horse and its allies in the family *Equidæ.* The name of the "family" is generally

derived from that of the "genus." In some cases, on the contrary, where there are but few genera, the term "family" is left out of consideration, and the "genera" are included directly in the "order."

The "order" is a division, including a number of "families" or "genera," as the case may be, allied to each other by some very prominent features in their economy. In this view the Rats and Mice possess a very prominent structural feature in the peculiar form and disposition of the incisor or front teeth, and in the deficiency of the canine teeth—a conformation of dental structure, investing them with an exceedingly powerful gnawing apparatus. This peculiar arrangement of the dental structures we find to be also exhibited by a great variety of other forms, such as Squirrels, Beavers, Porcupines, Hares, Rabbits, Lemmings, Marmots, etc.; and the characters derived from the disposition of the teeth are, therefore, accounted of sufficient importance to classify these varied forms together in an "order"—that of the *Rodentia* or "gnawing" quadrupeds.

The "class" includes "orders" related to each other by still wider characters than those which bind "genera" or "families" together to form an order. The "orders" included in a "class" must therefore exhibit a relationship through some common structural features, which exist independently of the general type or plan on which the "class" itself may be correlated with other "classes." The common structural feature sufficient to relate the *Rodent* order to a large number of other "orders," is found in the possession of "mammary glands;" and hence all animals possessing these glands, or suckling their young, are included in the "class" *Mammalia*.

The "class" being thus constituted, we find the grand feature of similarity in fundamental structure collating "classes" together, to form those large groups into which the entire animal world is immediately divided, and which are known as "sub-kingdoms." We accordingly observe that a morphological relationship of this broad and primary kind, irrespective of all other considerations,

unites the classes *Mammalia*, *Aves*, *Reptilia*, *Amphibia*, and *Pisces*, to form the *Vertebrate* type, or "sub-kingdom," as it is termed in the scheme of classification.

Such is a brief exposition of the system of classification of the animal series; a scheme admirably suited to the purposes of the systematic naturalist, and which presents the included forms in a sufficiently clear and ready manner, for the due investigation of the relations between individuals, or groups of individuals. The advance of scientific research will, doubtless, detect its more special and particular imperfections, and at the same time tend to their amelioration; but its general plan, founded on the deductions of morphology and physiology, presents us with as near an approach to a truly philosophical scheme as can well be expected or desired.

Lastly, the still existent and popular idea of a linear or continuous arrangement of the animal or plant series may be briefly noticed in the present instance. Such an idea may be regarded as a lingering remnant of that primitive classification already pointed out; which, destitute of a sound basis of morphological and physiological knowledge, sought to arrange animal forms in a single, continuous, and unbroken series. And it was thus conceived possible that we could pass continuously, and through a graduated series of animals, from the lowest to the highest form; each step or form in the series being supposed to be higher and lower than its respective predecessor and successor.

We have already seen, however, that the rank of every animal form is determined, firstly, by its special fundamental structure or "morphological type," and secondly, by the relative degree of perfection to which the "specialisation of functions" is carried out in its economy.

There can, therefore, be no comparison drawn between any two animals belonging to different morphological types, on the ground of the greater physiological perfection of either; nor, *vice versa*, can we compare two animals physiologically the same, but belonging to different types of structure. A *Cœlenterate* animal, in virtue of

its "type," is thus a higher animal than any *Protozoön;* and, similarly, an *Echinozoal* animal is of a higher type of structure than a *Cœlenterate.* Every *Annulose* form is *morphologically* inferior to a *Mollusc;* but the higher *Annulosa*—such as the insects, spiders, and crustaceans—are *physiologically* higher than the lower *Mollusca,* represented by "sea-mats" and "sea-squirts." But if, following the dictates of a "linear system" of classification, we were to arrange and classify the *Mollusca* and *Annulosa,* we should have to place the "sea-mats," and other lower Molluscs, below the insects, spiders, and crustaceans—a procedure obviously inconsistent with the nature of either series of organisms, when we reflect that the "type" upon which the "sea-mats" and all other Molluscs are constructed, is a higher "type" than that upon which the *Annulose* body is built up.

Thus the higher members of each type are *physiologically higher,* and at the same time *morphologically lower,* than the lower members of the superior and succeeding sub-kingdom. And whilst morphology thus refuses its assent to the construction of a "linear classification" on the ground of distinctive types, physiology also discountenances the idea on the ground that two organisms belonging to different types of structure may possess an equal physiological status, which would render it impossible to classify one above the other in so far at least as the functional perfection of either was concerned. Both morphology and physiology, therefore, discountenance the idea and scheme of a "linear series" of organic forms, as utterly incompatible with the natural arrangement, disposition, and relations of living beings. Morphology and physiology, together, express the correct status of any given form; but mere physiological differences are of no moment in the face of the considerations relating to type, and to the fundamental plan of structure: that is, an animal form must primarily be considered in relation to its type. It can only be compared, so far, at any rate, as classification is concerned, with the members of the same type, and not with those of any higher or lower type.