COMPARATIVE OSTEOLOGY:

BEING

MORPHOLOGICAL STUDIES

TO DEMONSTRATE THE

ARCHETYPE SKELETON OF VERTEBRATED ANIMALS.

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BY

JOSEPH MACLISE,

MEMBER OF THE ROYAL COLLEGE OF SURGEONS.

PREFACE.

A NEW idea may spring from many other sources besides that of the real or truthful, and may agree with many other bents of the understanding besides that of reason ; but a new idea in Science must be of a class *sui generis*, for however completely or imperfectly it may accord with any other mental conceit, whether of Poetry or History, it cannot disagree with the natural or exist incompatible with the reason, whose basis is fact and reality. It is the character of Science that all its opinions are freely submitted to demonstration ; its theories do not shun a close examination, or if they do not bear of this rigorous test, then we change the name theory to the name hypothesis, and this latter is nothing but vacuum, it has not even the materiality of the intrenchant air. The theory contrasted with hypothesis manifests as prominent a distinction of species as is apparent between the Newtonian system and the Miltonian rhyme : they are like two parallel lines, destined never to meet ; and if their species could by any possibility be mingled, the product would prove to be a mere barren hybrid, such as the work of the speculative visionary.

The mind balances between truth and error, between Science and the purely Imaginative ; and by experience it proves that every accession to Science causes an abatement in the same ratio to error. The more self-evident the truth is, the more apparent the error proves to be ; for if all the points in the circumference of a circle can be proved to stand equidistant from the centre, then every opinion which runs counter to this particular one must be false. Again, if the law of gravitation yields its own proof of correctness, it will be in vain that we try to reconcile with the same evidence the idea expressed in the line " and to this hour down had been falling." As facts, therefore, are of a species distinct and incompatible with falsities, it will be to no effect that we try to fuse them by words or fancies into one species. The operation of a natural law cannot be controlled by the mere phrase of speech. A solution of sulphate of lime, when poured into another solution of carbonate of potash will produce a phenomenon of elective affinity which the voice of Stentor will not prevail against, because words have no power against facts ; and it is well for Truth and Nature that it is so. The like observation applies to the subject of an anatomical unity of organisation, for it is evident that all the worded philosophy which has been shed down heretofore upon this theme has not rendered skeleton quantities uniform with each other, and the reason is because the fact is otherwise. They are not uniform because they are not equals, and therefore they cannot be read as uniform according to reason because they are not equal according to Nature. The germ of any new Theory respecting the law of formation which presides over skeleton development must take root in this fact of inequality, and grow from it as from a substratum. Before we can develope the ideas of unity between two or more forms which are actually unequal as to quantity, and only in this respect various to each other, we must first of all know the cause of their inequality. Now it requires as much, nay even more, labour to remodel an old-fashioned edifice, in order to make it agree

with the present taste, than would be amply sufficient to build one up anew from a new foundation upon the same site. The materials of the old fabric may be sound enough to serve in a new design, but the erection of this latter requires the dismemberment of the former, and the granite facts which outlasted the century may, by re-adjustment in a more modern style of architecture, be made to stand out another age just as well as if they had been hewn from the quarry only yesterday. Comparative Osteology is an ancient superstructure promising to be raised upon the facts of skeleton analogies, and according to the law of unity in variety; but the process of developing the complete design of this edifice has been carried on so slowly, that the materials have grown old, and have put on an antique facing before any one has as yet seen or understood for what general fabricated whole they have been piled together.

The cause of this slow process of formation may perhaps arise from the circumstance, that many architects, each with a design of his own, and various to that of all the rest, have been employed upon the construction of an entire fabric which was never yet, in any instance beside the present one, completed off-hand on this very account. The unity of an entire must be the work of one agent, and with whom all other assistants must work conformably. Nature is seen to operate upon this principle in all instances, and if we would ascertain clearly from what cause the mind so often overreaches itself and fails in the attainment of its purpose, we must compare the mental act with the natural operation, by which contrast the proof becomes evident, that as it is the law of Nature to fashion the unity of a whole by the subordination of its parts, so in opposition to this fixed rule it becomes impossible for the mind to know the unity of truth by giving way to ideas which distract contrariwise, and as it were all equally prominent in salient angles. When every individual interest is contending for supremacy and the first place, the common interest is then annihilated. The unity of the whole is broken when every part forsakes its proper locality, and for which alone it is a fitting element. As every arch is constructed of its subordinate parts, and is completed by the key-stone; as every state holds together lastingly by the harmonious union of its people, subservient to one chief magistrate; as enchained gradation is the principle of all things; and as all things which serve for a whole design are equally fitting and useful to that design; so does it appear that the principle of unity governs Nature in all her states; and as it is so, then the best test of truth in any science is in so far as this developes the idea of unity and the harmony of an entire.

Analogy is that principle whereby relationary facts cleave together, and body forth the whole structural design of unity. Analogy is the pabulum of Science, and to it Science owes its vital increase, because it is a something which Science may assimilate to her own person, and work upon after having digested it. Comparative Osteology, the unity in variety, and the law of formation, being the subject at present treated of, I shall state briefly the plan and order in which I have directed my studies, and how far the opinion here entertained of this law of development has grown upon the soil and basis of analogous facts.

In the schools we are taught the precept that the progress of Science must be according to Nature and her phenomena, and that every spoken or written opinion concerning the *natura* which shall seem a mystery in few or many respects cannot have that mystery cleared away from it by any other mode except by holding that opinion in comparison with Nature, and proving where it agrees or disagrees with her own person. For, assuming that every opinion whatever is upheld by an actual conviction of its truth and rationality, one has as good a right to stand by its cause as another; and however erroneous or truthful either may be in itself, there appears no other means of judging unless that of submitting both to the standard reality of Nature, before whose tribunal all opinions must yield if they be not according to her evidence and proofs.

The course which has been pursued here was to suffer Nature to conduct her own argument. And in order that she might be free to act and lead, it became necessary that her votary should first divest himself of all preconceived hypotheses, the prejudices of others as well as his own. Guided on by facts such as those of Anatomy, what need had he of words? And while there was every reason to apprehend that nomenclature, though unable to warp the actual state of facts, might nevertheless blindfold the ideas by dividing each of them between the ens itself and the name which falsely characterised it, what need was there of furnishing himself with that medium of nomenclature which, like a coloured glass, would but dye all objects seen through it of its own hues.

The present argument has been pointed to one idea, and to this end it was required that it should pass through many others, all of which were to be made parts of the argument ere this could develope the one idea. Unity, or the whole quantity, was the idea sought for, and this inquiry had to proceed through the countless evidences of a proportional variety which were necessary to be explained, taken up, and, as it were, assimilated to itself in order to grow to the recognisable dimensions of the unity. Thus it will be seen that this inquiry being conducted after the footsteps of natural operation, bears the same character as this operation itself. As Nature is seen to pass from original unity through the variety, the present task has been to retrace her steps from the variety back to the unity. As Nature appeared to have descended from the compound integer of unity to the simples of a proportional variety, so has this inquiry ascended from the simples or elements of form to the compound integer of unity—the archetype.

The genuine face of Nature herself manifests a plain and legible character, but it is we ourselves who bedim this character with the breath and halitus of words. When we would read her as she actually is, we should approach her with a timorous caution, lest we mingle ourselves in such a manner with her person as to make her a part of us; by this connexion she loses character and we lose the truth; her facts are not describable by our trammelling and soiling nomenclature, and therefore those facts will best interpret their own mode of creation.

When any complex subject engages our attention, we are required to disintegrate it and examine all its separate elements individually, to reduce the compound to its utmost simplicity, in order to know of what ingredients the conglomerate integer consists. Having ascertained the nature of the simples, we should then re-examine the effect of their combined state in a whole quantity, and this in reference to the principles or operative cause of the effect and actual condition of the ens. The form should be compared with not only those which manifest a nature similar to itself, but also with those of a contrary nature or condition; for it is by the contrast of two or more things of opposite qualities and character that we are enabled to see what at first sight might have escaped notice. The farther we extend our comparisons, the more certain is our knowledge, because the more extensive are the inductions upon which we found and build it.

A principle or original cause of formation is that which I have sought for by means of those comparisons which are here recorded, and the result is as it is; that is to say, it stands in that condition which, if false, no words of mine own shall endeavour to excuse, or which, if true, will be equally in vain for the words of any one else to deny; for a theory founded upon certain and indisputable facts can never suffer an overturn by any assailants of less import and effect than themselves, and if opposing facts of equal weight can be found, then let them confront those which have been here arrayed in relationary order, and while truth is the goal of all our researches, let error experience the repulse from every hand that can deal it rationally; that is, by experiment or the argument in which facts are vocal.

The present inquiry has progressed from a certain point to a certain point, and within the extent of this line have been arranged such anatomical evidences as I have thought would develope a knowledge of the law of skeleton creation. The extent of my interpretation of this law is not presuming to carry further than the facts will answer to the same. It is the facts which are speaking, and not ourselves, and neither they nor ourselves are answerable for more than they signify. The Mammalian serial skeleton axis has been examined by comparative rule, and for the present we shall consider this structure separately from any further relation which it may hereafter prove to have with the full sum of osteological evidence, whether of recent or fossilized specimens.

The reader, therefore, will examine my theory by those facts upon which it is founded, and he will judge of its truth or falsity by the same method which was pursued in the formation of it. If he be a reader who has accustomed himself to studies of this nature, he will excuse the faults of style, where these have happened, at places in which the praise of elegance was willingly sacrificed to the demand for clearness, in the explanation of those facts of "anomalous" formation which, as an anatomist, he must know are so many drawbacks to our knowledge of the natural rule of development.

The object which I have had in view was to gather together, under one notice, so many facts of development as would themselves express, in mass, an idea in generalisation, and a natural law in collective. Some of these facts I have met with while attending the lectures, and while engaged in dissections as a student of University College, London. Afterwards, when visiting the Schools of Medicine and Theatres of Anatomy on the Continent, many others of them were noticed, and the truth is, that the sum of what I had myself collected, I found was nothing more singular than those which all Museums present to the notice of everybody, namely, "anomalies of the human type," as well as those of other animals. These "bizarre productions" may be seen scattered through our own Museums, as also those of the Continent; and it is only while we view them thus scattered and dismembered like so many type letters, strewn here and there in unintelligible disorder, that they puzzle our ideas concerning the mode of their production, and express to us no one connected sentence. It is in this connected form that I have attempted to present them, and in the enchainment of their natural relationship, according to the rules of morphology.

The name Morphology being one which usually applies to studies of this nature, will sufficiently explain the sole interest which actuates the subject: it marks the principal feature of Comparative Science, and although it be known as the very antithesis of the practical, yet it does not hence follow that it may not lead to something worth knowing. The means which Nature uses in fabricating her designs is a study not unworthy the attention of at least all the thinking members of our profession, if those who run cannot find time to read. A knowledge of the law and process of design may not suit the immediate taste of the hurried practitioner, but yet it will not disagree with those who at thoughtful leisure confess that "Scientia, mater omnium bonarum artium, nihil est aliud, nisi ut Plato ait, donum et inventum Deorum"—"Est animorum ingeniorumque nostrorum naturale quoddam quasi pabulum consideratio contemplatioque naturæ."—*Cicero*.

While believing of myself that the subject of Anatomical Unity forms the goal of all comparative research, I sought also the opinions of those whose matured judgment is the student's guide in both the foreign and home schools. Amongst those Professors in the British school, whose opinions of the writings of Cuvier, Göthe, Geoffroy, Oken, Spix, Carus, and others, I could more freely obtain, I may mention Dr. Sharpey, Mr. Quain, and Mr. Owen, and from these I learned that the Law of a "unity of organisation" (*while contemplated within certain recognisable boundaries*) admitted now-a-days of as little dispute as a mathematical axiom; and that all the real knowledge which we at present possess regarding the Type Human, has been gathered from the field of comparative estimate. The lectures and writings of Professors Grant and Rymer Jones point in like manner, full to the theme of Philosophical Unity.

INTRODUCTION.

ANATOMICAL NOMENCLATURE—ITS ORIGIN, AND THE EXTENT OF ITS APPLICATION AS AN INSTRUMENT OF GENERALISATION.

REMARKS UPON THE NAME "VERTEBRATED."

THE anatomical fact which we have here undertaken to demonstrate is this, viz., that the form ordinarily described as *a vertebra*, both by special and comparative anatomists, *is not a whole quantity*, and of this the following reasons may be taken in proof:—first, that it is a figure subjected to plus and minus variations as to quantity; secondly, that all its plus varieties are simply an increase of its proportions by the addition of elemental structure ; thirdly, that all its minus varieties are simply a lessening of its proportions by the subtraction of elemental structure. We believe, therefore, that as any quantity, either of number or form, which fluctuates between plus and minus proportioning, must itself be a proportional quantity of some whole or integer ; so must *a vertebra* which undergoes the like genetic variation from plus quantity to minus be accounted *a part or proportional of a whole, or archetype quantity* ; and this latter is the figure which we have endeavoured to discover by the rule of comparison.

Now every fact which goes to prove that a vertebra is part of some whole quantity hitherto unknown, must at the same time create as it were the presence of this whole quantity, as is self-evident, for when to any given quantity Nature makes an addition, then that first quantity now becomes part of a fuller quantity, and this latter contains the former, hence the whole quantity becomes the integer. The vertebral form is one which Nature adds to, and consequently every addition of structural quantity must cause us to interpret the vertebra as being a part of the increscent sum, at the same time that such addition becomes creative of the presence of that whole quantity of which a vertebra is the proportional. If, therefore, it be true that the whole quantity, or plus, contains the minus quantity, or part, it then must follow that the minus quantity, or part, cannot contain the plus, or whole quantity. And applying this simple fact to the form named vertebra, we say that that whole quantity or archetype, plus structure, in which we find the vertebral proportional, must be said to contain the vertebral quantity, from which it must follow that the vertebral quantity cannot contain the plus archetype.

The part cannot contain the whole, because the whole contains the part.* A vertebra cannot contain the plus archetype, because this latter contains it ; therefore a vertebra must be a proportional of its archetype. Between plus and minus quantities of the same species or nature there can be no other condition of variety

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* " The whole is greater than its part."—*Geometrical Axiom.*

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except that of proportioning, and consequently those plus and minus quantities must be homologous in all their characters excepting that one of quantity. Comparative osteology has ever sought to determine the unity of organization, upon which all skeleton quantities have been planned ; but as it must be at once confessed that minus cannot be uniform with plus, that the part and the whole quantities cannot be equals, so therefore it is to the whole quantity, as containing the part, that anatomy must turn if it be destined ever to read the original unity of form, and the law creative of proportional variety.

If it be impossible to comprehend aright the passages of a general law without knowing of the whole structural quantity upon which that law operates, rendering it proportionably various, so must comparative osteology ever fail to demonstrate the law of unity in variety, until it has first ascertained the archetype figure, of which a vertebra is the proportional. The whole quantity must be unity, and, compared with this, all other forms which manifest no other character of dissimilarity than that of quantity, must be estimated as the proportionals of such a whole ; and this is the idea which we here entertain of the form vertebra, compared to the archetype whole quantity. The vertebra is not an entirety, therefore it must be part of an entirety ; and therefore as unity is the character of an entirety, so unity cannot characterise the vertebra. A perusal of all the records of anatomy penned between the age of Aristotle and that of Geoffroy, will leave this one fact salient within the memory, viz., that it is as impossible to define the form of skeleton unity upon the vertebra, as it is to demonstrate the whole quantity in any proportional of itself, and also that it is as impossible to define (between any two known vertebral quantities) any other condition of variety except that of plus and minus proportioning, as it is between an integer and its fractionals.

Between the unity and variety of skeleton form, as between the plus and minus of any quantity, there is no distinct boundary line possible to be drawn. But if it can be ascertained that unity is rendered various by the self-same process of metamorphosis or subtraction, which strikes minus from plus quantity, then it is the whole quantity which must be regarded as unity, and it is the simple rule of subtraction from such a quantity which must be esteemed as that law which is creative of proportional variety. Under these ideas the origin of the name "vertebrated" may be sought for, and we shall find that it was a name affixed to a certain osseous quantity developed in the special skeleton serial axis when the science of comparison was unknown, and the law of *unity in variety*[*] which governs the chain of animal being as yet unrecognised. In the name vertebra (derived from vertere) the anatomist can discover no meaning which may be said to keep pace with comparative reasoning progressive to the contemplation of whole quantities, or uniformity transmuted by a law. And the abortive special study of Athotis, Hippocrates, Vesalius, or Albinus, is dissipated before the science of Daubenton, Goethe, Geoffroy, and Cuvier, in search of general principles.

A history of the progress and cultivation of anatomical science, from the first observation of a few isolated facts of form to that extended gathering of the various particularities of form and structure presented in the animal kingdom, and from out of which the science of Comparative Anatomy has sprung to such reading as it exhibits in the present day, may be viewed as a type of the progress of an individual mind from the early stage of its infantile observations of a limited number of facts, and its premature interpretation of the same, to that stage of its adult reasonings when, having heaped together an ample store of materials, it

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[*] Leibnitz makes use of this term as expressive of his "loi de continuité." He defines the Universe as "l'unité dans la variété ;" he writes, "Tout va par degrés dans la nature, et rien par saut."—See *Œuvres Philosophiques de M. de Leibnitz*, Liv. iv., p. 440.

for the first time discerns a broad and relationary subject which binds, as with a cincture, those multitudinous facts together; and from the first recognition of this homology of plan in which they are produced, this mind engages in the task of sorting all similar figures which bear a reference to some standard unity of original fashioning, and from out of the otherwise indiscriminate mass elaborates for itself a generalisation which is the mind's repose in reason and in truth.

As it has ever been the natural course that the expansion of the human mind into its adult vigour of perfection should cancel all its earlier interpretations of objects, seeing that these interpretations have been the offspring of inexperience, and in nowise suitable to its present stage of reason, which has established its creed upon the more extended view of facts infinitely multiplied; so is it also with the course of development for any one of the natural sciences. And as to the interpretation of form or phenomena, such as it was given in the infancy of anatomical science (the facts observed having been as yet very few in number), when such interpretation is laid side by side with that which has originated upon a more generalised survey, this latter reading must necessarily cancel the former, for it is an impossibility that that nomenclature which has been founded upon the observation of a particularity can be rendered inclusive of all those after multiplied facts of form such as they present themselves under the law of unity in variety, and of this the present state of anatomical science, as delivered in the schools, gives striking evidence.

Thus the human figure, upon the contemplation of which has originated anatomical nomenclature, is now known to stand as an individual design of connected parts, a special variety included in the great scale or general type of vertebrated animals, and those names which are made use of as applicable to a description of it, are far from being also applicable to a description of each and all the varieties of the skeleton plans or designs, and hence cause doubts to arise in the mind as to whether such nomenclature be truthfully, be philosophically founded upon the nature of a law. The nomenclature originated upon the observation of any special form amongst the vertebrated skeletons is known at length to be inexpressive of the skeleton varieties; hence must this figure of the human skeleton be now interpreted in its specialty of plan by that nomenclature which is possible to be drawn from an observation of that general rule named "unity of type,"* which is everywhere manifested throughout the four classes of the endoskeleton figures; for it is reasonable to expect that that interpretation of the laws of form which shall spring in the human mind upon a comparison of facts accumulated, shall be a nearer approach to the only truthful reading in which this particular fact of form, viz., the human figure, is to be rendered.

Anatomical nomenclature, founded originally in description of the human figure, remained unchallenged as to its fitness, so long as the science of the comparative anatomist rested as yet unawakened to the true interest of its subject, which is the comprehension of a law; and for a certain period, in the slow advance of Comparative Anatomy, the same nomenclature was accounted amply sufficient for the description of the human form, and all those other examples of the skeleton fabric which had been viewed in reference to it as to some standard type. The human anatomist, busied only in observation of his isolated subject, had

* Geoffroy St. Hilaire, in his studies of Comparative Osteology, adopts this phrase; and concluding that all animals are created " sur le même plan," that " unitè de composition organique " prevails through the Animal Kingdom, gives this as the most general corollary of his " Theorie des analogues." — See *Principes de Philosophie Zoologique ; Philosophie Anatomique ;* Paris, tom. i., 1818, tom. ii., 1822 ; *Memoires du Museum d'Hist. Nat.,* Vol. ix. ; *Annales du Museum d'Hist. Nat.,* Vols. ix., et x.

already established in the schools certain fixed ideas regarding that design of the osseous skeleton which the human figure exhibits; whilst the comparative anatomist, taught upon the nomenclature of the former, carried his own observation into a more extended field of inquiry, and after having found certain plans of animal development manifesting characters sufficiently varied from what he had been at first led to expect, he himself next owned the propriety of either extending that nomenclature of anatomical science in such wise that it should include all additional facts of those seeming new creations, or else that each animal plan, such as it presented itself, should have a particular nomenclature of its own, according to its peculiarities.

The human skeleton fabric had been described by the special anatomist in the light of an unalterable design of connected parts; those parts presenting themselves as elements dissimilar to one another, but all combining to render the form a complete entirety. In this completed figure were described such elemental dissimilars as the craniofacial apparatus, the column of vertebral bones, the costal thorax, the scapulary and pelvic pairs of limbs. Furthermore, in each of these apparatus were also described the many contributive elemental ossicles found in each, thus the ossicles of the skull were counted by the special anatomist, so, in like manner, were those of the vertebral column, also those of the thorax, and those of the limbs; and education thus commenced upon a demonstration of the human figure, had so bent the mind to a special reading of this particular, that the names skull, vertebræ, costæ, and limbs whenever used in description of other skeleton designs, did not fail to recall certain fixed ideas in reference to that condition of development and arrangement in which those several parts appeared in the human body alone; even the ideas of the comparative anatomist when he contemplated those parts similarly named in the animal classes, notwithstanding their surprising varieties both in actual structure, and the relation of skull, vertebral column, thorax, and limbs to one another, referred for ever to the plan of the human form as standard, and upon this has all comparison been drawn.

At the period when special anatomy wrote its nomenclature, descriptive of the human framework, it drew its comparisons and analogies not according to the nature of an animal kingdom and unity in variety, for as yet the comparative science, referring Nature to herself, was unknown, but according to things extraneous to the person of animal nature, and hence foreign to the theme and purpose of anatomical pursuit. It is from this source that anatomy possesses the names coccygeal, coracoid, sacral, vertebral, clavicular, innominate; names which, however fitting they may prove to be for surgical records, possess no meaning consonant with the reality of knowledge derivable from comparative rule. The comparison of certain animal structures to a clavis, a χοκκυς, a χοραξ, and (when imagination failed to conjure up an analogue for anatomical fact from out of the mechanic's armamentaria) the naming of an animal structure as "nameless," as sacrifick, as fibular, or xiphoid, and such like vandal barbarisms of nomenclature originated in ignorance, became afterwards obstructive to the light of comparative reasoning by which Nature was made to interpret herself. To this effect Buffon remarks :—" For three thousand years," says this author,[*] " have they been dissecting human bodies, and the science of anatomy is as yet but a nomenclature, and hardly have they advanced but a few paces towards its real object, which is the science of the animal economy. We have thousands of volumes written in description of the human body. In man they have recognised, named, and described the smallest parts, whilst as yet they are ignorant if in other animals they could also find not only

* Tome vii., pages 21, 22, 24.

those small parts but even the largest. They have attributed certain functions to certain organs, without being informed if, in other animals, although deprived of these organs, the same functions are not exercised. In all those explications which they have wished to give of the different parts of the animal economy, they have had the double disadvantage of having first attacked the subject the most complicated, and afterwards of having reasoned upon that subject without the foundations of relations, and without the helps of analogy. What real knowledge can we derive from the study of an isolated object? The foundation of every science, is it not in the comparison which the human mind can make between objects similar and dissimilar, their analogous properties and the contraries, and between all their relative qualities? Thus every time that, in methodising, we restrict ourselves to a subject, which we contemplate solely and independently of all things which resemble it and which differ from it, we can never arrive at any real knowledge, still less elevate ourselves to any general principle; we can do nothing more than give names and make descriptions of the thing and all its parts."

In the progress of the cultivation of every science, there comes a period when the inquiring mind after having exhausted every source of new facts, turns to the task of generalisation, and these generalisations being founded upon the comparisons of forms or of phenomena, it thus arrives at the recognition of those broad truths which are the mind's final aim and object, and which spring inevitably as the consequence of facts accumulated, and held in comparison with each other; this is eminently the case in that science named Comparative Anatomy.

Those who first described the human form as it isolatedly presented itself, were followed by those who perused the animal forms, such as they severally presented themselves, and these latter anatomists have been followed by those who, benefitting by foregone labour in the record of facts observed, have sorted such facts according to their relationary analogies, and given the various gathering an order, binding them together with that belt of the generalisation which speaks of their common unity of character, and such was the idea meant to be conveyed in the name "vertebrated type," of the animal figures.*

But it was the human anatomist who first established for the science this name "vertebra," as attaching to certain osseous elements of the spinal axis, whilst the comparative anatomist borrowing the name, and taught by certain ideas associated with such form to distinguish it in all the skeleton figures noticed by him, has drawn his generalisation upon this supposed invariable element of the endoskeleton, and named them "vertebrated" at the same time that he failed to characterise its typical development upon a comparison of all its varying conditions of growth. Thus this figure named "vertebra," had been carried as the implement of generalisation over multiform facts observed by the comparative anatomist, notwithstanding that it was known to be a name applied to certain variously developed figures of even the human spine, by the special anatomist, who had never looked beyond his limited sphere of observation.

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* Lamarck characterised the two great divisions of the Animal Kingdom, as " Les animaux vertèbres " and " Les animaux sans vertèbres," and again subdivided these two into classes, viz., Mammalia, Birds, Reptiles, Fishes, &c., &c. The " Typical vertebra " is that unknown osseous quantity which comparative osteology seeks to determine even at the present day, and as if it were a something implying more meaning than what Lamarck supposed it to contain when naming the four higher classes as " Vertebrate animals." Still in the following remark the originator of the name " Vertebrated " seems to doubt the efficiency of it, or any mode of classification or nomenclature used in subdividing the continuity of the chain of nature. He writes, " Mais j'ai déjà montré qu'il est un produit de l'art et que, malgré les apparences contraires, il ne tient réellement rien de la nature."— *Philosophie Zoologique;* tome premier, chap. v., p. 103.

The cervical, dorsal, lumbar, sacral, and coccygeal bones are not produced as figures absolutely homologous to each other even in the human spine, much less in all the skeleton axes.

Although it be the natural capability of the mind ever to distinguish the merits of all reasonable proofs, although it shall seem plausible to the mind that all generalisations of facts can alone be well founded, by having been created upon a free and broad survey of all forms such as they present themselves, although it shall seem reasonable to assert that no idea in generalisation can possibly be originated upon the limited view of the specialty (yet is this name "vertebrated" sprung of such), still is it no less true that where the mind has already accustomed itself to a certain reading of form or of phenomena, it can, but with difficulty, emancipate itself from such habitude of its thoughts, even when figures in bodily form and tangible proof invite the reason to an opposite course of interpretation. The comparative science cannot be rendered lucid, except when freely admitting those abstract ideas which are its own creations. If unity be an integer or whole quantity, and variety be the proportionals of this unity, then it must follow that the abstract idea of uniformity, which is an idea in generalisation, and founded upon the analogy of form, must attach itself to that whole quantity, and not to any of its proportional parts. The vertebra is a proportional of its archetype, therefore it is not upon the form vertebra that we are ever to read uniformity.

The human skeleton axis, basis of the human form, as it had at first been described by the special anatomist, still bears the same interpretation, notwithstanding that accumulation of facts in the records of the comparative anatomist, which invites the reason back again to render a clearer interpretation of this figure, in sentences which should convey a fuller meaning than those applied to it in the infancy of anatomical science. It is the fashion still for the comparative anatomist to read all new figures of the endoskeletons in reference to this human figure as standard, and to borrow therefrom his nomenclature even when ample means are already furnished to him, wherefrom he could shed back upon it that light of interpretation which might enable him to pass unfettered into those domains of the animal designs within which he may commence a new course of distinguishing those designs in all their excelling plans. It is by the science of Morphology* that we open the volume of design, and read the paces of the law of unity in variety.

The human skeleton figure is not typical of all skeleton figures, nor as yet has there been noticed among the animal classes that form which could be accounted typical of this and them. Yet it is rendered fully evident to the eye, how that all the animal skeletons, notwithstanding their variations of developed plans, are struck in a somewhat common identity of character, which, whilst observed upon the general survey, has originated the idea of their unity of type. The diversity of form happening within the girding circlet of this unity of character is that problem which it has been the endeavour to solve ever since the days of Aristotle.

Amongst all known figures of those skeleton structures named "vertebrated," as well those of the extinct or fossil species as those of the existing race, there happens no one exception to that general rule of a common identity of character, which anatomists have ever noticed concerning them, at the same time

* Goethe adopts this title for the comparison of forms conducted in discovery of the law of their development.—See *Œuvres d'Histoire Naturelle de Goethe, traduits par Martins. zur Morphologie,* tom. i. Stuttgard, 1817—1825.

that it is also manifested how those same skeleton plans instance certain varieties of form and structure when considered relatively to each other, which strike the mind of some beholders rather in that train of reasoning which should read the one as instancing a new creation in certain parts of its construction when compared with another or with all others, than with those views which might regard those skeleton figures one and all to be fashioned of the archetypes of form common to all.

This unity of type common to all figures of the endoskeleton, and these seeming differences of form and structure, such as they are, this universal analogy interspersed with instances of special variation of plan and figure suitable to the particular demands in fitnesses, have engaged the attention of all reflective minds ever since Anatomy has been cultivated as a science.

All anatomists have owned to the striking fact of a unity of type among the skeleton figures : and all anatomists have agreed with Lamarck to affix this character of the unity to the spinal chain of bones named Vertebræ, and hence to designate the four classes of animals producing the endoskeleton, as " Vertebrated Animals ;" for as much as the chain of vertebræ appeared to be that central structure least subjected to change of form, and therefore longest persistent in all the classes; but it is now confessed that the vertebral chains of forms can with as little reason be accounted absolutely homologous to each other as the skeleton entireties themselves. The forms named vertebræ are not developed as equal quantities, neither are the entire skeleton forms produced as equal quantities. Even the human skeleton specialty instances a plus and minus variation of quantity, as will be hereafter shown, and thus it would appear that metamorphosis, or the subtraction of quantity from plus unity or the archetype, masks the original character of unity, and renders it minus and various.

From that period when Comparative Anatomy could fairly be acknowledged as a science built up of accumulated facts, dates the accession of that spirit of generalisation for this science named Philosophical Anatomy, which commenced to reason upon those same facts, and trace out further instances of the common analogy existing between endoskeletons than that one said to attach to the spinal chain of bones. For now the mind had been led to contemplate the skeleton fabric with a deeper thought, and it was seen that the farther these thoughts could be carried, the more surpassingly marvellous became those evidences of special designs still bearing record of the metamorphosis of the typical uniformity. Anatomical science had now gathered to itself a wealth of facts, and already weary of that dry detail in separate description of isolated objects, such as had been begun by a study of the human figure, the mind had now sought for its entertainment in the comparison of them.

This science of Anatomy thus having become rich in the store of facts observed, whilst it was now rendered evident that a general analogy existed between the individual animal figures, the mind next engaged in the task of assorting all analogous figures, and classifying them according to their nearest relations the one to the other. From this mode of classification according to the apparent analogies of form and structures relating individual figures of the animal scale to each other, sprung up at the same time that mode of observation which took account of all varieties of figures as well as all analogies of them, and hence dates the entry of such harassing questions into the schools as the following :—viz., Whether the differences or the analogies of form should claim a right to the profoundest inquiry, as also whether it were possible for the observer to trace out that limit, that vanishing point, where the differences ceased to

exist, or where the analogies commenced to arise.* To which the answer may be returned, that if unity be the integer or archetype, and variety be the proportionals of the same, then as proportioning, or the subtraction of quantity from an archetype, is creative of variety, it becomes impossible to draw a defined line of separation between such diversities and such analogies. The difference between any two skeleton quantities may be infinitesimal and inappreciable, incomparable, less than any assignable quantity, and therefore accounted as nothing. Thus may this pursuit after the vanishing point of difference introduce into comparative osteology the Differential and Integral calculus, or the doctrine of fluxions, which for obvious reasons we shall not adopt in these pages, further than may be required. It will be sufficient for anatomy that we clearly understand how the subtraction of quantity from one of two equals or analogues is that law which creates variety or difference as to quantity, and that the parts which remain for minus still hold their counterparts in plus.

The anatomist had now begun to perceive analogies to exist in other parts of the animal figures beside those of the central spinal chain of the vertebral bones. The unity of type was now observable in all scapulary and pelvic organs, despite the manifold examples of metamorphosis to which these seemed subjected ; so also were the vertebral bones traced through that transition development which planned, from out of certain members of them, the animal skull ; so also were the modifications of the thoracic apparatus noticed in a surprise ; and when the skeleton figures of all classes were held in comparison with each other, that marvellous circumstance of their special plans of different development instanced in the relation of skull to thorax, thorax to locomotive organs, the disappearance of one part, the reappearance of another, the apparent new creations of structures in many animal forms, and the lessening of the so-called normal type of others, nay the positive fact now and then appearing which proved that the human skeleton figure itself was a structure which increased by certain creations of superadded products, or decreased from the normal type in many examples,—these were the facts which rendered the phrase " uniformity " as one of doubtful meaning,† and to which mystery must for ever attach so long as it shall be applied to characterise equality amongst figures which are in fact the proportionals or variable quantities of an integer. All these possible variations of plan happening, whilst the uniformity of type, in greater or lesser degree, nevertheless prevailed and was discoverable through all, such were the facts which could not fail to have awakened the interest to the inquiry whether it be the unity which suffers modifications to the creations

* It has been the main object with naturalists of all ages to found a *perfect classification* of the Animal Kingdom, that is to say, a classification based on the exact and complete knowledge of the resemblances and differences between all beings of the animal scale, and of determining with precision and clearness the relations and analogies of anatomical structure. The difficulty of this subject is sufficiently proved, from the fact, that naturalists have occupied themselves, to very different results. Classifications are very numerous, and often based upon opposite principles. Even the classification of Cuvier himself has not completely satisfied the higher philosophy of the universal analogists. And it is most true that all progress in the science of comparison tends to the goal of unity rather than to that ideal place which classifiers have supposed to be situated between uniformity and difformity.

† Cuvier, while examining the principle of Geoffroy's " Unity of Organic Composition," expresses himself as follows :—" Si vous prenez les mots dans leur acceptation la plus rigoureuse, vous ne pourrez dire qu'il y a unité de composition dans deux genres d'animaux, qu' autant qu'ils sont composés des mêmes organes. Par *unité* vous n'entendez donc pas *identité ;* mais, donnant à ce mot un sens différent de celui qu'on devrait naturellement lui supposer, vous vous en servez pour signifier *ressemblance, analogie.* Parlez-vous d'identité absolue ou simplement d'analogies, de ressemblances ? " " Je n'ai," answers Geoffroy, " jamais rien entendu au-delà de ce que ces derniers mots expriment."—See *Les Temps* et *Le National* of March, 1830. Resumé des doctrines relatives à la ressemblance philosophique des êtres.

of apparent differences, whether it be the unity which alone can undergo those modifications, and whether it be not the truth that those resulting varieties still bear traces of the original or archetype of all.

It is owing to the facts of the common unity of type, and the accompanying circumstances of the variations of figure, that every great thought which has sprung up in adornment of this great department of natural science is attributable, and all labour for the solution of this problem of most surpassing interest, namely, the origin of all variety of the skeleton fabrics which evince, nevertheless, among themselves the character of a general analogy of construction. The mysterious creations of figures in seeming differences from each other, at the same time that there is everywhere manifested among them that original homology of cast which combines them in one common type, and serves the observation with an instrument for establishing its generalisation under a single name descriptive of them all, leaves it to be inferred that this name can only be applied to that form in abstract, which is the archetype undergoing metamorphosis for the creation of all variety.

The vertebrated axes of the skeleton figures of the four great animal classes have seemed to the comparative anatomist as structures manifesting certain fixed and invariable characters, and upon this presumption he has founded the generalised name of "Vertebrated." In his comparisons made upon these skeleton designs he has otherwise discovered an ever-moving metamorphosis among those other skeleton parts which he has named thorax, pelvis, scapulary and pelvic members. He has seen that the relative position which these structures assume one to the other, and the presence or absence of the same, either coincides with, modifies, or cancels altogether the rules by which he has founded his nomenclature. He discovers, for example, that a cervix is not a figure of constancy upon the skeleton form, neither is a lumbar spine, properly so called, that is to say, according to the human type ; also, that a costal thorax is projected from variable regions of that chain of bones which he has named the vertebral axis ; and lastly, when he is forced to reflect upon those conditions of skeleton development in which the relative succession of the classified forms of the vertebræ of the human spine are seen to vary so infinitely among spines of the animal classes, he must in truth be a fonder admirer of those false readings which the human mind establishes in interpretation of the natural work than of Nature herself, if he does not own that her Protean figures bespeak a profounder philosophy than can be set forth in words.

Does the name "Vertebrated" sufficiently characterise the skeleton forms of the four classes ? Does this name Vertebrated suitably and fully explain the proper conditions of development in which we discover the central axis of skeleton forms to have been struck ? Are the spinal chains of those osseous forms named vertebræ presented to the eye in fixed character ? Do we not rather find that the forms named vertebræ escape our identification as subtly as if they had been still of soft, impressible, and plastic matter, which every chance was liable to turn from their proper selves and remodel according to the capricious uncertainty of varying fancy ?

In what class of animals do we discover vertebræ to be produced typical of vertebræ in all other classes ? In what individual skeleton form do we find the serial order of vertebræ to present itself as being composed of units homologous to each other as to quantity ? What is the form of that vertebral bone which may be said never to change its character ? Can such a form be found in the human cervix, or dorsum, or lumbar spine, or sacral, or caudal ? And is it not an astounding fact that when we happen to number

any unit of the human spine reckoning downwards from the occiput, and compare such unit with others numerically corresponding in all the skeleton axes of the four classes, we observe this spinal element to give example of cervical, dorsal, lumbar, sacral, and caudal modification ? What is the typical form of a vertebra ? It is the law of form which produces the skeleton figures as proportional varieties fashioned of a uniform archetype structure, which must answer this question.

The abuse of names turns the mind still helplessly in quest of the phantom unity of form.* Not knowing of the law of form, what can we know of the archetype of form—the unity upon which the law is operating ? Not knowing of the archetype form, how can we appreciate the passages of that law which produces, by metamorphosis, the varieties of form from the figure of the archetype ?

A vertebra is not an archetype figure, and cannot be accounted such so long as we discover it to be a figure of increase. It is the name which blindfolds the eye of understanding. The capital of a column is not the column itself; the column is not the Parthenon itself; the acanthus is not the capital; the Parthenon is the name which expresses the whole design of connected parts, and is inclusive of all such parts; but the part is as little expressive of the entire structure signified by the name Parthenon as the vertebra is of the skeleton archetype, of which form it is a part. The part does not contain the whole, nor even if we call such part " Colossus," shall it add one inch to its actual dimensions; and it is even so with Vertebra, for although we shall be led to generalise upon an animal kingdom with this name, we shall still fall as far short of characterising the figure of archetype unity among skeleton forms as if we named the peristyle, acanthus, and drew our generalisation according to the proportions of the acanthus.

So long as, in comparative science, we allow ourselves to be imposed upon by a name applied to a part of a greater figure, we can never free ourselves from the trammels of nomenclature, and extend the observation to the contemplation of a whole. The name Vertebra has been fixed upon a part of the archetype structure, and comparative science has blindly founded its generalisations upon such name. But it must appear most evident that as the part does not and cannot express the form of the entirety, neither can the name of such part characterise the figure of unity, which is a quality of form possessed solely by the archetype or entirety.

The archetype being the complete form, and a vertebra being known to stand as part of this structure, it follows that if we found our generalisations upon the figure of that which is part, we choose a much less capable instrument for such generalising method, than if we had started at first in the use of the complete form which must include all forms lesser than itself. In a colonnade composed of identical or homologous columns, we choose one column as a type of all others standing in series with itself; such column is at once recognised to be a complete form, it is an archetype, and we understand the capital to be as part of this archetype. When we would generalise upon the series of those archetype forms which compose the colonnade, we do not make choice of any part of the archetype form, such, for example, as the surmounting capital, and then affix to the entire series of archetype columns the name which is proper to the part capital, and thus undertake to demonstrate unity by the use of such name; but

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* " This, if we rightly consider, and confine not our thoughts and abstract ideas to *names*, as if there were or could be no other sorts of things than what *known names* had already determined, and as it were, set out; we should *think of things* with greater freedom and less confusion than perhaps we do."—See *Reality of Knowledge*, LOCKE.

on the contrary we at once acknowledge the complete form of an archetype column, taken as a whole, and own it to be that form to which not only the several members of any column of the series may be referred, but to which even the complete figure of any column of such series may also be referred, and find in it its full and proper homologue. This is what we are to understand by the word archetype as hereafter made use of. It is this name which we shall apply to the primitive model of forms standing in series, to the αρχητυπος of that series, and our task shall be to prove that a vertebra is not this archetype of the spinal skeleton axis any more than the capital of a column is the archetype of the serial colonnade, and that it is as impossible to characterise unity in variety by the use of the name Vertebra, as it is to demonstrate the whole quantity in any proportional of itself. If unity be the whole quantity, and variety be the proportionals of the same, then a vertebra which is a part of its plus archetype must be a proportional variety of plus quantity, which is unity, as we shall hereafter prove.

There is an error deeply rooted in Comparative Science, and it is this :—This science talks of Unity, but it knows not of the figure and proportions of the form of unity. It talks of unity in variety, but it can know nothing of the law producing variety, not having ascertained that form of unity from which variety is struck out. It is an error, propagative of other errors, to speak of that quality of form, the unity, when we know not of the figure and proportions of it ; for what can we reason but from what we know? And whilst the science of anatomy at present only knows of the infinite varieties connected and related to each other by bonds of varying degrees of similitude, such as the skeleton designs represent, we still are destined to listen to anatomical discourse concerning the form of unity which it can no more render into substantial character for the contemplation of the wakeful eye of mid-day reason than if it were a figure of the dream. What anatomist is there who may be said to have characterised the form of unity ? There is no one of them who has approached this goal of comparative research, and we still are as blind to the actual figure of unity, as the Peripatetics were in ancient Athens, under their founder Aristotle,* or as those sages were who pondered upon this form as they studied in the groves of Academus.

Anatomical science still demands the demonstration of the form of unity. This science has had already a sufficiency of speech concerning the aerial existence of the qualities of unity ; but as the mere words are mere sounds, and passing as sounds, and as by analogy we may reasonably infer that the mere phrase of speech from modern philosophers concerning unity in variety, will pass from the mind like the intrenchant vision, just as it has done in bygone ages amongst the meditative Greeks, so has anatomical science assumed to itself the right of founding its belief upon the condition of unity only in so far as it can be spoken of demonstrably, and the first step towards this undertaking of demonstration must be to cancel from its nomenclature the name Vertebra as an implement of generalisation.

Anatomy being essentially a science by demonstration only, if unity be acknowledged already to exist as characterising animal forms, we have reason to conclude that this acknowledgment as to the positive existence of unity has been premature, forasmuch as no anatomist can draw the proportions of the form of unity. Hence, when the mind asks what anatomist is there who has not spoken of unity and unity in

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* Aristotle was deeply impressed with the philosophical resemblance of animal beings, and expressed his ideas as follows :—
" But some animals neither have parts specifically the same, nor the same according to excess and defect, but according to analogy ; just as bone is analogous to the spine, a nail to a hoof, a hand to a claw, and the scales of a fish to the feathers of a bird."— See *History of Animals*, book i., p. 4 ; transl. by Taylor.

variety, the mind may also ask what anatomist is there who may not be said to have discoursed of a form which he has never known, has never heard of, and can have never seen, and what is the substance of that discourse which only imagines a quality of form that it has never been able to demonstrate ?

Skeleton forms are not equal quantities, and, therefore, cannot be accounted uniform; but those skeleton forms manifest no other condition of variation than that which the proportionals of a whole quantity bear to that whole or archetype. What, therefore, is the form of this archetype ? Can this be ascertained by any process of comparative reasoning similar to the rule of equation ? We know that $a-b$ is then not equal to $a+b$; but it is this very process of subtraction which tells us that the addition of b to a will equate it to the whole quantity $a+b$, which we call the archetype.

Now, it has been said that every science possesses its own method of investigation, and has its peculiar elements of certainty ; that metaphysics and moral philosophy possess a metaphysical and moral certainty ; that the mathematical sciences are based upon self-evident propositions or axioms founded upon the nature of things, and by means of which they proceed from the known to the unknown, and from the ground-work of problems already demonstrated, ascend to new truths ; that the purely physical sciences are based upon constant phenomena, and hence that mathematics are directly applicable to them ; but it has been added that the zoological sciences, in which effects are seen to vary continually according to their causes, cannot have applied to them the art of numbers, or the rules of geometry. This assertion, however true it may be with regard to the *healing art* in its present state, which all, except the omnipotent charlatan, honestly confess to be unallied to mathematical certainty and broadly founded principle ; still, by no means, expresses the capability which comparative reasoning possesses of arriving at general truths.* The facts of development which comparative osteology takes account of, are those which appear within the bounds of philosophical analogy—are the creations of a law operative upon plus quantity, subtracting from that quantity or archetype, and thus establishing minus or proportional variety. However reasonable may be the objection to imitate a Condorcet by testing the moral code with $a+b$, yet it cannot be denied, that the entire subject of comparative osteology teems with this simple rule, and that unity in variety cannot be explained by any other reading.

The archetype skeleton form is in itself a completeness, and it is to the recognition of this figure that we have drawn our comparisons between skeleton structures. This archetype skeleton figure being a completeness, requires, like the circle or the sphere, neither addition to or subtraction from its own entire design, in order that such design may be rendered more complete. This archetype form is the prime model, and being so, must be regarded as the unity. Whatever shall be the proportions which science shall assign to this form in future time, it is well to know now at the outset, that a vertebra is not an archetype or prime model, for it is known to be a figure constantly subjected to modification by increase of parts or degenerescence of parts. It cannot be called unity, for it is not uniform either to itself or to those forms which take on the serial order with it. It is a form to which special anatomy has blindly applied a name ; and so long as comparative science blindly adopts such name and generalises with the use of it, that science will lead on to error, having commenced with error, for this is cause and consequence.

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* The science of Form which is developed according to the law of the φύσις must, whilst lying within the limits of physical operation, manifest of itself some elements of certainty, and " Quemadmodum in mathematicâ ita etiam in physicâ, investigatio rerum difficilium ea methodo, quæ vocatur analytica, semper antecedere debet eam quæ appellatur synthetica."—See *Newton's Optice, sive de reflexionibus, &c.*, p. 412.

Comparative science wants a general and comprehensive vision of the comparable designs of skeletons. It wants to know of the archetype from which they have been struck out in proportional variety ; but the form vertebra, should not be used as the telescope through which this vision of skeleton entirety is to be gained. We cannot comprehend the whole by the part, but if we continue to generalise upon the whole by such a part as the form vertebra instances, we shall view skeleton creation and the unity in variety only to the same effect that this condition of developed character has been ever seen, and that is through mystery. And perhaps it is this unproductive effort of demonstrating a whole quantity in a minus proportional of itself which distinguishes the foreign schools of anatomy from our own, and calls forth the remark from Carus, that, "Philosophical osteology is not indebted for any progress to the English or Italians." To which it may be added that there is far more science displayed in abandoning altogether the theme of philosophical unity, than in the attempt to demonstrate the quantity $a+b$, in $a-b$, the hyoid apparatus of an osseous fish in that of a Mammalian larynx ; the oary palm of a Cetaceous animal in the fore limb of an Apteryx, or the plus archetype of a spinal series in a vertebral quantity or minus figure.*

Anatomical science has not as yet comprehended the design and completed model of the skeleton archetype, and hence has not established the recognition of that form to which it may refer variety for lucid explanation. In the infinitude of variety it still appears to be cast away, and the name and sound of unity is all it has as yet known of this quality of form. When we enter the museums of osteological collections, we do not fail to recognise the imposing transient form of unity, but it is unity in variety ; and when we make effort to withdraw ourselves from the trammels of nomenclature, and seek to know the essential meaning of this law of development, to question the existence of the figure of unity and the source of variety, we are soon forced to confess that it is upon skeleton forms as a whole and in mass that this law operates. Unity being the thing $a+b$, variety being the thing $a-b$, we shall find that all skeleton designs entire, as well as all skeleton apparatus, whether between multitudinous species or between individuals of one species, vary by the differential law of subtracting quantity from original or plus uniformity.

The one spinal chain of vertebral bones does not express the unexceptionable character of unity in any stronger light than do the skeleton forms entire speak of the same unity ; but the mind is compelled to grant that, as the skeleton designs of the four classes are comparable to each other as varieties fashioned of unity, so must the reason make effort to interpret the form of unity from out of the figures of these same four classes viewed in the aggregate, and add those parts which appear to be wanting to the one form by drawing from the other form where they appear developed, and just as we would complete the circle for the semicircle, according to the proportions of another circle.

When we are forced to acknowledge that degradation and metamorphosis of an archetype uniformity is the source of variety, then reason has a free licence to reconstruct the parts known to have suffered metamorphosis in the one skeleton figure, according to the parts which stand as full archetype models in the design of another figure, and it is in this light that we shall be enabled to discover how vertebræ are as parts remaining after the metamorphosis of completer archetypes ; this must be the end and object of all comparative reasoning. If we are to take within the eye of reason the full vision of skeleton archetype

* "Magnitudes which coincide exactly with each other are *equal*. But the part is lesser than the whole quantity, and therefore the part and the whole are *unequals*. Yet the whole contains proportionals equal and similar to all disconnected proportionals of a whole quantity."—*Geometrical Axioms*.

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unity, we must read them in mass as being proportional varieties fashioned of original unity ; but the microscopic eye cannot encompass this entirety.   The moth clung up against the dome of Constantinople's mosque feels not the plenitude of that overvaulting form, and, not comprehending it, does not experience the want of it ; neither does the ant, who enters the Roman Coliseum and makes a long day's journey over some fragment of its fallen state, appreciate the transcendancy of that structural entirety.   Neither has comparative science as yet had sight of the skeleton archetype, but this science experiences the want, and the want, when felt, carves out for itself the discovery.   We should, however, first of all inquire into the character of that form named vertebra, and whilst we are compelled to acknowledge it to be produced as part of a completer and more expressive form, we should come at once to the conclusion that the reason can never generalise upon an entire by any form of lesser proportions than itself.   And the vertebra, being known to stand as part of some fuller form, cannot be extended over all skeleton creation ; nor should the name " vertebrated " block up the road to truth progressive by the rule of comparison, even though Lamarck has sanctified that name for the use of anatomy.   Anatomical nomenclature, like the arbitrary rules for animal classification seems destined ever to undergo modification, according as science turns to the investigation of the form, the thing, the ens, the being, the φυσις, and the natural law, rather than to the choice of what names shall most properly and comprehensively characterise that which is manifest metamorphosis.   The name is not the form, and the form is not itself persistently, even for individuals of one and the same species, much less for those of various species.

The Animal Kingdom, viewed as a whole, is an ens comprised of such relationary qualities, both of form and function, that it is impossible to draw the line of natural separation between presumed class and species. Conceit may establish its fancied line of classification as it chooses ; but rigorous reasoning annihilates the tottering fabric, and outsteps the barrier by which method would vainly strive to set the limits to inquiry. Cuvier classifies species according to fancied diversities ; but Geoffroy fuses all species into one line of extended analogies, and Nature herself responds to this latter interpretation.   The doctrine of analogy transcends all bounds; and even all that is truthful in method or classification is based upon the resemblance of form, whether contemplated in superficies or anatomically investigated.   To Aristotle, the relationary and differential characters of animal beings, seemed, in the general notice, twofold.   He distinguished two sorts of animals ; the one which *possessed blood*, the other which was *bloodless*.*   This idea underwent modification through Linnæus, who chose rather to designate the two sorts of animals as that possessed of *red blood*, and that which possessed *white blood*.†   Again, Lamarck substituted another formula, and, according to the presence or absence of an endoskeleton fabric, distinguished animals into *vertebrate* and *invertebrate*.‡   The osseous skeleton had now become the subject of philosophical disputation ; on one side, the definition of skeleton species was attempted to be demonstrated ; on the other, universal skeleton analogy was known to prevail ; and, to this hour, the question, as to the precise limits of animal class or species, has proceeded no further than where Aristotle had left it ; but it is confessed, that all promise of discovery leads the way in front of the doctrine of a limitless analogy, and the consequent fusion of proximate species.
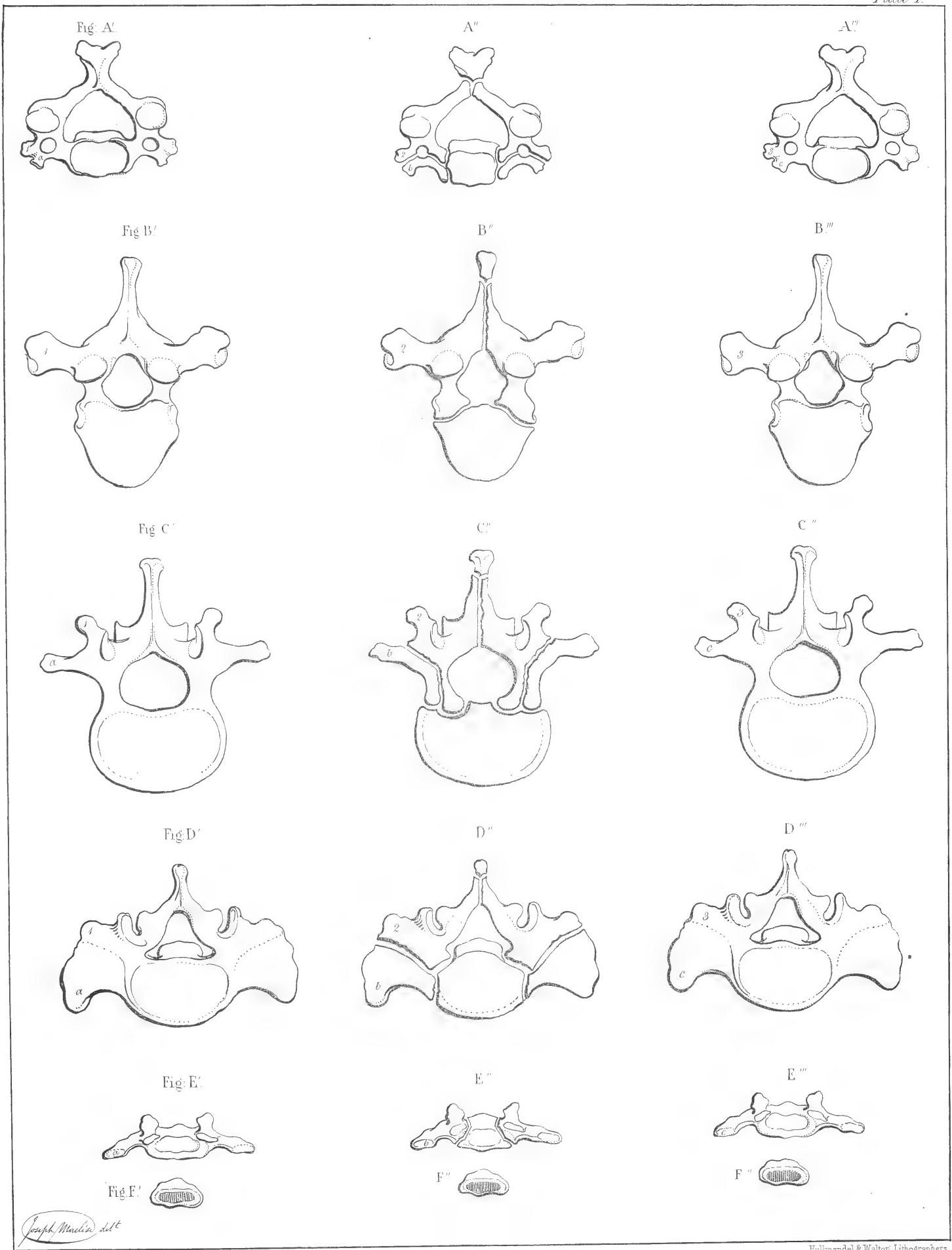
* History of Animals.   † Systema Naturæ.

‡ " Pour eviter toute equivoque, ou l'emploi d'aucune consideration hypothetique, dans mon premier cours fait dans le Muséum, au printemps de 1794 (l'an 2 de la Republique), je divisai la totalité des animaux connus en deux coupes parfaitement distinctes, savoir : Les animaux à vertèbres, et les animaux sans vertèbres."—*Philosophie Zoologique*, par T. B..P. A. Lamarck, tome i., p. 118.

Confining the attention to a comparison of the skeleton quantities, which is our more immediate subject, it would seem to be as difficult to define their species by a mode of absolute separation or isolation from each other, as it is to divide the relationary and combinative colors of the prismatic spectrum. The fluxion or fusion of analogous entities, produced in plus and minus quantity, is that state of a natural law under which it is totally impossible to circumscribe specific variation, which is nothing more than plus and minus proportioning. The following remarks will illustrate the truth of this. " I call that," says Cuvier, "a specific distinctness between animals which I have classed separately, which, though bearing the same name of hyoid apparatus, is furnished with elemental parts less in number and quantity for one animal than it is for another." And to this Geoffroy answers in effect, "Then must it follow, by parity of reasoning, that you rate as specific distinctnesses the beings of this one species, one of which shall have produced for it the hyoid apparatus connected by an osseous shaft to the temporal bone, the stylo-hyoid ligament having become ossified, and the other whose hyoid apparatus remains distinct from the temporal bone, the bond of connection being ligamentous." The Human skeleton furnishes example of this variety of development. Thus, have the questions of "absolute distinctnesses" and "absolute uniformity," baffled comparative reasoners, and, still, the argument gravitates by turns towards " unité de composition " on the one hand, and " diversité de composition " on the other ; forasmuch as by the former cannot be understood " identité de composition," nor by the latter, " diversité absolue." This argument as to uniformity and difformity, we shall, through the following pages, consider as one attaching to the variation of osseous quantity proper to each skeleton form considered as a whole design, or to each skeleton apparatus as it appears developed of its own fitting cast ; and, in order that we may the more closely track the paces of the law of unity in variety which appears to be one of proportioning minus quantities from a plus archetype or integral quantity, we shall fix attention first upon that minus quantity, *the vertebra*, and according as it shall extend itself, or as the analogue of itself shall be extended here and there through series to the archetype plus sum, so shall our ideas grow with the growth of the form, till they and it shall produce *the whole quantity* which, like a generalisation, will be seen to include many lesser subjects.

Plate I.

Fig: A'.　　　　　　A''　　　　　　A'''

Fig B'　　　　　　B''　　　　　　B'''

Fig C'　　　　　　C''　　　　　　C'''

Fig: D'　　　　　　D''　　　　　　D'''

Fig: E'　　　　　　E''　　　　　　E'''

Fig.F'　　　　　　F''　　　　　　F''

REMARKS ON THE FIGURES OF PLATE I.

THE VERTEBRAL TRANSVERSE PROCESSES COMPARED WITH ONE ANOTHER THROUGH SERIES.

WE proceed to identify the homologous elements of the several classes of vertebræ whose serial order constitutes the human spinal axis, to know clearly what are the elemental parts which shall be properly characterised by one and the same name, and which can have no other name than this applied to them, without confusing the ideas. The name once fixed upon the form, shall attend upon that form and no other ; and even though we shall discover it to increase or decrease beyond its most ordinary dimensions, from time to time, or in several places, still it shall not escape our identification of it as being one and the same thing.

The figures marked A are such as form the human cervical spinal region, and these are forms absolutely homologous both as to their general character and their several elementary pieces. The central form, marked A″, represents those elementary pieces separated the one from the other. These are the primary formative pieces of the cervical vertebra, and consist of the centrum or median element named the body, and the two lateral pieces arching dorsal from it to form the neural arch. Where these two lateral pieces meet behind, they are surmounted by another element named the spinous process. The so-called transverse process of the cervical vertebra is compound. It consists of double elements; the one placed posteriorly is marked 2 in fig. A″, and is a structural part produced from the lateral piece of the neural arch ; one elementary nucleus of osseous deposit fashions all parts of this lateral piece.

The anterior piece b, of the cervical compound transverse process, is totally distinct in early life from the posterior piece, 2. In adult age, for the most part both these pieces become united, but still they hold in the very same position in which they were first laid distinct. It is impossible (even when we see them in their state of coalescence) to forget that they were once distinct elements. We call the fused condition of both these elementary pieces the cervical transverse process, but we know it to be composed of double elements, the posterior element being an apophysis of the neural arch, whereas the anterior element is one developed per se. In figure A″, therefore, we say b is not to be confounded with 2, and also that even when we call their fused condition by the common name of transverse process, this name neither changes the elements as to their proper position or character. Even when we see them as in figs. A′ and A‴ combined, we still know that they were once separate, and that although now presenting themselves fused together, they have not changed sides. The anterior element is still itself, and no other. The posterior element is still itself, and no other. Whether these elements hold separable or become fused together, we fully understand that the anterior part of the transverse process of the figures A′ A″ A‴ is not the posterior part. Even though we mark them with distinct letters, such as 1a of fig. A′,

or 2b of fig. A″, or 3c of fig. A‴, still we know the positive identity of the forms themselves, that the posterior element is always posterior, and that the anterior element is always anterior.

The figs. marked B′ B″ B‴ are human dorsal vertebræ, and are homologous. In what respect do these dorsal vertebræ differ from those of the cervical class? In no other particular than that these dorsal forms are minus an element, and that the cervical forms are plus that same element. Fig. B″ shows the primary elemental pieces separated. The process called transverse, and marked 2 in fig. B″, is absolutely homologous with the process marked 2 in fig. A″. Both these processes are identical as to position and mode of development. They are the apophyses of the neural arches, and are produced of the same nucleus which fashioned the neural arch. The process marked 2, fig. B″, cannot be said to be the homologue of the element marked b in fig. A″, because these elements do not correspond in any respect whatever. The piece b of fig. A″ is produced distinctly, and created anteriorly to the piece 2 of the same figure. The piece marked 2 fig. A″ is the apophysis of the neural arch, and so likewise is the piece marked 2, fig. B″, therefore it is that we call them homologous. In the fig. A″ we find an element marked b, but we have no homologue for b in fig. B″, therefore it is that we say fig. B″ is minus the piece b. Hence we conclude that the cervical vertebra A″, minus the element b, equals the dorsal vertebra B″, or otherwise that B″, plus the element b, equals the figure A″. We say, therefore, that fig. B″ is only different from fig. A″ by being minus the piece b.

The figures marked C′ C″ C‴ are human lumbar vertebræ, and are homologous. In fig. C″ we see the elements separated, and these are marked with letters corresponding to those of fig. A″. The parts 2 and b of fig. C″, are identical with the parts 2 and b of fig. A″. These parts of both figures correspond both as to position and mode of development, therefore C″ is homologous with A″, but C″ is different to B″ for the same reason that A″ was different to B″, that is, B″ wants the element b, which we find in figs. A″ and C″.

The figures marked D′ D″ D‴ are human sacral vertebræ and are homologous. So also are they homologous with

figs. C″ and A″, forasmuch as we find their elementary nuclei corresponding both as to position and mode of development. The parts 2 and b of fig. D″, find their homologues in the parts 2 and b of figs. C″ and A″, therefore figs. D″ C″ and A″ are homologues, and are only different from fig. B″ by being plus the nucleus b which is wanting in fig. B″.

Figures E′E″E‴ are human terminal sacral vertebræ and are homologues of each other. They hold serial spinal order with figs. D″C″B″ and A″, but are not equal to those latter forms. How are they rendered unequal to those forms D″C″B″ and A″? It is by the atrophy or subtraction of elementary parts. Still we find in fig. E, certain elements which have their homologues in figs. D″C″B″ and A″, and therefore we conclude that fig. E plus those elements now lost to it, would render it equal to any other vertebra of the spine.

Figures F′F″F‴ are caudal human vertebræ holding series with all others of the same spinal chain. The fig. F is a fractional of such another unit as fig. D″, or C″, or A″. It is a centrum, and holds serial order with the centrums of all other vertebræ. Any vertebra minus all elements but the centrum, would equal a caudal bone, and this caudal bone plus those same elements, would equal any other vertebra.

The general conclusion, therefore, which is to be drawn regarding the figures of Plate I., is that plus quantity has been rendered minus by process of metamorphosis or subtraction, and that this process resembles $a - b = c$, which leaves it to be inferred that $c + b = a$, and thus proves that subtraction or addition of certain elemental nuclei is the sole cause of uniformity being rendered various through figs. A, B, C, D, E, F.

Now the reason why we have been thus careful to identify the homologous elements of figs. A, B, C, D, E, F, is because we believe that those figures represent a brief abstract of all the subject of comparative osteology, and that truth or error in this stage of our argument will draw after them truthful or erroneous interpretation the farther we advance in our reading of the law of skeleton formation from either groundwork. It has been well observed that, "Errores radicales et in prima digestione mentis ab excellentia functionum et remediorum sequentium non curantur."* Original error in the first digestion of the mind cannot afterwards be remedied, and so we say that if we do not now distinguish clearly between the exogenous pieces marked 2 in figs. A″B″C″D″ and the autogenous elements marked b in figs. A″C″D″, we shall not be able to rectify the error afterwards.

The processes called "transverse," in figs. A″B″C″ and D″ are not all produced of identical or homologous elements. It is plain that the piece marked 2 in fig. B″ is not the counterpart of the piece b in fig. C″, or D″, or A″, but is actually homologous with the process marked 2 in figs. A″C″ and D″. Fig. B″ has no elemental structure homologous to the piece b of figs. A″C″ and D″, therefore those latter figures are plus the element b. A radical error committed in the science of number would make nonsense of the whole system of algebraic computation.

An arithmetic based upon $2 + 3 = 6$, or an assertion that the sides of an equi-angular triangle were *unequal* to one another, would pervert the whole majesty of mathematical truth; and so would the assertion that the process 2 of fig. B″ was identical with the process b of figs. C″D″ or A″ distort the whole system of philosophical osteology and the unity in variety.

A comparison, therefore, held between the figs. of Plate I. involves the question as to uniformity and difformity of developed character. The law of species or individuality is likewise attendant upon those several forms of vertebræ as developed in the human spinal axis, and it is most true that the interminable argument as to the existence of an absolute unity prevailing through all fashions of endoskeleton formation in the four classes of animals may be also entered upon respecting figs. A″B″C″D″ and E: and hence it is most necessary plainly to state our ideas of the unity and variety which characterises those forms. This we shall do by asking ourselves the following questions irrespective of any theory, hypothesis, or favoured doctrine which might cause us to warp the facts of Nature :—

Are the figs. A″B″C″D″E″ and F uniform quantities; and when we name them vertebræ, do we mean that they are equals, both as to form, design, and quantity? They cannot be regarded as uniform any more than the several fractionals of an integer can be named uniform and equal to one another, and to the integer itself. For fig. A″ is as different to fig. B″ as 6 is to 5. Fig. B″ is as difform to fig. C″ as 5 is to 6. Fig. C″ is as difform to fig. E″ as 6 is to 3, and fig. F is as difform to all the rest as the unit 1 is to the integer 6, and to all the other quantities contained in 6.

What then is the condition of that variety or difformity which renders it wholly impossible to consider figs. A″B″C″D″E″ and F″ as uniform bodies at the same time that they are only dissimilar as unequal quantities? It is the variety of plus quantity subtracted from, and just in the same way as we would equate 1 with 7 by process of addition, $1 + 6 = 7$, so if we would read uniformity between figs. F″ and A″, we must estimate the common difference as to quantity between them, and calling this quantity by the name b, then fig. F″ plus b equals A″, and fig. A″ minus b equals F; which amounts to the same thing as saying that fig. A″ is a quantity which metamorphosis, or subtraction, might render equal to fig. F″, and therefore allows us at least strongly to suspect that fig. F is a special design metamorphosed from such an original quantity as fig. A. Be this as it may, however, all that we shall at present say is that the serial order of figs. A″B″C″D″E″ and F″ manifests only such variety as we find between proportional quantities, that figs. A″C″ and D″ are equal quantities, and produced of the like elemental structures, but that figs. B″E″ and F″ are minus certain elements, and hereby are struck various. The variety which dismembers the continuity of serial uniformity is only $a - b$ compared with $a + b$, and it is the rule of comparison teaches us that plus is various to minus by the presence of those very elements which when absent makes minus various to plus.
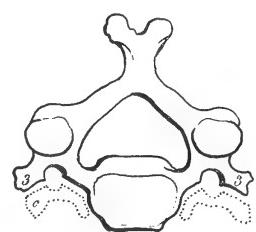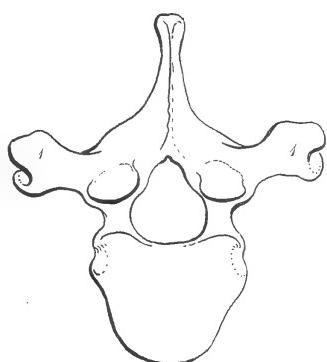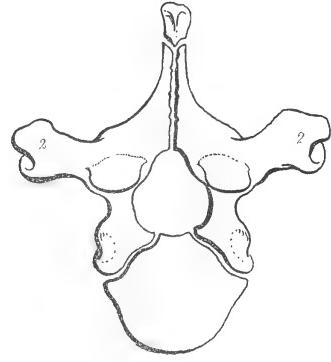
* Novum Organon Scientiarum, Aph. 30.
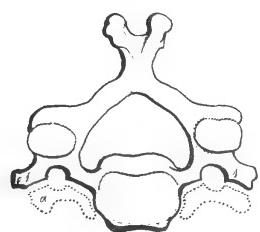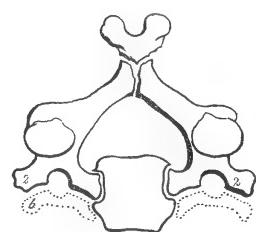
Plate 2.

Fig: A'.   A".   A'''

Fig: B'.   B".   B.'''
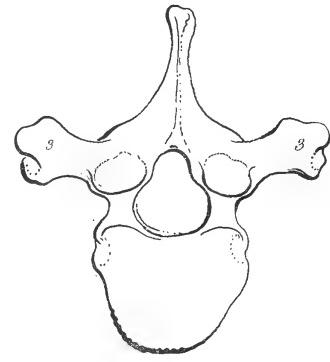
Fig: C'   C."   C.'''
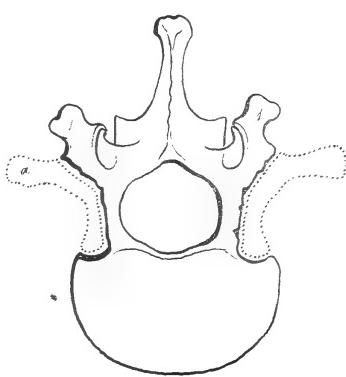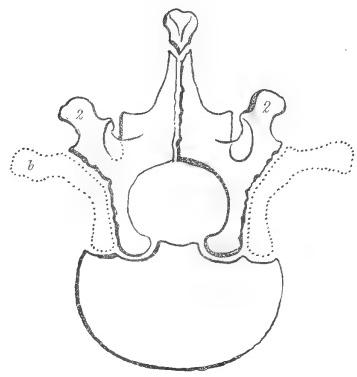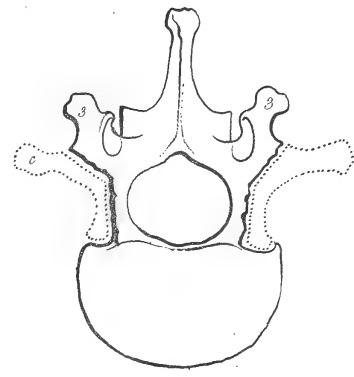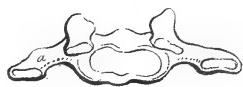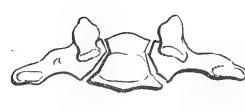
Fig: D'   D."   D.'''
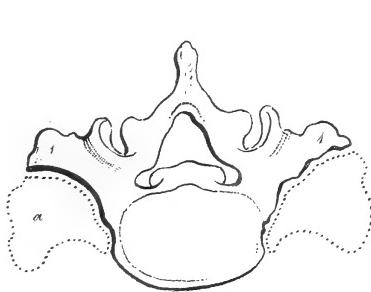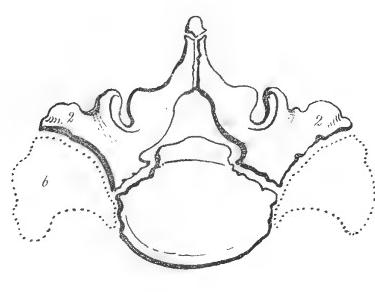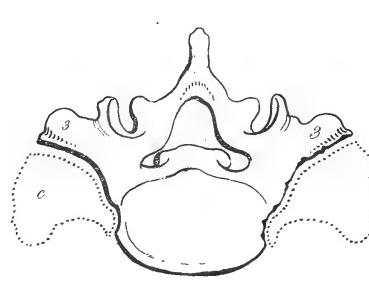
Fig: E'   E."   E."
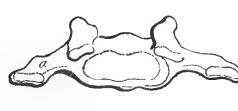
Fig: F'   F."   F'''

REMARKS ON THE FIGURES OF PLATE II.

SIMILAR PARTS ARE SUBTRACTED FROM SIMILAR VERTEBRAL QUANTITIES.

WHEN from equal things we take away equal things, respectively, the remainders will be equal. This is an axiom in geometry, and without a doubt applies also to comparative osteology. The creation of form must be through the agency of a law of development, and this law being uniform in its operation, must create figures uniform and homologous as to quantity. We say the creation of plus forms by a uniform law must be the repetition of plus form and quantity, but we by no means assert that all forms *are* created equals as to quantity. When two or more figures of one species or cast are created in full quantity, those figures are developed uniformly. When these same figures are varied from one another, the variation takes place by the non-creation or omission of certain elementary parts. The variation of form is plus and minus. The form of plus quantity is positive, the form of minus quantity is negative. Plus quantities are uniform, being positive creations. Minus quantities are various to plus quantities solely on account of the subtraction of elementary parts. The law of form appears to be one of addition and subtraction of elementary parts, and therefore the forms themselves must vary according to the presence or absence of certain quantities. For which reason it becomes impossible rationally to name plus and minus quantities (of one species, such as vertebræ) to be absolutely homologous or equal. Equal quantities are uniform and homologous; unequal quantities are different to these only by reason of the subtraction of parts. And the comparison of equals and unequals, or plus and minus quantities, will show how much the latter are minus compared with the former or plus, for it is true that we see in plus those very same elements which are lost to minus figures. Vertebræ are created under the operation of this law.

The figures marked A″ C″ and D″ are rendered equal with the figure B″ by subtracting the elementary piece *b* from them. The dotted element *b* is that quantity minus which would establish the figures A″C″ and D″ as the homologues of B″. But the element marked 2 in figs. A″B″C″ and D″ is still persistent and the same. It is the exogenous process of the neural arch being produced of the same elementary nucleus with this arch, and therefore cannot be mistaken for that element, which we have withdrawn, and which we have marked *b* in those figures. The element *b* is autogenous, that is to say it is developed from a distinct nucleus.

The exogenous process 2 fig. A″ is therefore contradistinguished from the autogenous process *b* of the same figure. We have abstracted the autogenous element *b* from the figs. A″C″ and D″, and thereby rendered them homologous to the fig. B″. In all the figures A″B″C″ and D″ the exogenous transverse process 2 persists, therefore we are always to read 2 of fig. B″ the dorsal vertebra as identical with the piece 2 seen in all other vertebræ, and never to confound the piece 2 with the autogenous element *b* of any of those serial vertebræ.

The figures E′E″E‴ of this plate express the same meaning as they did in the former plate. They are atrophied vertebræ, or minus certain elemental parts proper to the other classes of vertebræ. But the elements which they contain have still their homologues in the full vertebræ elsewhere developed.

The figures F′ F″ F‴ are proportionals of smaller quantity than is proper to the full vertebral form. They are the centrums of vertebræ, and this name amounts to the same thing as if we had said that they were metamorphosed from vertebral forms fully equal to D″C″B″ or A″.

When, therefore, we consider all those several figures comparatively, we are enabled to come to the plain conclu-

sion that the simple rule of plus and minus is that which renders them different one to the other. Fig. A″ plus the element b, equals fig. C″ plus that same element b, and fig. A″ or fig. C″ or D″ minus the element b, equals the fig. B″ which is minus the very same element b.

Any of these figs. A″B″C″ or D″ minus certain elements would render them equal to fig. E″, and if rendered still further minus would equate them with figs. F′F″F‴; consequently fig. F″ plus those very same elements would establish it equal to either D″C″B″ or A″, and this rule is productive of the idea that the plus quantity A″ equals the plus quantities C″ and D″, and is the archetype of B″E″ and F″ the minus quantities, whereupon it must be concluded that B″E″ and F″ are minus quantities of their own archetypes which fully equalled D″, or C″, or A.″

We should not forget that those elements which persist for the archetype, and which render it plus, are identical with those elements which fail for the minus vertebral figure, and which render it thus minus or various.

The subtraction of an element from a whole or plus quantity renders it now various to what it once was. When b is subtracted or omitted from A″, this is a variation from plus to minus. When equal quantities, such as the elements marked a, b, c, are subtracted from plus homologues, such as figs. A′A″A‴, then the remainders are equal and still homologous to each other, although various to plus quantity. When, again, the like autogenous elements a, b, c, are subtracted from figs. C′C″C‴, the same condition of variety occurs. This remark applies also to figs. D′D″D‴.

When a part is subtracted from a whole, such as part b from fig. A″, we are enabled (even without having seen the operation of subtraction actually performed) to ascertain by comparative rule how much quantity is lost to fig. A″. For, when we compare fig. A″ minus b, to another cervical vertebra plus b, we then create the idea of the element b for the minus vertebra, and the like remark may be made respecting figs. C″ and D″, these figures containing elementary parts identical with those of fig. A″. Hence, therefore, if figs, A″ or C″ or D″, deprived of the element b, will invariably create the idea of that quantity of which they are minus when compared to figs. A″, C″, or D″, where the same quantity b persists, so will fig. B″, which is now minus the element b, create the idea of this lost quantity when fig. B″ shall be compared to any form which contains b in the same spinal series.

The subtraction of equal quantities from equal figures will leave the remainders equal to one another. If the element b be withdrawn from figs. A″, C″, and D″, the remainders of those figures will be equals. But if unequal quantities be subtracted from originally equal figures, then the remainders of those figures will be unequal, and thus it is that figs. E″ and F″ are unequal or various to each other, and to figs. A″B″C″ or D″, which latter would also result as unequal quantities, if unequal quantities had been subtracted from them.

A comparison of plus and minus quantities which hold a serial order, such as figs. A″B″C″D″E″F″, will not fail to suggest the idea that they are only various to each other as unequal quantities, and this idea we believe to be inseparable from the one, namely, that they are thus created by reason of the fact that unequal quantities have been subtracted from archetype equals or plus forms, such as figs. A″C″ or D″.

It is certain that plus quantities, such as figs. A″C″D″, are equals containing homologous elements. It is also certain that those forms contain proportionals severally equal to figs. B″E″F″, and it is moreover certain that if any anatomist chose to assert that B″E″ and F″ were unequal quantities proportioned from such as A″C″D″, there could not be found in all the science of mathematics a single rule in denial of such interpretation. Hence, when we see that the simple subtraction of elementary quantity is sufficient to establish inequality or variety amongst serial forms, and also that the minus figure such as it is for B″E″ or F″, is still homologous to some quantity in either A″C″ or D″, then the interpretation defends itself under shelter of the following rule, viz.: "We must take care to admit no more causes of natural things than what are true and sufficient to explain their phenomena." "We must observe always to assign the same causes for the same natural effects." * The subtraction of quantity is sufficient to explain the variety which distinguishes figs. F″E″ and B″ from one another, and from figs. A″C″ and D″, and the same cause will always produce the same effects. Nature is simple in her operations, and never luxuriates in superfluous causes of things. The skeleton axis is like a geometrical series of proportional quantities, which decrease from the quantity $a+b$ to $a-b$, and thus we have figure A″ commencing series compared with fig. F″, which terminates it.
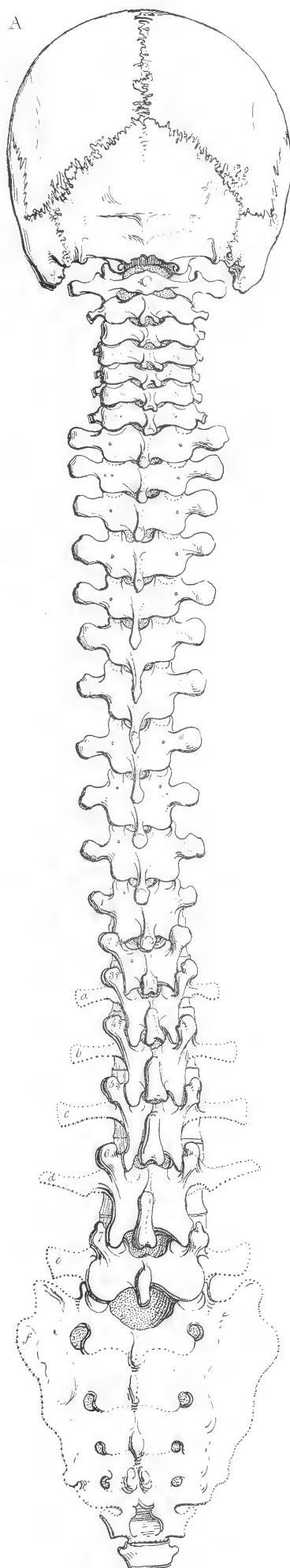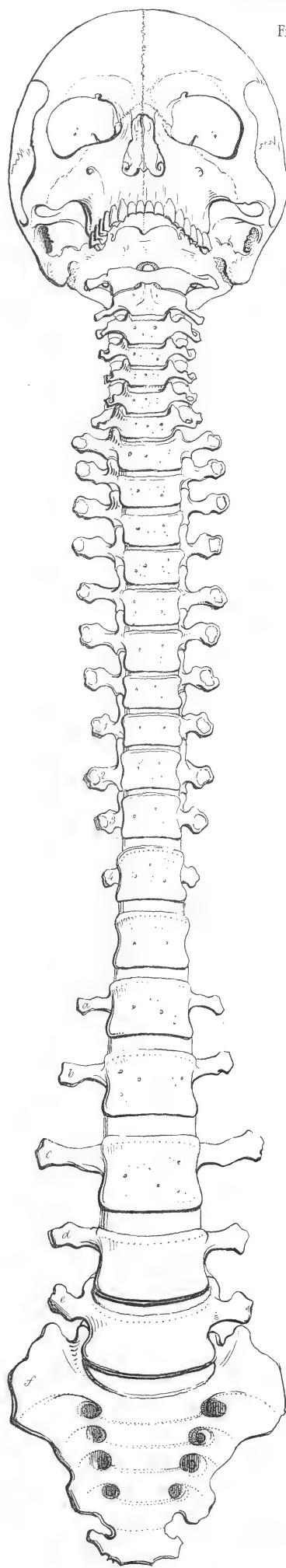
* Regulæ Philosophandi. Newton's Principia.

Plate 3.

Fig A

Fig: B

REMARKS ON THE FIGURES OF PLATE III.

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THE DORSAL TRANSVERSE PROCESSES ARE DISTINGUISHED FROM THE LUMBAR TRANSVERSE PROCESSES.

THE spinal axis is an example of serial order, and between the vertebral quantities of this axis, as between all other organic products which Nature develops in series, she never interrupts that order by any other condition of variety than that which minus bears to plus quantity. A geometrical or an arithmetic series is similar to a vertebral series in this particular, viz.—that in one, as in the other, calculations of the differential and the integral quantities may be made. The negative or non-existent quantity which causes differences between plus and minus through decreasing series, is inseparable from the consideration of the positive or existing quantities which increase from minus to plus, through increasing series. The vertebral axis is a finite series by the subtraction of quantity, and hence may be symbolically expressed by $1, \frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}, \frac{1}{32}$, &c. Now, just in the same way as we find that subtraction from vertebral quantities does, at length, terminate series at the last caudal centrum, so will we discover, that all the elementary pieces of vertebræ hold serial relation with each other, and, at last, terminate in a vanishing point, by the same process of subtraction. The dorsal transverse processes continued from the posterior or exogenous pieces of the cervical transverse processes, and passing into the lumbar tubercles, are lost upon the sacral structures at their posterior aspect.

FIGURE A represents a posterior view of the serial spine of the human figure. The serial regions named cervical, dorsal, lumbar, sacral, and caudal, present some slight modifications of form; but the elementary nuclei which fashion those vertebræ of the several regions, are unmistakeable as to their own proper character. Thus the last caudal bone is a vertebral centrum, and as such, holds series with no other elementary part of any other vertebra of series than that called the centrum. The posterior or exogenous apophysis of the cervical transverse process, is still continuous in series with the same named part of the dorsal, the lumbar, and sacral spine.

The exogenous element, named transverse process of the dorsal vertebra, is marked 1 in fig. A, and holds seriatim order with the like elements which pass down upon the lumbar region, and which are marked 2, 3, 4, 5, 6, 7; but the autogenous elements of the lumbar spine which are marked a, b, c, d, e, f, are not to be confounded with the transverse exogenous processes of the dorsal spine.

The transverse processes of the dorsal spine are exogenous, and pass into the lumbar spinal region under the name of "Tubercles." Those tubercles are also exogenous, and if we would fully identify them with their fellows of the dorsal spine, we have only to compare the fixed and unvarying position of both. The lumbar exogenous tuber-cles and the dorsal exogenous processes project severally from that primary piece which fashions the half of the neural arch.

It is evident that the piece c of fig. A is not the piece 5 of fig. A. It is also evident that the exogenous process 1, holding serial order with the exogenous processes 2, 3, 4, 5, of the lumbar spine, leaves it to be understood that all those processes are homologous; hence it must be evident that those processes 1, 2, 3, 4, 5, 6, 7, are not homologous with the autogenous processes a, b, c, d, e, f; therefore, those processes which are usually named "transverse" in the dorsal spine, are not homologous with the processes usually so named in the lumbar spine. The dorsal spine of fig. A shows its exogenous transverse processes to be homologous with the exogenous tubercles 2, 3, 4, 5, 6, 7, of the lumbar spine; but the dorsal spine as seen in fig. A. holds no elements which may be called the counterparts or homologues of the lumbar elements a, b, c, d, e, f.

Those processes a, b, c, d, e, f, which are usually named "transverse" of the lumbar spine, are not homologous with the processes commonly named "transverse" of the dorsal spine. The former processes are autogenous, the latter are exogenous.

Fig. B is a front view of the human spinal series. The autogenous transverse processes a, b, c, d, e, f, of the lumbar

spine are not continued in series from the exogenous transverse processes 1, 2, 3, 4, of the dorsal spine. These latter processes at 4 pass backwards and are continued into the lumbar exogenous tubercles. The close examination of any human spinal series will prove the truth of this observation, and much will be afterwards seen to depend upon our establishing clearly the distinctive character between the serial processes 1, 2, 3, 4, and those processes marked *a, b, c, d, e, f.*

The serial order in which spinal figures are developed is fully expressive of the homology of their form and elemental parts. Every vertebra of the same series is known to contain some structural quantity, (more or less,) which is repeated in the vertebra preceding and succeeding itself, and it is not possible for the anatomist to separate that form from spinal series which may be said to present any other variety than that which occurs by the subtraction of quantity. A series of forms is a succession or continued order of homologues repeated—it is a line of things created similarly and uniformly. Whenever we find an exception to this lineal uniformity, such exception is caused by an absence or negative condition of some elemental part of one of the figures of series. A hiatus or subtraction of quantity may dismember the continuity of the serial uniform line, but Nature never introduces in the stead of that lost quantity, any other thing of absolutely dissimilar kind.

In fig. A we see the serial order of the several elementary pieces proper to vertebral quantity. Spinous processes hold serial relation to each other from occiput to sacrum. Neural arches manifest the order of lineal series also. The bodies of vertebræ in fig. B in like manner are continued in series from the basilar processes of the occipital bone, to the last caudal nodule. These three orders of elemental structure are dissimilar to each other. The one serial order of elements is never confounded with, or lost in the other; they are created as separate entities, in separate localities, and they always hold separate. They are parallel lines of distinct structures, and when we see that either line declines, by process of subtraction, we still never find that the vanishing point of one series is the genetic point of another.

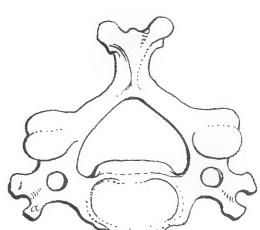But in each of these three series of distinct parts, in that of spinous processes, of neural arches, and of bodies of vertebræ, we find that the line of which each is composed, is the simple repetition of that structure proper to each line; and although we at once recognise the distinctness which characterises the structures of one line from those of the other, yet we cannot thus characterise distinctness or variety between the serial pieces of the one line. The spinous process, the neural arch, and the vertebral body, are structural varieties, and the series produced by the repetition of each of these structures is a various series, compared with the other two; but every elemental piece found in one serial order is the homologue of all other pieces of that same order, and in this order there happens no other condition of variety than that of plus and minus quantity. The spinous processes of the sacral vertebræ are only minus when compared with the spinous processes of the lumbar vertebræ. The caudal centrums are only minus quantities compared with the lumbar centrums of the vertebræ.

Two series of distinct structures are never found to flow into one another. Anatomy has never yet experienced the fact of a neural arch occurring where vertebral centrums hold serial relation. Nature is order as well in the microcosm of her infinitesimals as in her planetary location, and neither does the series of processes marked 1, 2, 3, 4, 5, 6, 7, in fig. A confound itself with the parts of that distinct series marked *a, b, c, d, e, f.*
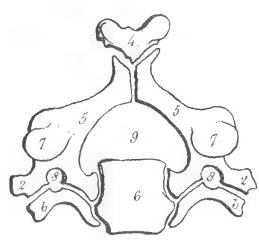
The serial order of vertebral quantities, as well as the serial orders of those distinct elements which are found in those quantities, may be contemplated in the same idea which science entertains of an animal kingdom, namely, that "the law of continuity requires that all natural beings should form a single chain." * The law of continuity is the law of series, and both are synonymous with the existence of linear homologues. Form is an ens, and the repetition of this is the creation of series or uniformity. The exception to uniformity is the absence of some known quantity which leaves the ens minus in relation with the ens plus. The processes marked 1, 2, 3, 4, 5, 6, 7, are continued in a line of plus and minus quantities from occiput to the sacral dorsum; but the processes marked in rising order from *f* to *a,* hold their own serial position, and become suddenly interrupted at *a,* not by natural subtraction of quantity, or graduated metamorphosis of structure, but by our own mechanical dismemberment of parts which are created continuously with *a* in full skeleton quantity, as will be hereafter shown.
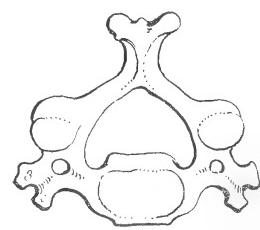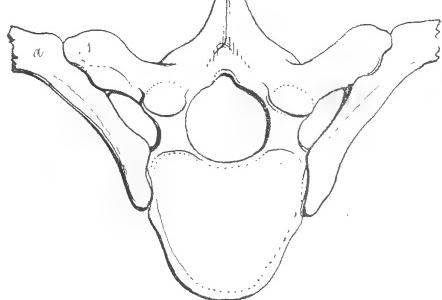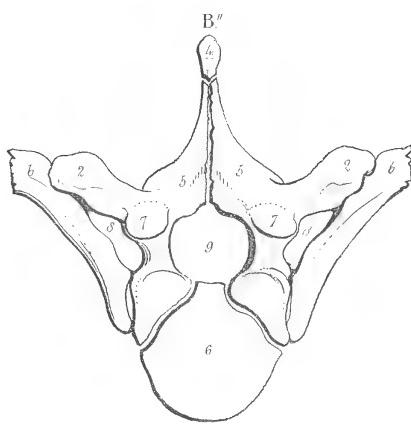
* Leibnitz—L'appel au public de Kœnig. Lettres.

Plate 4.

Fig A.

A''

A'''

Fig. B'

B''

B'''

Fig. C.

C''

C'''

Fig. D'

D''

D'''

Fig. E'

E''

E'''

Joseph Maclise del.
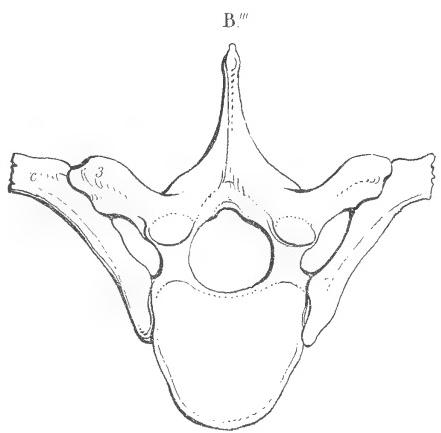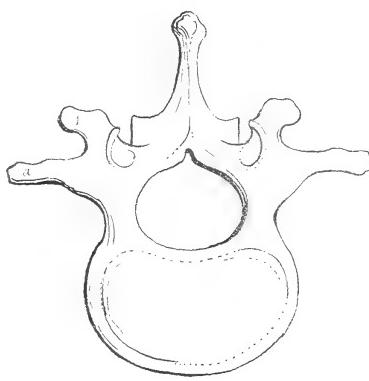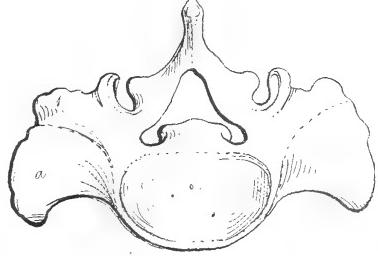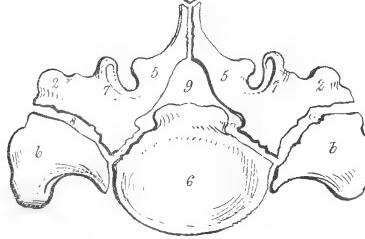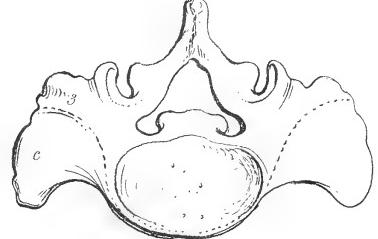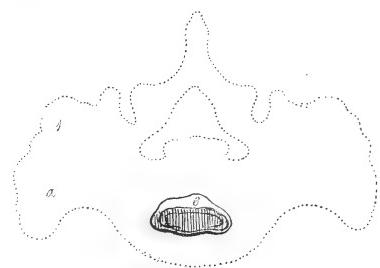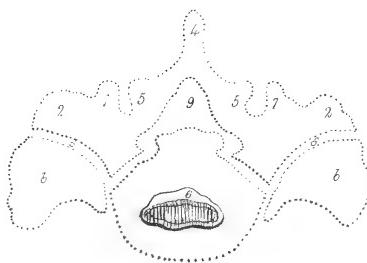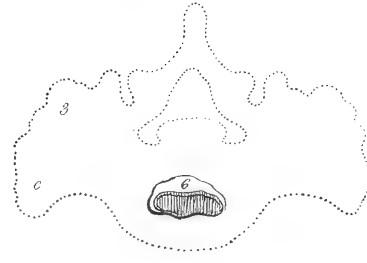
REMARKS ON THE FIGURES OF PLATE IV.

— ◆ —

SIMILAR PARTS ARE ADDED TO SIMILAR VERTEBRAL QUANTITIES.

IF to equal things we add equal things, respectively, the wholes will be equal. Uniformity and difformity, like equality and inequality, is original plus quantity, having undergone the process of subtraction. The persistence of plus quantities is the maintenance of uniformity amongst them. The subtraction of elementary parts from one or more of such plus quantities, is the introduction of variety amongst these figures. But the comparison of minus and plus quantities invariably teaches us that uniformity and v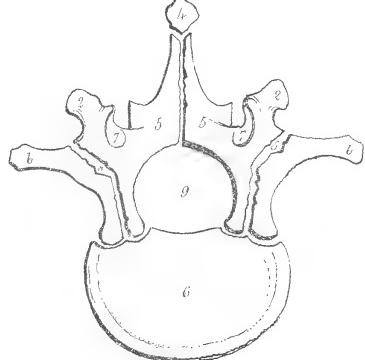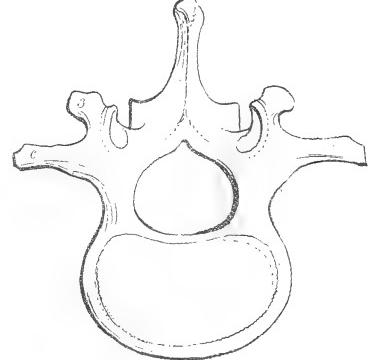ariety is, in its essence, nothing more than equality and inequality. Thus if $a + b$, and $a + b$ are in all respects equals, counterparts, or homologues, then variety or inequality may difference these twin homologues or Gemini by rendering one of the quantities in the condition of $a - b$ which when it shall now be compared with the persistent quantity $a + b$ must teach us the fact that b is a lost quantity, and thus by the rule of comparison we are enabled to create the idea of a quantity actually lost by natural subtraction just as clearly as if we had ourselves subtracted it. When we dismember the costa from the dorsal vertebra we then subtract from a plus quantity which Nature herself has left persistent, and by this subtraction 'tis we ourselves who create variety. When again we restore the costa to its natural place we then equate whole quantities by the addition of equal things.

The figures marked A are cervical vertebræ. Those marked B are of the dorsal class of vertebræ. Those marked C are of the lumbar class, and those marked D are of the sacral order. All these several classes of vertebræ of the human spine contain homologous elements, all hold identical quantities, and all are in general construction and character homologous to one another.

The figures marked A″B″C″ and D″ show equal numbers of elemental nuclei. Those nucleary pieces are similarly marked in each. The dorsal vertebral figure B″ is now seen to be equated with the cervical fig. A″, and also with the lumbar fig. C″, and with the sacral vertebra D″.

What is that element which by being added to the dorsal vertebra B″ renders it equal to all other vertebræ of the cervical, lumbar, and sacral regions? It is the part of a thoracic rib.

In fig. A″ we have marked the posterior exogenous moiety of the transverse process 2. The same figure in B″C″ and D″ indicates the like exogenous piece.

In fig. A″ we have also marked the anterior autogenous moiety of the transverse process with the letter b, and this letter indicates the homologous element in fig. B″C″ and D″.

In fig. B″ the part marked b is the proximal end of a rib. In figs. A″C″ and D″ the homologous elements marked b are similar to that part named b in fig. B″.

These are one and all autogenous elements, and stand in the very same position with relation to the vertebral centrum marked 6 and the exogenous process marked 2.

Now figures A′A″A‴ are evidently the homologues of each other; so also are figs. B′B″B‴; so in like manner are figs. C′C″C‴: and figs. D′D″D‴ are also homologous. These several species of forms are produced of identical elements equal both as to number, position and cast.

If fig. A′ be homologous with fig. A″ or fig. A‴ both in general and elementary character; so also is it by the same evidences homologous with fig. B, or C, or D, for the like elementary pieces are to be found in them all. Those pieces are similarly marked in each form, read from above downwards. Even the foramina and apertures are identical in each. The vertebral foramen 8 of the transverse compound process of fig. A″ is analogous to the costo-transverse cleft 8 of fig. B″. This aperture 8 is obliterated in figs. C″ and D″ in consequence of the complete fusion of the parts marked 2 and b of the same forms.

Figures E′E″E‴ represent the last caudal bones of the human spinal series. Around them is drawn the outline of the vertebral quantity from which they have been metamorphosed, and with which quantity they may be equated. It is by this rule of equations that we are enabled to esta-

blish in idea the serial vertebral uniformity.   Uniformity being rendered difform just as plus may be rendered minus, any vertebra of the spinal series may be metamorphosed to the caudal quantity ; and so may this caudal quantity be equated to the plus amount of the vertebral archetype.   In this mode we track the design of nature.

Now when we here name figs. A″ B″ C″ D″ as uniform and equal quantities, we are not to be understood to mean that these forms are so absolutely identical with one another that even a transposition from their natural situation in the serial spinal axis would not interfere with natural fitness.   Although it be most true that fig. A″ contains elemental quantity as similar to fig. B″ as the integer 6 compared to the integer 6, still it is equally true that fig. B″ would not suit the serial situation of fig. A″, nor this latter the situation of the former.   When we assert that fig. A″ is homologue of fig. B we simply mean that in the one form may be read the same formative pieces which are to be found in the other.   We know well enough that the general design of a dorsal vertebral quantity such as fig. B″ is one various to the design of a cervical vertebral quantity, such as fig. A″, but still we see that both contain similar parts and that those parts are also repeated in figs. C″ and D″.

The knowledge of a whole quantity in a series lends interpretation to all other quantities of the same series, provided these latter do not exceed the sum of the former. But it invariably happens that through the want of knowing the whole quantity we then fix attention upon a minus figure ; we give this a name, and consequently interpret all the other serial figures which manifest plus variations to this minus figure, as though they were anomalous, that is to say unaccountable.   Thus have anatomists * selected (B″ minus the costa b), from the serial axis and called it the dorsal vertebra, and upon comparing this with fig. A″ discovered that there existed a primitive or radical variety between both quantities, the variety being attached to fig. A″ whose transverse process contained the plus element marked b †.   Again on comparing fig. C″ the lumbar form with (fig. B″ minus b) they have found that the former was originally various to the latter by the existence of the autogenous part b' ‡.   Or

even when they named b of fig. C″ to be identical with the piece 2 of fig. B″ then the Tubercle 2 § of fig. C″ not having a counterpart in the dorsal vertebra was the unaccountable anomaly to vertebral uniformity.

In like manner the sacral vertebra fig. D″ was seen to be developed of nucleary parts which were not to be found in (fig. B″ minus the piece b), for comparison proved that fig. D″ was developed plus its element b ‖, and that such was the peculiarity of sacral form.   Whenever we choose from series a minus quantity and affix a name to it, as though it were a perfect figure not liable to any plus or minus variation, we then, on holding it in comparison with plus and minus quantities of the same series, will always discover variety to appear.   An example of this may be read in that minus quantity which special anatomists have named the dorsal vertebra, although they have never met with this form unaccompanied with its natural appendages the costæ.   Plus quantity is always various to minus quantity and so are figs. A″ C″ and D″ the cervical lumbar and sacral forms always plus and various to fig. B″ unattended with b its costæ.

Whenever, on the contrary, we rise to the appreciation of a whole quantity which is a perfect form, and as such contains parts equal to any other figure happening in the same series with itself, we then gain some insight into original uniformity, and at the same time acknowledge the condition of minus proportioning, or that law which subtracts from plus uniform originals and leaves behind certain quantities of graduated proportions.   Thus (B″ plus b), equals (A″ or C″ or D″ plus b), and contains the caudal quantity E″, that is to say contains a proportional quantity equal to the minus fig. E″, from which we can reasonably infer that fig. E″ has been metamorphosed from a whole quantity, such as fig. B″ or A″ C″ or D″.   The comparative rule tells us that the non-existent parts of a minus quantity are those which still appear in plus quantity, and this we have indicated in the outline drawn around fig. E″ the caudal centrum.   We shall continue hereafter through these pages to consider fig. B″ as inseparable from its costal appendages marked b, and because in nature we never see (fig. B″ minus b), produced as a quantity of serial order.

* Cruveilhier and Meckel, T. F., both of whose works "Anatomie Descriptive" by the former, and "Handbuch der Menschlichen Anatomie," Halle—Berlin, by the latter author may be said to have carried the special subject of human anatomy to the farthest limits of which it is capable of being cultivated apart from comparative science.

† For what have been named as the "peculiarities" of the seventh cervical vertebra respecting the anterior root of its transverse process, in connection with the creation of cervical ribs, consult the works of Cruveilhier and Meckel above cited, also Hunauld, Mem de l'Ac. des Sc. 1740—*Sue, Mem Pres. à l'Ae. de Paris*, vol. ii.—and *Nesbitt Osteogenie*.

‡ A peculiarity which is said by Cruveilhier to attach to this process, is that it sometimes remains separate, and appears as a "supernumerary rib."

§ The tubercle is also reckoned amongst the peculiarities of the lumbar vertebra.

‖ "Characteristic osseous pieces" of the sacral structures, as they are termed by human anatomists.   These pieces, from which are produced the anterior portion of the sacral lateral masses, are mentioned as additional centres of ossification for sacral vertebræ compared with the dorsal vertebra, viewed independently of the costæ.   See *Works of Meckel and Cruveilhier*.
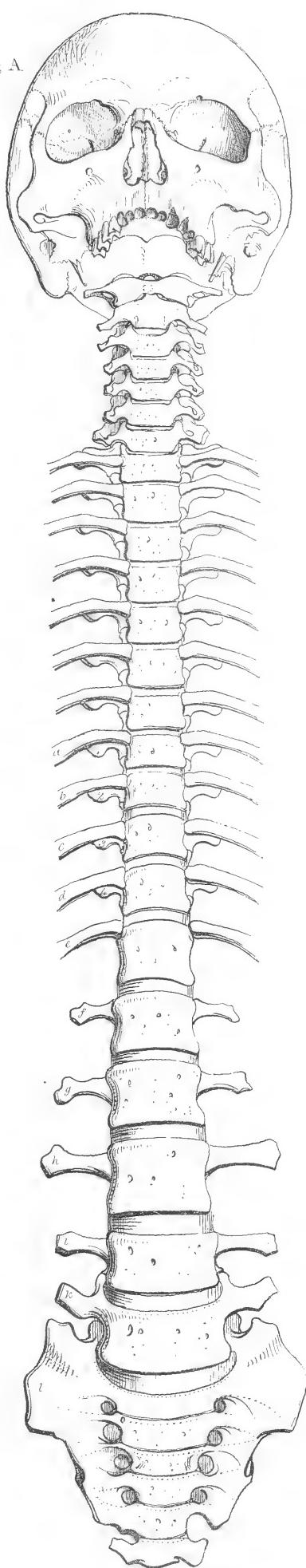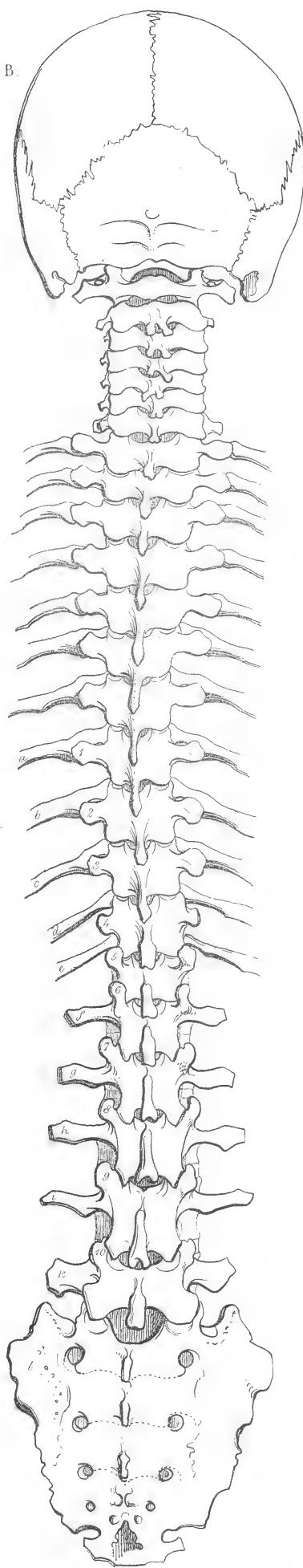
Plate 5.

Fig A.

Fig B.

REMARKS ON THE FIGURES OF PLATE V.

OSSEOUS quantities, such as those which constitute the spinal series, are repetitions of each other. The vertebræ of those several regions of the spinal axis, which anatomists name cervical, dorsal, and lumbar, contain identical elements, and thus the original or standard character of a skeleton serial axis being that of uniformity, the idea which fixes upon uniformity will best appreciate the design occurring by special modification. Serial figures which are produced of primary identical elements will, when viewed as such, express that transitional change by which secondary design has rendered various numbers of those same figures as regional fitnesses. Thus, while we know that elemental quantity is equal, homologous, and the same, for vertebral forms of either the cervical, dorsal, lumbar, or sacral regions of series, we then, compared with this original oneness of type, clearly understand how far Nature has, as it were, re-edited her work and written the specialty of cast on each compartment of series.

In fig. A, the front view of the human spinal series, we have marked those elemental pieces which hold serial order, passing downwards from the dorsal to the lumbar regions. The pieces marked a, b, c, d, e, are the heads of the thoracic ribs, which stand in serial order with f, g, h, i, k, l, the costal atrophied forms of the lumbar spine, and of which they are the homologues.

The pieces marked a, b, c, d, e, of fig. A are autogenous elements, and persist articularly separate from the dorsal vertebræ. In this particular they differ from the autogenous elements f, g, h, i, k, l, of the lumbar spine, to which these latter are permanently soldered by ossific deposit. But if this condition of development be accounted sufficient to establish the character of absolute difformity between both orders of the serial pieces, why then, for the same reason, we must conclude that a rib is not a rib when it becomes consolidated with a dorsal vertebra, and, also, that a lumbar autogenous process is not itself when it shall be discovered to hold articularly separate, like a rib, from the lumbar vertebra. This subject will be hereafter considered.

It is nevertheless most evident that the costal pieces a, b, c, d, e, fig. A, hold serial order with, and are homologous to, the autogenous pieces f, g, h, i, k, l. If this be the simple fact, then it is clear that we call the first order of pieces "ribs," on account of their operating articularly; whereas, we name the latter order of the homologous series "transverse processes," solely on account of their being permanently anchylosed to the lumbar vertebræ.

Now if the pieces a, b, c, d, e, hold serial order with, and identify themselves with the pieces marked f, g, h, i, k, l, then it is clear that we should not confound those latter pieces with those marked 1, 2, 3, 4, which are the true exogenous transverse processes of the dorsal spine.

For we see how that in fig. B those exogenous transverse processes of the dorsal spine, hold serial order with the exogenous "tubercles" of the lumbar spine. The piece marked 1 being in serial order with the homologous pieces marked 2, 3, 4, 5, 6, 7, 8, 9, 10, whereas, the costal pieces of the dorsal vertebræ, marked serially from a to e, pass into the serial pieces marked from f to k, and also to l of the sacral form.

The fact, therefore, which we seek to establish in this place is, that the processes named by the human anatomist "transverse" in the lumbar spine, are not homologous with the processes so named in the dorsal spine. In fig. B the piece marked h is not homologue of the piece marked 3, but the piece 3 is the homologue of the piece 8: and the piece marked c is homologue of the piece marked h. The serial order of the elementary pieces indicate the serial homologues. The serial order of dorsal transverse processes and lumbar tubercles, together with the fact that these processes are in genetic formation exogenous, proves them to be homologous. In the same way the serial order of the thoracic costal pieces c, d, e, and the autogenous lumbar projections f, g, h, i, k, prove themselves to be homologues.

Any two forms of the same series which shall present nucleary pieces equal, as to number and identical as to situation, may be taken as uniform quantities. Thus, in fig. A, by the addition of the costal piece e, to the last dorsal vertebra, we have made it equal to the first lumbar vertebra, which, but for the presence of e in the last dorsal

form, would have no counterpart for its own element, marked *f*. In the same way, as two unequal quantities of series may be equated with each other, so an entire series of plus and minus variation may be rendered continuously uniform with itself. For such is the order of Nature in her law of series and her creation of variety by subtraction from plus quantity, that the adjacent position of minus and plus quantities never fails to discourse of lost quantity, and to describe what is absent from the lesser by the produce of that which is present in the greater.

The parts marked in fig. B, with numerals from 1 to 10, form a linear series, distinct from the series lettered from *a* to *k*, but both orders of series are proper to vertebral quantities, and form two uninterrupted lines running parallel to each other. This is a fact which we should chronicle in the memory, and one which nomenclature cannot render awry, even though we confuse ourselves with the names costa, tubercles, and transverse processes, which special anatomy * makes use of, to the disturbance of the ideas of the order of natural and uniform series. 'Tis true that a dorsal exogenous process, such as 2, fig. B, is transversely placed, like a lumbar autogenous process, marked *h*, but it is not true that the one piece is homologous to the other, either as to serial position or original growth, and this is an objection which cannot be made respecting the comparison of *h* with any of those serial pieces standing in order with itself from *a* to *k*, for these are all identical elements. To surgery this distinction observable between the processes usually named "transverse" in the dorsal and lumbar spine may be of as little moment as it will be to the veterinarian when descriptive anatomy shall have to track in the neighbourhood of the lumbar spine of man or horse the course of a gunshot wound, but nevertheless comparative science † is not thus careless of the distinction which is always required rigorously to be drawn between forms which in no wise relate to each other.

* A reference made to any work written on Human Osteology will shew that the point of transition from dorsal to cervical series above, and from dorsal to lumbar series below, is that whereat nomenclature confuses the ideas and interferes with the strict identification of homologous structures.

† Equivocal nomenclature in comparative anatomy has called forth the following remark : " Cette methode peut être convenable à ceux qui traitent uniquement de cheval ; mais elle entrainerait des inconvenients en histoire naturelle lorsqu'on voudrait comparer tous les animaux les uns aux autres et les rapporter à l'homme."—*Daubenton, Description de Cheval* (tome iv., page 338).
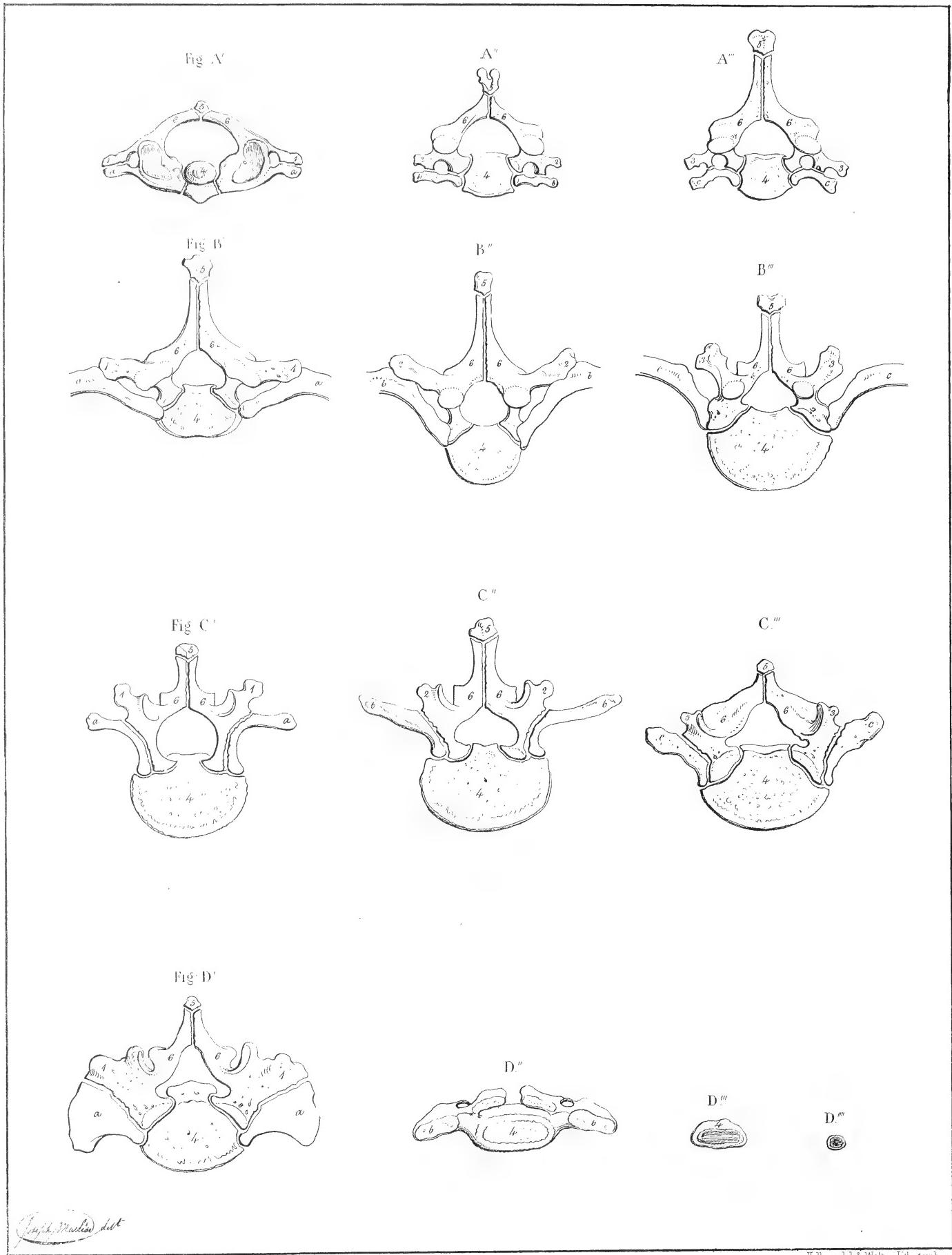
Plate 6.

Fig A'

A"

A'''

Fig B'

B"

B'''

Fig C'

C"

C'''

Fig D'

D"

D'''

D''''

REMARKS ON THE FIGURES OF PLATE VI.

VERTEBRÆ OF THE SAME CLASS IN SERIES ARE COMPARED AMONG THEMSELVES.

THOSE several classes of vertebræ which are named cervical, dorsal, lumbar, sacral, and terminal, do not present greater varieties of cast, compared to one another, than may be seen to characterise the several vertebræ of one class. That peculiarity of design which requires us to distinguish a lumbar vertebra from a dorsal vertebra, or this latter from a cervical vertebra, is not greater than that which exists between two or more vertebræ of the cervical order, between two of the dorsal, the lumbar, or sacral series. And hence if we are to acknowledge the reason why vertebræ of the several regions of one series should be classified as positive distinctnesses, the like reason for classification occurs for any two vertebræ in any one class. It is true, however, that all the vertebræ of series constitute a whole and uninterrupted design so far as their elementary parts are identical in one and all. Even where the series terminates at the caudex, we still read in that minus quantity the facts of similarity.

Slight transitional modifications of form are observable between vertebræ of the same class, but still their elemental pieces remain the same.

In figs. A'A''A''' we represent cervical vertebræ of the human spine. Fig. A' is the atlas or first spinal unit succeeding the occiput, and although it presents itself somewhat dissimilar to fig. A'' the 4th cervical vertebræ, and to fig. A''' the 7th cervical unit, yet still the same elements are to be found in all three. The modification between them is principally owing to the greater or lesser development of one or other of their elemental parts. In fig. A' the atlas, that part of the centrum or body marked 4, becomes soldered to the axis vertebra, and forms for it the process named odontoid. This is one of those extraordinary metamorphoses in furtherance of mechanical fitness which everywhere in organic nature turns the mind to marvel at the design and the simple means by which such design has resulted.

The figs. B'B''B''' are dorsal vertebræ rendered equal to the cervical forms by the presence of the costal elements a b and c, which mark the homologous parts in the cervical vertebræ also. Fig. B' is the first thoracic or dorsal vertebra. Fig. B'' is the 7th and fig. B''' the 12th of the thoracic series. Similar figures indicate the homologous elements of each of these dorsal vertebræ, and of each of those of the cervical order.

The figs. C'C''C''' are vertebræ of the lumbar class, and manifest parts similar to those found in the dorsal and cervical order.

In figs. D'D''D'''D'''' we see the graduated proportional metamorphoses of vertebræ of the sacral class. Fig. D' is homologous with figs. C'B' and A', but when compared with figs. D''D'''D'''', an instance of where subtraction from plus quantity creates the minus proportionals, is rendered evident.

Still the order of metamorphoses is so carried out that the last caudal nodule 4, fig. D'''', refers to no other part of any other spinal vertebra than the centrums marked 4.

Similar figures mark similar parts in the homologous forms A'B'C' and D', and it is also to be observed of all those figures, viewed comparatively, that whatever be their apparent modifications, still those modifications are happening under no other rule of development than that of the plus rendered minus. Fig. D'''' is a minus proportional of fig. D''', this is minus proportional of fig. D'', and this is minus proportional of fig. D', the first sacral vertebra. Hence fig. D' being equal to figs. C' or B' or A', leaves it to be inferred that figs. D''D'''D'''' are graduated proportionals struck out of archetype quantities equal to any vertebra of series. And whilst we assert thus much of fig. D'''', we believe that it is as much within the rule of reason as if on view of a column's capital cast separate and apart, we still named it to be a thing designedly related to a whole or column.

We have remarked that there occur, even amongst the vertebræ of any one class in series, such modifications of primitive samenesses as allow the word *species* to be applied to them as rightfully as between two vertebræ of separate classes. The atlas vertebra is as distinct a species of structural design from what the seventh cervical vertebra presents, as this latter is from a dorsal or lumbar figure. If this be a just remark, why therefore is it that we designate under a common name things of distinct designs, such as an atlas, an axis, and a seventh cervical

vertebra, and yet assent to name a dorsal, or lumbar, or sacral structure, as being things of separate orders, when in fact they are no more dissimilar to each other than forms which appear in one and the same order? But it is plain that if ever we are to interpret the law of species, it must be by first understanding the law of form, and so it would appear, for even though we wearied patience in comparing figs. A, B, C, and D, as distinct species, we can never penetrate deeper than the word "species" * or distinctiveness. But, on the other hand, when we at once acknowledge to the structural uniformity of figs. A, B, C, D, in so far as their elements are the same, then it is that we recognise the essential meaning of special variety which adapts A for one part of series, B for another, C and D for other localities, whereas at the same time all four make up the continuity of the spinal series.

When we compare variety to standard uniformity, we then can best appreciate variety or species, and so arrive at some goal or terminus. But the comparison of species to species is an interminable labour, and after all leaves no result but species or variety. In this respect a serial skeleton axis constituted of vertebral homologues which still manifest characters of special modification, may be regarded as a subject comparable to that of a serial animal kingdom, where uniformity is veiled by the infinitude of special metamorphoses. It is impossible to draw the differential line between the analogies and varieties of figs. A, B, C, D, and for this reason, viz., that analogy is plus, positive, and created quantity; whereas variety is minus, negative, and subtracted quantity. It is creation and non-creation, or presence and absence. It is fig. A''' compared with fig. D'''', the greater compared to the lesser.

* " Rien de plus fautif, que la distinction des espèces, fondée sur des caractères aussi inconstantes qu' accidentels."—*Buffon—Oiseaux*, tome 1, page 70.
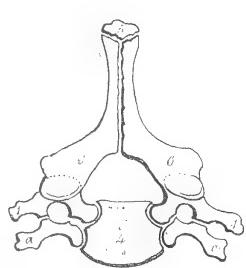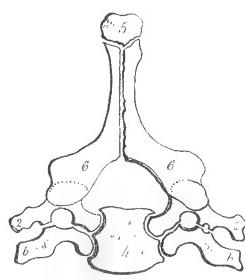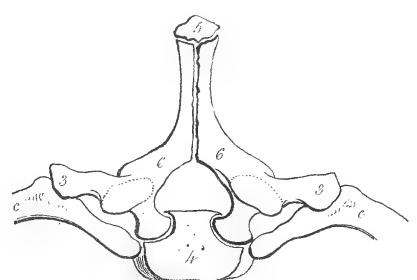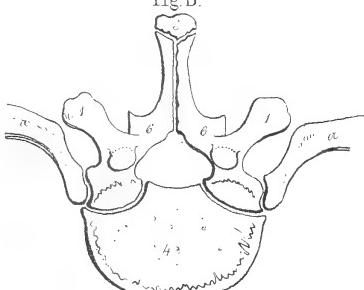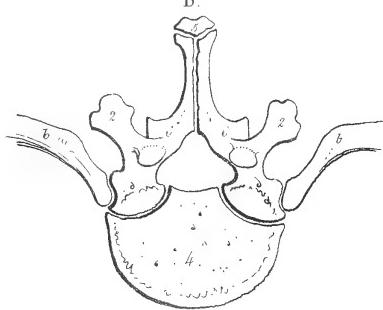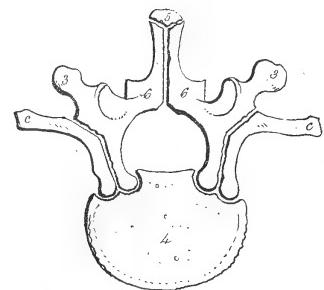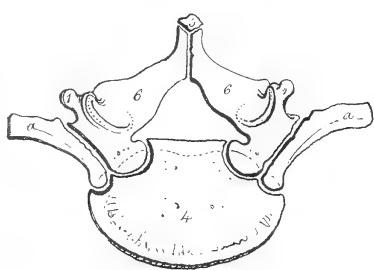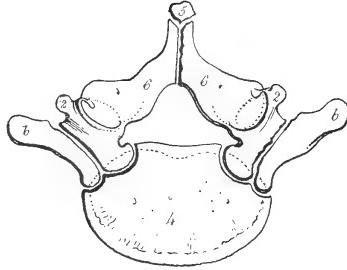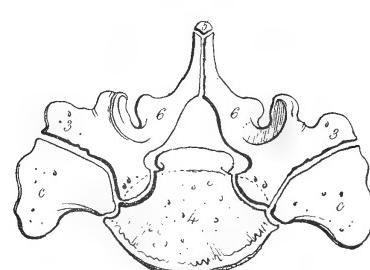
Plate 7.

Fig: A′.

A″.

A‴.

Fig: B′.

B″.

B‴.

Fig: C′.

C″.

C‴.

Fig: D′.

D″.

D‴.

D″″.

REMARKS ON THE FIGURES OF PLATE VII.

VERTEBRÆ OF TRANSITION ARE COMPARED TO EACH OTHER.

THE several classes of Vertebræ standing in series are linked together by vertebral forms which are of equivocal character, that is to say, of a caste which may be as well classed with one as with the other of those vertebræ which they enchain together. The last cervical vertebra simulates the form of the first dorsal. The last dorsal vertebra partakes of the character of the first lumbar, and the last lumbar nearly represents the form of the first sacral vertebra. The spinal axis, viewed as a whole, gives example of an uninterrupted series of individual vertebræ, and in it we also find that there exists a series of vertebral classes successionally arranged, such as the cervical, dorsal, lumbar, sacral, and terminal figures. Individual vertebræ are seen to stand in continuous order, from first to last, through series; and so in like manner do we find that individual vertebral classes hold serial order with each other, hiatus appearing nowhere. Absolute variety, therefore, does nowhere exist amongst serial forms which are developed as one connected entity. And as this is the condition of a spinal axis, it must follow that uniformity is a positive condition of growth, attaching to this particular at least. Graduated modification of primitive uniformity is the characteristic of the vertebral line.

Transitional vertebræ stand between those of the cervical and dorsal classes, between those of the dorsal and lumbar classes, and between those of the lumbar and sacral classes. Those vertebral forms which succeed the first sacral vertebra are graduatedly proportioned down to the quantity of the last caudal bone.

Fig. A′ is the 6th cervical vertebra. Fig. A″ is the 7th, and fig. A‴ is the 1st dorsal vertebra. In these three forms we mark a slight transitional modification, but whilst their elemental parts are the same, the modification can be no other than such as suits with the mechanical design of each.

Fig. B′ is the 11th dorsal vertebra, fig. B″ is the 12th, and fig. B‴ is the 1st lumbar vertebra. In these we also discover transitional modification, yet the elemental parts are still the same in each, and identical also with those of the cervical class.

In figs. C′C″C‴ we see the transitional variation from the 4th lumbar figure C′, through the 5th lumbar C″, to the first sacral C‴, but still the elemental pieces persist the same in each, and also the same with those of the dorsal and cervical classes of vertebræ.

In fig. D′ we see the 5th sacral form to be a proportional of C‴, the first sacral form, and also that D″ is the proportional of D′, just in the same rule which renders D‴ the proportional of D″, or D⁗ the proportional of D‴.

Between transitional vertebræ the modification of form is almost imperceptible. The cervical units pass into the dorsal units in such slight shades of change that it is impossible to mark the difference anywhere between them. The same may be said of the transition of vertebræ of the dorsal class to those of the lumbar, and the same remark holds good of the passage from lumbar to sacral vertebral formation.

But from sacral figures to caudal forms, the transition takes place from plus quantity to the minus. Some of the elemental structures of a first sacral vertebra are subtracted in order to fashion the last caudal bone; by which we mean that a caudal bone has been metamorphosed from a quantity originally equal to a first sacral figure: and this interpretation is equal to saying that all vertebræ, from the occiput to the terminal caudal fractional, have been originally equals; the rule of subtraction being that which renders them unequal whenever they happen to be so.

It is by the addition of the costal piece to the dorsal vertebra that this quantity has been equated with the cervical or lumbar vertebra. It is by the subtraction of certain elemental parts from the vertebral type thus established in the cervical, dorsal, and lumbar spinal regions, that the small fractional of a caudal bone has been metamorphosed to its own special condition of development. When we say that any form of lesser quantity has been metamorphosed from a plus quantity, we then are obliged to name the plus as archetype of the minus. The vertebra is archetype of the caudal fractional.

Figs. A′ B′ and C′ are equals or homologues. But figs. D′D″D‴D⁗ are the proportionals of such homologues.

When the eye follows the transitional change which Nature exercises upon original serial uniform quantities, such as appear in the spinal axis, the opinion which arises respecting this particular is as follows, viz., that the primitive cast of such a series is uniformity, and that the variety is not absolute, but only as it were resulting by an afterthought for special modification. It is unity itself which undergoes this modification, and thus there cannot happen in the one series any gap or abrupt differencing between form and form. The law of Nature operates in gentle gradations through a serial line. Forms which stand far apart in the same linear arrangement may present examples of almost unallied specialty, and in such distinctiveness as almost to mask the original features of sameness, but nevertheless we find (between two such extremes) the things of transition and easy passage—the things of fluxion, which render series as a oneness, and defy contrast by the imperceptible interchange of character. As it is through the serial line of an animal kingdom, so we find it in the serial line of vertebral quantities.

A single vertebra cannot be isolated from its fellows in series, and pronounced to be absolutely difform to any other quantity of that series. If one vertebra compared to another manifests some modification, and demands therefore the name of *species*, then species is but modification. If, again, an entire class of vertebral quantities compared to another class expresses some condition of modification, and requires therefore to be classified separately, then classification is based upon metamorphosis or modification. And he who would follow organic metamorphosis in quest of the end of that subject of classification according to distinctiveness of animal character, is like one who would seek to isolate a portion of time, or space, or number from all time, all space, and all number.

The vertebræ of transition between classes of vertebræ are like the animals of transition between classes of animals—they connect and enchain forms in one continuous series, and by their own equivocal character they defy all method, and render it an uncertain opinion.* Forms which are created serially within the *animal* cannot admit of classification as things absolutely distinctive. And forms which are developed serially within the abstract *animality* do not permit of classification as things

of absolute dissimilarity. The law of Continuity is creative of those entities which are continuous in a line. And this line, whether it be drawn of vertebral or of animal quantities, is only varied throughout its length by the subtraction from plus form, and is rendered finite by the same process. Thus we have fig. D'''' at the termination, and fig. A'' at the origin of vertebral series, just as we have a polype and an elephant at opposite extremes of the animal series.

The forms of series are cast in the same mould. Vertebræ of the same series give examples of a common analogy. This analogy is so positive a condition of these forms, that it is still evident amongst them even when degradation renders them as unequal things or quantities. The law of serial order compels us to name even things of unequal quantities under a common title, and thus it happens that we give to figs. A''' B''' C''' and D'''' the general name of vertebræ. But as it cannot be understood that this name " vertebræ " implies equality as to quantity (for no one shall undertake to demonstrate the whole quantity of A''', or B''', or C'', in D''''), and furthermore, as it cannot be denied that fig. D'''' refers to a certain known part of either fig. C''', or B''', or A''', which part is no other than the centrum, so we say that all facts and ideas springing from the comparison of fig. D'''' to any other quantity in serial order with itself, must inevitably draw forth the conclusion that fig. D'''' has been metamorphosed from a quantity equal to the fullest quantity created in the series.

Any series of quantities which form an uninterrupted line, and which vary from one another only by excess and defect, such as vertebræ, may have the phrase *unity of plan* applied to it without implying also a *unity of number* as to the elemental parts persistent for each form. And hence those forms of series which manifest no other variety amongst themselves than that of quantity, cannot be said to vary from serial uniformity otherwise than by quantity. Any classification of such forms must therefore be according to the differential quantities between them. But as this quantity may vary from plus amount to a microscopic molecule, or even a thing of lesser bulk, so will we for ever find that classification based upon the differential law is a subject without end.

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* Transition-figures occurring between two classes of a continued chain of forms, have called forth the following remark, viz., " Toutes les espèces qui occupent les régions *d'inflexion* et de retroussement devant être *équivoques* et douées de caractères qui se rapportent également aux espèces voisines. Il est même convenable à l'ordre de la nature qu'il y en ait."—*Lettres de Leibnitz.*
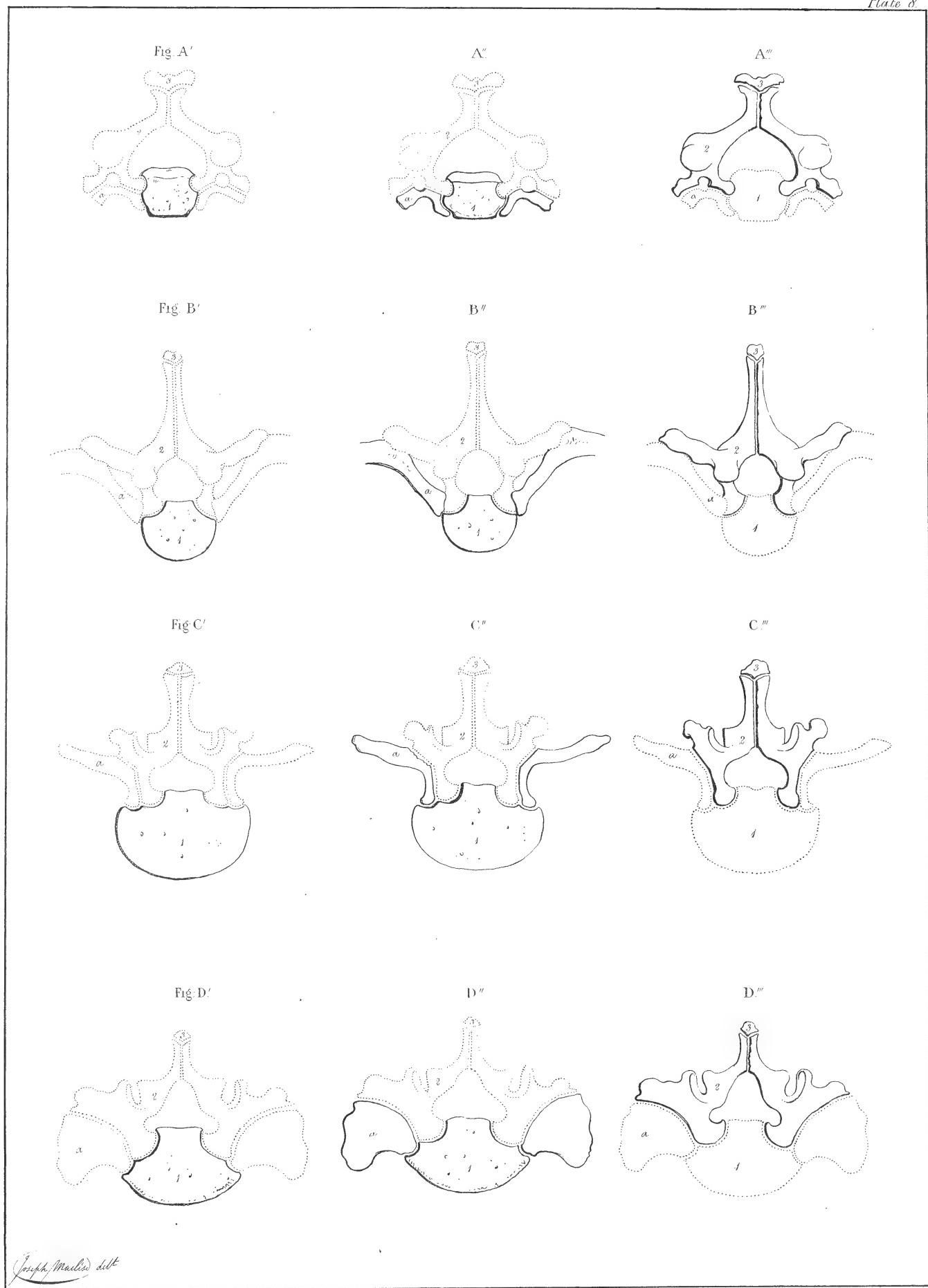
Plate 8.

Fig. A'

A''

A'''

Fig. B'

B''

B'''

Fig C'

C''

C'''

Fig. D'

D''

D'''

REMARKS ON THE FIGURES OF PLATE VIII.

EQUAL AND UNEQUAL QUANTITIES ARE SUBTRACTED FROM EQUAL VERTEBRAL QUANTITIES.

IF from equal things we take away equal or unequal things respectively, the remainders will be equal or unequal, as the case may be. This observation applies to any known quantity and its equals, as well as to the vertebral figure and its homologues. The repetition of a quantity, whether of form or number, is tantamount to the creation of homologues for the one, and equals for the other; and so the words homology and equality may be applied to the repetitions of either a number or a form. Thus, the repetition of the integer 9 is 9 *ad infinitum*; and the repetition of a cubic, a triangular, or a circular form, is a cube, a triangle, or a circle *ad infinitum*. In like manner, the repetition of a vertebra is, in the hands of Nature, the creation of vertebræ all through the serial line, however long it may be. Now, it also happens, that the subtraction of an equal or unequal quantity, whether it be from an integral number, a cube, triangle, circle, or vertebra, will leave behind equals or unequals of any of those several forms or quantities. But it also occurs, that, in the very act of subtraction from a whole or integer which we already know, and in the act of rendering it unequal or various to itself by the loss of parts, we leave, within the memory, an idea of that quantity which *was* proper to the whole; and so, whether it be an equal or an unequal quantity which we *now* view remaining, we still associate it with the full quantity or the archetype. When we have once seen a whole quantity, then any of its parts, occurring separately, will invariably create the idea of that whole figure.

The subtraction of elemental parts from archetype quantities is a process identical with the metamorphosis of such quantities, and both processes produce the same results.

The dotted outlines of the opposite figures indicate those elemental parts of the vertebral archetypes which have been subtracted or metamorphosed. The persistent elements of those vertebral archetypes are indicated by the firm outline.

In fig. A′, the cervical vertebra, all parts are omitted except the centrum 1. Figs. B′ and C′ and D′, which are the dorsal, lumbar, and sacral forms, have the like parts omitted, the centrums marked 1 alone remaining.

Figs. A″ B″ C″ and D″ are cervical, dorsal, lumbar, and sacral vertebræ, whose parts have all been metamorphosed except the centrum 1, and the lateral autogenous pieces *a*.

Figs. A‴ B‴ C‴ and D‴ are cervical, dorsal, lumbar, and sacral vertebræ, whose elemental parts have been all omitted except the lateral pieces 2 of the neural arch, and the spinous process 3.

The object which we have had in view, when drawing those figures, was to prove that the elemental pieces of vertebræ, when persistent, always appear in their own proper position, and thereby clearly indicate the parts which have been subtracted. Also, that when we regard any one element of any of those vertebræ, whether it be a centrum, a neural arch, a lateral process, or a spinous process, we invariably conjure up, in idea, the completed vertebral archetype.

In fig. A′ the centrum 1, although the other parts are annihilated, invariably names itself to be the centrum of a vertebræ.

In fig. A″, where we see the centrum 1 and the autogenous pieces *a* of the transverse processes to persist, whilst all other parts are wanting, still those persistent elements speak of the vertebral type.

In fig. A‴ where the neural arch 2 with its exogenous processes and the spinous element 3 alone persist, still they indicate the archetype quantity of which they are the fractionals. The same remarks may be applied to all the other figures marked B, C, and D.

The persistent elements *a* and 1 of the vertebral figure marked A″ speak of the subtracted elements 2 and 3 of that same vertebral quantity. The fractional refers to its integer, the part to the whole.

In the figs. marked A′ A″ A‴ let us suppose that the several elemental pieces indicated by the dotted outline were

absolutely annihilated, and that the different remaining elements of these three vertebræ were sufficient to fashion one complete figure; this figure would then be no other than the original archetype. If, for example, we add the pieces a and 1 of fig. A″ to the pieces 2 and 3 of fig. A‴, we would then create the very archetype quantity to which the pieces a and 1 of fig A″ refer.

Whatever be the elemental parts which are understood to be metamorphosed from the figure of the vertebral archetype, still we invariably find that the persistent elements happen in their own proper place, and holding serial order with their own homologous elements. If all pieces of the vertebral quantity be metamorphosed except the centrum, this element holds series with all the other centrums. If it be the spinous process which alone persists, this process still holds serial order with the like parts and with no others.

The degradation of form, by the natural process of metamorphosis or subtraction of quantity, is that theme which comparative science has always had before its contemplation. Even when it appears to have mistaken or forgotten its prime regard of this theme, still, all its reasonings have been instinctively based and generated upon it, and have tended to no other end than the acknowledgment of it. The unity under metamorphosis is a subject long since openly avowed; and we shall find, even if it have not been understood, that unity, like a whole quantity, is that which has undergone subtraction for the creation of things proportionally various to itself; still, that the observation and chronicle of every isolated anatomical fact, now constituting a multitudinous mass, indicates to-day, that something which is called unity is presented to the observation in a broken and disjointed shape. Comparative osteology is an amassment of observances of separated things which admit of readjustment, for the creation of the figure of unity; but it is not by a continuance in the description of any of the separate parts of this thing of unity or entirety that we can ever hope to advance beyond the science of the following sentence :—"Farther still, they also differ in multitude and paucity, in magnitude and parvitude, and, in short, in excess and defect." * In this observation is contained the whole subject of comparative osteology.

Things which differ only in multitude compared to paucity, in magnitude compared to parvitude, and in excess compared to defect, speak the truth, that the subtraction from multitude leaves behind paucity, that the subtraction from magnitude leaves parvitude, and that the subtraction from excess leaves behind defect: hence, if we must come to the conclusion, that one skeleton quantity differs from another only as excess differs from defect, it is also evident, that, as we cannot demonstrate the quantity of excess in the quantity characterised by defect, so must we turn the rule of comparison to teach us how much quantity is lost to the thing of defect, and this we can plainly demonstrate by comparing it with the thing of excess. Thus, as $a-b$, compared to $a+b$, tells that b is the quantity lost to the former, so will fig. A′ minus the parts 3, 2, a, teach us, (when we compare it with a cervical vertebra, which is plus 3, 2, a,) that 3, 2, a, is the lost quantity. And the knowledge of how much quantity is lost to any figure, is as real as the knowledge of that same quantity seen to exist in another figure.

Now, from this it follows, that if natural subtraction of parts from unity or the whole quantity is that process by which Nature varies uniformity to itself, and also, that if it be possible to imitate the natural process by one of our own mechanical acts of withdrawing quantity from plus and rendering it minus or various, then the opinion arises that *variety is equal to nothing*, that is to say, variety is consequent upon subtracted or annihilated quantity; whereas, on the contrary, *uniformity is an ens*, which, whether it remain in full condition or only in part, still finds something in series like itself. Thus, if fig. A′ persists complete in all its parts, it is repeated by the homologue fig. A″ through series, or even if fig. A′ be metamorphosed to the part marked 1, its centrum, still this part is again represented in fig. A″, or the homologues of A″ throughout series. We have shown that a cervical, dorsal, lumbar, and sacral vertebra are equals, and homologous to each other, and also, that even a caudal centrum and a cervical centrum reciprocally represent each other, hence causing us to interpret that Nature has metamorphosed the former from a quantity similar to that of a cervical form, which we ourselves might mechanically metamorphose to a caudal proportional, for it is evident that fig. A′ minus 3, 2, a, would then equal a caudal nodule; *ergo*, this latter quantity, plus 3, 2, a, would equal, &c., &c. Such is the inference to be drawn from a comparison of plus and minus quantities in series.

* Aristotle, *History of Animals*, Book i., p. 4.

Plate 9.

Fig: A′.   A″.   A‴.

Fig: B′.   B″.   B‴.

Fig: C′.   C″.   C‴.

Fig: D′.   D″.   D‴.

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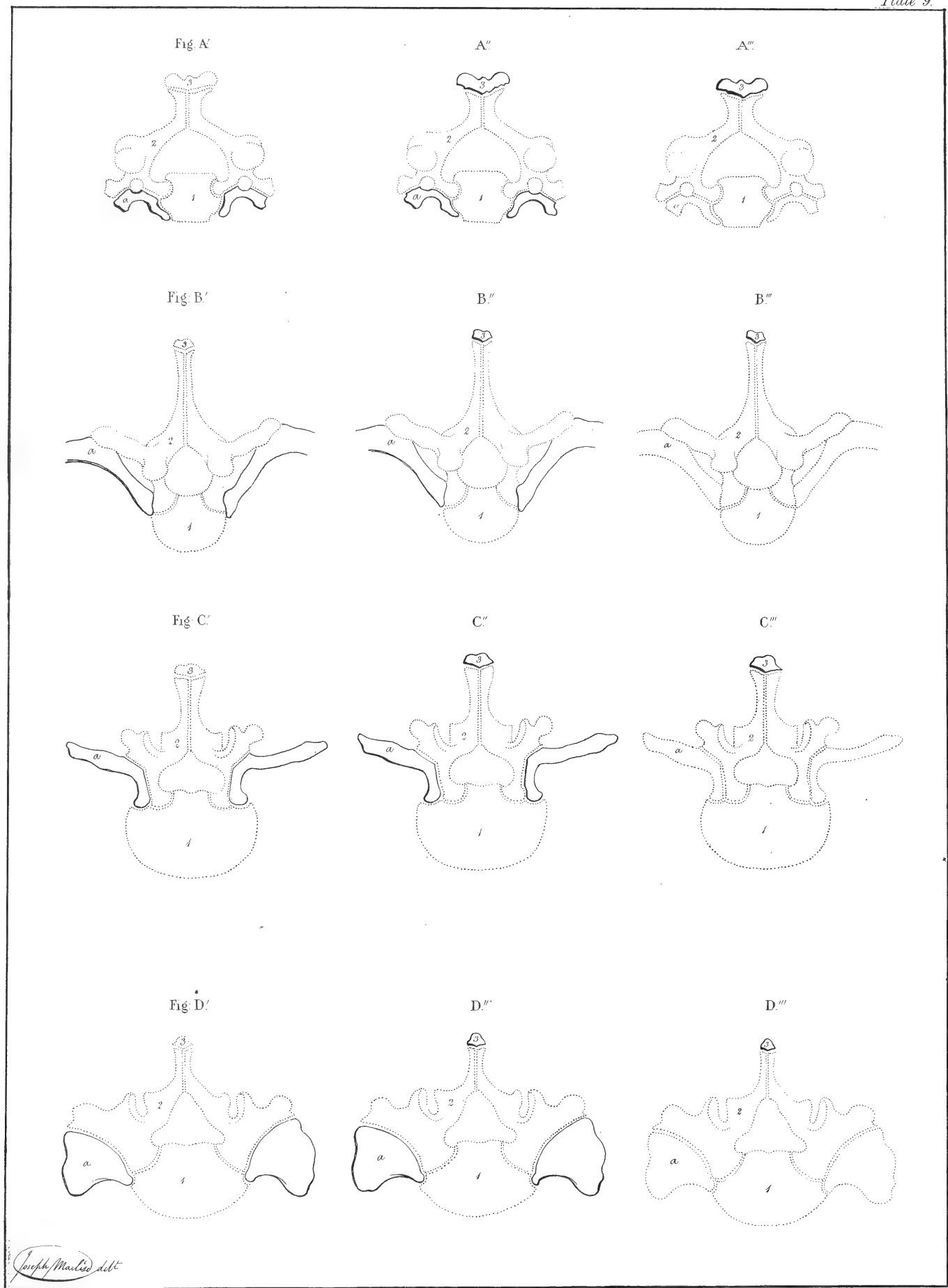
REMARKS ON THE FIGURES OF PLATE IX.

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THE PARTS WHICH ARE PRESENT RELATE OF THE PARTS WHICH ARE ABSENT FROM A WHOLE QUANTITY.

WHEN a comparison is held between two or more separate elementary quantities which we know to belong to a whole quantity, or its like which has suffered metamorphosis, then the object of the comparison must be to create the presence of the whole. Any comparison which shall be held between minus structures, and which shall aim at nothing further than viewing them *as such*, can never create the idea of unity or the archetype plus quantity. We know how possible it is to divide and subdivide any given quantity even to its infinitesimal parts, and we may also know that the comparison of infinitesimals as such will never recreate that quantity of which they are the parts. But, on the contrary, when we acknowledge them to be the *parts of a whole*, then the comparison which shall be made between the parts under this latter idea will always seek to re-adjust those parts in order to re-establish the combined figure of that whole. The knowledge which we already possess of a whole quantity is that by which we invest any separated part with rational interpretation. We call such part the part of a whole quantity with which we are acquainted, and thus it is that the idea of a whole is inseparable from a part of itself. It may indeed be doubted whether the geometrician who draws the segment of a circle can do so without having the attendant idea of the circle. And just in the same way when the anatomist contemplates any part or quantity of an osseous skeleton, it becomes impossible for him to isolate his ideas of it (the part) from the concomitant and spontaneous imaginings of the entirety.

When at length we have discovered the character and proportions of the archetype or whole quantity, then it is that we learn to express clearly the character of the parts separately persistent. The part refers to the whole design, or, if it does not, then we know nothing of design.

The autogenous element, *a*, of fig. A′, speaks of the metamorphosed elements 1, 2, 3, and thereby completes the idea of the vertebral form. This remark also applies to fig. B′, the dorsal vertebra, and to figs. C′ and D′, the lumbar and sacral forms.

The autogenous element *a*, and the spinous element 3 of fig. A″, refer to the lost elements 1 and 2 of the cervical vertebral form. The same remark applies to figs. B″ C″ and D″, the dorsal, lumbar, and sacral vertebræ.

Even the spinous element standing alone, as at fig. A‴, tells of the vertebral archetype and of the lost quantities 1, 2, *a*, of that whole form. This may also be said of the figs. B‴ C‴ and D‴, which are the dorsal, lumbar, and sacral vertebræ.

For it is evident that we can know nothing rational of the part if we do not know the complete figure of which it is the part.

Any persistent element of the vertebral whole refers to that whole, and creates the idea of it as clearly as if the whole itself remained persistent and complete. This is evident, for if we name the part 3 of fig. A‴ to be the spinous process of a cervical vertebra, then we refer to the character of such a vertebra, and in idea we add the lost parts 1, 2, *a*, to the persistent part 3, and so establish the idea of the whole quantity.

The law of series, which gives order to the vertebral units, all of which persist complete as to their elemental parts, still holds in an invariable order of series the several persistent elements left after the metamorphoses of all others. If, for example, we find that one complete vertebra is succeeded in any region of the series by a metamorphosed vertebra, then the elemental parts of the latter form which do persist are seen to hold series with their homologous elements in the complete form; and it is by the observation of this fact that we are enabled to tell how much has been subtracted from the metamorphosed form. If between any two vertebræ of the spinal series we discover an interval which had been once occupied by a third vertebra, and that no other element

of this lost form persisted except the spinous process, then this process still holds serial order with the spinous process before and behind it, and thus it is that we are enabled to call it the spine of a lost vertebra, such as the one before and after the interval.

Metamorphosis does not change the order or position of the vertebral elements. Whatever part of a vertebra remains after metamorphosis or the subtraction of vertebral elements, that part holds still the same position as it did when the form was complete. Whether the persistent part be the spinous process or the centrum, it still holds series with spinous processes and centrums. If all parts of fig. B″ were lost except the costal piece *a*, and the spinous element 3, still we find that *a* holds series with the part marked *a* in all the other vertebræ of series, and 3 with the parts marked 3.

The comparison of minus and plus quantities of the same serial order becomes a creator, if not of the thing, at least of the idea of that thing or quantity which is absent from the minus figure, for we find it represented in the plus form adjacently created. And thus it is that by the rule of comparison we are enabled to read the design of Nature, creative of a fitness in form as well by the omission of elemental quantity from one figure, as by the production of the like quantity for another figure. In organic nature we discover everywhere the manifestation of fitnesses and design, operated by the positive and the negative of some original quantity proper to archetype unity. And whenever we fully appreciate the passages of this law of creation, we do so by giving play to the ideas between the quantities present and absent. If, for example, the anatomist shall chance to find, on the topmost empyreal peak of the Himalayan mountain-chain, the human bone called astragalus, the ideas associated with this osseous quantity at once tells of its relationary parts absent; and these ideas make for him the abstract and combined prefigurement of the whole skeleton structure to which it must have belonged.* Comparison thus creates the idea of the thing absent as lucidly as if it were present and impressed his vision with its actuality. His knowledge of the part is real only in so far as it is attended by his knowledge of the whole design of a human figure: this next becomes representative of all its created homologues, and these of the graduated chain of animal being in which all anatomical structure of the same order and kind is varied only as minus is to plus.

The tusk of a mastodon and the canine tooth of a leopard vary as magnitude and parvitude. The heart of a leviathan and that of a mole vary only as excess and defect.
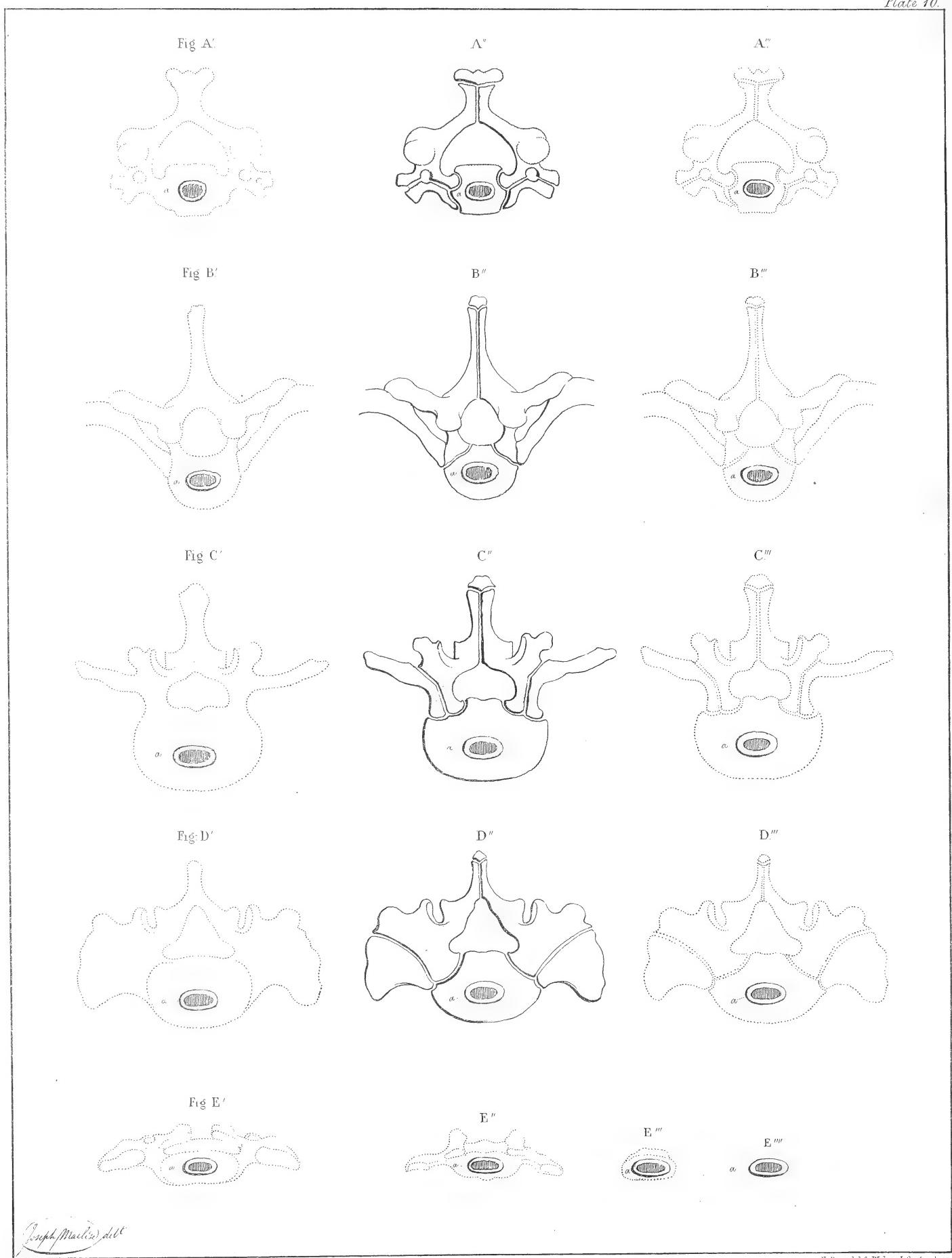
Quantities various as to excess and defect characterise the osseous skeleton axis also. These quantities, such as they are, stand in a serial order; and it is this law of series which invites the anatomist not only to appreciate the present and already created design, but to pass deeper into the ways of Nature, and know of the process by which such design has resulted.

The plus quantity, compared with the minus quantity, is equal to the comparison of the thing present with the thing absent; and it is in such a reading that the comparative reasoner may be said to people space or void. For if it be the fact that comparison teaches of the quantity which is actually lost to any minus figure of series by finding, actually created, the like quantity in another plus figure of the same series, then we say that the idea of the quantity absent is tantamount to the idea of the quantity present; and so, between creation and non-creation, or addition and subtraction of similar quantities, we read the design of Nature. We know, for example, that one form in series is a fitness by the absence of those parts which, being present for another form of the same series, make it a fitness also.

The subtraction from plus skeleton quantity as performed by our own act, and the subtraction as taking place by the act of Nature, has this remarkable difference between them, viz., that the former is productive of nothing except the mere loss of quantity; whereas the latter teems with an absolute beauty and perfection from the very fact of rendering the whole quantity imperfect as a whole. If we subtract from fig. A‴, in series, all its parts except 3, the spinous process, we know that a fitness as to form will not hence result, although we retain the idea of the quantity thus lost to the whole. But when, from such a whole, Nature subtracts a quantity and leaves a caudal proportional of the original figure still persistent, then we know that the absence of quantity has become the presence of design, this design being still (according to the rule of comparison) creative of the knowledge of how much quantity has been lost to the same. The comparison held between the lesser and the greater figure in series balances the ideas between that quantity which is absent to the former, and the like quantity which is present to the latter; and this in itself is like an equation.

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* If we consider the skeleton figure merely as an osseous whole quantity constituted of elementary parts, we shall find that any one of such elements occurring separate, will as potently refer itself to the lost entirety or whole, as that fragment of a skeleton which in the hands of Cuvier led him to the reconstruction of a lost species. The idea which associates a piece of a skeleton to the exact species to which it may have belonged, is a much more complex idea than that which refers any separated piece of a skeleton to some entire figure without regard to the species of such entirety. To understand that an astragalus must have belonged to some full skeleton quantity, is a simpler mental operation than to determine the species of such a skeleton. It is in illustration of the former idea that we apply the following sentence :—" Tout être organise forme un ensemble, un système unique et clos, dont les parties se correspondent mutuellement,"—" et par conséquent chacune d'elles, prise séparément, indique et donne toutes les autres."—See Cuvier, *Discours sur les Révolutions de la Surface du Globe.*

Plate 10.

Fig A′. A″. A‴.

Fig B′. B″. B‴.

Fig C′. C″. C‴.

Fig D′. D″. D‴.

Fig E′. E″. E‴. E‴′.

Joseph Maclise delt.

Hullmandel & Walton Lithographers

London Taylor & Walton, Upper Gower Street.

REMARKS ON THE FIGURES OF PLATE X.

THE MINUS PROPORTIONAL IS REFERRED TO THE PLUS QUANTITIES OF THE SAME SERIAL ORDER.

THE comparison of two minus quantities, even though they be homologous elements, will teach nothing further than that they are identical. But the comparison of a minus quantity with a plus archetype invariably points to the law of their difference as to quantity. When we subtract eight from the integer nine, as thus, $9 - 8$, we find the remainder to be 1, and so $9 - 8 = 1$. Now this remainder one can be considered in two different modes: first, we may regard it as an irrelationary quantity; secondly, as a quantity which relates to an integer. When we say $9 - 8 = 1$, it is the same as saying that one is a fractional quantity of the integer nine, and thus it relates to nine. For reciprocally as $9 - 8 = 1$, so $1 + 8 = 9$; thus one is a fractional of the quantity nine: and it is in this way that we here design to consider it. The comparison of the quantity one with such another quantity produces only the idea of equality. One added to one makes two, $1 + 1 = 2$, and one subtracted from one leaves nothing, $1 - 1 = 0$. But the comparison of one with the integer nine creates the idea that the latter quantity is plus eight to the former, and consequently that the former is minus eight to the latter; consequently, also, that one is now a quantity isolated and per se, because eight units have been subtracted from the integer nine. It is thus that minus may be compared to plus, in the quantities taking serial order for the spinal axis.

When we have once seen the figure of an archetype or entirety, we then never fail, when meeting with any single element left remaining after the metamorphosis of that archetype, to know the full form to which such element refers.

We have seen already that all vertebræ of series, reckoning from the occiput to the first sacral form, present the same elemental structures; and consequently that, notwithstanding some slight transitional modifications, those vertebræ were absolutely homologous. Thus A″, the cervical vertebra, is homologous with B‴, or with C″, or with D″, which is the same as saying that D″ C″ B‴ and A″ were all identical with each other.

Now it is very easy to understand, that if fitness demanded the modification or metamorphosis of any of those forms A″B″C″ or D″, it could obliterate one or more or all of their elemental structures, leaving either similar elements, persisting from each, or dissimilar elements of each. All may be homologously metamorphosed to the spinous processes, or the centrums; or else the spinous process of one, the centrum of another, the neural arch of another, or the autogenous costal process of another, may be the only element left remaining after metamorphosis. We know, then, that since the part speaks of the whole, so any one of those elements proper to the vertebral whole or archetype must refer to that archetype and to no other figure.

We say, therefore, that even though the form A″ suffered metamorphosis in all its parts, down to the nucleary piece, marked a, of its centrum, such a piece, whilst still holding series with all other centrums of the vertebral range, must refer to the vertebral archetype from which it has been metamorphosed. If A″ can suffer metamorphosis down to the nucleus a, so likewise can B″ or C″ or D″.

The form marked E‴″ is the last caudal ossicle, and it is seen to hold series with all the centrums of all the vertebræ; consequently, if we here interpret it as a form reduced or metamorphosed from a vertebral archetype which was the exact counterpart of any other vertebra of series, then we believe that there can be no objection to the reading thus given of it.

No one will hesitate for a moment in comparing E‴″, the ultimate caudal bone, with E‴, the penultimate caudal form, and wherefore, then, should any one object to comparing it with E″, with E′, with D″C″B″ or A″. If E‴″ be reasonably interpreted as a proportional of E‴, so may it also be named the proportional of such a form as E″, or E′, or D″C″B″ or A″.

Consequently we have referred fig. E‴″ to all the ver-

tebral forms of spinal series, and we have drawn around it the ideal figure of its own archetype quantity. But we have taken care to locate it in the centrums of all the archetype vertebræ, for it is no other elemental part of such archetype than a centrum. If we called E⁗ the spinous process of a vertebra, we then would evidently have misnamed the form, since it does not hold series with spinous processes.

As the part, therefore, speaks of the whole, as the last caudal bone speaks of the vertebral form, so does the whole series of spinal forms, from occiput to caudex, conjure up in the ideas a serial line of vertebral archetypes.

A series of plus and minus quantities, such as those which fashion the spinal axis, cannot be considered as equals or homologues; but, nevertheless, such is the order of their creation, that they generate the ideas of uniformity when once we admit that it is only degradation or subtraction of quantity which gives rise to the difference between them. We can readily fancy how any plus figure of series may be so degraded or metamorphosed as that it shall equal even the smallest quantity of the same series; and supposing this to have taken place, then a serial line of equal parts, such as the last caudal quantity, would range the whole length from occiput to the caudex. Now the admission of this possibility gives rise to another, viz., that as plus may be subtracted from and rendered minus, so minus may be added to and thus equal plus, however great this latter quantity may be. If this latter were the case, then a serial line of equal or plus parts, such as a vertebra, would range through the animal centre. However, in the created form as it presents itself, we see the fitness of a series of various proportionals, we acknowledge the design as such, but at the same time we understand that the proportionals must be the minus quantities of an uniform plus series.

It is possible for all the serial vertebræ to suffer metamorphosis to quantities equal to fig. E⁗, and in this idea is, as it were, mirrored the accompanying one, that fig. E⁗ may have been so metamorphosed from a plus vertebra equal to figs. D″C″B″ or A″. If the fact of referring fig. E⁗ to fig. D″ be too abrupt a comparison between plus and minus, then let us refer it to fig. E‴, the penultimate caudal centrum next above it, and on perceiving that the differential quantity is but very slight between both these forms, there can be no reasonable objection to our rising through increasing series from fig. E⁗ to fig. E‴; hence to fig. E″, hence to fig. E′, and hence to fig. D″, or any other plus form in series. If there can be no objection to the comparison between the two slightly differenced quantities of figs. E⁗ and E‴, neither can there be objection to the comparison between figs. E⁗

and E″, or E′ or D″. If we can readily grant that it is possible with nature to have metamorphosed the quantity of fig. E⁗ from such a quantity as fig. E‴, what can there be improbable in the assertion that fig. E⁗ may be a proportional of such another quantity as fig. D″? If we here venture to assert this latter reading, and that it is possible for fig. E⁗ to have been metamorphosed * from the ossa or figs. D″C″B″A″, just as it is possible with Nature to "degrade Mount Ossa to a wart," who shall be able to find a mathematical rule in contradiction of the same assertion?

Proportions and progressions are known to be a subject furnishing many theorems of practical utility in the sciences. Anatomical science teems with the beautiful subject, and the application of it to anatomy will no doubt yield some understanding of the law of form.

A series of quantities is said to be in *arithmetic proportion* when every succeeding pair have the same difference as the preceding; thus 1, 3, 4, 6, 9, 11, &c., constitute a series in arithmetic proportion; because 1 and 3, 4 and 6, 9 and 11, have the same common difference, scil. 2. In the same way a, $a + d$, b, $b + d$, c, $c + d$, &c., or a, $a - d$, b, $b - d$, c, $c - d$, are series in arithmetic proportion; because the first pair of terms in each have the same difference, d, as every succeeding pair. If we apply these facts to the interpretation of the serial proportioning of figs. D″E′E″E‴ and E⁗, taken as quantities of osseous structure decreasing from D″ to E⁗, or increasing from E⁗ to D″, we shall find that osteology and the law of skeleton formation will bear a much clearer interpretation than if we continue to draw analogy between fig. E⁗ and the χοκκυξ.

Again, a series of quantities is said to present in *arithmetic progression*, or arithmetic continued proportion, when they individually increase or diminish by a common difference. Thus the digital numbers 1, 2, 3, 4, 5, 6, 7, 8, 9, form a series in arithmetic progression, because the terms increase by the common difference 1. Thus also a, $a + d$, $a + 2d$, $a + 3d$, &c., or a, $a - d$, $a - 2d$, $a - 3d$, &c., are a series in arithmetic progression; the terms of the former increasing, those of the latter diminishing, by the common difference d. Even this definition, if applied to the interpretation of the series of quantities ranging from fig. D″ through figs. E′E″E‴ and E⁗ in decreasing order, or from fig. E⁗ through the others to fig. D″ in increasing order, will yield a clearer understanding of the ways of Nature than may be had from the following definition of her as "Principium et causa motus et ejus in quo est primo per se et non per accidens," according to Aristotle, or else by viewing nature as a blind and inevitable course of necessity, according to the Stoics.

* In the works of Vicq d'Azyr,. we find the dominant idea of a graduated or proportioning degradation of form : he writes, " qu'on observe partout ces deux caractères que la Nature semble avoir imprimés à tous les êtres, celui de la *constance dans le type* et celui de *la variété dans les modifications.*"—See *Mémoire sur le Parallèle des Extrémités*, &c.

Plate II.

Fig. A′. A″ A‴

Fig. B′. B″ B‴

Fig. C′. C″ C‴

Fig. D′. D″ D‴
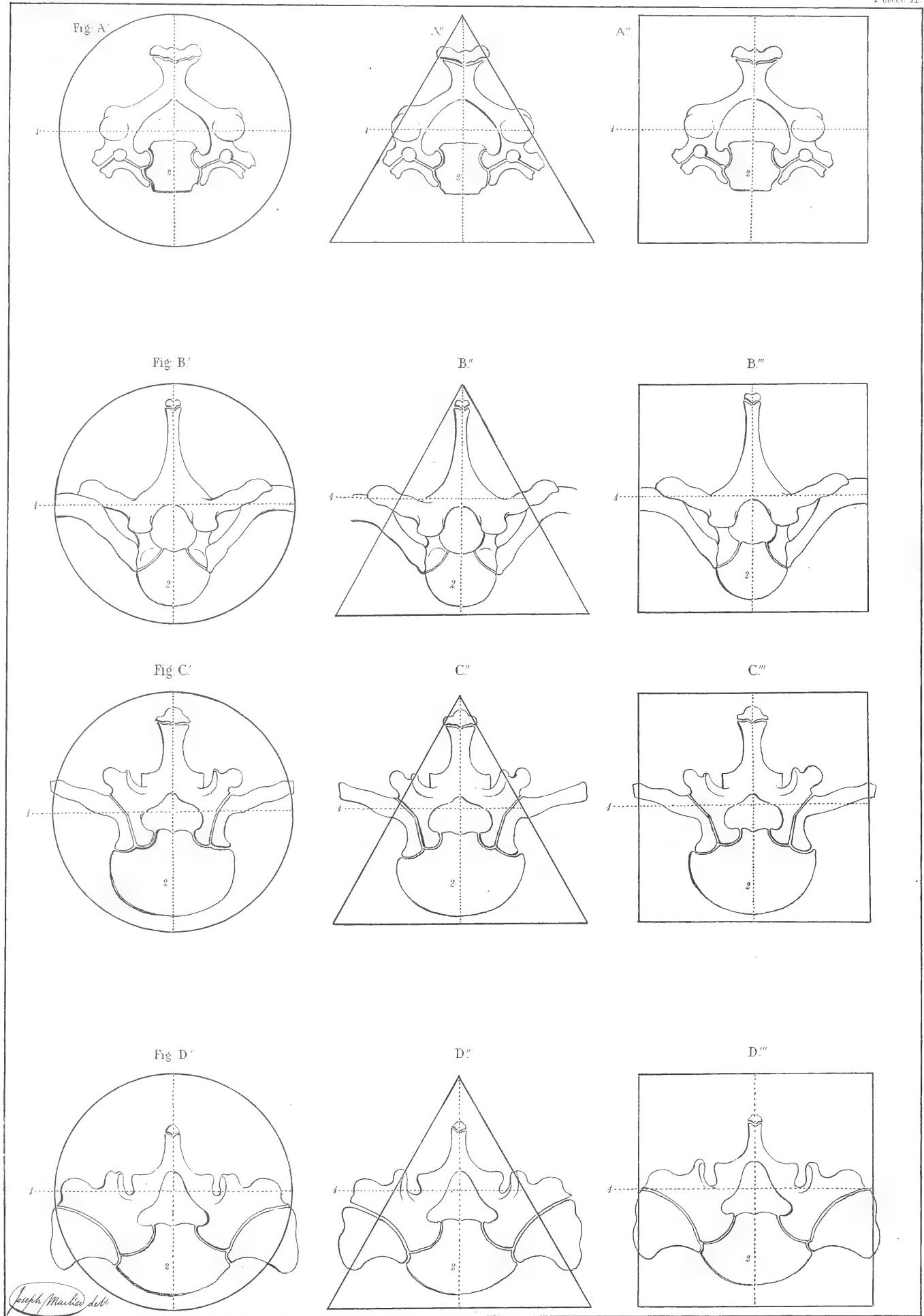
REMARKS ON THE FIGURES OF PLATE XI.

VERTEBRÆ POSSESS A LATERAL BUT NOT AN ANTERO-POSTERIOR SYMMETRY.

WHEN we discover in any forms that character which they do possess, it is this very character present which indicates that the opposite character is absent if it be so. In Nature we always find that qualities of absolute contrast always stand opposite to each other; and thus when we see that a thing possesses but one absolute quality, this in itself expresses that the other absolute quality is not characterising the same ens. When we make use of the word fulness, we mean the opposite to void. When we say that the colour of a body is white, we mean the opposite to black. Day is opposite to night. The positive is opposite to the negative. Matter is not annihilation. Thus it is that opposite qualities or characters of things relate of each other. It is the same with the condition of symmetry, for when we find that any figure manifests this character, we instantly distinguish symmetry from asymmetry, and so the contrast becomes the rule of comparison. Even when a body shows itself to be symmetrically cleavable through one diameter, we seek to know whether it be so through another and opposite diameter. If the thing be bilaterally symmetrically cleft, we then ask the question, whether it be also symmetrically cleavable as to its anterior and posterior faces.

All the vertebræ of spinal series, from occiput to sacrum, are produced of homologous elements. A vertebra of either the cervical class, or the dorsal, lumbar, or sacral form, is therefore the homologue of any one of the series. Any vertebra of any of those classes will, when viewed separately, manifest the character of symmetry, and symmetry is the common character of all vertebral forms.

When we cleave through the median line, the vertebral figure, from the spinous process behind to the centrum in front, the resultant halves will fairly represent each other. The one half is therefore homologous with the other half of the same vertebra. But still further than this, we observe that as all vertebræ present the like number of elemental structures, and as these structures are symmetrically arranged in all, so will the one half of any vertebra of series represent, as to elemental quantity, not only the corresponding half of any other vertebra, but even the opposite half of any other.

In figs. A″B″C″ and D″, which represent cervical, dorsal, lumbar, and sacral forms, we see that the common median line, marked 2, cleaves all those figures symmetrically, and just in the same way as it cleaves all the triangles which enclose those figures.

So likewise in figs. A′B′C′ and D′, surrounded by the circle, we see that the common median line 2 cleaves both circles and vertebræ into equal sides, semicircles and semi-vertebræ being the resulting figures.

The figs. A‴B‴C‴ and D‴, enclosed by the square, and having the median line 2 passing through all forms, both of vertebræ and squares, yield symmetrical sides. This is a common character of vertebral forms and such complete figures as the triangle, circle, and square.

But the vertebra is not symmetrically cleavable by the median line 1, carried through its transverse diameter in any of the opposite figures. Neither is the triangle symmetrically cleft by the same line of cleavage, 1. In this condition of form the vertebra agrees with the triangle.

The median line 2, and the transverse line 1, both cleave the circle and the square into equal sides, and in this particular the forms circle and square differ from the forms vertebra and triangle, and from this it may be concluded that circles and squares have some quality of form which triangles and vertebræ have not.

What is this difference which characterises vertebræ and triangles from circles and squares? It can be no other than this, viz., that both the vertebra and the triangle are minus quantities of some plus archetype figure which is itself cleavable, like the square and circle, from back to front or from side to side, into symmetrical halves.

The vertebral forms, figs. A B C and D, are symmetrically cleavable through their antero-posterior diameter, but they are not thus cleavable through the lateral or transverse diameter.

Symmetry is a law which governs the development of all

organised bodies. The vegetable as well as the animal kingdom manifests the general prevalence of this law, and even where we find some few seeming exceptions to it, still a closer examination of these will prove that each exception may be fairly interpreted as a modification proceeding from no other cause than such as admits of being retraced to the original condition of symmetry.

A perfect figure, such as a sphere, is symmetrical by all lines of cleavage whatever, provided such lines pass through the centre of the sphere. This is also the character of an ovoid figure. But such is not the case with the hemisphere. Neither do we find it to be the character of any of the vertebræ as drawn opposite. The hemisphere is not a full quantity, and hence it fails of that character which is found to attach to the sphere. The vertebræ are not cleavable by all lines passing through the centre of each, and hence perhaps it may be concluded that the vertebræ figs. A B C D are not full quantities.

It is evident from the comparison held between the sphere and the hemisphere, that the first is symmetrical by all lines of sectioning which pass through its centre, mainly on account of its being plus a hemisphere; and also, that the latter is not capable of being thus cleft because of the fact that it is minus a hemisphere, that is to say, while we regard the sphere as unity or a whole. Now may it not also be thought probable that the vertebral quantity fig. B or C, which is laterally but not antero-posteriorly symmetrical, possesses this positive and negative character by reason of its being the minus proportional of some full quantity which may be regarded as unity and a whole.

It will be at once granted that any figure which, like fig. B, is bilateral, and hence symmetrical, may be asymmetrical as to transverse cleavage solely on account of inequality between its anterior and posterior structures. If, therefore, lateral symmetry prevails for fig. B, because a side repeats a side, whereas antero-posterior symmetry is not attending fig. B, because of the back not being a repetition of the front, and knowing as we do that all perfect quantities, or whole structures, are capable of being cleft symmetrically by both modes, we may hence conclude that fig. B, not being thus cleavable, is not a full or whole quantity; nor is it one, in fact, as we shall hereafter discover.

So true is it that the whole organic quantity is always symmetrically* cleavable by transverse as well as by antero-posterior lines passing through the centre, that when we find this character to be absent from the form, we invariably discover that some quantity has been lost to it. This loss of quantity is evidently the means by which Nature plans her designs; but it is long since agreed upon by anatomists, that the unity of form can never be understood by holding a comparison between things considered as functional designs or fitnesses. If a figure be but a half or a less quantity, proportioned so as to be the better operative for some function, still this function need not prevent us considering the form itself independently of any use to which it may be applied. We may acknowledge the fitness of a form which is in itself a minus quantity, and thereby operative in functional fitness, but still we may also know it to be a part of a fuller form whose homologue is existing somewhere in series, and so (considering the form per se and not functionally) we thus isolate the μορφή from its acts. The function constitutes no more a part of the organ the *forma*, than does the name by which we designate it. When forms which evidently manifest *one nature* as to analogy of composition and structure are to be compared, their several functions and names need not here attend them. The body is the ens, and as such is to bear comparison with an homologous ens, notwithstanding the name or sound by which we may choose to difference them. When we are to compare two forms which manifest a common analogy together with a proportional variety, such structures are not to be differenced by either the function or the name, though one of those structures be known as the hand of an ape, and the other as the palm of a dolphin. And in the same way, when we shall examine the law of skeleton formation by the condition of symmetry, we shall do so, regardless, for the time, of either names or functional differences.

* Anatomists have always admired the beautiful law of symmetry which presides over the development of all skeleton formations, however varied these may be as to quantity. The *bilateral symmetry* is that which has struck their attention more forcibly when regarding the skeleton figures. But it is also true that we find in several skeleton axes certain forms which manifest an *antero-posterior* as well as *bilateral symmetry*, a fact to which we shall hereafter call attention. Symmetry, according to Bichat, distinguishes the organs of animal from those of organic life (see *Recherches sur la Vie et la Mort*), whereas the law of symmetry, as described by Flourens, characterises both orders of organs: "La loi générale est la symétrie."—See *Etudes sur les Lois de la Symétrie, &c.*, Mémoires d'Anat. et de Physi. comp., tom. i., p. 1: Paris, 1844.

Plate 12.

Fig A'

A''.

A'''

Fig B'

B''

B'''

Fig C'

C''

C'''

Fig D'

D''

D'''
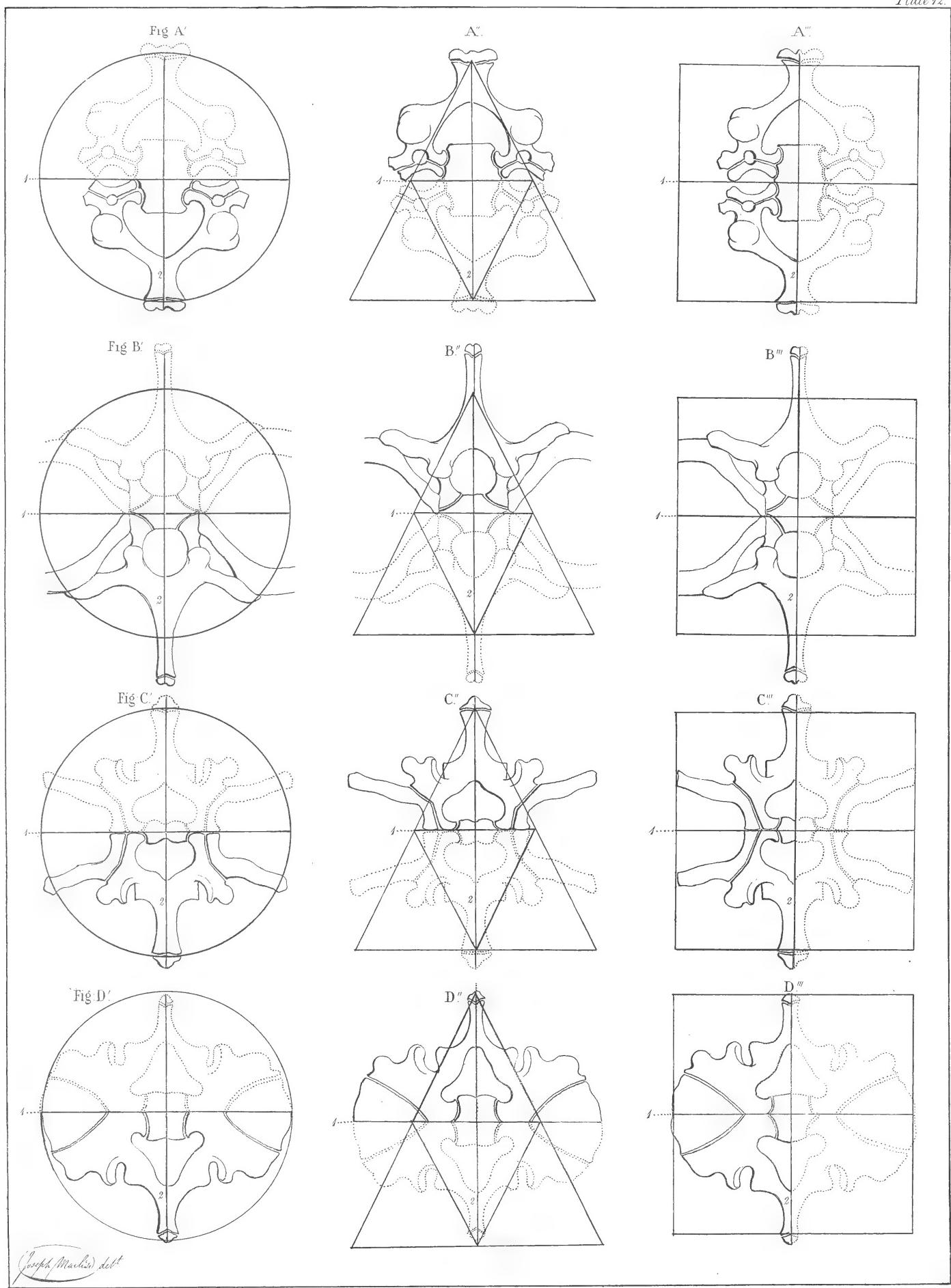
REMARKS ON THE FIGURES OF PLATE XII.

THE DUPLICATION OF A VERTEBRA CREATES A FIGURE OF BILATERAL AND ANTERO-POSTERIOR SYMMETRY.

ORGANISED beings, throughout the entire chain of animate nature, are developed symmetrically. The fossilized animal remains manifest the character of symmetry, and thus we see the law to prevail not only generally through existing nature, but even to have existed through the records of all time past. The duplex or bilateral form is one of self-centering, and the median line which ranges between both sides from end to end of the being, is that place of fluxion where duality becomes the azygos structure. The development of the animal form, from the primitive germinal trace to the adult completion of the process, continuously obeys the law of symmetry, and this so correctly, that a side of the animal represents its opposite in all respects not less truly than the one half of a perfect sphere imitates the other. But though it be the general rule for all animal forms to present in bilateral symmetry, or the absolute homology of sides, we find that symmetry is a character not generally attaching to anterior and posterior faces. The vertebral figure also is thus characterised,—its dorsal face does not always represent its ventral face ; but then, as it is acknowledged that as yet we do not understand the typical or archetype vertebral quantity, so it would be premature and useless either to affirm or deny whether symmetry does or does not manifest itself on all sides or faces of this figure. It is quite evident that antero-posterior symmetry does not characterise the form which they call vertebra in the human skeleton axis, but then there is every reason to believe that this vertebral figure is not a whole quantity, and perhaps it is on this account that it presents to us in bizarre or eccentric shape.

If a part tells of the whole quantity of which it is a part, so will the half still more potently speak of its counterpart ; and thus complete, in idea, the whole form. Even when we meet with either the part or the half standing isolately, we cannot fail to sum up the ideas of the remainder which is lost, and thereby complete the archetype form of symmetry. In short, the rule of analogy is never absent from the mind, and this is proved by the fact, that the half of any quantity of form or number in nature is suggestive of its analogue, or else suggests nothing at all concerning truth. The half of an oak, cleft perpendicularly, the half of a sphere, cleft through its centre, or the half of a man, cleft through his median line, causes us to equate the half with the whole, and so to create, in imagination, the idea of the entire oak, or sphere, or human figure. All perfect forms, whether of inorganic or organic nature, are symmetrical.

The repetition of any form whatever is productive of symmetry ; when we repeat a side, we produce a form of symmetrical sides or analogues, and when we repeat the symmetrical form, we produce a homologue. The repetition of form is productive of the Beautiful; for the symmetrical is the Beautiful, since it then becomes the intelligible.

When we repeat the semicircle at fig. A', or the triangle at fig. A'', or the semi-square at fig. A''', we then create the circle, the double triangles, and the square figure, and these forms are one and all symmetrically cleavable through the antero-posterior median line, 2, as well as being symmetrically cleavable through the transverse diameter, 1. The repetition of a vertebra, and the application of the centrum of one to the centrum of the other, produces in like manner a form which is symmetrically cleavable from back to front, and from side to side, as seen in the opposite figures.

In fig. A' we see that the vertebral form, repeated above as below, produces an entire structure, which, like the circle, is symmetrically cleavable either by the line 1 or 2.

In fig. A'', again, we see that the vertebral form, repeated below as above, produces a structural entirety

which, like Triangles placed base to base, is symmetrically cleavable by the line 2 perpendicularly, or by the line 1 transversely.

In fig. A''' we see that the half of a vertebral form, repeated above and below, still produces the same form of entire quantity when we again repeat those halves by opposite halves. The vertebral structure, thus fashioned, becomes, like the square figure, symmetrically cleavable by either the perpendicular line 2 or the transverse line 1.

This character of transverse and perpendicular symmetrical cleavage, which attaches to cervical vertebral form, when doubled or repeated, as at A'', characterises likewise the dorsal vertebra, as seen at fig. B'', or the lumbar vertebra at C'', or the sacral vertebra at D''.

The object which has been had in view, when drawing these forms, was to show, that, as the repetition of form produces a structural entirety, symmetrically cleavable from back to front, and from side to side, so may it be understood that the vertebral figure, which is only cleavable into symmetrical sides by the antero-posterior diameter alone, is actually but as part of an archetype structure, which will hereafter show itself to be a form symmetrically cleavable in both directions, transversely and antero-posteriorly, like the circle, or the square, or triangles placed base to base.

It is observed that Nature, in the creation of all first designs, stamps them with the character of unity or completeness by the similarity of sides or faces, and that she leaves this character persistent for the forms until some disturbing cause, consequent to a first cause and necessary to a secondary adaptation of form for particular fitness and design, works some afterchange upon the figure of unity, and thus adds to it the cast of variety. Unity in variety may hence be regarded as a prime model subjected to modification. The creation of a first ens, and the modification of the same thing afterwards, is in fact a cause drawing after it an inevitable consequence, which is the suiting of a form to all external circumstance. It is most true that the animal form is indicative of its proper sphere in nature; for the wing of an eagle, the palm of a dolphin, and the foot of a lion, express the fact of unity in variety adapting itself to Nature, which is unity in variety also; and thus stands the relationship between the "natura naturata" and the "natura naturans," both of which constitute a το παν inseparable and circumvolved.

Form, in its genesis, is cast orbicularly. The circle or the sphere is its primitive figure. The ovum is thus cast, and even the microcosm of its primitive cellular organism displays a conglomeration of spheres. A sphere is the archetype of symmetry, and all those secondary forms which Nature fashions from it are symmetrically produced. The cellular mass, the ovum constituted of it, the primitive being created of the same, are things of symmetry, or the repetition and homology of sides. The embryo being itself symmetrical, traverses the matrix of symmetry, and its first act after the birth is to milk a homologue of the opposite organ; it lives by comparison, reasons by analogy, mates with its fellow, acts conformably

with its kind, and its whole history is marked by the avoidance of all that is diverse or dissimilar to its own being in nature. The being, which is itself symmetrical, and the duplicate of its right side, allies itself to forms which most nearly resemble itself, and so the fixity of its species is the effect of its own first law—self-devotion. The form for ever turns towards its analogue, and the coincidence of analogues is the creation of Gemini, exactly as we see them in the opposite figures.

The duplication of half is equal to the whole, just as the bisection of a whole is productive of its halves; and so, the whole form being one constituted of relationary halves, it follows that when we meet with any separate half, we have only to repeat it in order to reproduce a whole quantity. In Nature, we always find that whole quantities are capable of bisection in any direction, but that a half quantity or form is only to be bisected in certain directions. A sphere or circle may be rendered bipartite by any lines of section passing through their centres; but a hemisphere or a semicircle, though capable of being themselves subdivided into equal parts, do not admit of bisection in all directions; and the reason is, they are only half quantities. This character, which attaches to the semicircle, is one which characterises the vertebra also; and hence we infer that the vertebra, which, like the semicircle, is only bilaterally symmetric, is a half, or it may be a lesser quantity, of some complete figure, for we find that the duplication of itself, fig. A', creates a whole quantity which we can bisect transversely and antero-posteriorly.

Now it is true that when we view the semicircle, we also see the homologue of itself in itself, and this is equal to the knowledge of the whole circle, fig. A'. It is possible, therefore, to ascertain the dimensions of an entirety from an examination of its separate half, for we have only to make a duplicate of the half in order to re-establish the existence of the whole. It is even possible to reconstruct a whole from its fourth part, for the quadruplicate of the fourth is equal to the whole, see figs. A'A''A'''. It is possible, therefore, to create the complete figure of circular symmetry (even if this figure were not already existing in nature) by imitating or repeating the quantity and form of its half twice, and its fourth four times. And it is also possible to reconstruct a complete vertebral form (complete, that is to say, so far as regards symmetrical cleavage by the transverse and antero-posterior lines of section,) by the repetition of its half twice, or its fourth quantity four times, as seen in the opposite figures.

We see, therefore, that it is the character of a whole form to be symmetrically cleavable into halves, and these again into fourths. This is the character of figs. A, B, C, and D. And also we find that the same lines which bisect the whole symmetrically both ways are not capable of again bisecting the half, except in one direction, viz., by the line 2. Furthermore, we see that the lines 1 and 2 are totally incapable of bisecting symmetrically the fourth part of figs. A, B, C, and D. Thus we discover, that, according to the degree of subdivision performed upon a whole, there is a graduated failure of symmetrical

cleavage to its parts. The half can only be bisected in one direction, as by the line 2; and the fourth is not to be symmetrically cleft by either the line 1 or 2 applied to it. Hence it would appear that the law of form is so inseparable from the law of symmetry, and that both are so absolutely dependent upon the creation of homologues, that the combined operation of the three is typified and embodied in the figure, which is capable of being bisected transversely and antero-posteriorly. In the whole form we find homologous halves * and homologous fourths. In the half, we only find homologous fourths of the whole; and in the fourth, we discover a quantity incapable of being itself cleft symmetrically, because of its being a fourth of the whole. The opposite figures will verify these remarks, with this one exception, viz., that the fourth of the square fig. A''' is still homologous as to form with the whole quantity, and is, like it, still capable of symmetric cleavage both ways.

The fact, therefore, to which the foregoing remarks would tend is this, viz., that the osseous quantity which we name vertebra in the mammal spinal axis, presents to us the same condition of symmetric cleavage as we find attaching to the semicircle of fig. A', or the triangle of fig. A''; that there is for either figure but one median line, 2; and also, that, as the duplicature of the semicircle and triangle, figs. A' A'' forms the circle for the one and the quadrilateral figure for the other, both of which have now become symmetrically cleavable by the lines 1 and 2, so does the duplicature of the vertebral quantity in figs. A', A'', gain the like condition of symmetric cleavage by the lines 1 and 2; and hence, as the semicircle is half of the circle, so may the vertebra be a proportional of a whole quantity cast in dorso-ventral as well as lateral symmetry.

* In Geometry, the word "homologous" means *corresponding;* thus, the *halves* of equal things are equal, corresponding, or homologous; consequently, the doubles of equal halves produce equal wholes, which are homologues.

Plate 13.

Fig: A.

Fig: B.
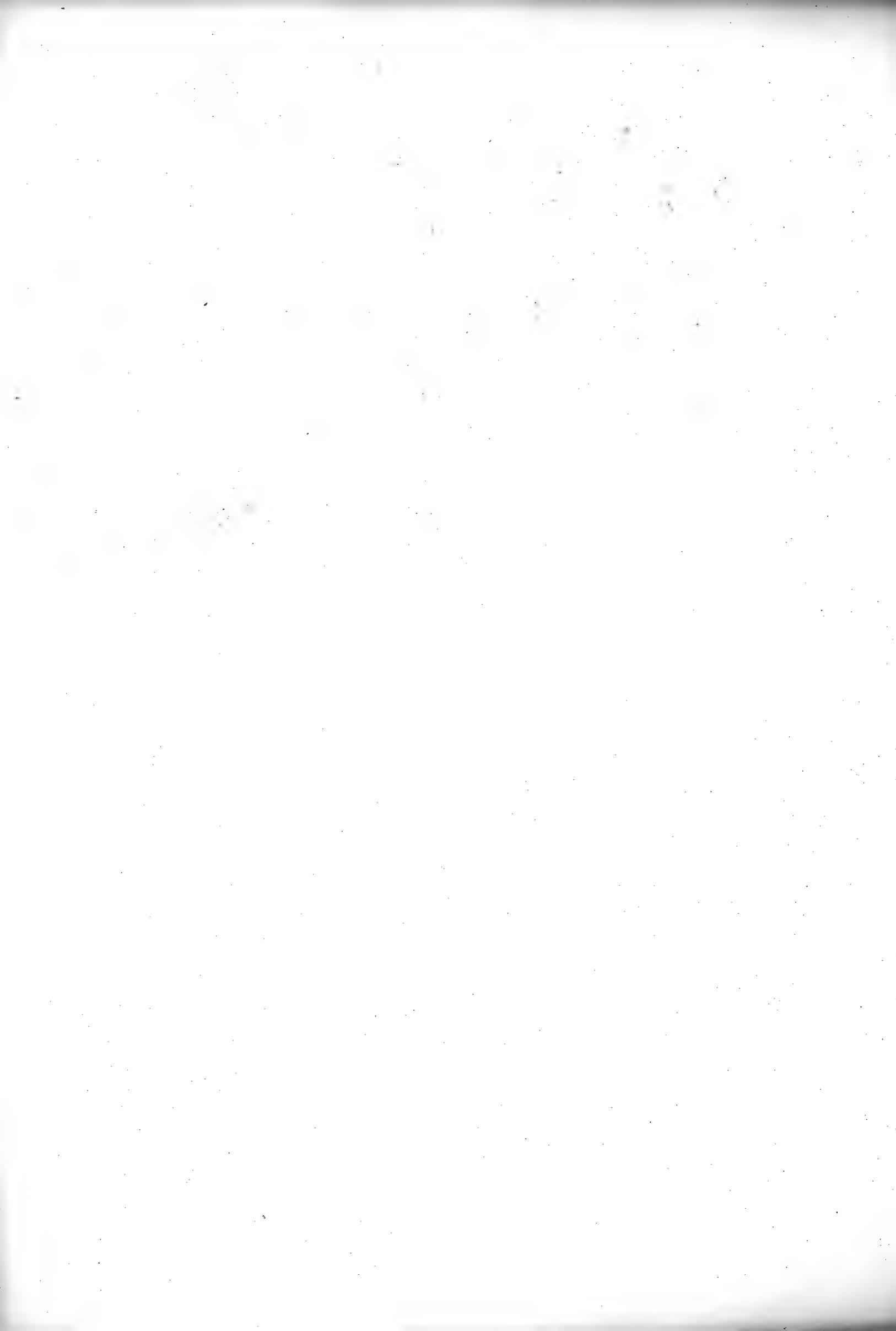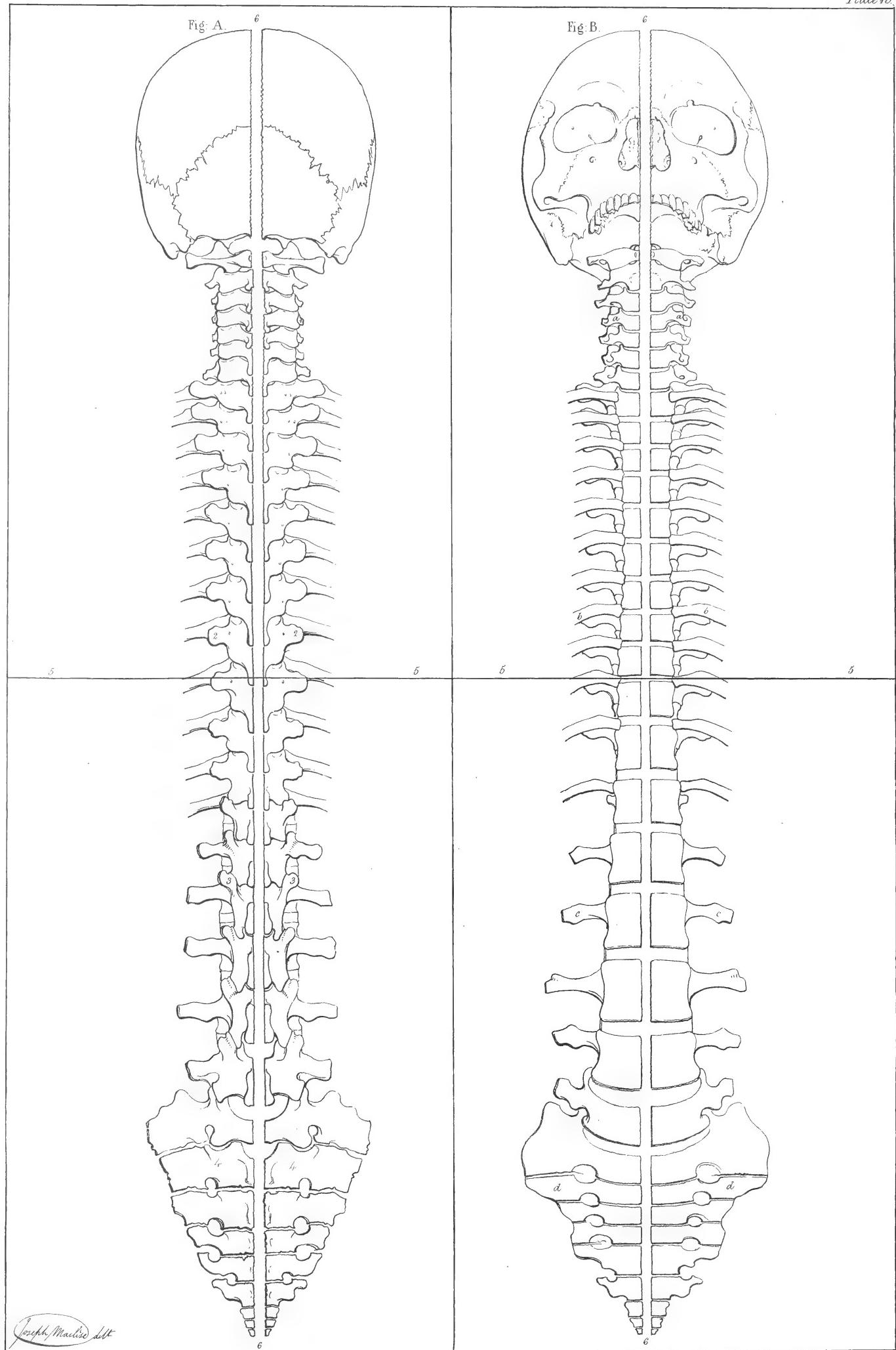
REMARKS ON THE FIGURES OF PLATE XIII.

THE UNIFORM VERTEBRAL SERIES POSSESSES A BILATERAL SYMMETRY.

IN a series of quantities, each of which might be termed absolutely equal, uniform and symmetrical throughout, we would expect to find the first quantity equal to the last, and both equal to all the rest. Such is not the case with the mammalian spinal axis, for in it we see an example of how the law of series is greatly modified by the law of proportioning, which latter renders the former finite as to the figures of its creation. When we contrast the operation of the law of series with the law of proportioning we then contrast original uniformity with proportional variety, and such is the character attaching to the mammal spinal axis, which evinces a creation under both influences. The development of an absolutely uniform and symmetrical series of equal vertebral quantities, would have produced, at the caudal termination, figures in plus character, and equal to those which we find persisting at the lumbar, dorsal, or cervical regions of the same series. The supposition of such a cast of formation at once describes the fact of unfitness, although the cast would be that of uniformity throughout the series. But when we contrast this serial uniformity with the actual condition of figures displayed in the spinal axis, we then hold comparison between the form as it is and the form from which it has been proportioned, and hence estimate its present fitness with its original unfitness. Hence we know that the mammal spinal axis is now existing as a fitness produced by the operation of three combined natural laws, one being that of symmetry, the other being that of serial uniformity, the third being that of proportioning. Hence we say that the latter modifies the creations of the two former, and terminates series at the caudex by the subtraction of elements. But this subtraction, or proportioning, takes place, for the most part, symmetrically.

Every vertebra of the spinal series is cleavable, through its median line, into symmetrical sides. Those sides contain, as we have before seen, identical elements. The one side of a cervical form is similar to its opposite. The same remark applies to the vertebra of dorsal cast, to that of the lumbar, and to that of the sacral form. Moreover, we have seen that the vertebræ of cervical, dorsal, lumbar, and sacral forms, contain the like number of homologous elements, consequently all the vertebra are homologues, and the one is representative of the other and of all others. We do not pretend to say that the last caudal ossicle is equal to any vertebra of series; this assertion would at once appear absurd. But we only say that it is a minus quantity compared with the vertebral plus quantity, and that this caudal ossicle is a vertebral centrum, holding series with all other vertebral centrums. We name the caudal ossicle to be a centrum, and this amounts to the same thing as if we called it the centrum of a vertebra, which it really is, and so we say of it that it has been metamorphosed from a vertebra equal to any other.

Now all those vertebræ of series are related to one another by the fact, that the common line of median cleavage passes through them one and all from occiput to the terminal caudal nodule.

Fig. A is a back view of the human spinal series, and the common median line passing from the vertex 6 to the terminal caudal ossicle, renders bipartite all the vertebral forms. This line severs them all behind through the spinous processes, and leaves the one side of series homologous with the other.

Fig. B is a front view of the same spinal series, and in it we see that the same median line has passed through all those homologous vertebræ at their centrums or bodies, from the first vertebra named atlas, to the last named caudal ossicle.

The law of symmetry is thus seen to prevail for the entire skeleton axis. The same law which renders any

one vertebra of series symmetrically formed gives this character of symmetry to them, one and all. The spinal axis, viewed as a whole, is symmetrical, and so is any vertebra of series. The symmetry of the unit of series implies the symmetrical condition of the whole series.

In fig. A we say that every vertebra of such series holds identical elements. At the cervix of fig. A we see that 1 is the homologue of that piece marked 2, in the dorsal class, also of the piece marked 3, in the lumbar region, and of the piece marked 4, in the sacral class. Those pieces are the exogenous transverse processes, and are severally developed from those primary nuclei common to them and the laminæ of the neural arches.

In fig. B we also discover that similar elements are to be found in all the vertebræ of series, for the piece marked a, at the cervix, is the homologue of the piece marked b at the dorsal region, also of the piece marked c, in the loins, and of that marked d in the sacral region. Those pieces are the autogenous elements located in front of the exogenous transverse processes. Those autogenous elements a, b, c, and d, are undoubtedly homologues of each other, and it matters not what name we give them; it matters not whether we call them transverse processes at the cervix, costæ at the dorsal region, transverse processes at the loins, and lateral masses at the sacral spine, for they are still identical elements.

As the perpendicular median line of cleavage divides the spinal series into identical halves, and passes through the common centre of all the vertebræ from occiput to caudex, so may it be said to sunder the created plus forms of vertebræ ranging between occiput and the first sacral vertebra; whereas this median line only severs the minus proportionals of the like vertebræ in those figures of sacral and coccygeal order. It is sufficient that we understand the last caudal ossicle to be the centrum of a metamorphosed vertebra.

The horizontal line 5, which passes through the dorsal region of the vertebral series, may, therefore, be said to divide the series of forms, which are all homologously developed above and below itself. The cervical vertebra contains elements the same as that vertebra standing at dorsum, loins, or sacrum.

Bilateral symmetry, which we observe to characterise the mammalian spinal axis, necessarily occasions an inquiry as to how it exists, and upon what other conditions of development it is dependent. Whether in the order of those created serial forms upon which the law of symmetry attends there can exist any absolute difformity—and if there be such, how it can happen that the common character of symmetry should thus enchain uniformity and difformity in one continuous line. In the mammal spinal axis we discover the result of three relationary laws, all combining to a harmonious effect, and because their several operations are in harmony with one another. One of those laws is symmetry, the other is series, the third is propor-

tioning, and the figure which is created under their joint operation is the mammalian spinal column.

When we examine the acts of nature as to the creation of things in symmetry and in serial order, we find those acts to be based upon uniformity absolute and *per se*, upon a uniform operation so totally isolated from diversity, that, considering the former as existing, we may account the latter as null and void. For we find that a form which is symmetrical is an existing evidence of nature repeating herself in developing one side after the plan of the other, and thus by the uniform act giving rise to a uniform creation— that is to say, to a thing of symmetry equal as to its sides.

Again, when we question nature as to her creation of serial order which those things of symmetry assume one to the other, we find that this is also founded upon uniformity or the repetition of one quantity in another, and this in the next. The first creation of a symmetrical unit, such as a vertebra, will, when repeated again and oftener through a serial line, be resulting not only in serial symmetry but in serial uniformity—and so the result of both laws is a simple multiplication of a first design. The law of symmetry and the law of series are uniform operations, and are hence productive of uniform, equal, and homologous forms and quantities. *

Still, however, we find that the mammalian spinal axis, although equal and symmetrical as to sides, is not uniform as to the several quantities of series—and hence arises the question as to how the series exists symmetrically, at the same time that we must acknowledge the series to be one of unequal quantities at its sacro-caudal termination.

This question is answered by the very facts of the case itself. For, while we know that series terminates by process of proportioning, or the subtraction from plus quantities, and that a caudex is only various to other regions of series, just as minus is various to plus, we then clearly understand that process which fashions the caudal series as a special design and fitness from out of plus quantities equal to those elsewhere occurring in the same series. We still find that symmetrical formation is characterising a caudal series. We also find that caudal modification holds in the same continuous serial order with all the plus quantities, that the one common median line bisects the whole series of plus and minus figures, and hence we infer that the only variety between these quantities of the one serial line, is that resulting by the law of proportioning, and that this law has acted symmetrically by the degradation or subtraction of quantities equal from one unit at both sides of its median line, and graduately for succeeding units at both sides of their median line down to the last caudal bone.

And herewith, under the above interpretation, it will occur that while we bisect series in figs. A and B from the atlas vertebra to the last caudal bone, we cleave in the latter minus quantity the actual centre of a figure metamorphosed symmetrically from a plus quantity, or whole

* Tam miram uniformitatem in planetarum systemate, necessario fatendum est intelligentia et concilio fuisse effectam. Idemque dici possit de uniformitate illa quæ est in corporibus animalium.—Newton.—*Optice, sive de reflex.*, &c. p. 411.

vertebra; and this is enough to know in furtherance of the present argument. The proportional, however small it may be, is still the proportional of an integer. The caudal bone, however small it may be, compared to other quantities of the same series, is still the caudal proportional of a vertebra—and hence the common median line which severs symmetrically this caudal quantity, bisects at the same time the *ideal form* of that vertebra of which it is a proportional. Hence, also, when we carry the horizontal line 5 transversely across the series and examine the existing serial quantities above and below it, we well know that if a caudal ossicle, which terminates inferior series, be not equal to that form which commences superior series, or to that which may be found in any other region of the same continuous line, still it is not various to its fellows in series by any other condition of development save that of being a minus proportional of its own plus form, which, if we were required to imitate, might be done according to the fashion of any of its existing serial analogues.

Before proceeding any further in the development of our present views, it becomes absolutely necessary to state in plain terms what those opinions are to which our anatomical facts of comparison shall never lead us. The interrogative sentiments which anatomists of the school of Cuvier have put forth triumphantly against the doctrine of absolute uniformity, are as follow:—They ask, " Y a-t-il unité de structure ?"—" Y a-t-il unité de composition ?"—" Y a-t-il unité de type ?"—" Y a-t-il unité de plan ?" If, say they, you mean to support your views of uniformity according to

the affirmation of either of these questions, then demonstrate to us the identity between a polype and a cephalopod, between either of these two and a whale.* These requisites for the illustration of nature's uniformity, we at once emancipate ourselves from promising to supply, and indeed it may be doubted whether the pleasantry occasioned by the proposition demonstrated *ad absurdum* attaches more to the question asked than to the position sought for, and though it be still most true that the analogists have turned back on classifiers the cannonry of their own argument in defiance of their classification according to absolute difformity, still we shall continue to pursue the present subject in its own distinct course, believing that the difference which exists between a structural plus and minus quantity cannot suffer them to be named absolutely equal and uniform in this sense, even though they be bound together by the zone of Newton and unity. Neither by the existence of the same facts of plus and minus proportioning, can the difference between two such quantities allow of their being read as species in the sense of an absolute difformity of nature, even if they were separated from each other by an interval sufficient to receive all the volumes of Cuvier written to that end. If we admit that the law of proportioning is that whereby skeleton forms are varied from each other, then we may reasonably make effort to determine, by the facts of comparison, what is the character of that plus or archetype form which suffers metamorphosis or proportioning. And such is our immediate purpose.

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* " Qui osera," demands Cuvier, " nous dire que la méduse et la girafe, que l'éléphant et l'étoile de mer, résultent d'un assemblage de parties organiques qui se répètent uniformément." To this question Geoffroy replies that, " Il y a une confusion manifeste dans les raisonnemens de l'argumentation ; et cette confusion me paraît même portée à son dernier terme, quand, ne s'appliquant point à discerner les divers degrés de l'organisation, l'argumentation demande qu'on lui fournisse *ipso facto* les rapports immédiats de la méduse et de la girafe, de l'éléphant et de l'étoile de mer. Un tel *à fortiori* n'arrive sans doute point là *en desespoir de cause*. Je regrette véritablement de rappeler cette expression. Cet à fortiori n'est probablement qu'une négligence échappée à la plume de mon savant confrère. La phrase a fait, je crois, sourire quelqu'un dans l'assemblée ; mais, je le suppose du moins, elle n'aura porté de conviction dans aucun esprit."—See *Principes de Philosophie Zoologique, discutés en Mars* 1830, *au sein de l'Acad. Roy. des Sciences.* Par Geoff. St. Hilaire.

Plate 14.

Fig. A.

Fig. B.
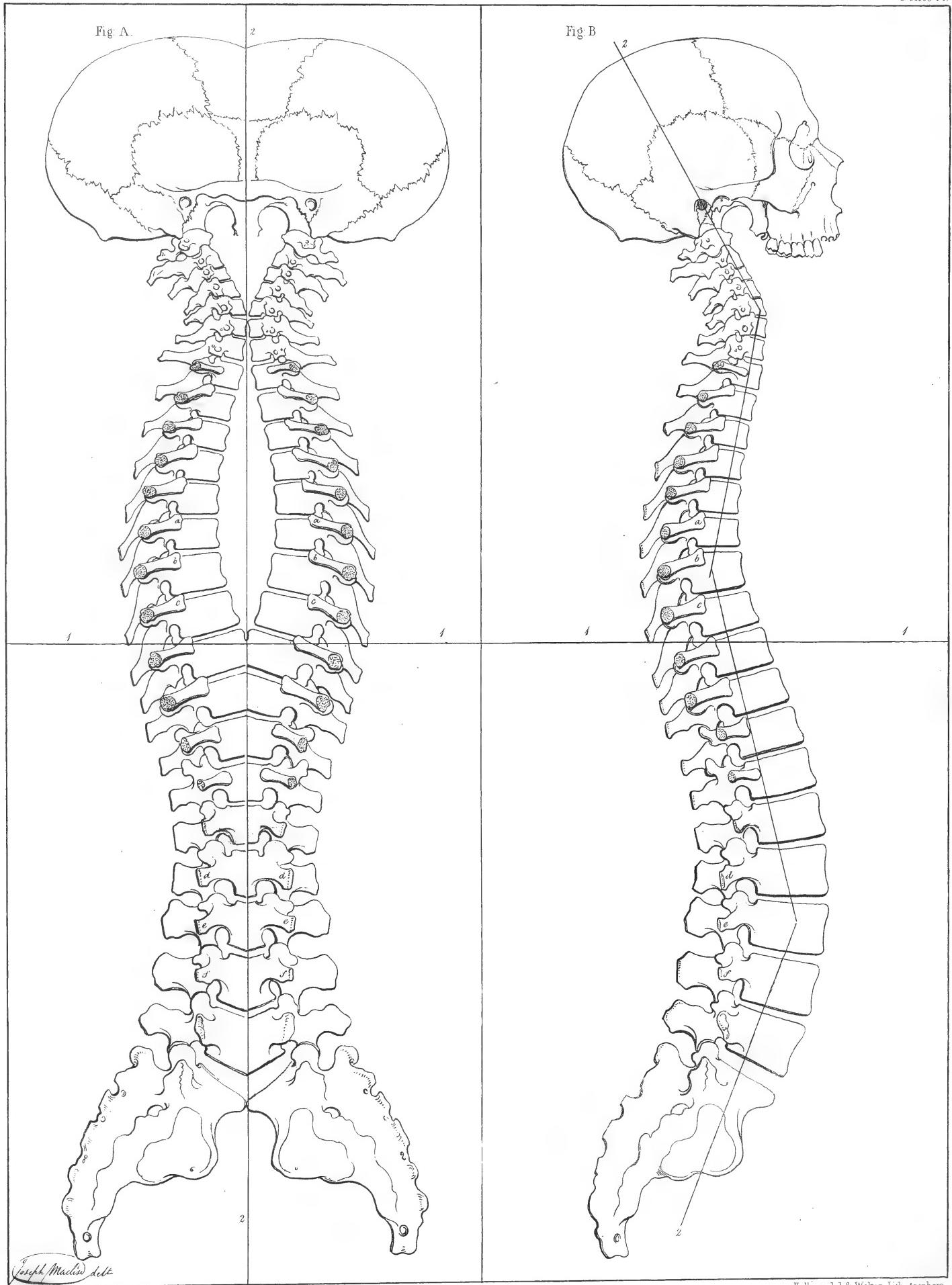
REMARKS ON THE FIGURES OF PLATE XIV.

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THE DUPLICATION OF VERTEBRAL SERIES GIVES THE FORM AN ANTERO-POSTERIOR SYMMETRY.

A SERIES of equal quantities which constitute a uniform line will still retain through metamorphosis the character of uniformity, provided the modification which may affect any one quantity in any one manner shall operate in the same way on all the others. When vertebral forms are plus throughout the serial line, we shall see that such plus series is uniform to itself. When from each of these plus vertebræ equal quantities shall be subtracted, these forms of proportioning will still be uniform with one another. When, again, from plus vertebræ unequal quantities shall be subtracted in several parts of series, then series is struck difform to itself, but the difformity is relative not absolute, for it has resulted by process of subtraction. Lastly, we find that whatever be the condition of the serial line, whether it be equal or unequal throughout its extent, still the duplication of the series yields a figure of symmetry both as to lateral and antero-posterior faces. The equality of serial forms is synonymous with the homology of those forms. The multiplication of equal forms in series implies the condition of uniformity. When we compare with this state of formation another state, wherein we find that forms are multiplied in series, at the same time that the process of subtraction is rendering those forms unequal to one another, then all we can truthfully understand of the series thus produced is, that if subtraction had not occurred, plus equals would have persisted through uniform series ; but subtraction having occurred, and serial inequality being the result, we then attribute the effect to the cause, and know the secondary state of modification by comparing it to the primitive uniform state. Now the symmetry of serial sides is, like series, dependent upon the repetition of form ; and as series may be modified from plus to minus quantities, so may symmetry become exceptional by the very same law of proportioning. We seldom find that bilateral symmetry is interrupted, whatever be the degree of modification carried out upon series. But more frequently we find that antero-posterior symmetry does not endure, and the sole cause of this may be dependent upon the metamorphosis of dorsal structures. For we see that the ventral face is plus compared with the dorsal face of the mammal spinal axis, and also that the repetition of the dorsal structures at the ventral region gives the entire form a dorso-ventral symmetry.

Symmetry is the repetition of form. Any figure, which considered, *per se*, instances the most awry character, will, when doubled or repeated, and placed opposite to its counterpart, produce the form of symmetry. The law of symmetry, therefore, is, in essence, dependent upon no other fact than that of Nature repeating her prime creation. The side is homologue of the other side, because Nature has repeated the side.

We have seen that all vertebræ of series are cleavable through the median line passing from the spinous process behind through the centre of the body before ; and we have also seen, that when a vertebra was divided through its transverse diameter, the resultant pieces were dissimilar ; but we have further seen that when two vertebræ were placed body to body, then an entirety of form was constructed, which was capable of being divided into symmetrical sides, both by transverse and perpendicular cleavage. The same remarks apply to the spinal series, when viewed as a whole.

The mammalian spine of human form is capable of

being symmetrically cleft by a line which passes from the vertex to the caudal ossicles through the spinous processes behind, and the bodies of the vertebræ in front; but transverse cleavage, through all the spinal axis, will not leave the front and back of that axis as homologues.

In fig. B, the lateral view of the skeleton axis, we see that the line 2, which passes through it from vertex to caudex, would divide series into a back and front of unequal formation. The pieces marked *a*, *b*, and *c*, in the dorsal region, would stand on one side of such a cleaving line, and would not have counterparts on the opposite side of this line. In the lumbar region, the pieces marked *d*, *e*, and *f*, would happen likewise on the one side, and have no homologues opposite.

In fig. A we have repeated figure B, and even though it be a transgression beyond the laws of nature, in establishing the human design, such as it is at B, still we see how that the repetition of form, such as B, produces a figure capable of being cleft, both perpendicularly and transversely from vertex to the caudal series. A median line which passes through the double figure A, from 2 to 2, would sever the entire form into homologous halves, and even if this figure were cleft through the opposite series of spinous processes, still the resultant sides of the form would be symmetrical.

In such a figure as A, the median cleavage, whether carried transversely or perpendicularly, would strike halves homologous, both as to general form, and as to the elemental pieces contained in each. The line marked 2, 2, would sunder equal forms, both having the pieces at the dorsal region marked *a*, *b*, and *c*, and at the lumbar region the pieces marked *d*, *e*, *f*.

Now, the horizontal line marked 1, will, when carried through both the figures A and B, produce these remarks, namely, that above and below this line 1, the other line 2 will be producing dissimilar results on the forms A and B; for we see that the line 2 would sever the figure B into unequals as to back and front, although the line 1 would have serial vertebral homologues above and below it; whereas, the line 2 would sever the figure A into equals as to back and front, although the line 1 would still have serial homologous forms above and below it.

The only observation, therefore, which we shall enforce respecting fig. B, at present, is, that it cannot be cleft symmetrically by the line 2, and that this is owing to its being the metamorphosed proportional of some archetype structure which is capable of being symmetrically sundered by the line 2. However, we by no means say, that this archetype is such a one as fig. A, in general design; but only, that like fig. A, it admits of symmetrical cleavage both ways, and is composed of a series of figures all homologously developed from cranium to caudex.

It may be regarded as an incontestable truth, that as by the comparison of plus and minus quantities we are taught how much is lost to minus by what we find in plus, so by the comparison of opposite faces whose main difference depends upon the persistance of plus structure for one, and the subtraction of the like structure for

another, we should read the design accordingly. In series we discover the difference between the existing quantities to be that which always occurs between plus and minus. In symmetry we also recognise the difference (when it happens that there is any), between opposite faces, to result by the very same rule. When subtraction is graduated for serial forms, as from the first sacral vertebra to the last caudal bone, this latter is different to the former only as a minus quantity is different to a plus quantity. When, again, we still discover that bilateral symmetry prevails for the sacro-caudal series, we then understand that equilateral metamorphosis, graduated and proportional, has not disturbed the law of bilateral symmetry, but has only rendered the superior structure plus and symmetrical, whereas the inferior structure is minus and symmetrical. Series and symmetry are two conditions of development which we find attaching to the one form, and the difference which happens to either of those laws arises by the operation of a third law—viz., that of metamorphosis or the subtraction from plus quantity.

All forms which are created by natural operation are as the symbols expressive of the laws of their development. If we view the form without regard to the law by which it is a creation, it then stands for nothing more intelligible either to the eye of body or of understanding than any hieroglyphic pregnant of its own occult meaning. But when we consider the form in presence of the attendant laws which have presided over its creation, it is then that we furnish both to it and ourselves the history of its present condition. The form as it is, and the form as it might have been, contains the whole account of those operations of nature which have rendered it what it is, viz., a fabric of symmetrical and serial homologues having been subjected to proportioning.

When we say that the skeleton axis as it is is not such as it might have been, we only mean that those serial forms which we now discover to be minus might still have persisted as plus quantities characterised as serial and symmetrical equals. The laws of series, symmetry and proportioning point to the original whole quantities from which the existing minus figures have been by their agency created and designed. These laws of formation stand manifested between the minus and plus quantities, and, Janus-like, they indicate by one aspect that quantity to be present in plus, which, by the opposite aspect, they describe to be lost to minus. The sentence which they speak has this relationary meaning, viz., that if $a - b = c$ so $c + b = a$, and the one condition is expressive of the other or else of nothing.

Considering the mammalian spinal series as a design resulting from the combined operation of the three relationary laws, that of symmetry, of series and of proportioning, so the subject or form itself must bear interpretation accordingly. And hereupon we remark, that if serial forms, such as vertebræ, be the simple repetitions of each other, and when varied from each other, be only varied as to proportioning, then all we can say of this condition of development is, that plus uniformity is the original, and

proportional variety is the secondary operation. If, again, bilateral symmetry be the result of a repetition of the side, and where it happens as an exception that one side is plus and the other minus (this variety of sides being nothing more than plus and minus), then in like manner there can be nothing further said of this condition of form than that plus uniformity on one side has become minus variation on the other. Again, when we shall hereafter find that a plus ventral series is a face diverse to a minus dorsal series or face, we may hence reasonably infer that the anterior aspect is not the counterpart of or symmetrical with the posterior aspect, because of quantity being lost at dorsum.

As we find that bilateral symmetry is the simple repetition of sides, so may we take a precedent of nature and create an antero-posterior symmetry by the simple repetition of a back or front. The duplication of fig. B, in fig. A,* is productive of antero-posterior symmetry. Whereupon, if it be inferred that fig. B, not possessing antero-posterior symmetry either as we now see it, or as we shall hereafter see it with its thoracic apparatus attached to it, is, by the very fact of wanting this condition of formation, existing as a fitness compared to fig. A, which does possess antero-posterior symmetry, and is hence unfitting; still there appears to be no reason why we should not interpret fig. B as it stands, to have resulted various as to its back and front by the simple law of subtracting from its

plus quantity. It is evident that fig. B is minus compared to fig. A, and also minus to fig. B when producing the thoracic apparatus.

When we pass from fig. B to (fig. B plus the costal thorax), we shall have advanced only from minus to plus quantity, from a proportional to an archetype, which latter we shall still find to be subjected to the relationary laws of series, symmetry and proportioning.

It is to the recognition of a skeleton archetype or plus series of osseous quantities, that our observations have hitherto inclined, and shall incline henceforward; and for this reason, because we believe that there is in nature some prime model of full and completed structure to which all lesser quantities of skeleton forms refer, and of which they may be read as the proportionals. This archetype we believe to be one of serial and symmetrical equal quantities from origin to termination of the line, and may hence be regarded in itself as absolute linear uniformity and as containing proportional homologues of the whole infinitude of proportional variety. While there appears every good reason to infer that one form is various to another of the same series, only by the fact of subtracted quantity leaving proportional degradation as the result, so must the acknowledgment of this condition cast before it the attendant idea (as substance casts its shadow and cause its consequence) that minus quantity is minus by the loss of that which, when present, makes plus quantity a whole.

* This figure has been designed merely to illustrate the fact that the duplicity of form is productive of symmetry as to all sides or faces. But still we cannot be unmindful that the figure as it presents simulates very closely the duplex anomaly described by so many anatomists. It cannot be doubted that all those extraordinary anatomical facts, the "anomalies of organization," do (notwithstanding the careless apathy with which the votaries of "the practical" regard them) express *as creations* a reference to some as yet unrevealed law of Nature, the knowledge of which might throw the light of just interpretation upon their actual and obstructive reality. They form part of that circumambient subject named "Transcendental Anatomy," and have had some fixed place allotted to them in the generalizations of those who, knowing that comets are not vagrant beyond the law of orbits, believe that monstrosities of animal form are also encompassed by some general rule of development. In the works of Geof. St. Hilaire—*Philosoph. Anatomique des Monstr*. Of Serres (C. R. A.)—*Recherches d'Anatomie Transcend*. Blumenbach (J. F.)—*De Anomalis et Vitiosis, &c.*—Carus, and many others, enquiries into the cause and origin of monstrosities may be read.
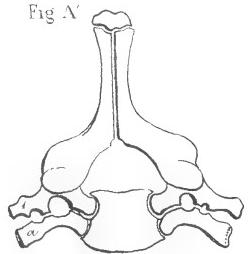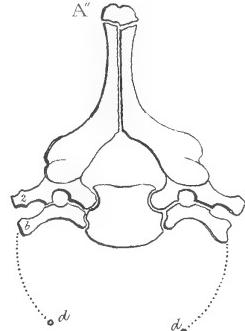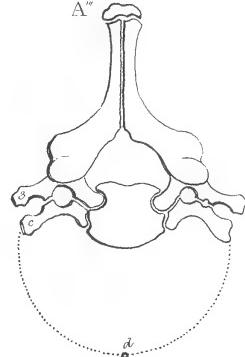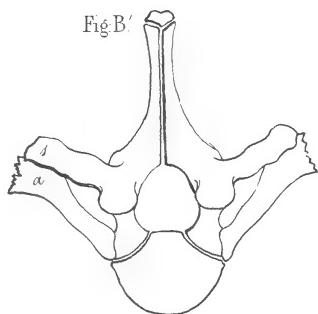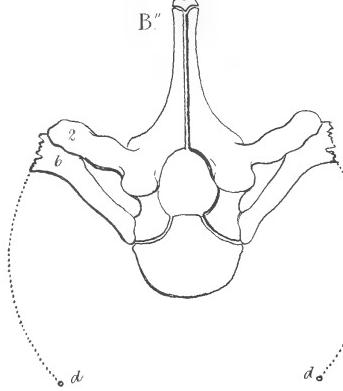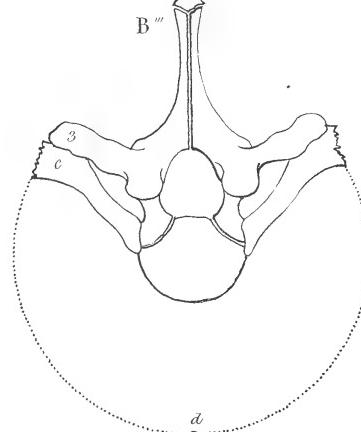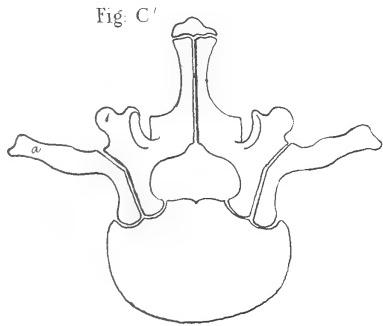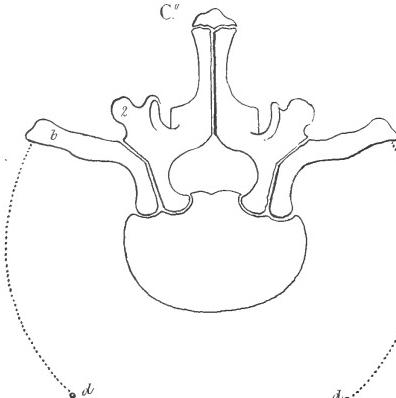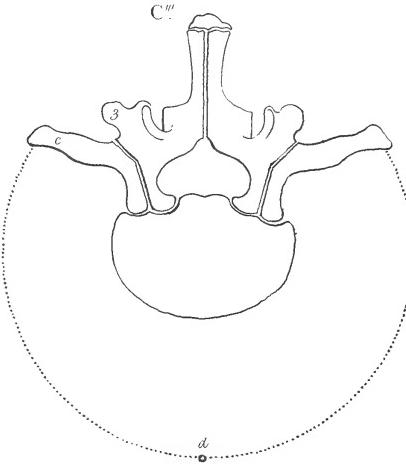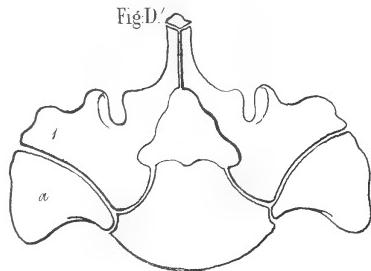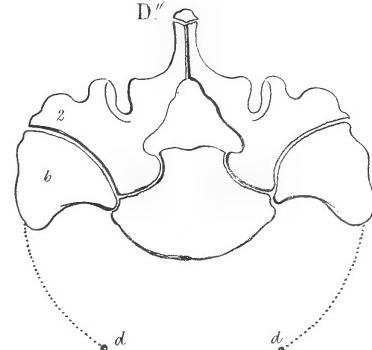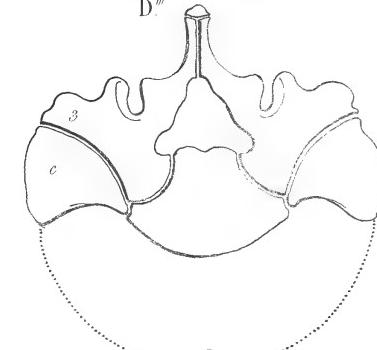
Plate 15.

Fig A'　　　　A''　　　　A'''

Fig B'　　　　B''　　　　B'''

Fig C'　　　　C''　　　　C'''

Fig D'　　　　D''　　　　D'''

REMARKS ON THE FIGURES OF PLATE XV.

UNITY under metamorphosis is an archetype plus quantity, being subjected to the law of proportioning. Unity and the archetype may hence be regarded as one and the same thing, consequently the metamorphoses and proportionals are also to be understood as the products of unity or the archetype. Now, whilst we grant this, we must also acknowledge to the fact, that the several proportionals which we name differently owing to the circumstance of a variation of bulk, can still (through the mist of such nomenclature) be known as the parts of unity or the plus archetype. If we may reasonably interpret this lesser form to be a proportional of that greater form, there being no other difference between the two than that which exists between $a-b$ and $a+b$, then the facts remain easily recognisable, notwithstanding the nomenclature by which we perversely read the thing $a-b$ as in nowise related to the thing $a+b$. For it is still evident that the greater quantity contains the lesser, and hence it becomes no less evident that the latter standing alone is to be regarded as a proportional of the greater.

A vertebra is a figure of increase. Its general design and proportions are subjected to the rule of plus and minus development; of this there can be no doubt entertained, and consequently the plus form must be regarded as the archetype of the minus form. Any one vertebra of series may be recognised as performing these variations from minus to plus quantity and from plus to minus quantity, and consequently all vertebræ of series pass through the like mutations, for which reasons we venture to assert, that as all vertebræ are but the proportionals of a common archetype quantity or plus design, so must this archetype be regarded as the unity, the minus proportionals being the varieties.

Fig. A′ is a cervical vertebra whose composite transverse process presents two pieces; 1 being that which is exogenous to the neural arch; the other, a, being the autogenous element. The piece marked 1 is of an invariably fixed character, it never increases beyond these set proportions; but, on the contrary, the anterior or autogenous element a is subjected to mutations by increasing to plus quantity, and oftentimes arches ventrad even as far as the sternal structures, thereby imitating the costal forms of the thoracic region. In fig. A″ this autogenous piece is marked b, and the dotted line d, indicates the direction of its growth ventrad. In fig. A‴ this same piece is marked c, and the median point d, is that where it occasionally meets its fellow of the opposite side. It is self-evident, therefore, that fig. A′ must be regarded as the proportional minus quantity of fig. A″ and this of fig. A‴ when these latter shall have performed plus increase to the point d.

Fig. B′ is a vertebra of the dorsal class, having the exogenous piece 1 homologous to the piece 1 of fig. A′ the cervical vertebra, and having also the piece a homologous to the piece a of the cervical vertebra. In fig. B′ this piece a is the proximal end of a rib, and fig. B″ shows this costal piece b disposed to traverse the dotted line d, and even to meet at the mid point d of fig. B‴. If, therefore, fig. B′ with its piece a of costal structure, will, when shown to any anatomist, invariably suggest the idea of its being the proportional quantity of a full costo-vertebral archetype which generally takes the form of B‴, what then is the interpretation reasonably to be affixed to fig. A,′ whose element a is the homologue of the piece marked a in fig. B′?

Fig. C′ is a vertebra of the lumbar class, having also the exogenous piece 1, homologous to the piece marked 1, in both the cervical and dorsal forms, and having also the autogenous piece a homologous to the piece a of both cervical and dorsal vertebræ. This autogenous element a of fig. C′ is also disposed to pass through plus mutations, either increasing to d of fig. C″, or even as far as the median point d of fig. C‴, and thereby imitating the plus thoracic archetype. If therefore fig. B′ be a proportional of B‴ produced to d, what else is C′ but the proportional of fig. C‴, which latter is the homologue of fig. B‴?

Fig. D′ is the first sacral vertebra holding the pieces

marked 1 and *a*, homologues of the pieces so marked in figs. C′ B′ and A′. The cast of development necessary to sacral form does not admit of the piece marked *a* to perform the plus mutations to the points *d* of figs. D″ and D.‴ But still the piece *a* of fig. D′ is the autogenous homologue of the pieces marked *a* in figs. C′ B′ and A′, consequently, &c.

A vertebra is therefore to be regarded as a proportional of some fuller archetype structure. We already well know that fig. B′ is a proportional of the costo-vertebral figure. What then are figs. A′, C′, and D′, to be accounted whilst we consent to read them as the homologues of fig. B′?

Every form in the one series, every form, for example, which we name a vertebra, may be said to hang suspended between two possible conditions of variety, viz., that of a plus increase, and that of a minus decrease. It appears to be not more possible to vary the vertebral quantity by rule of subtraction, than it is to vary it by rule of addition. These being the actual facts of the case, it will also appear that if we continue to pursue minus variation between vertebral quantities in the hope of arriving at the limit of analogy, where this is supposed to inosculate with the genesis of diversity, we then shall be led to the state of vertebral nonentity or $9 - 9 = 0$, and so comparative rule ends. But the result is different when we follow the law of skeleton formation from minus quantity through all its increasing series. The degradation of form terminates in 0, whereas the plus genesis of form increases to certain limits, and beyond these creation never passes.

The genesis of formation may be said to follow through that serial line of increase or addition which has minus quantity at one of its extremes and plus quantity at the other. The quantity which stands minus in this series, is liable to plus increase, just as the created plus quantity is itself liable to all minus degradation. All the anomalies of the minus quantity are the simulations of plus quantity, and all the anomalies of the latter are representations of minus quantity. Form balances between the plus and minus conditions; and not only do we find this to be the general law through an animal kingdom, but even the quantities of the individual serial skeleton axis give example of the same law. For it is quite true that fig. A′, the seventh cervical vertebra, and fig. C′, the first lumbar form, do now and then produce their pieces marked *a* to the anomalous condition of costæ, and thereby giving us to understand that the present condition of their elemental part *a* is a costal quantity minus to plus.

Now when we consent to read the law of formation, it is evident that we must contemplate the ens independently of its name. The thing is a creation of Nature, whereas the nomenclature is a creation of our own. Form, as developed under the guidance of a natural law, is not form such as we too often consent to read it, namely, as though Nature were to be girt by any name, and bound down within the scanty limits of its meaning. If we agree to name the pieces *a* of figs. A′ B′ C′ and D, as "transverse processes," "ribs," and "lateral masses," as though these parts never varied from themselves through plus increases, all simulating the costal character: then it is plain that we suspend between ourselves and the actual truth the draw-blind of a nomenclature which absorbs all other interest by its own barbarism of obstructiveness. We say that the name is not the form, and when to this we add that the form is not itself of fixed character, * we are only then speaking as to the actual facts of the case, for it is evident that the element *a* of fig. A′ the seventh cervical vertebra is to be known as no other thing than part or proportional of the costa *c* of fig. A‴, when we shall afterwards discover *c* to be produced to the point *d*, and the whole still known as the seventh cervical vertebra. We apply the same remark to figs. C′ and C″, with their costal pieces marked *a* and *c*.

When we ourselves metamorphose fig. B′ from its whole structural quantity, and in this minus character find that its elements represent those which are to be found in figs. A′ C′ or D′, we do not in such case call the piece *a* of fig. B′ a "transverse process," or any other name than that of a costal proportional; for we know that Nature has produced it as such. And when again we find that Nature, agreeably for design, presents to us in series, such quantities as figs. A′ C′ and D′, with their homologous elements *a*, in the same condition as *a* of fig. B′, why then should we understand the parts *a* to be anything else than as metamorphosed costæ? Is not this sentence spoken through the facts that all the plus varieties of the pieces *a* of figs. A′ C′ and D′ are representations more or less complete of the full costal quantities which we know to fail for fig. B′?

The plus anomaly of an ordinarily minus quantity is interpreted by the normal plus quantity elsewhere produced. The minus anomaly of an ordinarily plus quantity is equal to a normal minus quantity in the same series; and as it is so, hence may it be concluded that fig. A′ or C′, together with their anomalous costæ, are to find interpretation in the archetype of fig. B′, which we already know to be the full costo-vertebral thoracic structure. We say, therefore, that figs. A′ and C′, and consequently fig. D′, are now fitting designs, by having been metamorphosed from a plus uniform costo-vertebral series, which (comparing Nature with herself) we shall proceed to recognise in the plus archetype of fig. B′, which is the dorsal structure.

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* An osseous quantity holds *an invariably fixed position* in the skeleton forms, and hence it is that we are always enabled to recognise it as the same ens through all its phases of metamorphosis. But though it manifests a sameness of character as to place, still *its bulk is not always of fixed character* as to proportion or extent, function or destination, degradation or subtraction of parts; the rendering a thing minus from plus, is that law which (according to the present views) fashions a minus "transverse" process at the neck or loins from out of a plus costa. "L'ostéogénie est constante, en ce qu'un même os est toujours à la même place."—Goethe, *Œuv. d'Hist. Nat.*, p. 41. Traduits par Martins.

Plate 16.

Fig: A'

Fig: B'

B"

Fig: A"

Fig: C'

C"

Fig: A'''
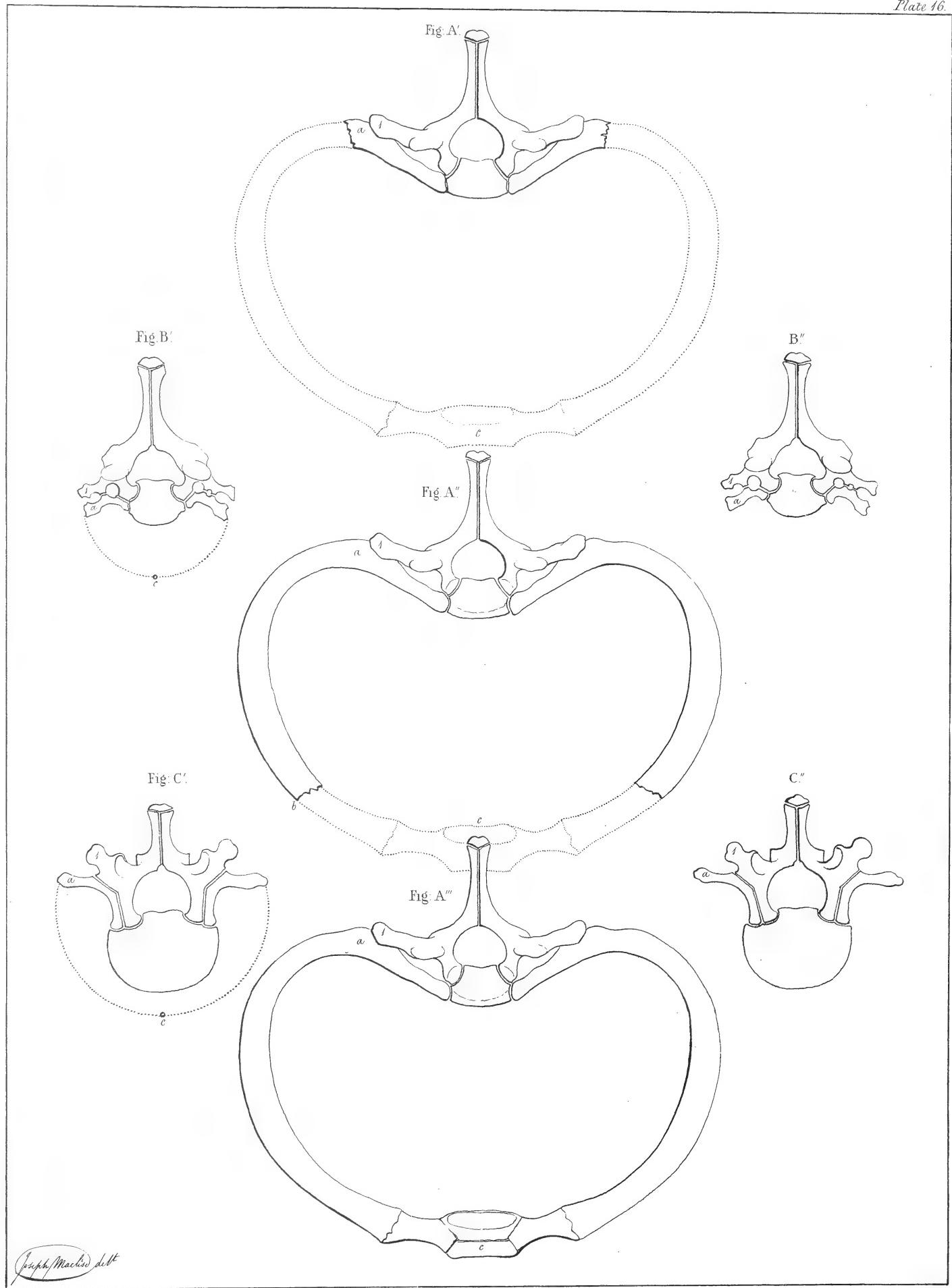
REMARKS ON THE FIGURES OF PLATE XVI.

THE COSTO-VERTEBRAL THORACIC FIGURE IS THE ARCHETYPE OF SERIES.

UNITY, or the archetype, is a name which may be applied to characterise that whole structure which is capable of undergoing metamorphosis or subtraction through all degrees of quantity severally equal to all those proportional forms which stand in series with itself. And this name archetype will still more fittingly apply to this whole quantity when we shall find that it contains not only proportionals equal to the normal condition of minus serial forms, but equal also to the abnormal varieties, whether of plus or minus, in which we occasionally find those minus serial quantities to be produced. A thoracic costo-vertebral figure is a natural symbol expressive of an integer, and when we view it in connexion with all the other serial quantities of the mammalian spinal axis, we discover that it contains proportionals equal to any minus form of the same series ; just as when we write the integer 9, we know it to hold quantities equal any one of decreasing series 9, 8, 7, 6, 5, 4, 3, 2, 1.

It is quite possible to imitate Nature in her simple law of metamorphosis from plus to minus quantity. The Rule $a - b = c$, or $c + b = a$, affords a symbolic illustration of that law by which nature designs the mammalian skeleton axis from the series of plus archetype quantities.

In fig. A′ we see the costo-vertebral archetype holding the exogenous piece 1, called transverse process, which never exceeds these set dimensions, whereas the autogenous piece a is part of the fuller quantity ranging from a to c. The entire structure is such as we find in the thoracic region of the serial skeleton axis; so, therefore, it must be clear that when we break off the costal forms at the point a, we then produce a structure, terminating at a, as a proportional of the once complete structure whose costæ were fully produced to the point c. Hence, therefore, it becomes totally impossible for us to regard fig. A as broken off at the point a, without knowing it to be minus something.

Fig. A″, which has the elemental piece a produced from this point to b, is consequently to be understood as the plus archetype of fig. A′ broken off at the point a.

Fig. A‴, therefore, which has the piece a produced from this point still further to the sternal element at the median point c, must be interpreted as the plus archetype of figs. A′ and A″. When, therefore, we compare the fig. A′ broken off at the point a, to the fig. A‴ produced to the point c, we then reasonably interpret fig. A′ to be a proportional minus the quantity proper to the archetype A‴, and so the comparison of the proportional fig. A′ with the archetype plus fig. A‴ will cause us reasonably to infer that fig. A′ is minus the quantity ranging between a and c.

Now, therefore, as figs. B′ or B″, and figs. C′ or C″, are the homologues of the proportional A′ broken off at the point a, so the remainder of the subject may be plainly inferred.

It is an undeniable fact that fig. B″, the cervical vertebra, is rendered anomalous to itself by the occasional production of the piece a beyond its usual proportions, and also that this piece a traverses the line from a to c of fig. B′.

It is also a fact that fig. C″, the lumbar vertebra, is now and then anomalous to itself, by the production of the piece a towards the mid point c of fig. C′, and therefrom we infer that figs. B″ and C″ are minus proportionals of some plus quantity which is archetype.—What, then, is the form of this archetype? It may be known by the following remark.

If figs. B″ and C″ contain elements equal to fig. A′ metamorphosed at the point a; if, furthermore, we readily understand fig. A′ to be a proportional of the known quantity fig. A‴, and that we discover how the anomalies of figs. B″ and C″ are solely owing to the fact that the pieces a now and then imitate the costa $a c$ of fig. A‴, so therefore, &c.

When we compare the minus quantity with the plus quantity, we are invited to equate the former to the figure and dimensions of the latter, and by this process of reasoning we are enabled to track the rule by which Nature metamorphoses plus to minus, and fashions the design of fitting proportions.

We at once acknowledge to the fact that fig. A‴, considered as a whole quantity, contains within its own dimensions proportionals severally equal to figs. A″ and A′, for it is true that fig. A‴ may be metamorphosed at those points of itself which correspond to the points b and a of figs. A″ and A′. Now, the idea must also occur that

when we shall find figs. A‴A″ and A′ standing in serial order, we are then to read the two lesser quantities as having been proportioned from their own archetypes, which may be said to have equalled fig. A″, for it is evident that there exists no other variety between the three figures than that of quantity. It is this difference of quantity which also renders figs. B″ or C″ various to fig. A‴, with which they stand in serial order, and therefore we say that figs. B″ and C″ are the proportionals of quantities equal to fig. A″; and this conclusion may be drawn even independently of the speaking facts that figs. B′ and C′ occasionally produce their elements *a* to costal character.

The metamorphosis or degradation of a whole quantity would appear to be the law by which Nature creates a serial skeleton axis. And when we disintegrate the whole number 9 into the progressive decreasing series of 9, we have 9, 8, 7, 6, 5, 4, 3, 2, 1, as the *rational numbers*, together with all the intervening *irrational numbers*, which latter we may fancy without the demonstration of them. Now it is plain that the several quantities expressed in the collective symbol 9, are equal to the separated quantities of 9 when specified as 9, 8, 7, 6, 5, 4, 3, 2, 1, and hence we understand that 1 or 2 are as well the proportionals of 9 as 7 or 8, or any other quantity contained in 9, the whole number. In the same way we may understand that fig. A‴ can suffer metamorphosis or disintegration for the decreasing series of figs. A‴A″A′B″ or C″ as rational quantities or proportionals, together with all the irrational proportionals intervening between fig. A‴ as plus, and figs. A′ or B″ or C″ as minus quantities, and herefrom we also infer that figs. B″ or C″ are to be accounted the proportionals of such as fig. A‴ as well as figs. A″ or A′.

The knowledge of a law of formation includes all the facts created under the influence of that law, and lends to each of those facts the light of rational interpretation. If under one point of view we know it to be possible for fig. A‴, the archetype symbol of unity, to undergo metamorphosis,* so as to represent fig. A″A′ or B″, we then know that all the plus anomalies of figs. B″A′ or A″ are but as approaches to the condition of the structural whole, and hereupon we discover that all minus quantities, whatever be their condition in series, cannot be named as anomalous to the whole quantity, for we see that this contains an equal to any proportional of series, and just as $a+b$ may be said to contain $a-b$.

When we would track the evidences of a law in nature, we do not need the assistance of nomenclature towards this end, for it is the form, not the name, which is the subject matter. While we understand that fig. B″ is a proportional quantity of such an archetype as fig. A‴, we feel that there is more substance in this account as tending to interpret the law of form † than in continuing to analyse sound, or nomenclature, in order to determine which of the two figures A‴ or B″ shall be named vertebra. For, after all, what is there in the name vertebra when used to characterise the thing fig. B″ or C″ as a form which "turns," except, indeed, it be meant that all the subject of comparative osteology turns to truth or error, according as we truthfully or erroneously interpret the design of its creation. It is in the ens, not in its name, that the science of its nature resides; and when we acknowledge thus much of the thing, it will matter little whether we choose rather to draw its sounding title forth from the catalogue of the Homeric ships, or rest contented with the name vertebra, as signifying the full meaning of the anatomical fact. The name is but a sound, whereas the subject which it too often falsely signifies is a creation by some natural law, which, if we could but discover its meaning, would always appear to encircle that creation like a luminous halo. The name is but a sound, and signifies no more in the Latin or the Greek than in the Patois, the Arabic, or the Hebrew. The name "Homo diluvii testis et Theoscopos" is painted upon a fossil salamander; and because it sounds of something, it is left to stand like other geological phrases, as if it expressed a truth in any other sense than that immortal error has a fixed place, by direct inheritance, in that temple where the student cannot, unless with an effort, consider the plain facts of Nature except through the "brouillard" of nomenclature and Scheuchzer, poetical licenses and palæontological void imaginings of the epochs of the world's past history; through "cataclysms and catastrophies;" through the "reptilian and carboniferous ages;" through Nature in self-slaughter; through "the abortive gulph and void profound of unessential night;" through "Chaos, Phlegethon, and illimitable ocean;" through the "eternal anarchy and noise of endless wars of Tartarus and confusion;" through "many a frozen, many a fiery alp, rocks, caves, lakes, fens, bogs, dens and shades of death, a universe of death;" "where all life dies, death lives, and Nature breeds, perverse, all monstrous all prodigious things, abominable, unutterable, and *unkindly mixed;*" through Milton, Whiston, Woodward, and cosmogenists; through all who would rebel against the majesty of the following definition of the creative force—"Qui sit ubique scilicet præsens, possitque voluntate sua corpora omnia in infinito *suo uniformi sensorio* movere." ‡

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* When we recognise the presence of a whole quantity as unity or the archetype, and discover in its own dimensions the equals of all those proportional quantities which stand in series with this whole;—when, again, we admit the evidence of a law of degradation, and know how possible it is to metamorphose an archetype proportionally, then it is that we may also safely conclude that every proportional of series is part of an archetype or whole quantity. It is not possible for the law of metamorphosis or degradation to fashion a whole from a proportional. But it is within the pale of possibility for it to fashion any proportional from a whole. When we view a whole quantity in presence of the law of metamorphosis, we then give space and material for the exercise of a law of Nature, and thus runs the bearing of the following sentence :—" Mais la Nature n'aurait pas pu les diversifier ainsi à l'infini, si elle n'avait pas un espace suffisant dans lequel elle puisse si jouer, pour ainsi dire, sans sortir des limites de la loi."—Goethe—*Œuvres d'Histoire Naturelle,* page 42.

† "Natura non facit saltus."—Linneus—*Systema Naturæ.* " La Nature ne va jamais par sauts."– Buffon, tome xiv. page 12.

‡ Newton—*Optice. Sive de Reflex,* &c., page 412, in edit. S. Clarke.

Plate 47.

Fig: A'

Fig: C.

Fig: B.

Fig: A''
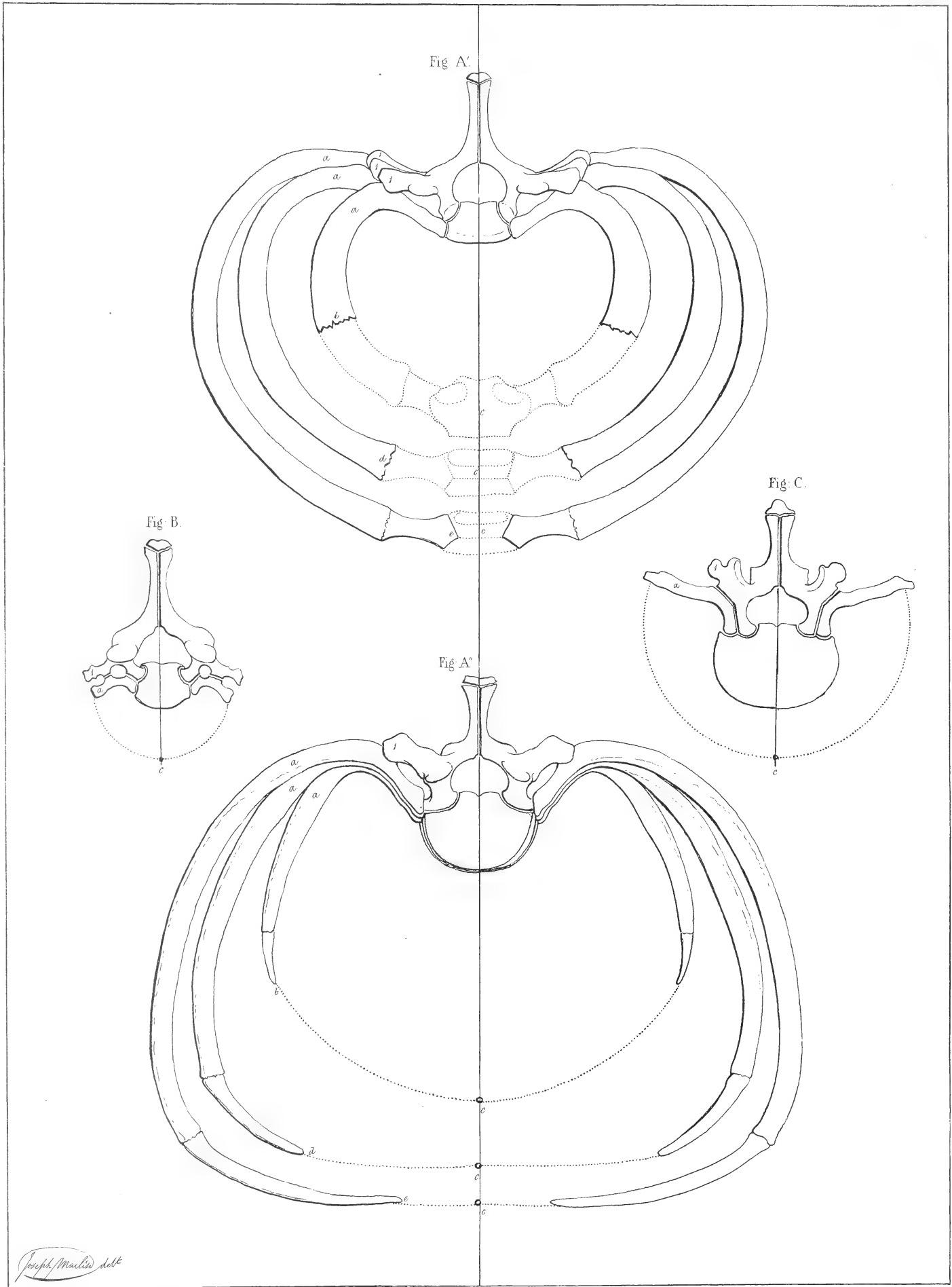
REMARKS ON THE FIGURES OF PLATE XVII.

THE CERVICAL, ASTERNAL-THORACIC, AND LUMBAR OSSEOUS QUANTITIES ARE COMPARED TO THE PLUS
ARCHETYPE.

THE degradation or subtraction of quantity from the archetype or fullest figure in series may take place to any amount. Subtraction may be infinitesimal and inappreciable by sense, in which case it would seem as a differential nothingness, or else it may be so considerable as almost to annihilate the original thus subjected to the operation. In the former case the archetype form would still persist, scarcely altered from itself, whereas in the latter case the archetype would be so metamorphosed from its plus proportion, that it would be difficult to say whether the quantity left from it after subtraction were a part of the original or not. However, the law of proportional series becomes the index and demonstrator of the effects exercised by metamorphosis upon the form of the plus quantity. And those effects are still further interpreted by the facts that minus quantities occasionally are seen to simulate the plus figures. When that form of the cervix or loins develops the cervical or lumbar ribs, then we say that subtraction from an archetype has not operated to the same extent as in ordinary rule.

When we name a form to be the proportional of its archetype quantity, the interpretation presupposes the existence of the archetype. Forms which when held in comparison with each other manifest no other character of difference than that occurring by the proportioning, must then be one and all regarded as the proportionals of the plus archetype which, when subjected to metamorphosis, produced them as they appear. The archetype series must be serial uniformity, whereas the series which manifests proportional character is only rendered various as minus is to plus.

Fig. A′ represents the first three thoracic quantities, and we see that it is possible to render them proportionally various to each other by breaking off the costal forms at b, d, and a. But even if these three thoracic homologues were presented in such condition to the view of the anatomist, he never would fail to read them as forms graduatedly proportioned from the plus quantities which perform the circle, and meet at the sternal region c, c, c. Thus the part would suggest the idea of the whole.

Fig. A″ represents the last three thoracic forms termed "false." If we change this name "false" to minus, then we shall have a clue to the right interpretation of them, as the minus proportionals of plus or archetype quantities. The last floating rib, marked $a\,b$, is evidently the minus proportional of the next rib above it, marked $a\,d$, and this again is as evidently proportioned from the plus quantity

marked $a\,e$. Evidently, therefore, fig. A″ produces the costal forms $a\,a\,a$, as ranging through the lines $a\,c$, and for this reason they may be regarded all three as the varied proportionals of forms fully produced to the median line c, and so they undoubtedly are. For we see that all the anomalies of the asternal costæ principally depend upon the plus advance through the lines $b\,c, d\,c$, and $e\,c$, thus approaching the sternal median line in front.

In fig. A′ we see how the costal circles, when broken off at $b\,d$ and e, would invariably suggest the full archetype quantities produced to the sternal line c. In fig. A we see where Nature metamorphoses the proportional quantities, in fitness terminating them at the points $b\,d\,e$. If, therefore, fig. A″, with the costæ metamorphosed by Nature at the points $b\,d\,e$, be in fact the proportional homologues of fig. A′, whose costal forms are metamorphosed or rendered minus at the points $b\,d\,e$, so may it be inferred that fig. A″, with its asternal costæ, are as minus quantities metamorphosed from archetype originals equal to the forms of fig. A′ in full sternal costo-vertebral type. The variety, therefore, which we see between fig. A′ and A″ is no other than that which plus bears to minus, and so the forms which Nature leaves standing in one region of series as plus quantities have their homologues metamorphosed by Nature in another region of series to minus quantities. Such is the design.

Fig. B, the cervical vertebra, and fig. C, the lumbar

form, hold series with fig. A′ and A″. The exogenous pieces marked 1 in all these forms are still holding their own serial order, and the costal pieces marked *a* in these forms are likewise standing in series, and proving themselves as being only various to each other by the rule of plus rendered minus. That rule which proportions the several figures of the skeleton axis, is also seen to perform the like variations upon the lumbar vertebra C, and the cervical vertebra B, for their autogenous or costal element *a* occasionally traverses towards the median point *c*, thus imitating figs. A″ and A′.

Now it is to be observed of the serial quantities of fig. A′ that, as sterno-costo-vertebral forms, they are still presided over by the law of symmetry. The median line bisects at the same time their sternal pieces *c, c, c*, anteriorly, and their vertebral quantities posteriorly. At both sides of this median cleavage result homologous moieties of the complete circle. And it is also to be noticed that there exists for the forms of fig. A′ not only a lateral homology of structure but also a serial homology. Thus half of the first costo-vertebral circle not only represents its opposite side, but even the corresponding and opposite side of the next succeeding costo-vertebral circle. Furthermore, when we proportion them at the points *b, d, e*, provided we do so symmetrically in reference to the sternal median line *c*, still this line will bisect each proportional quantity equally as to its sides. But as we see them to be unequal as to quantity, the first having been metamorphosed at the point *b*, the second at *d*, and the third at *e*, so are they now rendered serial unequals. However, it is sufficient that we know how the three forms had once actually met at the sternal median line, and consequently they are now to be regarded as various to each other only by our having proportioned them unequally from uniform plus equals. In what other respect, therefore, are we to account the series of fig. A″ to be different to the series of fig. A′, except as minus quantities metamorphosed from such plus forms as fig. A′? If we say that the sternal pieces exist for fig. A′ and not for fig. A″, what else can the difference be except that of plus and minus, creation and increation? If the median line bisects the *sternal pieces c* of fig. A′, does it not also bisect the *linea alba* of fig. A″? If we regard fig. A′ as plus and fig. A″ as minus quantities, who then shall define *genus* or *species* by any other fact of skeleton formation than this of plus quantity being subtracted from? If all the plus anomalies of fig. A″ are but as the approaches towards the median line *c*, does not this very occurrence seem a natural rule of fig. A″ equating itself with fig. A′, the archetype of series?

What is species? Let us first understand what is the law of form. If it be true that the laws of species are centred in the laws of form, then it is reasonable to expect that the revelation of the laws of form will best expose to the root the laws of species. Are the vertebrated skeletons uniform as to quantity? Are the serial homologues of the one skeleton axis uniform as to quantity? Neither skeleton figures of animals nor serial osseous quantities

within the one animal being as absolutely uniform quantities, what then is the source of their difformities and their analogies? Are the skeleton figures produced as things of one species? Are even the serial figures of the one animal produced as things of one species? The answer being in the negative for both questions, let us then inquire whether the source of their structural difformities be the cause of their varieties in species.

What is the law of forms in variety? Is it the law of metamorphosis? If it be so, what then is the archetype figure or quantity which suffers metamorphosis? Should it not be to the recognition of this archetype that all the science of comparison ought to lead? And until it be discovered, what can we know of the transcendent walk of Nature and design, of her creations of forms in variety, and of her species, which are those varieties? What are the differences between figs. B and C compared to fig. A″, and this compared to fig. A′, but proportional differences? Does not the one common median line bisect them one and all, such as they are in series; and does not the serial order bind them together as one continuous entity? Is not the quantity of fig. B or C to be found in any of the asternal costo-vertebral quantities of fig. A″, and are not these latter to be found in the sternal costo-vertebral quantities of the archetype series fig. A′? Is it not within the limits of possible operation to metamorphose from fig. A′ quantities equal to those of fig. A″, and hence to those represented in figs. B and C? Can we not reasonably conceive that the plus originals of figs. B, C, or A″ were equal to those of fig. A′, and that these originals in series represented the prime model of uniformity? May we not state thus much of figs. B, C, A″, and A′ without asserting *ad impossibile* that all these forms are now existing as uniform quantities? If we here assert that they are the several proportionals of a uniform plus series, and that as such they are only various to each other—specifically different as proportional unequal quantities of a plus uniform series, will this interpretation sin either against the law of Nature or the law of reason? Or, supposing that we read them as examples of an absolutely different species, can we at the same time cast aside all ideas of their relationary character, and conjure up to ourselves such vivid impressions of hiatus and dissimilarity between figs. A′, A″, B, and C, as we may recognise between the leaf of a tulip, the proboscis of an elephant, a crystal of sulphate of lime, and a chemist's blow-pipe? If between these things we grant a specific difference in many other respects, beside the fact of their *not* being as the proportionals of each other, certainly the same specific variety cannot be asserted of the opposite figures, which *are* proportional osseous structures, and only diverse as serial plus and minus forms.

Still holding, therefore, to the examination of the word *species*, as applied to characterise *difference* between skeleton quantities, and still believing that a precise definition of this word, as descriptive of the difformity existing between two or more organic products, to be the ultimate aim of comparative science, we shall venture to assert thus

much, viz., that not only is it an impossibility to lay down *this precise definition of species* * between two or more skeleton forms of animals, but it is impossible even to define a constant and fixed special variety between two or more osseous quantities of the one skeleton serial axis ; nay, it is a positive fact that the isolated thing, fig. B, or C, or A″, is not always produced in the condition such as we see it here, for do we not find that either of these figures passes through the variations of excess and defect? To what end, therefore, let us ask, is this laboured search after the limit of special variety and the differential method to lead? Is this finis page of the subject of specific distinctiveness to be found somewhere amongst the infinity of osteological and Palæontological facts of development? Is it still buried amongst some unknown mass of facts which are one day to be discovered to us, or does it lie concealed in some as yet undiscovered law, which awell-grounded principle of comparison carried out upon the facts already known might reveal to us? Before we pass into the subject of animal species, let us first understand something of how fig. A″, the asternal-costo-vertebral forms, are different to fig. A′, the sterno-costo-vertebral archetypes of series.

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* " To conclude, this *whole mystery of genera and species,* which make such a noise in the schools, and are with justice so little regarded out of them, is nothing else but abstract ideas, more or less comprehensive, with names annexed to them. In all which this is constant and invariable, that every more general term stands for such an idea, and is but a part of any of those contained under it."—*Locke—General Terms Human Understanding,* vol. i., p. 439, 20th edition.
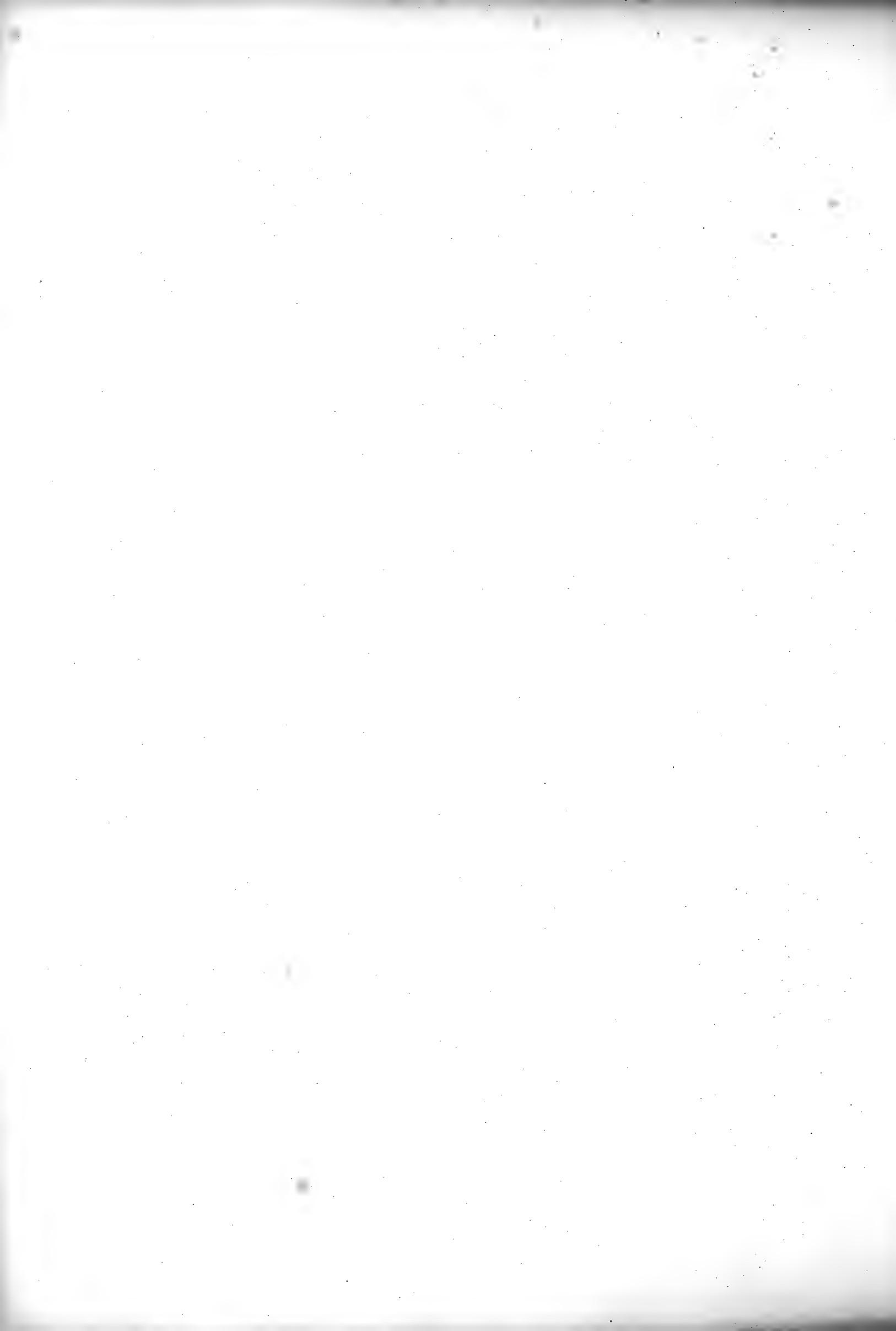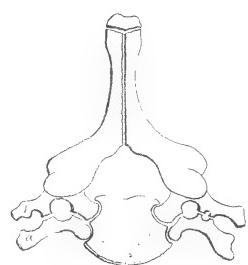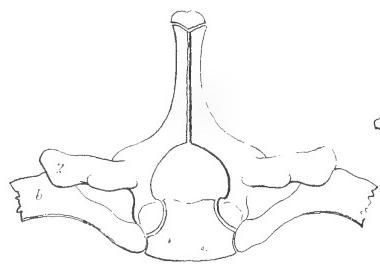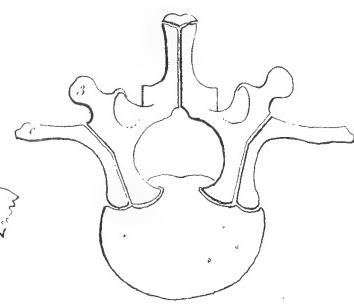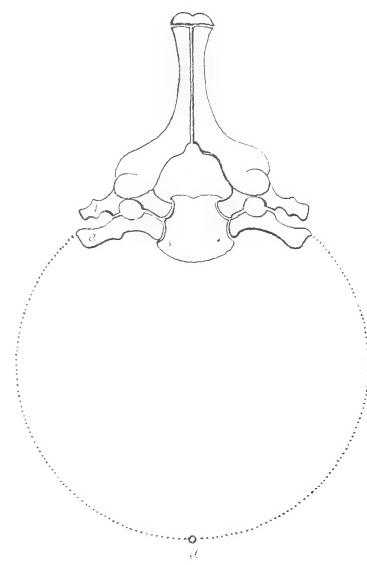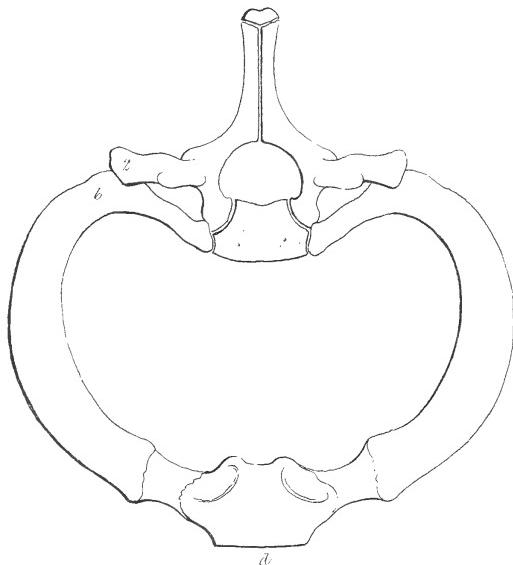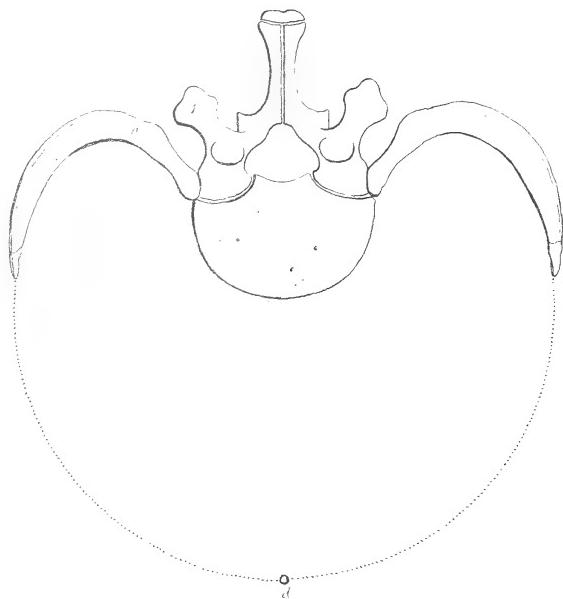
Plate 18.

Fig A

A'

A''

Fig B'

B''

Fig C'

C''
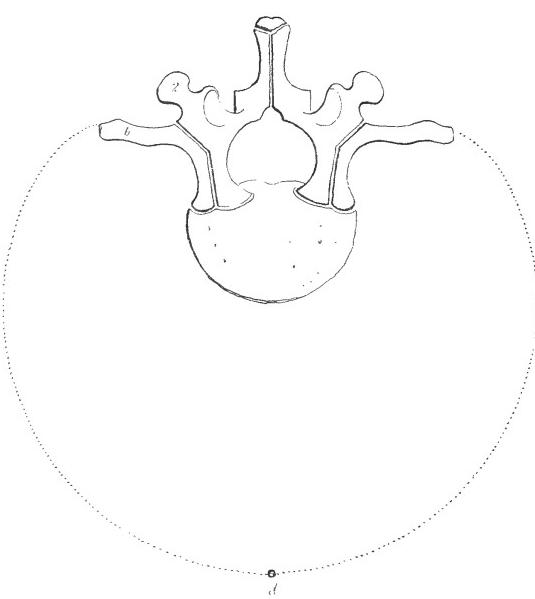
REMARKS ON THE FIGURES OF PLATE XVIII.

THE SEVENTH CERVICAL, FIRST THORACIC, TWELFTH THORACIC, AND FIRST LUMBAR QUANTITIES OF SERIES ARE COMPARED.

SERIAL osseous quantities, in each of which we discover certain elemental parts which are to be found in all, must be accounted as of the same order of growth; but this assertion requires that it should be read in company with the following remark, viz., when we see that those serial quantities are developed in minus and plus condition; it will, therefore, be in vain that we name them to be homologous as to quantity and the number of elemental constituents. If we view the proportional series 1, 3, 5, 7, 9, 11, 13, and call it a homologous series, as though the quantities were all equal to each other, then the term homologous, taken in this sense, must be void and absurd. If we name the serial osseous quantities of the mammalian spinal axis to be homologous in such sense, then the term, as applied to this form, must be also absurd. We do not, therefore, call the osseous quantities, known as cervical, dorsal, lumbar, sacral, and terminal, homologous, in the sense of equality. These quantities *are* unequal; therefore, they cannot be now *named* equal. But if it be said, that since they are not equal, homologous, or identical, they must therefore be named difform and specifically various, severed apart from uniformity, and in nowise allied to it, because they do not absolutely figure the shape of equality, which is *complete* uniformity—then we say that this conclusion would be no less absurd, for we find that, although they cannot be named equals as to quantity, still, on the other hand, they cannot be called species absolute and *per se* in any other sense than that of being the proportionals of a common archetype form. What, then, are we here to understand of these serial quantities, which cannot be named uniform, and yet cannot be named absolutely difform? We must content ourselves to read Nature as she is, viz., a creation of original uniform plus series, under a metamorphosis whereby equality is rendered unequal.

When equal degrees of metamorphosis take place upon the forms of three or more archetype quantities in series, then equal proportionals are the result. Thus, fig. A″, the proportional of a thoracic archetype metamorphosed at the point b, is rendered equal to fig. A′ the cervical vertebra, and to fig. A‴ the lumbar vertebra. These three forms, such as they are represented, manifest homologous elements; but whilst we know that it is we ourselves who have metamorphosed fig. A″ from the thoracic full quantity, and have thereby equated it with figs. A′ and A‴, so, for the like reasons, may fig. B′ or C″ the cervical and lumbar vertebræ, be equated with fig. B″ the full or plus quantity of series. This interpretation would not transgress the the law of Nature, for there is not, in fact, anything more mysterious in Nature herself fashioning the vertebræ of cervix or loins as a minus quantity of the plus archetype, than there is in any one severing the form A″ from the

form B″. The law of Nature is always simple enough; but it is we ourselves who complicate her, and heap over her person the incongruous ruin of misinterpretations.

Fig. B′ is the seventh cervical vertebra, and is a form homologous to a certain proportional quantity of fig. B″ the first thoracic archetype. Both these figures are placed in series adjoining each other. In fig. B′ we find the piece 1, and in fig. B″, we find the like exogenous piece marked 2. In fig. B′, again, we find the autogenous element marked a, and in fig. B″ we find the rib marked b. What, then, is the conclusion to be drawn from both these facts? Is it not that Nature has metamorphosed fig. B′ from a form such as fig. B″? For do we not find, that the anomalies of B′ traverse the circle ending in the point d, just as we find figure B″ making the circle with its costæ meeting at the sternal point d? And can any one deny, that the costal anomalies of the cervical vertebra

B′, are the projections of the autogenous piece a, just as the costa of B″ is produced from the piece b, to the mid sternal point d.

Now, fig. C″, the lumbar vertebra, is seen to hold elemental pieces similar in form and equal in number to fig. B′ and fig. A″, which are the cervical and dorsal proportionals of the thoracic archetype B″; and we find that the autogenous elements b of fig. C″ occasionally traverse the circle towards the median point d, hence, simulating the character of fig. B″. It is for this reason that fig. C″ must be interpreted as the proportional of such an archetype quantity as fig. B″.

Fig. C′ is the last or twelfth thoracic quantity, and its floating costa marked a performs, in like manner, through some part of the circle towards the mid point d. Hence it is also to be accounted as a proportional of the archetype quantity equal to fig. B″.

Fig. B′ and fig. B″, therefore, mark the proportional transition from cervix to thorax; whilst fig. C′ and fig. C″ mark the proportional transition from thorax to the lumbar spine. In the former transition, we discover minus to be succeeded by plus; whereas, in the latter transition, we see that plus has been metamorphosed to minus. This variation we believe to have occurred on the figures of originally homologous archetype quantities, such as fig. B″.

In the duty, therefore, of interpreting Nature as she is, and not, as it were, recreating her and bending her design to suit with preconceived hypothesis, we apply ourselves to the study of her serial order, and find the quantities of this to be arranged in plus and minus variety. These quantities, such as they are, manifest the fact that the minus figure is to be found in the plus figure, and, also, that the plus figure may be subtracted from, and rendered equal to, the minus quantity. Hence, we say, that the minus quantity may, by addition of elemental structure, be equated with the plus quantity; and if this be said to be a licence performed upon created series with too free a hand, we then, in reply, say that Nature herself is known to perform the same acts, and, therefore, that it is only a copy of natural precedent. For it is the truth, that fig. A′, *the seventh cervical vertebra*, is seen occasionally to *equate itself* with the plus amount of fig. B″, *the first thoracic archetype*; and also that fig. C″, *the first lumbar vertebra*, now and then actually *equates itself* to the proportions of fig. C′, *the last thoracic quantity*. Whereupon, we venture to ask the following question, as to what we are to understand of the word *species* as characterising fig. B′ from fig. B″, or fig. C″ from fig. C′, when it is a living fact that fig. B′ is not itself fixedly, nor fig. C″ remaining itself persistently, even in the one serial order of human type?

When we shall consider the facts of how *minus quantity increases to plus*, and how *plus quantity decreases to minus*, we then will acknowledge to a condition of development which can, with as little propriety of speech, admit the application of the word species (in the sense of absolute difformity) to plus or minus quantity, as the *oscillations* of a pendulum can suffer to be described as *fixation*. Evidently, therefore, if we would understand something of the comparable minus and plus figures, such as figs. B′ and B″ or C″ and C′, we should concentrate attention as well upon the law of their development as upon the things produced; and just as when we contemplate the body itself, whilst oscillating through an arch, we inquire, at the same time, into the laws of its motion. If we name fig. B′ as one species compared to fig. B″ as another, at the same time that we know the former is only minus and the latter plus, and also that minus grows to plus, just as plus may be metamorphosed to minus, then we say that there is as little substance in the word species, when applied to characterise the *permanent distinctness* of these bodies, figs. B′ and B″, as there would be in applying the word species to characterise difformity between two or more radii of the same arch, when the motionary pendulum, as one and the same thing, becomes each radius successively.

Acknowledging, therefore, to the facts of the case, we say of fig. B′ that it is a minus quantity compared to fig. B″, a plus quantity, and that we find both these figures standing in the one serial order. With this acknowledgment, which cannot be disputed, we shall next briefly consider the two following themes, viz., the law of species and the law of form. And first, let us ask ourselves the question, to what end does the study of one and the other of those laws promise to lead us? Has the differential method of searching out the limits of species in osteology any end? This must be answered in the negative; for, not to mention the fact that it is a theme which stretches as far back into antiquity as when Hippocrates, stringing vertebræ together, offered them, as indecipherable enigmas, to the Delphian God, and gave up, as a lost subject, the pursuit of specific variety whose name was infinity; so let us here know plainly, that if, by the differential method, we continue to read fig. B′ as a species of fig. B″, we should also, at once, understand that fig. B′ becomes, by the like rule, a species to each and all of its phasial plus conditions of infinitesimal additions of quantity, till we find it of the same plus cast as fig. B″, the whole quantity. And to this let it be added, that fig. B″ is struck specifically various to itself through all the phases of infinitesimal subtraction of quantity, till it represents the form of B′, a proportional quantity. For the plus figure becomes varied by subtraction as much as the minus figure is varied by addition.

The differential method is a subject illimitable in all cases as well as that of comparative osteology; and it is, therefore, that the mind renounces it altogether, or sleeps over it, for this is the physiological fact which we always observe to be evinced by an audience when the lecturer, *subdividing a point, annihilates the thing by the act*. When we are told, that between the rational numbers 1 and 2, there exists an infinity of irrational numbers, who then shall remain awake and interested for the demonstration of the mean proportional of 1 and 2, or the root of 2, while we find that 1 is not sufficient, and $1\frac{1}{2}$ too much, from which, if we subtract $\frac{1}{8}$, we shall have subtracted too much, and if $\frac{1}{16}$, too little? If this be all necessary to the

rigorous investigations of mathematical law, surely it need not be applied to comparative osteology, especially if we may, by the spontaneity of a quick conviction sufficient for anatomical truth, already know that fig. B″ is the whole or rational quantity, that fig. B′ is a proportional of the like quantity, and that the irrational numbers or quantities between plus and its proportional are such as we have marked them in the points of the circle *d* of fig. B′, though perhaps not numerously enough.

If, therefore, the law of species, as pursued by the differential method be a theme which dates from the Stagyrite,* and in all probability will, if pursued in this spirit for three thousand years hence, be still the same. If its proper emblem be the "quadrature of the circle," so far as it is not worth one jot to comparative anatomy, whose sole object is to know of *the whole quantity of unity*, and to understand how the metamorphosed figures of this may be infinite, as species are infinite, in such case we say that it is the law of metamorphosis to which unity is subjected, just as it is the law of motion to which matter is subjected, which must become the theme of limitation. And in this understanding, we shall name fig. B″ as the symbol $a + b$ which quantity, when b shall be subtracted from it, will become fig. B′, which we shall know hereafter by the symbol $a - b$, and so of all the plus and minus quantities of the series.

* In ancient Athens, as in modern Paris, the differential method has been pursued only to the same result, viz., the parallelism of plus and minus figures, with still the disputed questions of unity and variety. "Since some of them *differ in the more and the less* with respect to *man*, and man *differs in the more and the less* with respect to *many animals.*—(Aristotle,—*History of Animals*, book viii. chap. i.) "Car, allant d'une espèce à l'autre, il fait chaque fois appel de tous les materiaux, et met sur le compte des différences, *l'absence ou l'atrophie des uns, et l'hypertrophie des autres.*"—Geof. St. Hilaire.—*Principes de Philos.-Zoolog. Disc. Prelim.* p. 12.
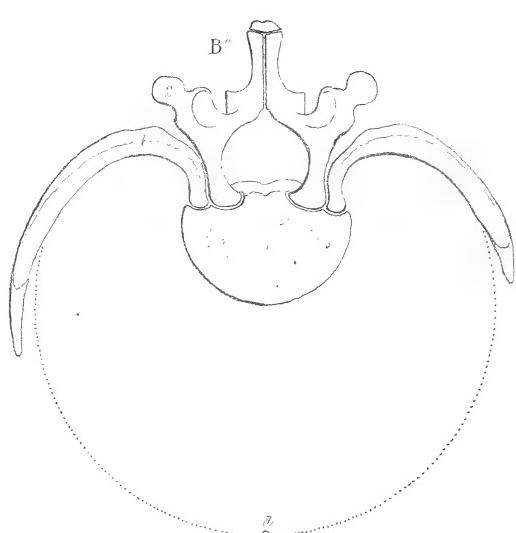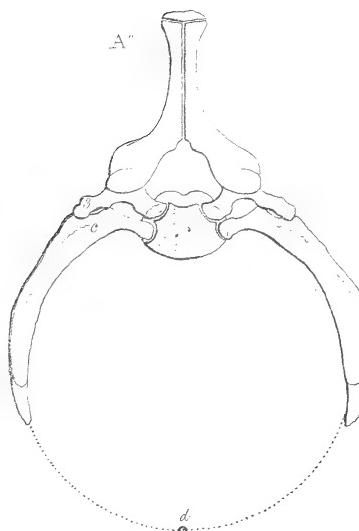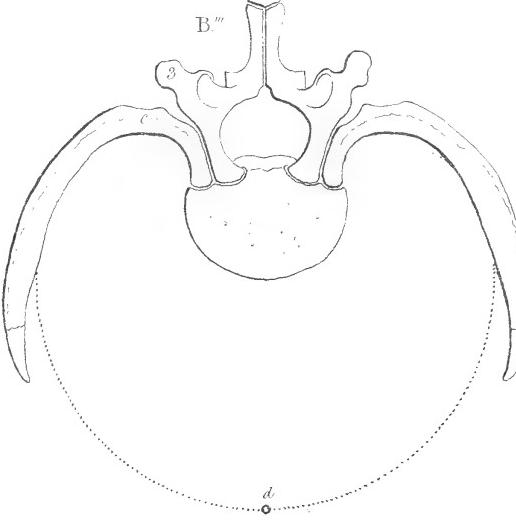
Plate 19.
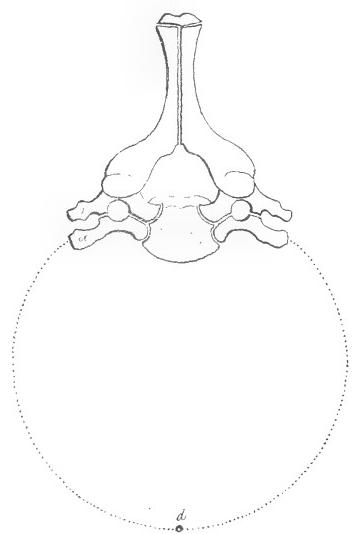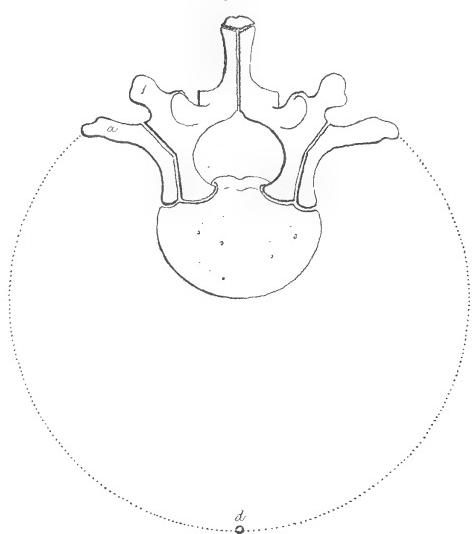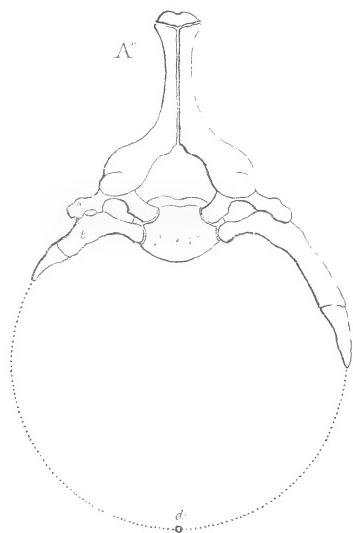
Fig. A'.

Fig B'.

A''.

B''.

A'''.

B'''.

Joseph Maclise delt.

REMARKS ON THE FIGURES OF PLATE XIX.

CERVICAL AND LUMBAR RIBS ARE THE PROPORTIONALS OF THE PLUS ARCHETYPE OF SERIES.

ANOMALIES of formation are created things produced as integral parts of existing quantities, and being so, we should ask ourselves the question, whether they may not be "anomalous" rather to our own creation of nomenclature, than to the law of form under which they appear as the creations of Nature? When we limit inquiry to certain prescribed bounds, we then blot out from the chart of experience all other creations lying without those boundaries. When, on the contrary, we widen the sphere of observation, and are determined to carry comparison as far as it will go, it is this broad survey of relationary facts which, in an inverse ratio to itself, contracts the space where anomalies have once stood unaccountably created, by lending them the light of interpretation. The anomalies of form in special anatomy become the very bonds of connexion which render comparative anatomy a continued chain of extended reasoning carried out in discovery of a law, and this law appears to be that of a graduated chain of form.

The plus quantity of series must be regarded as the archetype of series and also as the unity. For it is evident that since variety is only the minus proportional of the plus, and as Nature can metamorphose, from plus, a graduated serial variety even to terminal atoms, such as will escape all physical vision, so must we rather mount up to archetype quantity for the character of unity than pass down with Nature and make search for it amongst her infinitesimal atoms. The archetype quantity we know can be metamorphosed to the smallest proportional quantity, and the knowledge of this fact is all sufficient.

Fig. A′ is the seventh cervical vertebra, or the seventh spinal unit of series. In one human cervix we meet with this condition of development where the autogenous element a has not passed beyond its usual dimensions.

Fig. A″ is another condition of development presented by this seventh spinal cervical unit of series, and in it we discover that the autogenous element b is produced through some part of the circle towards the mid point d. On the opposite sides of this fig. A″ we see that this autogenous element b is unequally produced. It is longer on one side than on the other, but still the longer side is seen to traverse the circle.

Fig. A‴ is a third condition of development in which this seventh cervical spinal unit presents to us, and here we discover that the autogenous elements c of both sides have still further traversed the circle towards the mid point d. The special or human anatomist names figs. A″ and A‴ as the anomalies of fig. A′.

Fig. B′ is the first lumbar vertebra, or the twentieth spinal unit of series, and presents this condition of form in one human loins. The autogenous element a has not exceeded its ordinary bounds.

Fig. B″ is another condition of form presented by this same twentieth spinal unit of series, and here we find that its autogenous pieces, marked b, have traversed the circle with unequal degrees on either side towards the mid point d.

Fig. B‴ is a third condition of development presented by this same twentieth spinal unit of series, and it shows how the autogenous pieces c have still further progressed through the circle towards the point d. The human anatomist names figs. B″ and B‴ as the anomalies of fig. B′.

Figs. A′ A″ and A‴ represent the seventh cervical spinal unit proportionally various to itself. Can any one therefore doubt that fig. A′ is the minus proportional of fig. A‴?

Figs. B′ B″ and B‴ represent the first lumbar or twentieth spinal unit proportionally various to itself, and who will doubt that fig. B′ is the minus proportional of fig. B‴?

If this interpretation cannot in reason be doubted, perhaps there will be as little reason to doubt the fact proved by general comparison carried through the animal kingdom, that all these figures are but the minus proportionals of the thoracic archetype quantity, which is the archetype unity.

It may be taken for granted that any interpretation of the forms of Nature which shall reconcile the anomaly

as product of a law, must be correct. And thus it is that we call figs. A′A″A‴ a series of proportionals metamorphosed from an archetype which we find still standing in thoracic series, under which interpretation we include figs. B′B″B‴ also.

Hitherto we have compared one figure with another separate figure in the same serial order, and we have seen that these were the proportionals of an archetype common quantity. But now we compare the same ens with itself, and discover it to be proportionally various to itself. Thus figs. A′A″A‴ are several conditions of the seventh cervical vertebra, and figs. B′B″B‴ represent several varieties or proportional quantities of the first lumbar vertebra.

With these facts before us, we shall briefly consider the several views of the three departments of anatomical science, in so far as the subject of osteology concerns them separately, and we shall inquire of each, to what result they promise to lead onwards from what we already know.

Special anatomy gives the name vertebra to fig. A′ and B′ of the cervix and loins. Vesalius has called these quantities vertebræ, and —— continues to call them by the same name to this hour. Vesalius would have named figs. A″ and A″ the anomalies of fig. A′, and so does —— to this very day push blindly against figs. A″A″ as though they were obstructions met with in the dark. Thus special anatomy remains still in that condition in which it found itself when it first begun, certain of no failure, because rising to no effort.

Now, comparative anatomy pursuing the differential method in the vain and useless quest of the line which separates special varieties, continues also to know fig. A′ as a vertebra the seventh quantity of the mammalian cervix, and because it wishes to read it as a law invariable that the cervical region of the mammal spine should (for its own sake) never overstep this set rule of *a cervical region of seven vertebræ*, so, even when it does transgress and make exception to the stated rule, why then "*the exception does but prove the rule*," and so the rule endures. But does this rule endure in nature? Are there not exceptions, many and various, in an animal kingdom? Many even in the class mammalia? Many even in the human species? Many even in any and every species? Nay, more, is it not the fact that the transition region between the mammalian cervix and thorax is as much liable to overturn the cramping rules of nomenclature as the transition region between the mammal thorax and loins? Still, by the differential method, comparative anatomy draws the arbitrary line of special distinction between Mammals as a class and that of Aves, of Reptilia and of Pisces, for as much as fig. A′, the seventh vertebra of the mammal cervix, is at least *said* to terminate this region, which is then immediately succeeded by the thoracic series. If this be the fact, whence comes the seventh cervical form of fig. A″ or A‴, which not only interrupts the rule of classes but even the rule of species? Is it not plain that the same crude method by which the human anatomist distinguishes the seventh cervical vertebra from the first thoracic form (heedless of the proportional series of figs. A′A″A‴ with which he may fill up hiatus) still guides the comparative anatomist * to make search after the root and origin of the form of species or difformity, which is in fact non-existent, rather than to make search after a law of formation, which must discover to him that uniformity is absolute unless when negatived by the subtraction of quantity, which negation is and ever has been the *ignis fatuus* or intrenchant nothingness, impersonated only by the sound or name of difformity or species, and hence mistaken for an actual creation.

Philosophical anatomy reaches to the comprehension of a law.† It beholds the creations of Nature as things comparable to one another, notwithstanding the existence of proportional variety. It contemplates those creations in the aggregate, and it reasons upon them in the abstract, invoking the adage "ab uno disce omnes," because all facts point to the oneness, and because in this oneness consists all the series of facts. Because unity is the abstract idea, and because all varieties still describe this abstract truth. Lastly, because all truths are abstractions, and because it is Nature herself who invites to this mode of contemplating her works. The simple rule of $a+b=c$ is an abstract idea, implying also that $c-b=a$. The comparison held between two vertebral quantities is another. The "calculus infinitesimalis" is a more complex abstraction of the mind, and the "unity in variety" of anatomical reasoning is its counterpart law of certainty. From the simplest to the most complex mental operation, whether in mathematical calculation or in anatomical comparison, the reason passes through a series of abstractions, and the farther we penetrate into the law the more general and comprehensive are the truths which it reveals.‡ The farther we advance in the rule of comparison the more extended becomes the field of analogies, and the nearer we approach to uniformity the more does *specific variety*, *difformity*, and *anomaly* become dissipated in the light and revelation of a law of nature.

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* " Nos nomenclateurs modernes, paraissent s'être beaucoup moins souciés *de restreindre et reduire au juste le nombre des espèces* ce qui néanmoins est *le vrai but du travail* d'un naturaliste, que de les multiplier, chose bien moins difficile et par laquelle on brille aux yeux des ignorants ; car la réduction des espèces suppose beaucoup de connaissances de réflexions et de comparaisons, au lieu qu'il n'y a rien de si aisé que d' en augmenter la quantitè."—Buffon, *Oiseaux*, tom. i. p. 71.

† " *Les lois*, dans la signification la plus étendue, sont *les rapports nécessaires* qui derivent de la nature des choses."—Montesquieu, *Esprit des Lois*, lib. i. chap. 1.

‡ " En récherchant les lois suivant lesquelles sont formés des êtres distincts vivant et agissant par eux-mêmes, nous ne nous perdrons pas dans l'infini, mais nous nous instruirons sur ce qui nous concerne. L'idée seule d'un être vivant, existant par lui-même, séparé des autres et doué d'une certaine spontanéité, emporte avec elle *l'idée d'une variété infinie dans une unité absolue*."—Goethe, *Œuvres d'Hist. Nat.* p. 69.

Plate 20.

Fig A'7.

A''7

A'''7

Fig. B'1.

B''1

B'''1

Fig. C'1

C''1

C'''1

Fig D'1

D''1

D'''1

E''1

E'''1

Fig E'1

Fig F'4

F''4

F'''4
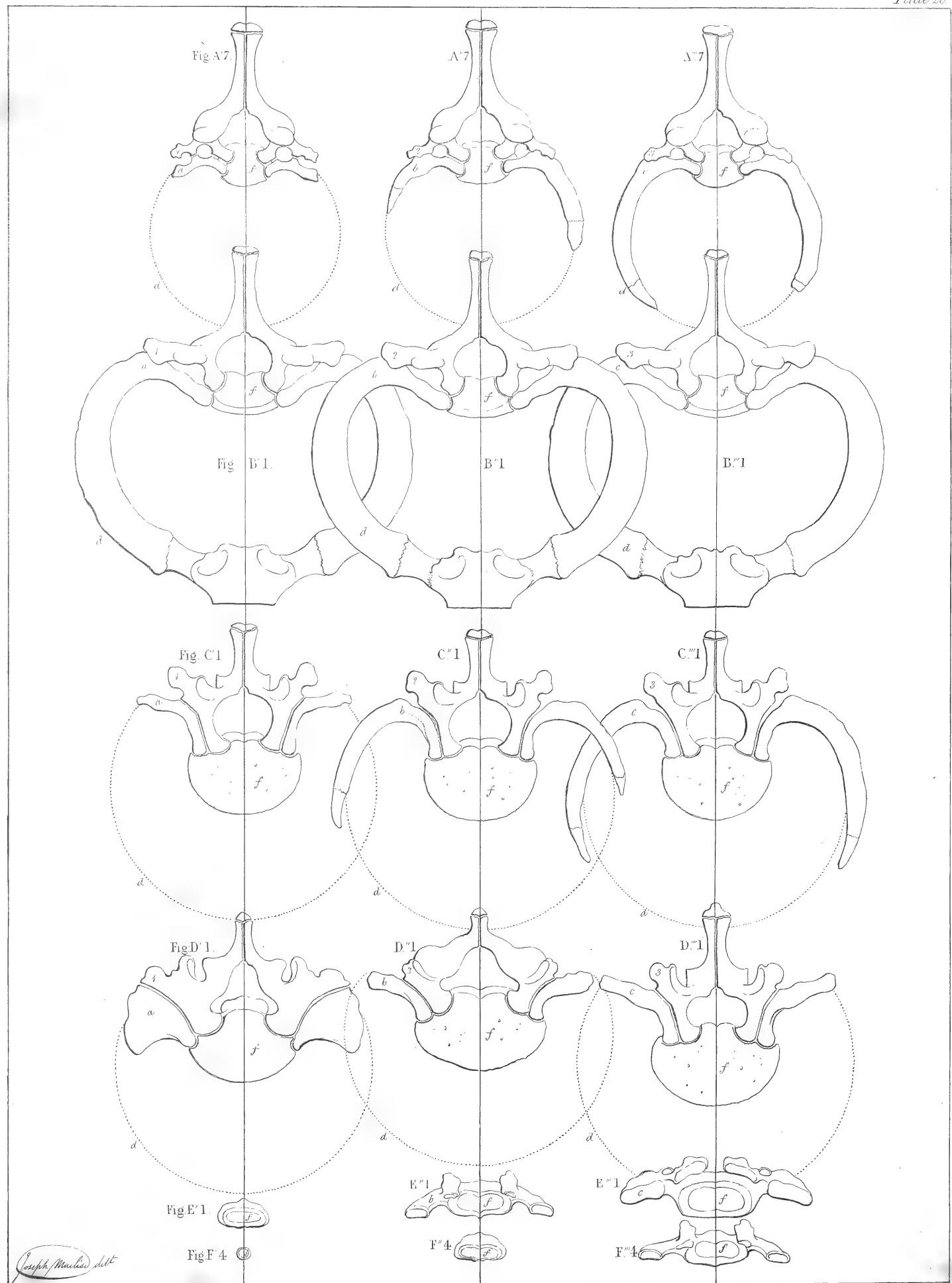
REMARKS ON THE FIGURES OF PLATE XX.

THE NORMAL AND ABNORMAL OSSEOUS QUANTITIES OF SERIES ARE PROPORTIONALS OF THE PLUS ARCHETYPE

TRANSCENDENTAL Anatomy has for its object the comprehension of that whole quantity which is the sum and substance of unity. Its comparisons lead onwards to that generalisation or abstract view which pervades many particulars. It is taught under the light of comparison and by the actuality of similitude, that all particulars point, in mass, to the figure of a whole quantity or unity, which, when it has recognised in combined shape as an integer or plus structure, it then turns into the track of a law of formation, since it easily discerns how the disintegration of unity, or the whole, can furnish all diversity and the parts. The whole quantity contains all the parts, and therefore it is that those parts admit of being readjusted, so as to recreate the figure of the whole quantity, and this is the aim of all comparative reasoning. The comparison of parts or fragments as such will never rise above specific distinctions, but the comparison of fragments, having for its ultimate aim the reconstruction of the whole by the coaptation of all its relationary parts, is a process of the reason which promises a final result. Skeleton quantities are the parts of unity, or a whole ; hence, the comparison of such quantities, parts, or fragments, conducted under the search of specific differences, may be accounted a theme which takes a lease of infinity and submits to all the future a task as boundless as that which has busied all the past. Difformity is the characteristic of the parts, forasmuch as those parts may vary as to quantity in infinitum. But unity is that finite whole quantity which the natural relationship of the parts with one another make a completed ens.

The fitting and the anomalous forms are what we understand to be the normal and abnormal products. Cervical and lumbar vertebræ, preceding and succeeding the thoracic region of series is the fitting condition of development for a mammal spinal axis. There is no one who will venture a doubt as to the design of nature in thus fashioning the fitness of form. We at once see it, we know it, and we acknowledge the fitness; but still we remain inquisitive about the law which produces it : and we here assert, that this law is one which shapes the required design from an original archetype series of figures, such as those standing at the thorax; also that the law is one of metamorphosis, which degrades the form of the archetype to fitting proportionals; also that the cervical or lumbar anomaly of costal form is nothing more mysterious than being a proportional of the archetype quantity left standing of larger dimension than is ordinarily presented to the anatomist's observation. Hence we infer that the form, which is anomalous to the type human, is not anomalous to the transcendent type of unity, from the figure of which latter all variety is struck out, and which varieties are nothing more than proportionals of archetype quantity.

Figs. A′ A″ A‴ represent different conditions of development seen in the seventh cervical unit of series. Fig. A′ is a proportional of fig. A‴.

Figs. B′ B″ B‴ represent homologous conditions of de-

velopment proper to the first thoracic unit, which is the eighth unit of the spinal series. Fig. B′ is homologue of fig. B‴, and figs A′ A″ A‴ are the proportionals of such as fig. B′.

Figs C′ C″ C‴ are different conditions of development, seen in the first lumbar vertebra, which is the twentieth unit of spinal series. Fig. C′ is the proportional of fig. C‴, and this is a proportional of fig. B′; that is to say, of the homologue of fig. B′.

Figs. D′ D″ D‴ are different conditions of the first sacral vertebra, which is the twenty-fifth unit of spinal series. Fig. D′ is the proportional homologue of fig. D‴, and this is the proportional of fig. B′ also.

Figs. E′ E″ E‴ are various conditions of the first caudal vertebra, which is the thirtieth unit of spinal series. Fig. E′ is a proportional of fig. E‴, and this is a proportional of fig. B′.

Figs. F′ F″ F‴ are various conditions of the last caudal bone, which is the thirty-second or thirty-third unit of spinal series. Fig. F′ is a proportional of fig. F‴, and this is a proportional of fig. B′.

In figs. A′ A″ A‴, therefore, we see that the seventh cervical unit is only created proportionally various to itself by the very same rule of metamorphosis which renders figs. A′ B′ C′ D′ E′ and F′ proportionally various to each other.

But whatever be the degree of variety as to proportioning which marks those several forms, we still see that their serial order, from first to last, renders them cleavable through the median line. This same median cleavage, which passes through the centre of the thoracic archetype B′, divides the smallest proportional of such an archetype in fig. F′; the last caudal nodule.

The median line, which renders the created archetype fig. B′ bipartite, may be said to pass through the centre of the ideal archetype of fig. F′, its smallest proportional.

We have described the circle of increase through which all those forms A′ B′ C′ D′ E′ and F′ are more or less produced.

Now, hitherto we have confined our comparisons to the serial osseous quantities of the one species of spinal axis, and the reason is, because we have seen that it contains within its own proportions the very same subjects of "specific variety" and of "unity" which pervade the general animal kingdom. In the comparison of those proportional quantities which constitute the human spine, the anatomist may (according to the bent of his capacity,) pursue either the differential method of characterising two or more quantities of osseous product as species, or he may point his method so as to work out the creation of original uniformity upon the facts of analogical reasoning. But before we pass into the infinity of specialities which pervade an animal kingdom, we should first have exhausted comparisons by the facts of development nearer at hand, and when we shall have gathered together the full sum of even these—a comparative few—perhaps we shall be better prepared to comprehend the universal many.

It is by the diligent observance of phenomena near at hand and in view that we are enabled to discover the general laws of Nature, removed to a distance both as to time and place. It is by the proximal and existing rule of analogy that the mind is invited to the interpretation of remote phenomena, and to deduce, if it cannot actually demonstrate, the transcendent and universal operation by those which lie immediately within our reach. For Nature repeats herself throughout infinity, and the visible and adjacent proofs of this fact render all further deductions of this kind most plausible. We are thence taught to depend upon the supposition that the Auctor Naturæ operates uniformly, and in constant observance of those rules which we now take for principles. The comparison of several facts or phenomena renders observable the likeness or conformity existing between them. The natural operation, within presence of which we stand, is analogous to the operation far remote. In Physics, the gravitation of a stone, the rising of the sea to the moon, and the cohesion and crystallization of bodies are not stronger evidence of the oneness of universal law, than is the human skeleton fabric (constituted of proportional quantities) a proof that it is the like law of proportioning from plus quantity which extends itself through the graduated chain of being.

Conducting our comparisons, therefore, amongst the osseous quantities of the one serial axis, we find the law of formation to be one of metamorphosis, or the subtraction from a plus original, and the adjacent proof of this fact gives the whole history of the law which presides over the development of all the skeleton fabrics of an animal kingdom. For, connectedly, as we see figs. A′A″A‴ to be a proportional series of the seventh cervical unit, so, connectedly, we infer that figs. A′B′C′D′E′ and F′ are also a proportional series of separate units whose originals are the equals of fig. B′ the archetype of series, or that plus quantity to which may be referred not only all the normal proportionals of series, but even all the abnormal products which occasionally make the mammal axis vary to itself. And who shall stay this ever-occurring variation of quantity by the rule of specific distinction? If classifiers designate one species by the existence of fig. A′ as a seventh cervical figure, and another by the existence of fig. A‴ as another condition of development proper to the seventh cervical unit, then let them carry out their rule and establish special variety between three human skeletons from whose cervices we have taken figs. A′A″A‴ as the seventh cervical vertebra.

But there is a call which invites the mind to cast aside the everlasting labour and unproductive task of endlessly recording specific variation and of chopping the unity into its infinitesimal parts, and trammelling these with such names as Epial, Perial, Cycleal, Paraal, Cataal.* Unity, or the whole quantity, is the intelligible bond of plurality, or the parts of unity.† When the figure of unity, or the Warwick Vase, shall chance to fall from its pedestal, and shall lie strewn before us in fragmental plurality, we then would not have recourse to the lexicon, in order to create the long account of nomenclature as recordative of the many, which only relate of the original one. When we read the Epic through its rise and fall of action, we do not merge the unity of its whole design in the barren criticism of its isolated words and letters. And when, by a comparison of the opposite forms, there appears every reason to interpret that fig. B′,‡ like a whole quantity, suffers metamorphosis to the proportional variety of figs. A′ C′D′E′ and F′, why need we, then, vex the drowsy ear of Morpheus with the senseless drumming of a nomenclature which, even though it be classically founded, cannot blind us to the facts that fig. A′ may be figs. A″ and A‴, and consequently the proportional of fig. B′; to which latter quantity even fig. F may rise by a mode of equation, because fig. F is none other than the proportional of such as fig. B′. If we never discover this to have place in the mammalian serial axis, the "teleological" fact is, that the mammal axis, which is a fitness by converging series, would be an unfitness by the existence of all the series of plus archetypes or costo-vertebral forms.

* Names used by Geoffroy to characterise the several pieces of his "typical vertebra."

† "Reason's comparing balance rules the whole."—Pope. *Essay on Man.*

‡ "La partie d'un tout organique est incontestablement douée d'un organisation d'autant plus élevée *qu'elle répète plus parfaitement en elle l'idée du tout*, et le tout lui-même est d'autant plus parfait, qu'il correspond d'avantage a l'idée de la nature entière dont nous dévons reconnaître que l'essence est *l'unité des lois éternelles révéllées dans l'infinie diversité de la manifestation.*"—C. G. Carus, Traité Elément d'Anatomie Comp. Chap. II., p. 26: traduit par J. L. Jourdan. See also Carus, Von den Urtheilen des Knochen und Schalengerüstes, fol., Leipzig, 1828.

Plate 21.

Fig. A'   A"   A"'

Fig B'   B"   B"'

Fig C'   C"   C"'

Fig D'   D"   D"'

Fig E'   E"   E"'

Fig F'   F"   F"'
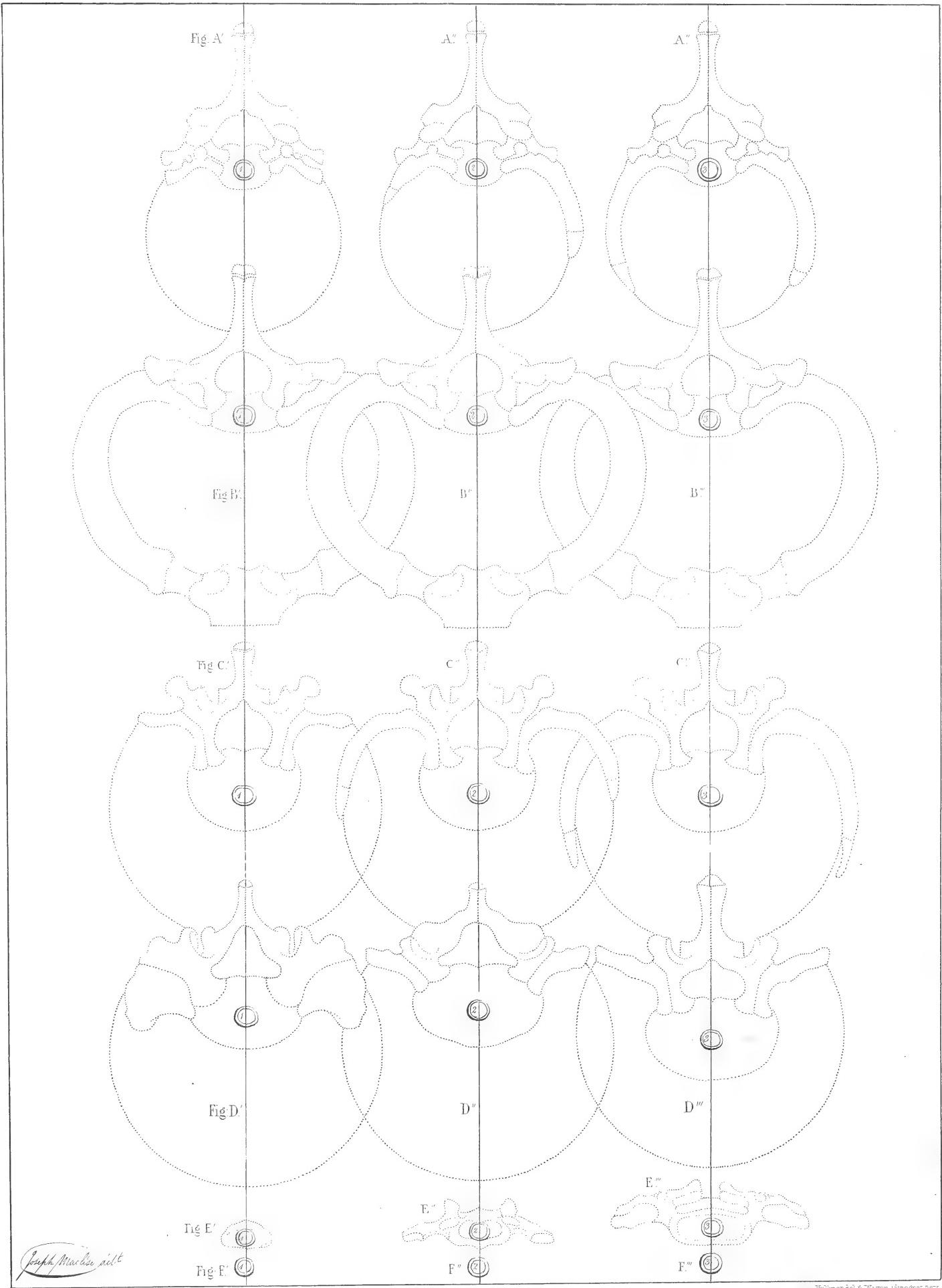
REMARKS ON THE FIGURES OF PLATE XXI.

THE CAUDAL QUANTITY IS COMPARED WITH EACH QUANTITY IN THE SAME INCREASING SERIES.

METAMORPHOSIS, or the subtraction of elementary parts, has no limit on this side of total annihilation. Any whole quantity, however great may be its proper dimensions, will consequently, when submitted to the operations of metamorphosis, be varied from its original self, through all gradations of change which can occur between the extremes of plus and minus. Variety is infinite, because the law of its creation is one of infinite gradation. When from any given integer this law of metamorphosis subtracts an infinitesimal part, therewith may be said to commence the line of species or variety, and this line extends itself till metamorphosis which first subtracted an infinitesimal from the integer, may degrade the integer to an infinitesimal at last. The law of species follows the law of subtraction not only through the rational numbers or quantities of decreasing series, but also through the irrational numbers; and therefore it is that we say any search which will be made for the limit of special variety, must be irrational also, for it is located *in nihilo*. On the other hand, we find that the law of increase, or addition, is bounded by certain limits. The archetype or plus sum of form is limited. The integer of number is, like the integer of space, an unknown quantity. But form, or the measurable ens and created embodiment of a thing which has its counterparts in Nature, must have limits. The thing which comparative osteologists name as unity, must have limits, and those limits must be a whole structural entirety.

The smallest proportional of series which can be referred to a part of the archetype quantity standing also in the same series, must be a proportional metamorphosed from its own archetype. Thus, as we find that, in the serial spinal axis, the last caudal ossicle stands in the line common to all the centrums, so therefore as it holds series with the centrum of the thoracic archetype, it must be a proportional of its own archetype which may be considered equal to that of the thorax.

This assertion may at first sight appear to be a mere stretch of imagination. But it is a fact that natural truth far outstretches even the imagination, and we only for the first time discover the truth when we progress with nature through her easy law of gradation passing from plus to minus by those slight shades of variation which are scarcely discernible between the adjoining quantities, but which become fully obvious as a sum total when compared by the extremes.

The plus and minus quantities of the serial spinal axis are instanced in the thoracic archetype and the last caudal bone. Between the sternal thoracic quantity or plus and the next proportional of such a plus, viz., the asternal thoracic quantity, the variation is but slight. Between the last thoracic quantity, or twelfth costo-vertebral form, and the first lumbar vertebra, the variation is also slight. So, in like manner, but a very slight variation marks the penultimate and ultimate caudal bones. But when we hold in comparison the sternal thoracic archetype with the last caudal ossicle, its fellow of series, then it is that we marvel at the extremes of variation. This variation, however, is only one of proportioning, metamorphosis or subtraction, and hence if we interpret the caudal ossicle to be a serial proportional of such an archetype as that standing in the thorax, we believe that reason is not sinned against any more than if we say 99 subtracted from the 100 integer would leave behind the unit of such integer; $a - b = c$ and $c + b = a$.

All the opposite figures are the same as those represented in Plate XX. We have called them all the proportionals of B′, the thoracic archetype quantity with which they hold serial order, and so likewise does fig. F′ the caudal ossicle which we have referred to the centrums of all those forms.

As all the forms A′ C′ D′ E′ are but the varied proportionals of such as B′, so may fig. F′ be referred to them as proportionals, and to B′ as the archetype.

Fig. F'1, the last caudal nodule, holds series with figs. E'D'C'B' and A'; so therefore, as it is easy to understand how metamorphosis could degrade any of these forms to the centrums marked 1 in each, and thereby render them equal to fig. F', we have equated F' with themselves, and drawn around it all the proportionals of the serial spinal axis.

The common median line which would pass through the figs. A'B C'D' and E' would, when cleaving the centres of those several forms, divide, in the body of each of them, a proportional similar to that of the last caudal bone F', and it is for this reason we say how that the median line which cleaves the archetype B' in one part of series, cleaves likewise the ideal homologue of such an archetype when it passes through the centre of F' at the extremity of the same series. For we here interpret F' to be the proportional of such as B'.

Now this comparison of fig. F with fig. B', is like a comparison held between the fractional of an integer and that integer itself, and granting this to be a rational comparison, it must be also granted that all conclusions or inductions which shall perform, as it were, their orbits around a central reason, may be held to partake of its own quality. For though fig. F be the vanishing point of series consequent upon the law of metamorphosis, and though the presence of fig. F in contrast to fig. B' shall be actually a contrast of extremes, still we say that if we interpret fig. F as a creation resulting from metamorphosis, then must we inquire the character of the thing metamorphosed. If anatomy already grants that fig. F is a metamorphosed vertebra, then, we ask, what are the proportions of the form which anatomy names vertebra? If it be answered that it can be seen in the region of the cervix, the loins, or the sacrum, then may it be asked, why not also in the region of the thorax? As fig. F differs from fig. E only by the subtraction of quantity, and from figs. D' C' or A' only by the like process and with the same result, so, for the like reasons, we may infer that fig. F, and all the other proportionals of the same series, differ from fig. B by the same law of metamorphosis.

From this very contemplation of a graduated or proportional series (interpreted as having been created under the operation of a law of metamorphosis), springs, as it were, the genesis of the idea of uniformity together with the law of species or variety. For in the present condition of fig. F we read all the history of its past changes, the proof of which changes may be drawn from the fact, that if the whole quantity fig. B were now subjected to the same process of subtraction, it would yield the special

proportional fig. F; and hence we infer that the whole quantity or original of fig. F equals fig. B, which equation then yields the idea of original uniformity as by a mode of abstraction. It is true, therefore, that fig. F, such as it stands, refers itself first to the whole quantity fig. B, and thence to its own lost quantity, which equalled fig. B; and this is a comparison of Nature with herself, to which mode of comparison she herself invites by the creation of her proportional series, whose several members differ from each other in no other respect than by quantity. The cervical, thoracic, lumbar, sacral, and terminal figures vary only by quantity, as we have already seen; and, further than this, we have understood that even the abnormal productions of figs. A''' C''' D''' E''' F''' are still only minus quantities compared to fig. B''' the thoracic archetype.

Thus then it appears that fig. F in its minus character, discourses of its own past changes from plus and the archetype, to its present existing state; and also, that so long as it shall be viewed in the same series with fig. B, it is to be known as indicator of the differential quantity existing between B as plus, and itself as minus.* Thus, as the hand upon the serial dial still and for ever records the march of time, and points to the visible present symbol which divides the past from the future; so fig. F, the vanishing point of the converging serial line, tells, like an index, the differential quantity between itself and fig. B, as also between itself and total increation.

We say, therefore, that between plus quantity and its proportionals resides the *immateriality of species,* and we call it immaterial, because it depends upon the mere *negation of quantity.* For as $a-b$ is a species compared to $a+b$ so (as by the addition of the quantity b to the former, or by the subtraction of b from the latter, we can render them in either case equal and identical) we then assert that species is consequent upon the presence or absence of the thing b, and like its shadow follows it, or like the shadow, is nonexistent when the thing b is annihilated.

To search for the *ens* of species would therefore be as vain as to seek for the ens of *nihil,* for *species* is nothing more than the state, *subtraction, absence, void,* or *darkness,* each of which is a state of mere negation, and when we give it the symbol o, it implies the absence of some thing or quality of a thing which when present, invariably opposes itself to species, and by re-establishing the presence of a whole quantity or unity renders the negative or species as a state extinct, by the same mode that the presence of matter becomes the absence of vacuum or void.

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* We apply to the graduated serial line of the skeleton quantities, the same opinion which has been entertained of a serial graduated line or chain of animal quantities. "Parmi les considerations qui intéressent la Philosophie Zoologique, l'une des plus importantes est celle qui concerne la dégradation et la simplification que l'on observe dans l'organization des animaux, en parcourant d'une extremité à l'autre la chaine animale depuis les animaux les plus parfaits jusqu'à ceux qui sont les plus simplement organisés."—Lamarck, *Philosophie Zoolog.,* chap. vi., p. 130, *degrad. de l'organisation.*

Plate 22.
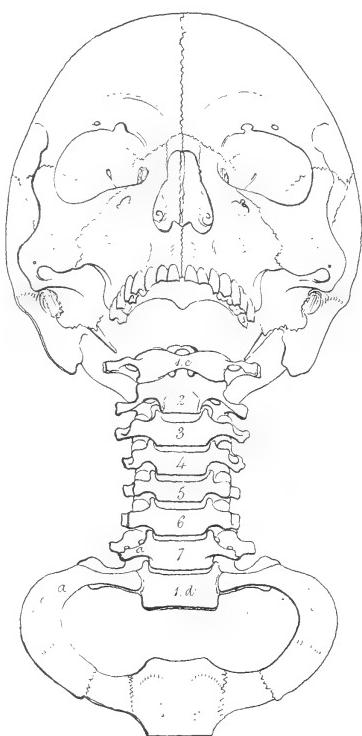
Fig: A.

Fig: B.
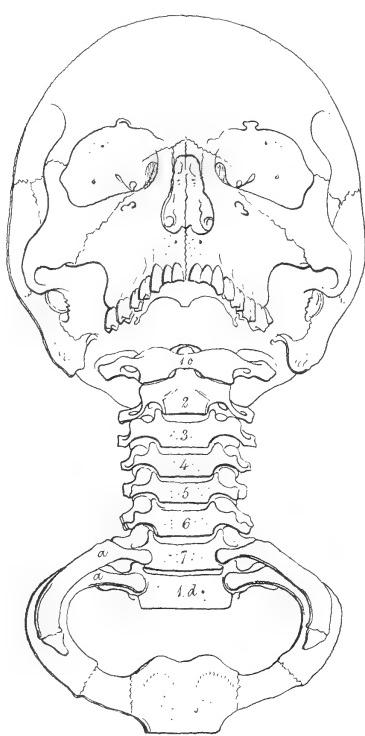
Fig: C
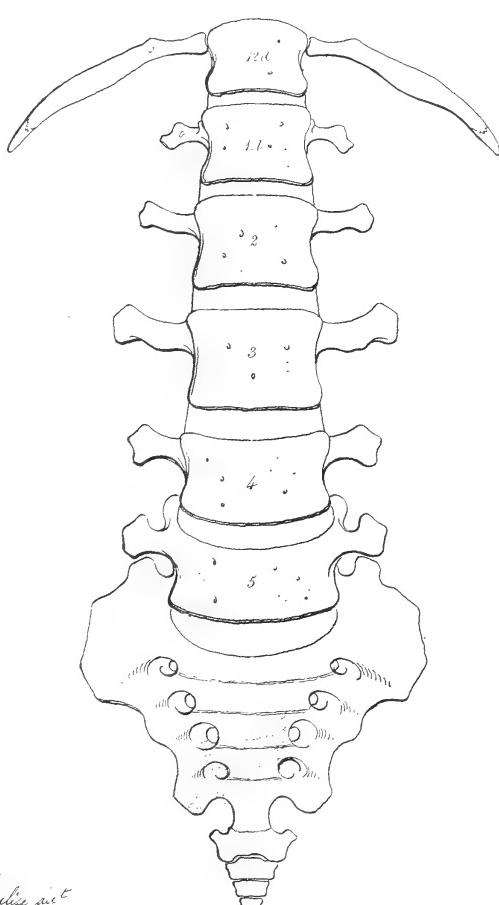
Fig: D.
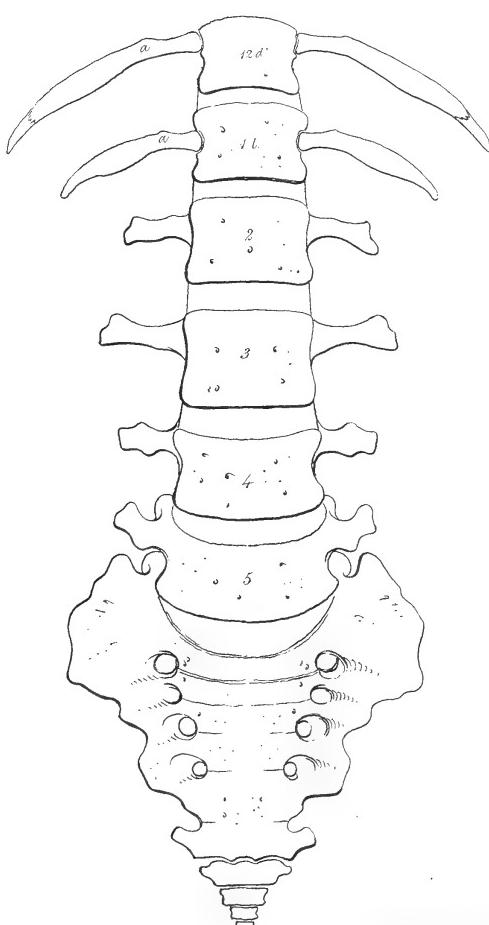
REMARKS ON THE FIGURES OF PLATE XXII.

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THE CERVICAL AND LUMBAR REGIONS OF THE MAMMALIAN SPINAL AXIS ARE INCONSTANT AS TO THE NUMBER OF THOSE FORMS OR QUANTITIES USUALLY NAMED VERTEBRÆ.

H IATUS, gap, deficiency, or vacuity, is caused in plus serial quantities, by the subtraction or metamorphosis of elementary parts proper to the uniform archetypes. Those archetypes or serial plus figures persisting in full structure from first to last, throughout that line which they describe, give example of a plus uniform creation uninterrupted in its whole extent, and may be symbolised thus—9, 9, 9, 9, 9, 9, 9, 9. But when fitness requires that this uniform series should undergo modification in some region or regions of its extent, then the purpose is effected by a subtraction of quantity from one or more of those serial units, and this causes hiatus or void, which is tantamount to species, which is a mode of increation, and bears to be symbolised thus—9, 8, 8, 8, 8, 8, 8, 9 ; or, according to the degree of subtraction, will specifically vary from the plus sum of original series, and yield the figure in many graduated conditions of development, as, for example, 9, 7, 7, 7, 7, 7, 7, 9, or 9, 6, 6, 6, 6, 6, 6, 9, or 9, 5, 5, 5, 5, 5, 5, 9. Subtraction of quantity taking place upon the same units of the original series of the quantities 9 will at length reduce them to this state, 9, 1, 1, 1, 1, 1, 1, 9. But yet it will appear that this latter state of series will refer itself to the original plus condition, and so, between the contrast or comparison of series as it is, and of series as it once was, we read the paces of the law of form. The extremes of the metamorphosed series, 9, 1, 1, 1, 1, 1, 1, 9, while still remaining in plus condition, indicate the degree of subtraction which has taken place upon the quantities of the original means, or intervening quantities, and thus the integer 9 lends interpretation to the fractional 1, by telling that that 1 occurs in series, by the subtraction from 9, for $9 - 8 = 1$. The cervical and lumbar regions of the mammalian axis are the effects of the act hiation, which subtracts quantity from the original series of costo-vertebral archetypes or integers, after the same manner as above specified.

That series of proportional quantities which holds within itself at some one region or other the archetype form to which all such proportionals can be referred, may be numbered from end to end as though it were a series of archetype quantities. For we understand the proportional only inasmuch as we know it to be the proportional of some full quantity or archetype. Therefore as the part speaks of the whole from which it has been metamorphosed, so when a vertebra as part of the thoracic quantity or whole stands in serial order with this archetype, we then may number the minus vertebra as though it were a plus thoracic quantity, since we know it to have come of such quantity. The archetype quantities are uniform, and the vertebræ are the proportionals of such as these. Since $a + b = c$, then $c - b = a$; or in other words, since the vertebra plus the costæ equals the costo-vertebral archetype, then this archetype minus the costæ equals the vertebra.

Fig. A represents the human cervical region of spinal series, and we number the serial quantities from the atlas above to the seventh vertebra, after which the thoracic quantities ordinarily commence. The seventh unit of series is marked 7, and in it we see the autogenous piece a. This seventh unit is immediately succeeded by the first thoracic quantity marked 1 d, and from it we see projecting the costa a to meet its fellow of the opposite side at the sternal median line in front. It is evident that this costo-vertebral quantity contains within itself a proportional similar and equal to the vertebra marked 7 a; and therefore it is that we interpret the form 7 a, to be a proportional of such a form as 1 d a. With this interpretation then, we become prepared for all the plus anomalies of the minus quantity 7 a.

Fig. B proves the correctness of the above interpretation, for we actually find that the seventh cervical unit has produced its autogenous elements a, to the character

of costal forms, and thereby simulates the thoracic quantity 1 *d a.* Hence we say, that as the seventh unit of Fig. A is a proportional of the seventh unit of Fig. B, so are they both to be interpreted as the proportionals of such a quantity as the eighth unit marked 1 *d a,* which is the first thoracic archetype.

Fig. C represents the human lumbar region of the spinal series, and we have numbered its vertebræ according as they are described by the special anatomist. The twelfth thoracic quantity 12 *d a,* is succeeded in series by the first lumbar vertebra marked 1 *l,* and holding its autogenous element *a.* Now there is no doubt that 12 *d a,* contains a proportional homologous to 1 *l a,* and therefore we interpret 1 *l a,* to be a proportional of such a form as 12 *d a.* By this reading we are forewarned of all the plus anomalies which occasionally happen to the minus quantity 1 *l a.*

Fig. D proves the truth of the foregoing remarks upon fig. C, for in fig. D we find that the first lumbar unit, 1 *l,* produces its autogenous elements *a,* in the character of costal forms, and thereby becomes homologous to the thoracic quantity 12 *d a.* Hence we assert that as the first lumbar unit of fig. C is a proportional of the first lumbar (now the thirteenth thoracic form) of fig. D, so may both be interpreted as the proportionals of the full thoracic costo-vertebral sternal archetype, the only difference between these serial forms being that which is consequent upon lost quantity.

As consequent, therefore, upon the foregoing observations the question must arise as to the fitness of that nomenclature which we make use of in our descriptions of the several regions of the mammalian serial axis, and also as to the nature of that form which we name "vertebra." For we see that it is a figure very changeful as to the volume or dimensions of its development, and that moreover the cervical and lumbar regions of series obey and are wholly influenced by that condition in which we find the vertebral quantities. When we shall ask the question as to whether the mammal cervix is constantly produced of the number of seven vertebræ, we will find that much doubt attaches to the answer, and that this doubt altogether hangs upon the character of the seventh cervical unit, which may be of cervical cast or else of actual thoracic proportions, and that this duplicity or protean assimilation to the cervix above, or to the thorax below, gives the like inconstancy of meaning to any name which shall be affixed to the form itself. The presence or absence of the costæ appears to be the main reason why interpretation may be right or wrong according as the fitful fancy shall choose to render it. The assertion that the mammalian cervix *develops seven vertebræ constantly* is falsified by the assertion that this condition of formation is *by no means invariable;* and thus it is that our readings of the law of Nature has nothing more of definitive meaning in themselves than the sounds from a tabor head, and the notes which issue from it are but as responses enunciative of the things which strike it, and if these happen to be the *main du singe,* or the *pied fendu,* then in such

case the music of truth and concord will never be heard, however long and wearisomely these play upon the instrument. And this bears intimately upon the case in hand, for it is not true that the cervical or lumbar region of series are constant figures even in the human skeleton axis, much less in mammalian formation generally; nor will the assertion *that what is not, is,* be made to bear persuasion with it, even though it be found in the pages of that anatomist whose name shall shine upon his title-leaf, luminous as a blazing star, with an alphabetical coma drawn after it. The case is not so, therefore it will remain in its own natural state, despite all announcements which shall be made to the contrary, and hence springs the right for every one to think for themselves, a charter or immunity which will not be refused to anatomical inquiry at least.

But it will be said that if seven vertebræ for a cervical region be not a constant condition of form with mammalian skeletons, still there exist but very few exceptions to the rule; and, therefore, that this rule is true, being general, for *the exception does but prove the rule.* To this it may be added, in the form of interrogation as to the rationality of such inference, that if we could, contrary to the law of gravitation, cast projectiles to the moon, or to Saturn, would we in such case understand the law of gravitation to be proved the better by the exception? A general law abhors exceptions, just as "Nature abhors a vacuum" and without a doubt, when we conform to name all abstract rules, as being perfect, from the very facts of their requiring stability by the crutch and prop of an avowed exception, which is infirmity, we are then only consenting to give that form of argument the hollow facing of perfection, at the same time that we know it to be minus something at its vital centre.

If it be said that figs. A or C are such casts of development as we generally find in the mammalian skeleton of human type, then we advance figs. B and D as the obstructive exceptions to that generalisation, and without passing farther into the multitude of animal classes, genera, and species, where a first error laid *here,* at hand, will grow to giant and rank proportions *there,* remotely situated and beyond control; we therefore say, that as there is something yet to be gathered from the comparison of fig. A with fig. B, or fig. C with D, in reference to the law of form and the creation of species, so should we, first of all, strive to determine what this something means.

And when we inquire into the nature of those facts of development which are rendered salient by the comparison of two figures of one and the same species, such as figs. A and B, do we not find them to be still dependent upon plus and minus quantities? Is it not fully apparent that the serial quantity marked 7 *a,* fig. A, is a proportional of the quantity marked 7 *a* in fig. B, and herewith is it not also evident that the quantity 7 *a,* of fig. B, is a proportional of the next succeeding figure, 1 *d a,* of the thorax? If, therefore, binding all facts together, we arrive at the conclusion that the cervical series 1, 2, 3, 4, 5, 6, 7, in each of which we find a minus costal quantity, have thus been

fashioned from serial plus archetypes, like the first thoracic quantity, 1 *d a*, why should we, in such case, choose rather to deny the anatomical fact, and be content to follow in the eternal train of doubt which anatomists* entertain regarding the creation of cervical costæ, than, by owning fully to the fact, to recommence anew by measuring their presence with the law of their production? The appearance of cervical ribs in fig. B. shortens the cervical hiatus between occiput and thorax. The appearance of lumbar ribs in fig. D lessens lumbar hiatus between the thorax and sacrum, and, consequent upon both conditions of a plus increase, we find that the thoracic series extends itself like all other modes of creations which force their way and passage into space and make an expanding presence there equating to the form of serial plus unity, or that individuality which transcends all specific difference or minus condition. The human thoracic plus series is seen to encroach upon the cervical and lumbar regional and minus quantities, form is changed even for the normal human type, and we find that species is not constant even for the human figure; so, therefore, on the principle of Γνῶθι σεαυτόν, let us first question the creation of specific variety between the opposite figures; for it is true that, notwithstanding our consent to read them as being of one and the same species, yet they are as difform to each other as those which, in other animals, we call absolute specific distinctness.

If we are to own to the facts of anatomy at all, we then must proceed to gather the full account of these, and if it be asked what are those anatomical conditions of development which may fairly be accounted as happening amongst the genus *fact*, we answer that they are such as we may lay hands upon and circumambulate. Cervical and lumbar supernumerary costæ are of such an order of facts, and it is no less true that when they do appear, the processes which we name "transverse" on the cervical and lumbar vertebræ disappear, because the plus creation of the former involves the minus creation of the latter, and both prove themselves to be one and the same thing; forasmuch as they occupy one and the same place, and forasmuch also as (in nature, at least) no two separate and distinct things can at one time possess the same place. Of this kind or genus fact may also be regarded this other order of Nature—viz., that things of absolutely distinct character or specific variety are never seen to occupy the same serial order, and therefore we say that the anterior roots of cervical "transverse processes" which hold serial relation with thoracic costæ, and these, with lumbar "transverse processes," are all three of the same order of growth varied to each other only by the law of proportioning. And the anatomical fact, such as we find it, is no other than that the transverse process of cervix or loins in one skeleton axis, becomes the costa for another skeleton figure, and this is an occurrence which pervades all classes, all genera, and species, causing all method to be like a shifting scene, vain, delusive, and unreal, for this is also a fact, and as such has been handed down to modern times through the successive epochs of Natural History, from Aristotle, Ælian, Pliny, Solinus, and Theophrastus, for the consideration of Aldrovandus, Linnæus, Buffon, Cuvier, Lamarck and Geoffroy.

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* The occurrence of cervical and lumbar ribs has been differently interpreted by anatomists, and perhaps the contrariety of opinion has been occasioned by a nomenclature of doubtful meaning, as much as from an inclination to hold to a rule of development which (whether unexceptional or otherwise, according to the facts of Nature,) was willingly admitted to be general and unexceptional for convenience sake. The mammal cervix was already known to be produced of seven vertebræ, and even when such instances occurred as those of a mammal cervix having but five or six of those quantities named vertebræ, or, as in other examples, where the cervix consisted of eight or nine cervical vertebræ, still the name cervix, as used to characterise mammalian form, was a synonyme of the number seven, and hence we have the following observations. Although Hunauld broadly affirms that the transcendental law gives to the human skeleton more than twelve ribs, still Meckel reads these supernumerary cervical and lumbar ribs as being prolonged "transverse processes," and Blainville interprets these products as belonging to a category of ribs proper to themselves, distinct from those of the thorax, and also distinct from those ordinarily named "cervical ribs." Sandifort has figured cervical ribs in his work, and Carus generalises upon their existence, calling them "protovertebral arches." The subject has also interested the thoughts of Blumenbach, Riche, Sylvester, Buffon, Cuvier, Vicq d'Azyr, Wiedemann, Goethe, Rousseau, Richard, Bell and others.
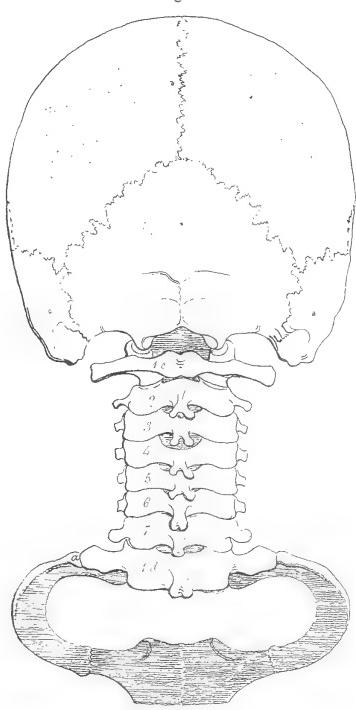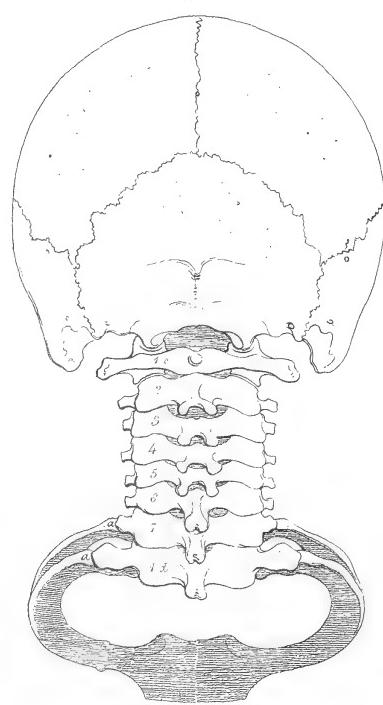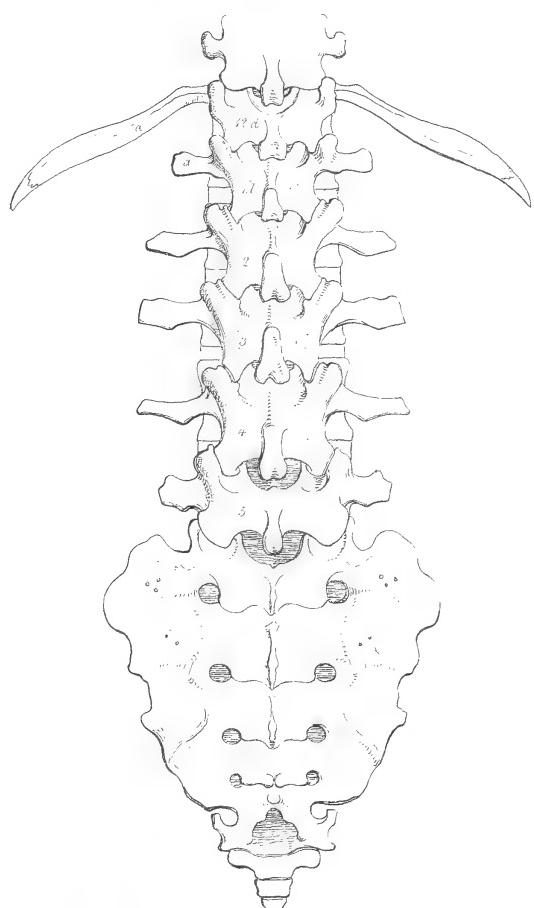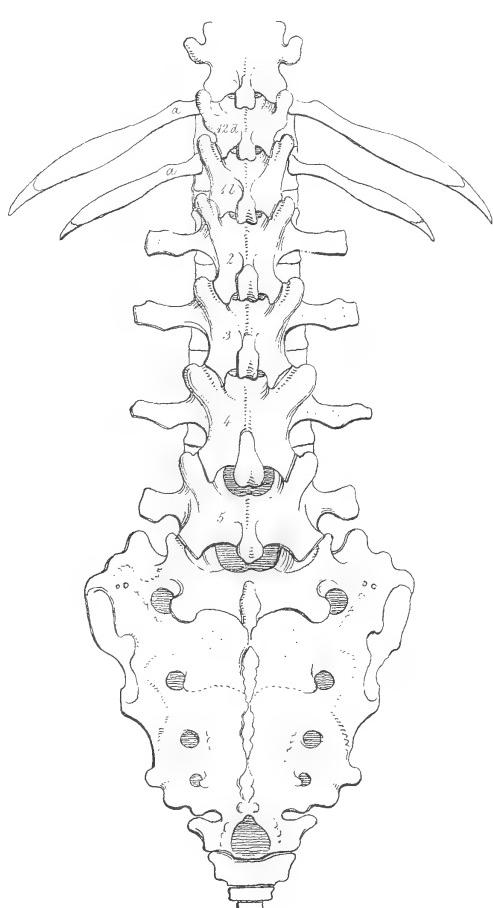
Plate 23.

Fig: A.

Fig: B.

Fig: C.

Fig: D.

REMARKS ON THE FIGURES OF PLATE XXIII.

THE VERTEBRAL LENGTH OF A CERVICAL OR LUMBAR REGION DEPENDS UPON THE PRESENCE OR ABSENCE OF COSTÆ.

FORM is a creation which balances between the opposite conditions of excess and defect. The excess is uniformity ; the defect is species or variety. Between these extremes of excess and defect, we discover that all the quantities of serial order constantly play ; and hence it is, that they are not to be fettered by a nomenclature, however laboured this may be. For when the form is itself illusory as to character, the nomenclature must, in the same ratio, be infirm as to capability. When we affix a name to minus quantity, we afterwards find that it advances to plus condition, and, in the very act, it bursts the bonds of nomenclature. When, again, we give a name to plus quantity, we afterwards discover that the form shrinks from its original bulk, and leaves the bond of nomenclature lax and useless. In this state of unfixity of character manifested by the serial line of quantities, we are compelled to follow the natural law of plus and minus proportioning ; and upon seeing that species is negation of parts, and also that unity follows plus increase invariably, we, hence, track creation in the produce of whole quantities until we arrive at the sum total of development, beyond which nature does not pass. This full form or quantity is then named unity, and the multiplication of this form through series is named serial uniformity. But as one or more figures of such a series may be arrested in a minus stage and cause gap or hiatus, so we call this state " species by subtraction of quantity," and if we are asked, of what quantity ? Nature herself answers this question, by the plus figure produced in some part of her series. The cervix is minus, and the thorax is plus.

Figs. A, B, C, and D, are back views of the figures of plate 22, and show that it is the autogenous or costal elements of the cervical and lumbar vertebræ which undergo the mutation of plus and minus proportioning. The exogenous pieces which stand behind in the cervical compound transverse processes, figs. A, B, together with the exogenous dorsal transverse process which stands behind the head of the thoracic rib, and the exogenous tubercles which, in the same way, project behind the autogenous costal elements marked *a, a,* in figs. C and D, never vary materially as to plus and minus proportioning.

The thoracic costæ *a, a,* figs. A, B, hold series with the anterior or autogenous element of the cervical transverse process, and also with the autogenous costal pieces *a, a,* of figs. C, D, usually named transverse processes of the lumbar spine. These are homologous elements, and the varied proportionals of costal full quantity.

The comparison of a cervical or minus series with a thoracic or plus series, is like the comparison of negation with affirmation, that is to say, of increation with creation. Where form *is not,* then no manner of reasoning can re-create the form ; and where *form is,* then, in like manner, no reading can render it otherwise. But where form is proportional, and still holding series with figures which stand in plus created condition, then we say, that, by the rule of comparison, we are taught to fill up hiatus, and by this very process of re-establishing serial uniformity, we retrace natural design to its very source, and expose the fount and spring of all its process.

In figs. A, B, C, and D, we view hiatus produced in series, and bounded by the plus original quantities, standing full at the extremes, as thus, 9, 5, 5, 5, 5, 5, 9. This hiatus is the effect of quantity subtracted, and we say that the plus extremes inform us of how far subtraction or metamorphosis has been carried upon the means. The quantities marked as 5, 5, 5, &c., are severally minus 4 fractionals when we compare them with the plus integer 9 ; and under this reading we interpret that the seven osseous quantities, known as the cervical series of fig. A, are severally minus those costal forms which we find produced upon the first thoracic figure 1 *d a.*

Now, as the quantity 5 is evidently a proportional of

the integer 9, so will we find, that all the plus additions to the proportional 5, will be but approaches to its equation with 9. For $5+1$, $5+2$, $5+3$ are proportional plus advances to the quantity $5+4$, which is *nine* and the integer. In the very same way we find, that all the plus increase of the seventh cervical unit in series is but an approach to the plus condition of the first thoracic quantity, or costo-vertebral structure; and thus it happens that we have fig. B plus a thoracic quantity, and, consequently, minus a cervical vertebra, solely occasioned by the circumstance of the seventh unit of series equating itself to its own original costo-vertebral quantity.

The lumbar region which succeeds the thoracic quantities is like the cervical region which precedes the thorax, for in the loins, as in the cervix, we view a series of minus forms whose plus "anomalies" are simple equations with the thoracic series. In fig. C, the first lumbar unit $1\ l\ a$, occasionally assumes the plus condition of $1\ l\ a$, in fig. D, and thus simulates or equals the quantity next above it, marked $12\ d\ a$. The same proportion which 5 bears to 9, we find that the cervical or lumbar osseous quantity bears to the thoracic archetype; and just in the same way as $5+4=9$, so is a cervical or lumbar vertebra plus the costal quantity, equal to the thoracic original.

In reality, therefore, these cervical or lumbar ribs are, when existing in series, the simple persistence of original quantity, and, regarded as such, they cannot be named anomalous or abnormal to the prime model. For it is most true, that when they do appear in series upon the lumbar or cervical vertebræ, as for example, $1\ l\ a$, of fig. D, and $7\ a$, of fig. B, they are not now, (so to speak,) more unfriendly to the order of series than are the normal osseous quantities marked $1\ d\ a$, of fig. A, or $12\ d\ a$, of fig. C.

All plus structural quantities express the full sentence of unity and uniformity. All minus structural quantities will, therefore, (while following in series with plus struc-

tures,) evince their own present design, when they shall be compared with the plus originals; and this will fill up hiatus, as well for serial forms as for serial and flowing interpretations of the natural design. Since it is true, that the anomaly in form is ever attended with the gap and dislocation of false interpretation, so will the reconciliation of anomalies to the general law of formation fill up vacuity in the serial order of ideas. There is a gap or hiatus in the wall of anatomical reasoning, and its typical embodiment is represented in that condition of development which a cervical or lumbar minus series evinces in relationship with the plus thoracic quantities. A cervix or loins, considered as an anatomical fact, isolated and *per se*, is an idea separated and cut apart from natural intercourse, and lying, as it were in cold obstruction, produces nothing. But when a cervix or lumbar region is weighed in comparison with plus thoracic quantities, to which the order of natural series relates both, then it is that we are enabled to read the creation of minus quantity in the neighbourhood of plus, as pregnant of design and fruitful of ideas.

The operation of a law in Nature is the only manifestation which we have of a designing will and potency[*], and when the mind contemplates the demonstration of this force or law, or general life and agency which stirs through all creation, and reveals its boundless presence with immeasurable and countless instances of itself, which is universality of purpose and nihil supervacaneum, then admiration gives the force a personification and material finite shape, clothing it in the imperial robes of the following definition; "Deus est ens uniforme, organorum membrorum partiumque expers[†];" or else discourses of it as "Hæc opifex rerum, sui generis, docta, a nullo edocta, saltus non facit, nihil frustra nihilque supervacaneum agit [‡];" or, when assigning a place to it, describes that πλατύς ὁ κοσμος θεον οὐ δέχεται.

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[*] Effectivement, il ne saurait etre ici question de merveilles, mais de l'action du temps, mais *de progrès dans le rapport de moins a plus.*— Geoff. St. Hilaire, *Principes de Philosophic Zoologique, Disc. prelim.* p. 22.

[†] Newton, *Optices Questio*, 31, p. 412.

[‡] Seneca, 111, 29.
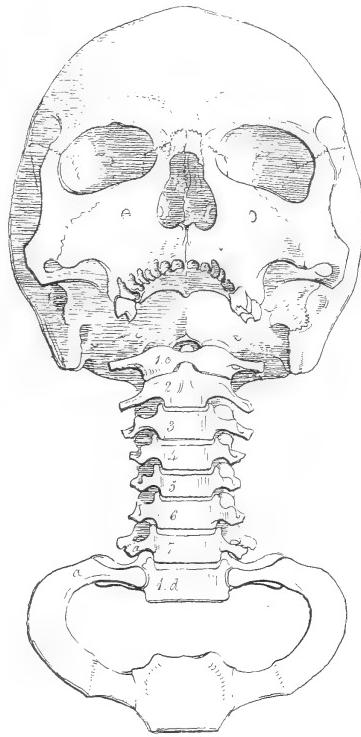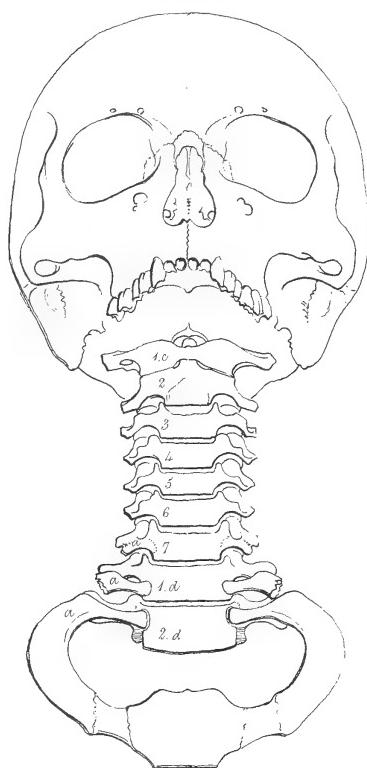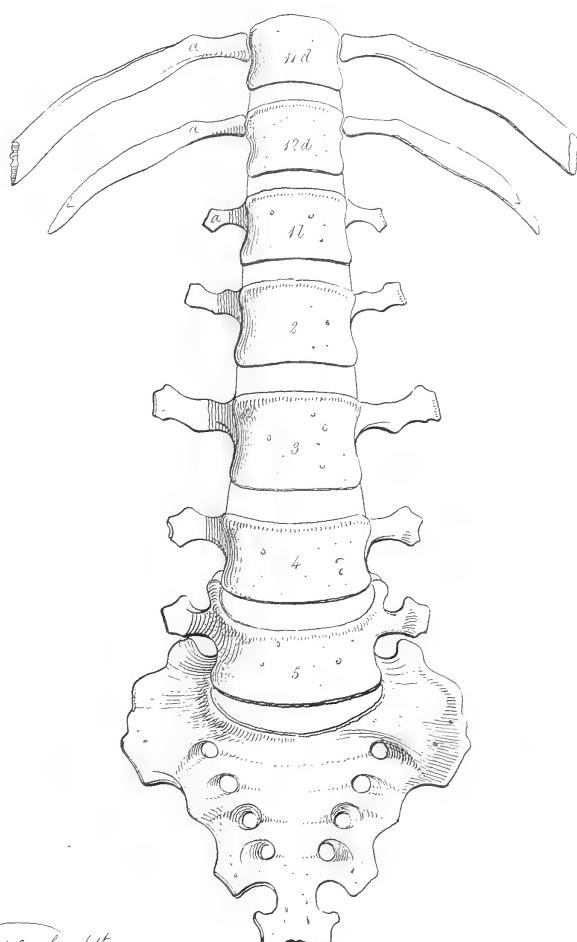
Plate 24.

Fig: A.

Fig: B.

Fig C

Fig: D.
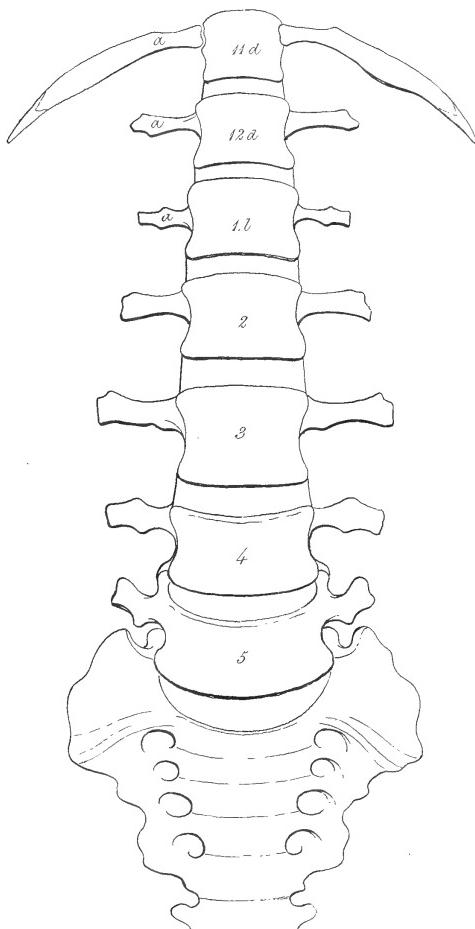
REMARKS ON THE FIGURES OF PLATE XXIV.

THE CERVICAL AND LUMBAR REGIONS COMMENCE AND TERMINATE BY THE SUBTRACTION OF QUANTITY FROM THE PLUS ARCHETYPE.

DESIGN, as occurring by the operation of a natural law, may be contemplated under two modes of ideas, each leading to a special appreciation of the actual result. First, we can consider the creation which presents to us, as a form perfect in itself, as a mechanical fitness which wants not the addition of any part to render it more complete, and which holds nothing superfluous. Secondly, we may estimate its present design as a figure, created by a law of formation from another original figure or prime model, and compared with which, we can now learn to place full value on the existing speciality. Under this latter mode we here track the law of design which yields the mammalian spinal series as a special creation. The self-evident proposition of created mechanical fitness manifested by a cervical and lumbar series, has already had an universal anatomical acknowledgement, and this needs no further comment. But there is no doubt that comparative science seeks for some further demonstration of a law of formation, or that process of creation which fills the eye with the theme of unity, and, at the same time, transcends all account of unity by the inexhaustible infinitude of special and various detail. The mammalian skeleton series is not unity or uniformity, compared either to itself or to other species. It is a special design amidst the infinity of specialities, and has its archetype or original from whose plus form it is as a subtracted quantity. It is a figure designed by the loss of quantity. It is a fitness on account of that loss, and, as such, is to be valued only by holding it in comparison with its archetype, which is plus uniformity.

A costo-vertebral archetype is the plus quantity of series. A vertebra, wherever it stands in series with such an archetype plus, must be interpreted as the minus proportional of such another plus, consequently the cervical and lumbar regions of series must be accounted minus, compared with the thoracic region of the same series; and for the same reason, are to be interpreted as regions rendered proportionally minus from their own plus quantity. This quantity is of the thoracic stamp, and this idea is equal to the original uniformity of serial archetype quantities ranging throughout the whole length of the spinal axis. When we compare the present condition of the spinal series of minus and plus quantities with the original series of plus quantities, then we interpret the present design of Nature with her own prime model, and this is a series of costo-vertebral thoracic forms holding an unbroken order from first to last.

When Nature creates the mammal cervix, consisting of seven vertebræ, she may be said to have rendered seven archetypes at the commencement of series, minus or of vertebral formation. When we observe that those seven cervical vertebræ are homologous quantities, then we interpret the law of their formation to be as follows, viz.: that Nature has subtracted equal quantities from equal archetype figures, and left equal proportionals such as cervical vertebræ standing. But when we meet with a human cervix, producing cervical costæ, from the autogenous pieces of the cervical transverse processes, then we say that Nature has subtracted unequal quantities from the originally equal archetypes, and left remaining cervical units which are unequal to one another; still, this costal inequality of the cervical forms is only the inequality of proportioning from the original figures of the archetypes. How else can the creation of cervical ribs be rationally accounted for?

Fig. A represents the cervical region of the human spinal series. In the seventh cervical spinal unit we see the autogenous element, marked a, holding series with the first thoracic costa marked a; and the same autogenous element is to be found in all the cervical vertebræ. It is

for this reason that we say the seven cervical vertebræ are proportionals of their own archetypes, since they are the proportionals of the first thoracic archetype, marked 1 *d a*; and, therefore, if it be asked of what archetype quantities do we suppose that the cervical vertebræ are the proportionals, we answer of such as fig. 1 *d a*, which holds serial order with all the other spinal forms.

In fig. A we interpret that the cervical vertebræ numbered 1, 2, 3, 4, 5, 6, 7, are the proportionals of archetype quantities, such as that quantity which next succeeds them in serial order; we mean the quantity marked 1 *d a*, the first thoracic unit. The plus anomalies of these cervical vertebræ are cervical ribs, and these anomalies serve as proof of the truth of this interpretation, for they are seen to be only as the proportionals of the plus quantity first in the thorax. Therefore, Nature may be said to have subtracted or metamorphosed from each of the first seven archetypes of series, such as 1 *d a*, of the thorax, all that quantity which is distal to the point *a*, of the first thoracic form. Under the operation of this law the mammal cervix may be said to be created.

In fig. B we see how the metamorphosis of the costæ of the first thoracic quantity 1 *d a*, at the point *a*, would render this equal to any other proportional of the cervical series. The unit marked 7 *a*, and the unit marked 1 *d a*, would then be equal quantities; whereas, the human cervix would now present as consisting of eight vertebræ, and the first of the thoracic quantities would commence at the ninth unit of series marked 2 *d a*. If then we see that the metamorphosis of the archetype 1 *d a*, of fig. A, would render it in such condition as we see it in 1 *d a*, of fig. B, and also that it would now equal the unit marked 7 *a*, so may we interpret, that the unit 7 *a*, has been metamorphosed from its own archetype, after the same manner as 1 *d a*, of fig. B. The anomalies of cervical ribs would then appear to be a creation proportionally intermediate to the first thoracic quantity and the ordinary cervical vertebra.

Fig. C represents the lumbar region of human spinal series, and shows that condition of development usually met with in a skeleton of the human type. The unit marked 12 *d a*, is the last thoracic quantity, and is evidently a proportional of the unit 11 *d a*, which precedes it in series. Now, it may also be taken for granted that the unit marked 1 *d a*, the first of the lumbar series, is a proportional of 12 *d a*, of the thoracic region, and for the following reason :—

Fig. D shews that the unit, marked 12 *d a*, has here assumed a lumbar vertebral cast, and if we enquire into the law by which it has assumed this character, it will be at once apparent that it has happened by proportioning *a*, of the unit marked 12 *d*, fig. D, from the rib *a*, of the unit 12 *d*, fig. C, and also by giving anchylosed fixity to this element *a*, of 12 *d* fig. D. We hence are only led to name that to be a "transverse process" of the lumbar spine which was elsewhere a costa articularly separate.

The comparison of fig. C with fig. D will, at once, under the foregoing observations, explain how one lumbar spine is produced as having five vertebræ, whilst another develops six in series.

The law of metamorphosis is the law of proportioning minus quantities from plus archetypes, and the serial order of spinal units teaches us that a cervix or loins is minus compared with the thoracic plus formation.

The science of comparison has for its object not special distinctiveness, but a principle of comparison which shall be demonstrative of a law of specific creation. Its object is not, or should not be the vain endeavour to measure species or infinity, but to discover the figure of finite unity, which, like an integer, holds within its own dimensions all quantities equal to all species. For who shall enumerate the long account of special variety? or, supposing that this were possible, who will essay that task, and proceed undismayed by the damping inquiry *cui bono?* which question will still present itself even if the comparative anatomist, were licensed to take the whole concave blue ether for his chart, and, with the plume of an unwearied patience, had written upon that broad expanse the entire catalogue and sum of possible variety. Like number the variety has no limit. Do we not see that the variety of fig. A compared with fig. B, and of fig. C compared with fig. D, is (in the one species) an infinite subject? If we continue to search out the limit of special variation between forms such as those which we account one species, and fail to find this limit, why should we then hope to find it in the countless states of an animal kingdom, where the myriad, like the unit, still rises from and sinks into the illimitable sum of variation?

The law of form creates species by the anihilation of quantity. This is evidently the substance of the argument of comparative osteology, for fig. C has lost a quantity in comparison with fig. D, and hence the one form is a species *per se*, compared to the other. Hence it must follow that fig. C of human species is a speciality compared to fig. D, still called a human species; and thus we see, that even one species may be disintegrated and struck various to itself. Whereupon we ask, what are the assignable limits of species?

But it will be said that if fig. C is special and various to fig. D, still both are special to other mammalian figures, and, consequently, figs. C and D are distinct compared to other mammal forms, and as such, must be accounted special to the same. To this we may answer that figs. C and D are special to one another, and this must be equal to the assertion, that species cannot be isolated as a fixed thing or quantity of set dimensions, for figs. C and D are named as being of one species, and yet we know that they are different forms, having some quantity and character in common; but yet having a plus and minus variation of quantity; as fig. C is plus a costal pair and minus a lumbar vertebra, while fig. D is minus that costal quantity, which circumstance renders it plus a lumbar vertebra.

What is the law of form, we therefore ask, while there appears every reason to abandon, as a hopeless task, the differential method, as pursued for the isolation of the phantom called species? What is this law of form which

is the fount and source of specific variety, and which law seems to forewarn the comparative reasoner that species is nonentity, or the loss of some quantity proper to archetype unity and uniformity? What is this law which operates for the creation of special variety? Is this law much more simple in its acts than the complexity of laboured argument would confess it to be? Is the simplicity that which belongs to Nature? and is the fog and mist of sophistry and verbose difficulty all our own? What is the form of plus unity, the integer or archetype to which all skeleton species may be compared as proportional quantities? Does this figure of unity contain all skeleton minus variety, just as fig. C may be seen to contain fig. D. If there be in Nature such an archetype quantity, to which all skeleton variety may be referred as minus creations, then may we hope for such a revelation of the law of form and resulting design as will prove that the eye of reason, when searching through the facts of comparison, will teem with the fruition of a subject which the differential method * carried on in pursuit of the limit of special variety can never encompass, even though they arm vision with the microscope, and lay the oppressive cables of a nomenclature upon the infinitesimal world.

Every subject amongst the many of which the φύσις is pregnant has a definite and indefinite, a limited and a limitless side, wherewith inquiry may busy itself. The definite purpose of enquiry is some general principle which may be said to encompass not only the known facts which relate thereunto, but even the unknown facts, or all those which may possibly happen within the circle of that one enclosing principle. The indefinite inquiry is, on the other hand, that which endlessly pursues the facts of variety, as being things isolated and distinct from each other, and never subjects them to the rule of comparison, which alone can yield the cause and effect of natural operation, and teach us something of the mode, the source, and objects of their creation. This pursuit after specific variety is one of preadamite date, and marks the primitive and barbaric stage of every people. We cannot tell when this mode of investigating the *natura* had commenced,

and no one can foretel, with any probability, when it will end, for it is a subject without limit, it withers hope and holds out no promise of a consummation. It is like a pilgrimage to the sea-shore, undertaken for the purpose of counting the pebbles there, or like a sojourn in some Vallombrosa with the object of numbering the autumnal leaves. There is no purpose or principle attending upon this mode of study. The infinite promises nothing to any human effort. We may lay the hand upon the pulse and count its beating through a long life, but this will never teach us the *quid est?* And so we find that the octogenarian sinks under the fruitless rule of number, to no better effect than when, in his first childhood, he commenced his labour.

If each species presented to us as a creation fixed, distinct and *per se*, then each one of them would demand a separate consideration; but as the case is otherwise†, as every speciality is but a subdivision of unity, so must we read all species as being the simples of a compound integer, having their several places in that integer or whole quantity, and to which they naturally refer. If the ass, the horse, and the *tertium quid* or *hybrid* manifest all three a somewhat common character, then we give them collectively the general term *animal*, and though we by no means would thereby imply that they are absolutely the same, still we shall not, upon this admission, undertake the somniferous labour of searching for the limits of their distinctiveness by numbering the hairs upon their hides, or of anatomising their infinitesimal differentials upon the field of the microscope. In like manner, and upon the same principle of analogy, shall our natural human weakness forego the differential method in the comparison of figs. A and B, C and D, and make search for the law which creates those figures as homologues, and which varies them as quantities ‡. Hence we shall prefer the secure repose upon that generalisation which spontaneously recognises their analogies, and at the same time admits the fact that fig. C is plus that costal pair, which being lost to D, causes this latter to be plus the lumbar vertebra, and which fact leaves it to be understood that the vertebral quantity is a proportional of the costo-vertebral plus form.

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* "Species autem illa, *abscissio infiniti* recte vocari possit."—Bacon, *Novum Organum Scientiarum*, aph. xxvi.

† "La loi de la continuité porte que la Nature, ne laisse point de vuide dans l'ordre qu'elle suit."—Leibnitz, *Œuv. Philosop., nouv. Essais, &c.*, liv. iii., p. 267.

‡ "As I have said, however, most parts, and from which the whole bulk is composed, are either the same or differ in contrarieties according to excess or defect."—Aristotle, *History of Animals*, Book i., p. 4.
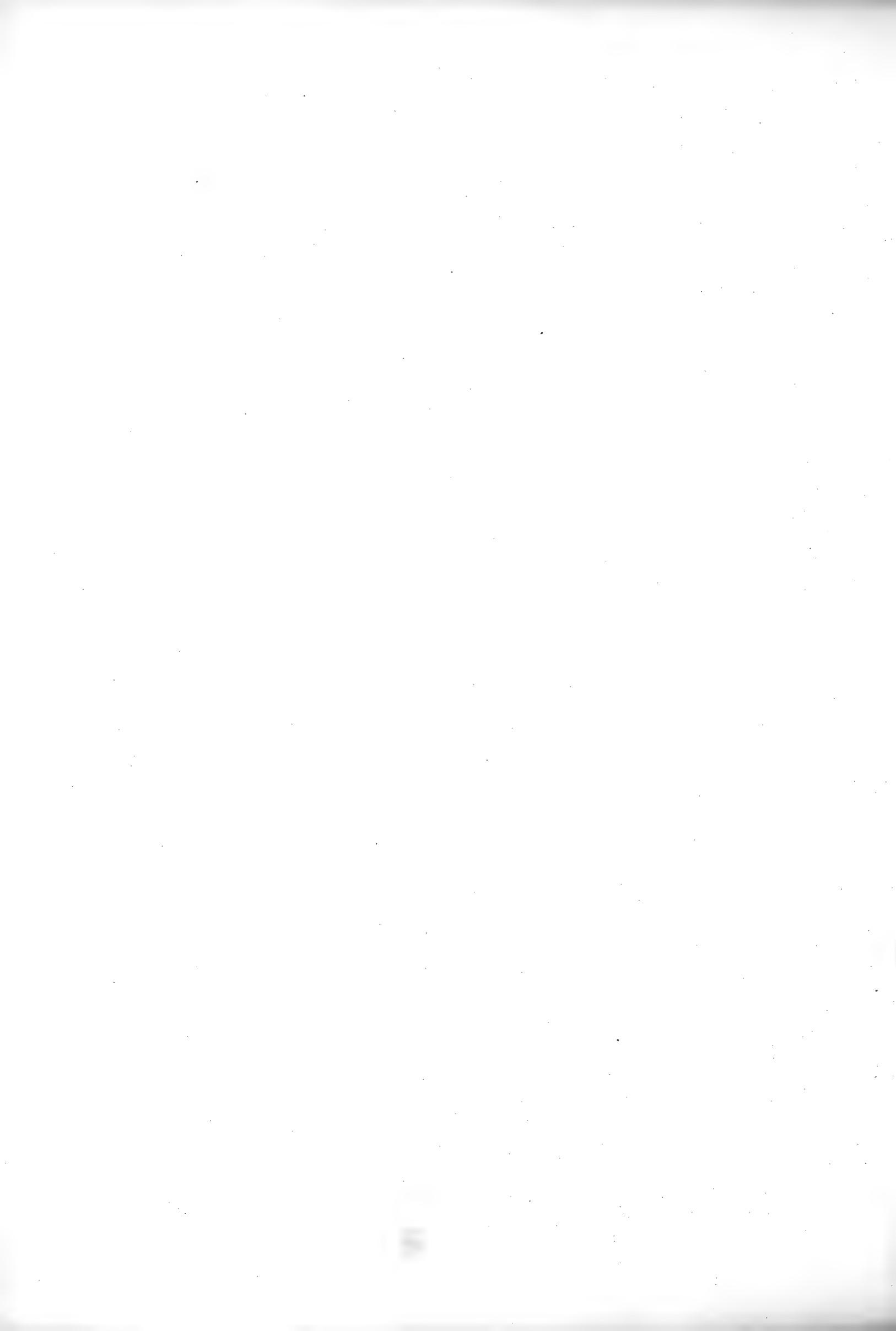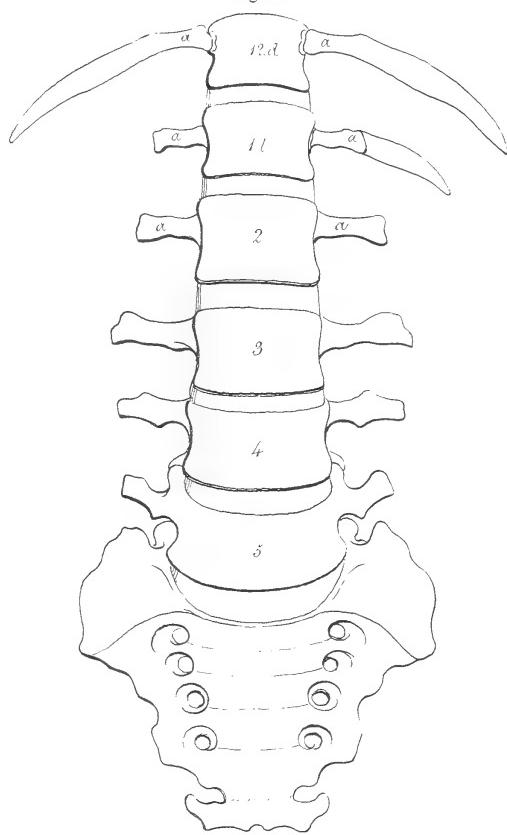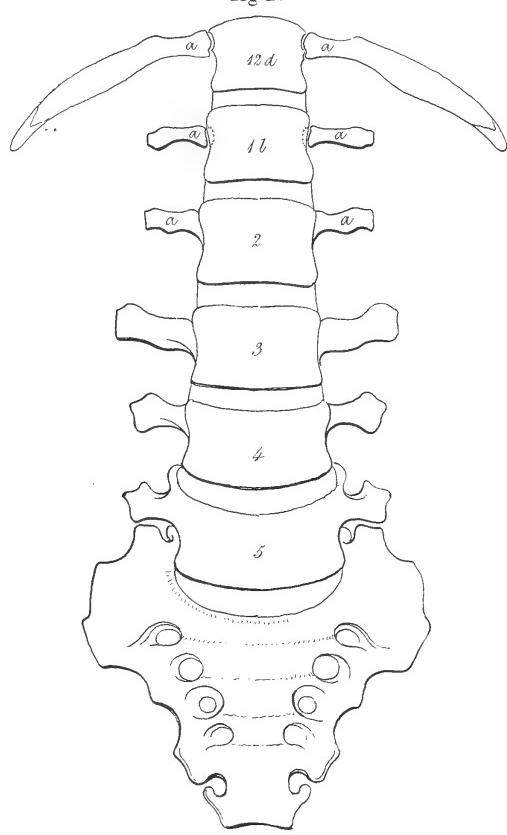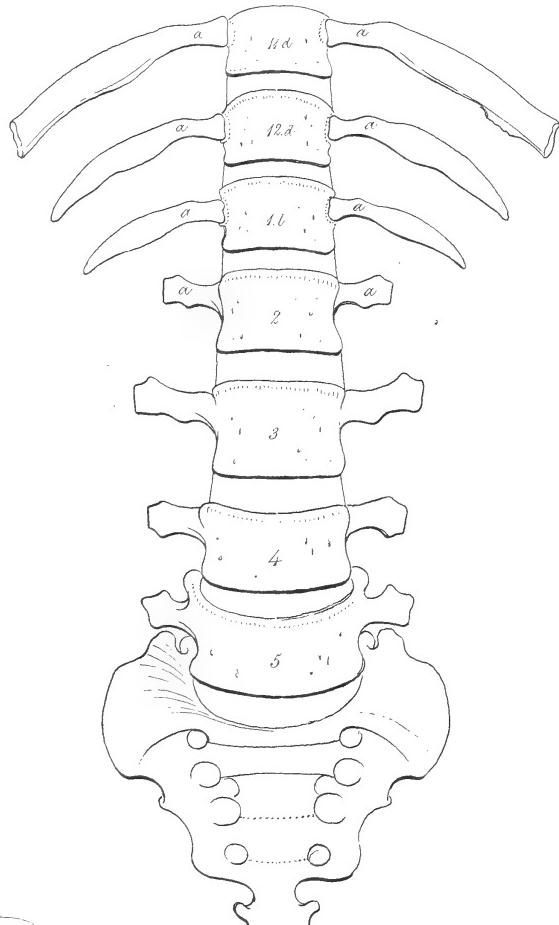
Plate 25.

Fig. A.

12.d

11

2

3

4

5

Fig. B.

12 d

1 l

2

3

4

5

Fig: C.

11 d

12 d

1 l

2

3

4

5

Fig D

11 d

12 d

1 l

2

3

4

5
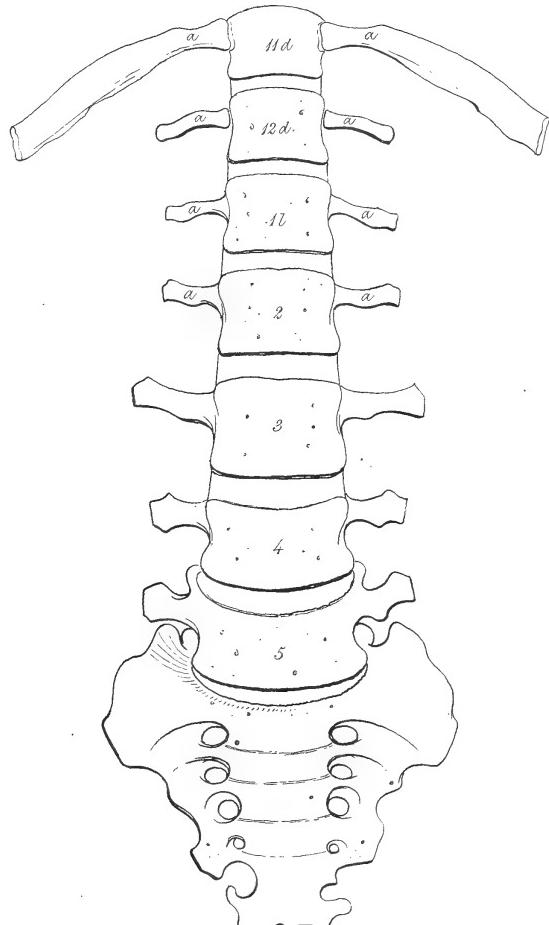
REMARKS ON THE FIGURES OF PLATE XXV.

————◆———

THE LUMBAR SERIES DOES NOT INVARIABLY COMMENCE AT THE SAME VERTEBRAL FIGURE.

A LAW is that general interpretation which an assemblage of relationary facts expresses with regard to those facts. Such a law is based upon the principle of analogy, and necessarily comprehends all those facts which manifest, however closely or remotely, a common conformity of character. Analogy is the basis of all laws, forasmuch as it becomes the principle of concentration; whereas diversity is the dissolution of a law, and consequently repels all interest in its endless account, just in the same degree as it disintegrates and divides apart (as by an unnatural force) all those facts which cleave naturally towards each other. Analogy is positive. Diversity is negative. Analogy is creation. Diversity is increation. Hence it must follow that as facts are analagous creations, and of the positive condition, so should these be chosen as the only proper groundwork of a law, and because it is impossible to frame any law or generalisation upon *nihil,* or the absence of quantity, which is increation, and the negative condition. The skeleton forms, notwithstanding their diversity of character, still manifest this salient and positive creation of analogy, and the comparison of them to one another as entities explains the fact that their nonentities, or subtracted quantities, constitute their species, in the same way as $a-b$ is a species in presence of $a+b$. The loss of quantity is the loss of that which, had it remained, would have found its counterpart in creation, but being *null* is equal to the species. All skeleton forms would be created in plus uniform condition, but for the metamorphosing act which, by the subtraction of greater or lesser degrees of quantity, renders them various as things of excess and defect. The law of form must hence be studied according to the evidence of unity or plus quantity passing under metamorphosis, and with this understanding we shall pursue our inquiries, not for the purpose of demonstrating difformity, but with the view of ascertaining how forms become varied to each other, for in the knowledge of this exists the state of a law.

The mammalian cervix is an instance of where Nature generally practises her law of proportioning upon seven units of series. The mammal cervix usually contains seven vertebræ, but this is all that can be granted concerning this region of the spinal series; for in despite of all that anatomists have said regarding this rule of development, still it must be owned that the exceptions to this rule are of too much importance to be passed over with the careless remark that "exception proves the rule." Any rule well founded and philosophically understood can admit of no exceptions.

It is a fact that even the mammalian cervix is very constantly encroached upon by the development of thoracic quantity, such as cervical ribs, which, whilst increasing the dimensions of the thoracic apparatus, diminishes at the same time the length of the cervix.

It is a fact of still more frequent occurrence, that the human lumbar spine, to say nothing of other mammalian loins, developes an inconstant number of vertebral forms, and that when those forms are minus to the ordinary or normal number, the thoracic series are increased in number; whereas, on the contrary, when the lumbar human vertebræ are plus to the ordinary number, then we see that the thoracic figures are minus their normal series.

In figs. A, B, C, and D we see that the human lumbar spine varies considerably as to the number of its vertebral forms. Those vertebræ are similarly marked in all the opposite figures, and a comparison of those units of series which bear similar marks will indicate the law of proportioning which renders them in such condition as they present themselves.

In fig. A, the first lumbar unit, marked 1 *l a*, developes on the left side of us the autogenous or costal process fixed, and on the opposite side its fellow is produced in the articular form of a last thoracic rib. All those pieces of fig. A marked *a*, are serial homologues proportionally varied.

Fig. B shows the same first lumbar unit, 1 *l a*, to present on both its sides the small costal forms marked *a*, and we see that those forms do not exceed the dimensions of the autogenous pieces *a, a*, of the succeeding unit marked 2, at the same time that they are articularly operative upon the vertebral centrum, like the last ribs of the thoracic series. All those pieces marked *a*, in fig. B, are serial homologues proportionally varied.

Fig. C shows that the lumbar spine is reduced to the number of four vertebræ, and the thoracic series increased to the number of 13, by the simple fact of the autogenous pieces of the unit marked 1 *l a*, being produced to costal form.

Fig. D represents how the lumbar spine increases beyond the normal number of five vertebræ, at the same time that the thoracic series diminishes to the number of 11, costo-vertebral forms, by reason of the fact that the costæ ordinarily developed upon the sides of the unit 12 *d*, are now reduced to the minus quantities marked *a a*.

It would appear, therefore, that serial proportioning is that law which reduces plus quantity to minus, and once admitting this undeniable fact, that the first lumbar vertebra, whatever be its numerical position in series, is a proportional of the last thoracic costo-vertebral quantity, there can be no reason why we should not also conclude that the serial vertebra, wherever produced, is as the proportional of the fullest thoracic figure.

A comparison made between figs. A, B, C, and D demonstrates the fact that the same numerical unit in series is not always existing of the same proportions, and that consequent upon this variation from plus to minus happens the circumstance that the same unit is at one time of thoracic series, and at another time of lumbar series. When the unit 1 *l a*, of fig. C, is plus, then it ranks with thoracic quantities; and when, again, this unit 1 *l a*, of fig. D, is minus, then it takes order with lumbar quantities. And fixing the attention upon this particular, we isolate it, and withdraw ourselves from the overwhelming general theme of unity under metamorphosis, in order to begin with the ἀρχή of the process, and thereupon to determine the common source whence issue the confederate streams of uniformity and speciality.

Relationary facts yield the combined evidence of a law. Comparison is the instrument whereby analogous operations are made to express their one and general character. A phenomenon indicates its own natural connexion with all similar phenomena. These, collectively considered, constitute a law, and this law is expressed by a general or abstract term. From several particular propositions, inductive reasoning infers one general rule or law, and thus it is that a Franklin establishes identity between the phenomenon of a galvanic battery and the lightning of the cloud; thus a Newton identifies the phenomenon of attraction manifested between bodies and the earth, between the moon and the earth, between the planets and the sun, to

be one general agency; and thus, also, by an extension of the like observation, the expectant Le Verrier proclaims the advent of a planetary stranger already created within the firmament of analogical reasoning, before its own person became demonstrable in Nature. Comparison which is conducted behind the breastwork of anatomical facts, is also capable of leading to some general principle. The unity of type has become the theme of anatomical science, but as it still remains an unsettled question whether the anatomical law gravitates more to the side of unity or to that of diversity (a fact which hangs suspended somewhere between the doctrines of Geoffroy and Cuvier), so may any one, standing before the altar of Nature, assume to himself the right of searching through her volume, and of thinking for himself whilst engaged in the measurement of both these subjects.

Now, the weight of a reputation, however ponderous it may be when compared with that name which has no moment, appears itself but of comparatively light account when placed before the massive presence of Nature and her argument, and hereupon we find that inquiry will sometimes dare to acknowledge this, and after having pondered long over the themes of unity and of variety, as recorded in books, will at length turn to question Nature herself, and ascertain of her own person how far she is uniform, and in what degree she is various. Whether it be the fact that she is altogether absolutely uniform to herself, or whether it be true that she is absolutely difform, and whether (upon finding that the *absolute* condition is in fact characterising neither the one or the other form of development) it may not be *the operation of a law exercising upon whole quantities, and subtracting* * *from the same*, that yields the result as we see it, viz., a *natura*, or *serial order of forms which possesses certain parts in common, but which are not all equal as to quantity*. If this question be asked of Nature herself, we shall find that she quickens with a ready answer in the affirmative, and demonstrates that her serial quantity 1 *l a*, fig. D, is a proportional of the same numerical unit, 1 *l a*, of fig. C. And as this latter is evidently the serial proportional of 12 *d a*, fig. C, which unit is again the proportional of 11 *d a*, fig. C; so by serial natural creation, contemplated under serial mental inference, one may regard the unit 1 *l a*, of fig. D, to be as the proportional of the thoracic quantity 11 *d a*, fig. D, by which comparative and combinative reading we associate the "anomalies" † with the normal forms, and both with the common law which presides over their creation.

And drawing our conclusions according as the anatomical facts present themselves, we say that it is the law of proportioning from a plus archetype figure which renders figs. A, B, C, and D various to each other in respect to quantity *only*, and that the same law may be traced through the several conditions of the serial figure 1 *l a*, which is at one time plus and at another time minus.

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* " But of this frame, the bearings and the ties,
    The strong connections, nice dependencies,
    Gradations just, has thy prevading soul
    Looked through? or can a part contain the whole?"—Pope, *Essay on Man.*

† " Le temps viendra peut-être, que l'on joindra en un corps régulier ces membres épars; et s'ils sont tels qu'on le souhaite, ils s'assembleront en quelque sorte d'eux-mêmes. Plusieurs vérités séparées, dès qu'elles sont en assez grand nombre, offrent si vivement à l'esprit leurs rapports et leur mutuelle dépendance, qu'il semble qu'après les avoir détachées par une espèce de violence les unes des autres, elles cherchent naturellement à se réunir."—Fontenelle, *Préface sur l'Utilité des Sciences, &c.*
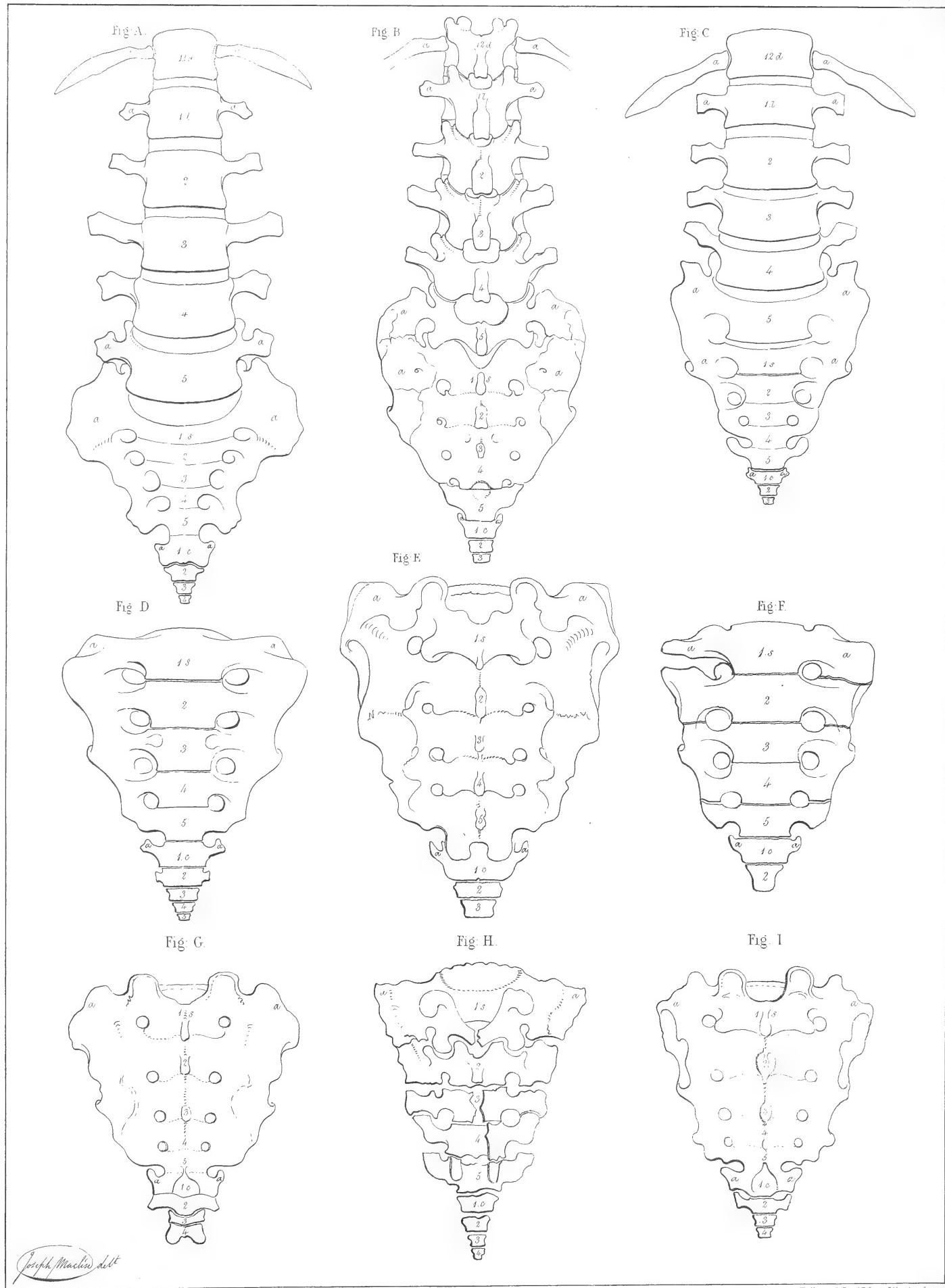
Plate 26.

Fig: A.

Fig: B

Fig: C

Fig: D

Fig: E

Fig: F

Fig: G.

Fig: H.

Fig: I

REMARKS ON THE FIGURES OF PLATE XXVI.

THE LUMBAR, SACRAL, AND CAUDAL SERIAL REGIONS VARY AS TO THE NUMBER OF THEIR VERTEBRAL QUANTITIES.

SPECIES or variety is ever attendant upon metamorphosis, and is a synonyme of modification. The comparison of two or more serial axes of one and the same recognised species of animals, will oftentimes prove the fact, that these forms are as diverse to each other as those which may be found in two or more separate animal species; and consequently, specific variety does not suffer itself to be limited by any arbitrary rule of nomenclature. Admitting the facts of the case to stand thus, the reason at once renounces the differential method for the persuasive argument of generalisation, upon the facts of a common analogy of type; and, in despair of ever summing up the whole record of special variation, it recommences upon a new and better system; one by which it is enabled to encompass under a general term a multitude of relationary facts, and thereby to span plurality with the enclosing arch and government of a law. If nature outpaces all the efforts of human industry in establishing its differential nomenclature by casting abroad her prolific genesis of multitudinous and infinite variety, still the fecund act of creation bears within itself the seeds of a connective argument, which is, the analogy of form and the comparability of individuals. The comparative method, then, is taken as the guiding helm, and the pursuit of samenesses and similitudes marks all the progressive way of ratiocination, or the act of deducing consequences from premises. If $a+b=c$, then $c-b=a$; consequently, the presence and absence of the quantity b, is the differential law, and consequently the persistence of b, for both quantities will render them equal; for it is seen that the abduction of b, from one of two equal quantities is the cause which renders them unequal. In the same way, we are to understand that the presence or absence of the costæ is the differential law; for when a vertebral quantity is plus the costæ, it persists in thoracic series, and when a vertebra is minus the costæ, it constitutes a unit of either the cervical, lumbar, or sacral series.

It is impossible to establish any marked distinction between the forms of series, which, in reality, have no other difference than that apparent between plus and minus. Forms which are only proportionally various to each other can have no other difference than that of quantity. And serial forms which manifest this condition of proportioning must severally express or refer to the full archetype quantity from which each has been proportioned. The fullest form of series must be archetype of that series, since even the smallest proportional form of the series bears the same comparison to the existing archetype which any minus quantity of an integer bears to that integer.

The opposite figures show how the lumbar spine follows the thoracic series just as minus follows plus quantity, and also how the lumbar spine passes into the sacral spine as this does into the caudal series, without hiatus or any condition of absolute difformity.

The same units are marked with similar letters in all the opposite figures, and it is by our keeping to the fixed numerical position of any unit of series that we are enabled to trace the law of form which renders it at one and the same place in either of minus or plus character.

The same law which has rendered the first lumbar vertebra, $1\,l\,a$, of fig. A as a proportional of $12\,d\,a$, of the same figure, is that law which, ceasing to operate, leaves the vertebra $1\,l\,a$, in another lumbar spine in the character of a thoracic form. The mystery is revealed when we understand that plus is reduced to minus; for if plus be not reduced to minus then it still stands as plus, and consequently plus must be the archetype.

We have before seen that the number of lumbar vertebræ, as well as the number of thoracic quantities, depended upon the condition of development of the last thoracic form or of the first lumbar unit. In one spinal series, that unit which presented as the last thoracic form was, in another spinal series, fashioned to the character of a lumbar vertebra. The plus quantity had been reduced to minus, and, consequent upon this, the number of forms in either thorax or lumbar spine varied.

The number of vertebræ in the lumbar spine may also vary according to that unit of series which shall present in the character of a first sacral vertebra; hence we have figs. A and B presenting the units marked 12 *d a*, as terminating the thoracic series, consisting of the usual number of 12 costo-vertebral figures, whilst, nevertheless, the lumbar spine of fig. A holds 5 vertebræ, although that of fig. B contains only 4. There can be no other reason given for this variety than such as follows—viz., the unit marked 5 of fig. A takes on the sacral form marked 5 in fig. B or C.

The number of vertebræ proper to a sacrum is not fixed, neither is the number of vertebræ proper to a caudal series fixed. The number of either class of vertebræ is dependent upon the serial or numerical position of that unit which shall be rendered of sacral character, or reduced to a still smaller proportional, when it then becomes of caudal stamp. The variation of character follows the law of proportioning.

In the figs. D, E, F, G, H, and I, the homologous units are similarly lettered, and they will (viewed comparatively) indicate the law by which both sacral and caudal series are developed. The plus is reduced to minus, and this is all the difference between them.

The last caudal nodule is the smallest proportional of the archetype of series, and when we reckon the serial units of the human spine from occiput to the last caudal nodule, we then discover that the same units do not terminate the several regions of series in all human skeleton axes. The figures prove this, and the law under whose operation the facts are occurring, must be interpreted according to those facts.

Now in all themes which occupy human inquiry, as well as this one of comparative osteology, it will be plainly apparent that it is the nomenclature, and not the facts of nature, which excites disputation as to whether the ens is or is not thus. For when we designate by a name of one signification two things which have diverse quantities, or when we apply different names to characterise two entities as being various at the same time that they exist in nature as analogous, then it is that we envelope in a fume and cloud of sounding phrase of speech, the actuality and entity of natural fact, and would hence be led by nomenclature to conclude that nothing is but what is not, only that we may readily experience the corrective matter of presential nature, and know therefrom that nothing is but what we may lay hands upon, dissect, and reason about according to analogy.

The several regions of the mammal serial axis are fettered with the bonds of a nomenclature, with which (despite the observation that Nature herself is continually emancipating her person from it, and passing free) we still are pursuing her footsteps, and vainly endeavouring to interpret her person, not according to what she is, but to what we falsely conceive to be her condition. We name her *cervix* to consist of *seven vertebral units, invariably ;* but still the fact is not thus. We name her *thoracic series* to consist of *twelve costo-vertebral units, invariably ;* but still she transcends that rule. We name her *lumbar, sacral, and caudal regions* to be developed of *fixed numbers of vertebral units,* but still she overreaches our rules. We say that *each unit of* series is produced of *fixed osseous quantity,* but still the rule is void. We give *to one form* the name of *vertebra,* but yet we do not know of the form thus suitably named. We say that her *regions of series* severally commence and severally *terminate at such and such a numerical unit,* but still we cannot name the fixed serial situation of those units; and still we indulge in nomenclature, regardless of the facts that the *transition serial quantities* between the several regions of cervix, thorax, loins, and sacrum *may be and are* from time to time of either *cervical, thoracic, lumbar, or sacral character ;* still we endeavour *to define species as a fixed character of any quantity,* compared to other quantities standing in the same serial order, and still we find that *any one of those serial quantities* may assume *any character of species.*

Finding these to be the actual facts of development produced in the mammalian serial axis, need we pass from these further into the subject of an animal kingdom for discovering the law of an ever-moving metamorphosis, which not only varies two or more entities amongst themselves, but which moreover actually causes a third ens to assume the special character of either ; and it is this which reads the lesson, that as there is nothing fixed in nature but her law, consequently there cannot be any other fixed knowledge than that which concerns her law, and this is one of metamorphosing special proportionals from whole quantities, and in this process is contained the long account of species. For while we discover that the *twentieth spinal unit* is (in one mammalian skeleton axis) the *first lumbar figure,* and that this same *twentieth unit* is (in another mammal axis) the *thirteenth thoracic form ;* then we say, that by reading them as the variable proportionals of a whole quantity, we may arrive at a clearer understanding of a law than if we continue for ever to rack ourselves between the counter-arguments for unity and for species.*

The differential method pursued for the isolation of species, (as it commences from *nihil* and ends in the same) may itself be called the visionary and the abortive. For *species* having its location in *subtracted quantity,* may be

* " Il est aisé de voir que *le grand défaut* de tout ceci est une *erreur de métaphysique* dans le principe même *des méthodes—erreur* qui consiste à vouloir juger *d'un tout par une séule des ses parties.*"—Buffon, tom. i. page 20.

said to be symbolic of the past or of the future, forasmuch as it is a *non-existence* which holds no local habitation anywhere, excepting under the anomalous dominion of imagination, weakness, phrensy, ignorance, or enthusiasm.* And regarding the serial skeleton axis (to which we confine our attention at present), whilst we find that *lost quantity* becomes the *sole difference* between two or more figures, and that this difference is *species* or the quantity $a - b$, in presence of $a + b$; we therefore say that any one who will undertake to *define nonentity*, as though it were *an ens*, will prove himself the exact counterpart of him who, as a descendant of Machaon, shall profess such a close intimacy with the secrets of Hygeia as to be capable of diagnosing serous from subserous inflammatory action, or of individualising the affected lobule of a conglomerate gland, and prescribe accordingly.

* It has been long since generally confessed to be impossible to render an anatomical definition of animal species. The animal chain being one of serial gradation is the cause why anatomy cannot isolate even one form as absolutely various to another ; and the same may be said of the serial chain of osseous quantities. Classification, according to specific distinctiveness, that is to say, according to absolute anatomical diversity, has never yet defined the differential line or hiatus between serial beings ; and this remark applies to the skeleton axis or series also. " *Ce moyen* (d'une classification) *supplée a notre foiblesse*, facilite nos études et nos connoissances, et son usage est pour nous d'une nécessité indispensable ; mais j'ai déjà montré qu'il est un produit de l'art, et que, malgré les apparences contraires, il *ne tient réellement rien de la nature*."— Lamarck, *Sur l'Etat de la Distrib. et de la Classif. des Animaux.*   Philos. Zoolog., tom. i. chap. v. page 103.
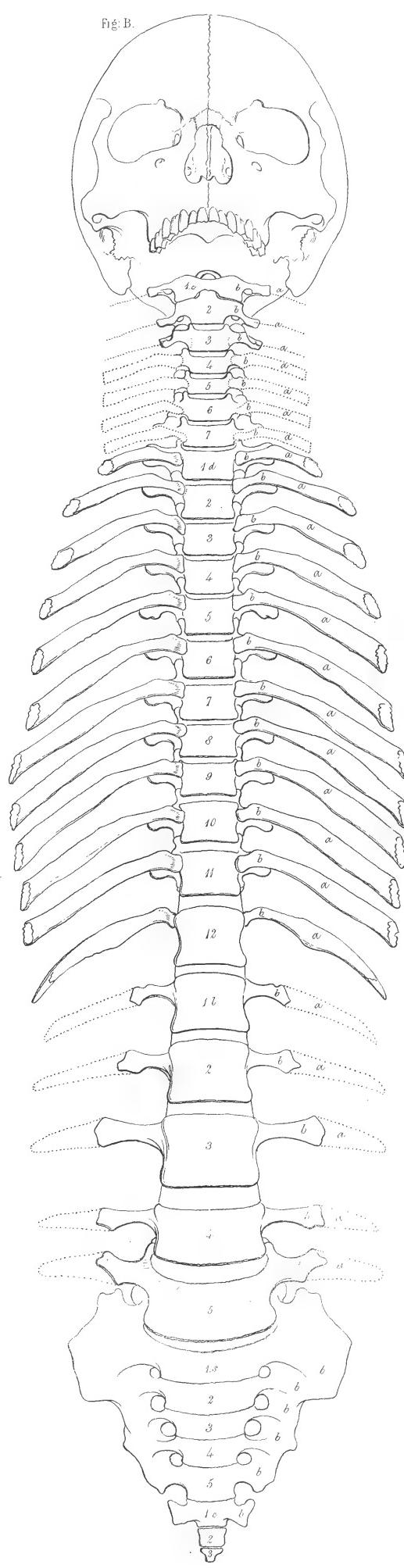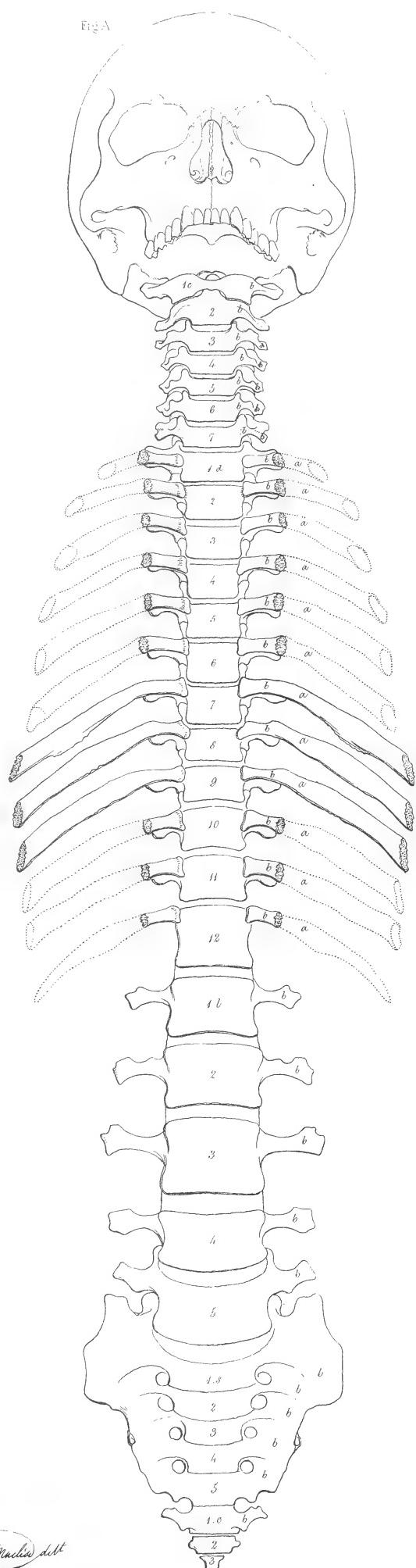
Plate 27.

Fig: A.

Fig: B.

REMARKS ON THE FIGURES OF PLATE XXVII.

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THE CERVICAL AND LUMBAR REGIONS OF SERIES ARE MINUS, COMPARED TO THE THORACIC REGION WHICH IS PLUS.

ANALOGY exists amongst the several osseous quantities of the mammalian serial axis, notwithstanding the fact that those quantities vary to each other by plus and minus proportioning. If a cervical series cannot be said to give example of the plus quantities constituting a thoracic series, still the former is referrible to some proportionals of the latter. If a lumbar, sacral, or even a caudal series, does not instance the same plus condition visible in thoracic series; yet it is quite true that the former do still point to their counterpart proportionals in the latter, and consequently the thoracic series being plus, is only in this respect different to the cervical, lumbar, sacral, and caudal series, which are minus. Now, as it is on the one hand possible to abduct quantity from the plus thoracic series, so as to render them in a condition equal to a minus cervical or lumbar series, so is it possible to add quantity to a cervical or lumbar series in order to equate them with the plus quantities of a thorax. And acting upon these premises, we produce certain consequences which are the actual imitations of natural operation. For we find that the subtraction of costal quantity from a thoracic series is attended with a lengthening of the cervix and loins, whereas the addition of costal quantity to a cervix or loins, causes in an equal ratio an extension of the thoracic series, and a shortening of the cervical and lumbar regions. The progress of Nature herself may be tracked through this wake of evidence; for while in one mammal series she terminates the cervix at the seventh unit, and commences the lumbar region at the twentieth; she also may be seen to have created another mammal series, whose seventh and twentieth units produce the costæ, thus rendering the cervix and loins each minus a vertebra, by no other cause than that the thorax remains plus two costo-vertebral figures or archetypes.

The serial spinal axis is one of graduation and proportioning. The complete thoracic costo-vertebral quantity is that which we name the archetype of the series. The last caudal bone is that which we name the smallest proportional of such another archetype quantity. This is our interpretation of the law of formation respecting the mammalian serial axis, and we believe that it would be as impossible to find reasonable grounds for denying the truth of that interpretation as it would be to deny that $a—b=c$, or that the integer 100 minus 99 equals 1.

Now we have already seen that no one region of even the human spine can be mentioned as commencing or terminating invariably at the same numerical units of series. The cervical region cannot be said to terminate invariably at the seventh spinal unit, for we have examples of the sixth and seventh cervical vertebræ producing costal forms; and, consequent upon this fact, neither can the thoracic region be said to commence at the eighth unit of series, for we see that it sometimes begins at the sixth cervical costal quantity.

Furthermore, we also observe that the thoracic region does not always terminate at the nineteenth serial unit, for we have examples of where it terminates at the eighteenth, and so lengthens the lumbar spine by a vertebra; and also of where it is continued to the twentieth, or even the twenty-first, thus encroaching upon the lumbar region, and diminishing it by the quantity of two vertebræ.

The like remarks apply to the sacral and caudal regions of series, for these do not commence or terminate at the same numerical units invariably. Neither does the human spinal axis terminate at the same unit; for we see that, numbering all the serial units from the occiput to the

terminal caudal bone, this latter will be the thirtieth, the thirty-first, the thirty-second, or even the thirty-fifth, in several axes; thus proving that the number of serial units is not constant even in the human type.

If, as indicated in fig. A, we metamorphose the thoracic quantities from the unit marked 1 *d b*, to the thoracic unit marked 6 *b*, cutting off the costal forms at the point *b*, then it is plain that we reduce the thoracic plus series to the minus condition of cervical units. All units now which hold serial order between the first or atlas 1 *c b*, and the mid-thoracic unit marked 6 *b*, at the dorsal region, would present as homologous quantities each unit holding the same number of identical elementary pieces. In this way the cervical region may be extended down to any extent through the thoracic region. Or, in the same way, if we metamorphose the costal forms of the three last thoracic quantities marked 10 *b*, 11 *b*, and 12 *b*, at the point *b*, then it will be seen that we extend the lumbar region of series upwards into the thoracic region, at the expense of the thorax. Now, the units marked 10, 11, 12, would be homologous with lumbar vertebræ.

Or if, as indicated in fig. B, we continue the series of thoracic quantities through the cervix and the loins, producing the autogenous pieces *b*, of the cervical or lumbar vertebræ through the pieces marked *a*, then it will be seen that we extend the plus thorax through the minus regions of the spinal series, and so re-establish serial plus uniformity from first to last.

It will be at once granted that, in fig. A, the units marked 1 *d b*, and 12 *b*, which commence and terminate thoracic series, will be, when rendered minus the distal piece *a*, equated with the seventh cervical unit marked 7 *b*, and the first lumbar unit marked 1 *l b*.

It will also be granted that, in fig. B, the lumbar unit marked 1 *l b*, and the cervical unit 7 *b*, will, when rendered plus the costal quantity *a*, be equated with the last thoracic quantity marked 12 *b a*, and with the first thoracic quantity marked 1 *d b a*; and, if so, then we may easily infer all the rest respecting the law of unity rendered various through the mammalian serial axis.

For it must be already fully apparent, that while we number the serial units of figs. A and B according to those quantities which the human anatomist describes as constituting the regions of cervix, thorax, loins, sacrum, and caudex, we do so, altogether heedless of the facts by which the law of form out-paces our nomenclature and proves it to be of scanty signification when applied to characterise the ens independently of the rule of its creation. It is not the ordinary or normal condition of form to which the anatomist is to limit his attention if he would rise to question the law of Nature, but it is by fully acknowledging to all the possibility of modification to which the ens is liable, that he may hope to interpret Nature as she is. The creation when viewed in presence of the law which creates, becomes the limit of anatomical enquiry; and when we would fully estimate the fitness of the present design of fig. A or B, as ordinarily produced of *seven cervical* quantities, *twelve dorsal*, *five lumbar*, *five sacral*,

and *three caudal* proportionals, we can only do so by reading it in company with the fact of development, which proves that if fitness demanded the creation to be otherwise than what it now presents, the ends might be effected within the simple limits of that operating law, which subtracting from plus quantity, can render any plus unit of series in the condition of a cervical, lumbar, sacral, or caudal proportional, just as it is possible to degrade the plus existing thoracic archetype to the same dimensions.

The mammal spinal axis, fig. A, presents to us as a series of quantities where minus stands in the presence of plus; and we find that the minus quantities are named cervical and lumbar figures, whereas the plus quantities are named the thoracic forms. Such is the design occurring naturally and fittingly. But when we say that this condition of development admits of serial enumeration, and that the law is fixed for the production of seven cervical, of twelve thoracic, and of five lumbar quantities, for all mammalian figures, or for even any one species of mammalian type, we then are only asserting a rule of form, which Nature herself is not constant in observing, and under this evidence and these circumstances, it becomes safer for the anatomist to progress with Nature and gather the full sum of her manifestations, all pointing to unity and to that ideal type in generalisation, which without passing from the domain of facts, shall indicate the way and progress of the law of design, than for the anatomist to rest contented with any method pointed out by any classifier in defiance of all natural exceptions, the most trivial of which is sufficient to shake the whole mountain pile and throne of system, even though it be ascended by the Titan in the effort to define the absolute difformity of species.

For, though on the one hand it can never be the rational object with the analogist to pursue his study of the law of unity in the hope of manifesting the absolute identity between the forms of excess and defect, still, on the other hand, it can never be the rational expectation with the classifier to define the difformity of species otherwise than as the thing of excess compared with the thing of defect. It is not by everlastingly making search for the limit of special distinctiveness, that we can ever hope to encompass the law of form which produces that which we call species. Nor is it by the vain effort of defining the quantity of the thing of excess in the thing of defect, that is to say, of seeking the quantity of that which is *species by excess*, as though it were existing in that which is *species by defect*, that we can ever demonstrate the whole quantity of unity, or the law which degrades the whole and renders it minus or specially various. For if it be the living fact, that the human skeleton of excess be specifically various to the human skeleton of defect, by that very condition of development which is found to vary one of the lower animals from another; if, as we find to be the fact, that one human skeleton is plus in cervical and lumbar ribs, whereas another human skeleton is minus not only those abnormal quantities of cervix and loins, but minus even the normal costal quantity of thoracic

series, then we may safely assert that neither the absolute condition of species, nor the absolute character of uniformity can be defined by either one view or the other exclusively contemplated, even though the weight of the name Cuvier, turns the balance preponderating at one time to specific variety, and the transcendental philosophy which encircles the name Geoffroy, turns it at other times gravitating to the side of unity.

For, setting aside the word *species* as well as the word *unity*, and viewing the ens in presence of the law which creates it, we attach ourselves to the comparison of fig. A with fig. B, whereupon we find that owing to the simple law of subtracting from plus quantity, the one form may be rendered as various to the other, or even the one form as various to itself by the like operation, as that variety which we find characterising the skeleton axis of a hippopotamus, a cachalot, a vampyre, an ornithorhynchus, a vulture, an alligator, a frog, or a salamander. It is not in human ingenuity either to establish their absolute uniformity, or to demonstrate the hiatus of absolute specific difformity between *the things of serial graduation*, for whereas the law of formation manifests itself in simply degrading from the greater and thereby establishing the creation of the lesser, so must it be evident that the lesser the degree of subtraction performed upon the figure of the greater or whole, the lesser will be the variety produced, and consequently the greater the degree of subtraction, the greater will be the degree of proportional variety. If from fig. B, (whose archetype, plus thoracic series, we have for illustration reinstated and drawn from the atlas to the first sacral bone) Nature, in furtherance of design, subtracts costal quantity, and thereby creates the design of the cervix and loins, such as we find it in fig. A, then fig. A differs from fig. B according to the amount of subtracted quantity. If, again, exceeding the degree of natural subtraction, we ourselves metamorphose the costal forms of all the thoracic quantities of fig. A, leaving only the three mid thoracic forms standing, such as those marked 7*ba*, 8*ba*, 9*ba*, then fig. A will be struck as various to its former self of normal condition, as we conceive this normal human type to be various to archetype serial plus uniformity indicated in fig. B.

Nature subtracts from plus serial uniformity, and varying designs occur according to the varying degrees of subtraction. This is the simple fact to which our observations tend, and we prefer the plain exposure of this fact by an open demonstration, than to continue questioning the precise import of word or phrase, of species or of unity. For as in the presence of the anatomical entity, the name or sound is nonentity, so we find that the names of species and unity whether applied to characterise the absolute difformity or the absolute identity of the things $a-b$ and $a+b$ have never led, and can never lead, to any other interpretation than that the one is minus and that the other is plus. There cannot be any other absolute uniformity, save that of a plus series, and the degradation of this is the source of proportional variety.

And therefore as it appears most true that species follows subtraction, while unity mounts by addition, we must hence conclude that species occurs as well by the subtraction of microscopic infinitesimals, as by any greater degree of quantity; [*] and for this reason we abandon the pursuit of isolating species as hopeless, and turn our attention to the pursuit of unity or the whole quantity, as being a limited and definable creation. For if the idea which fig. B supplies, serves us with the interpretation that it is a whole serial sum, plus in costal quantity at its cervix and loins, and that from it such a minus figure as fig. A may be subtracted by the simple omission of seven costal pairs at the cervix, and five costal pairs at the loins; so may we conclude that fig. B is plus unity, whereas fig. A is minus variety or species. And from this reading we start in quest of that figure of serial costo-vertebral uniformity, which has an actual existence in Nature, such as we anticipate it in the plan of fig. B. The whole osseous quantity of unity cannot be that series which, like fig. A, possesses the minus regional divisions of a cervix and loins, and wherein we occasionally meet with a plus "anomalous" increase such as cervical and lumbar ribs. But the whole form of serial and continuous uniformity [†] must be that plus sum upon which metamorphosis has not exercised for the production of hiatus or minus regions. Hence the minus regions of cervix, loins, sacrum, or caudex, cannot exist in it as being the original or prime model. As the minus regions of series are formed by vertebral quantities, and the plus or thoracic regions by costo-vertebral archetypes, so must the prime model or serial uniformity consist from origin to termination of its line in the condition of costo-vertebral forms, and this is the standard whereunto all minus designs are to be compared.

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[*] "Entre *le dégré le plus bas* et *le dégré le plus élevé* de la Perfection Corporelle ou Spirituelle, il est *un nombre presqu' infini de dégrés intermédiaires*. La suite de ces dégrés compose la chaîne universelle. Elle unit tous les êtres, lie tous les mondes, embrasse toutes les sphères. Un Seul Etre est hors de cette chaîne, et c'est celui qui l'a faite."—Bonnet, *Œuvres d'Histoire Naturelle et de Philosophie, Contemplation de la Nature*, Chap. ix.

[†] "Continuatio est partium inter se non intermissa conjunctio."—Seneca, *Natur. Quæst.*, lib. ii. *Bibl. Class. Lat.*, Lemaire, vol. 87.
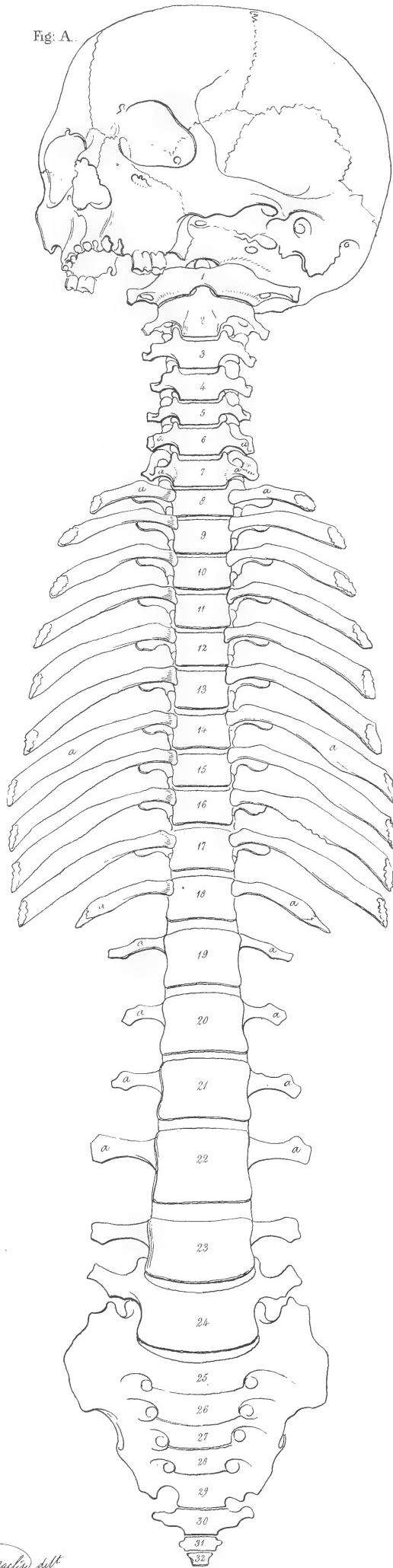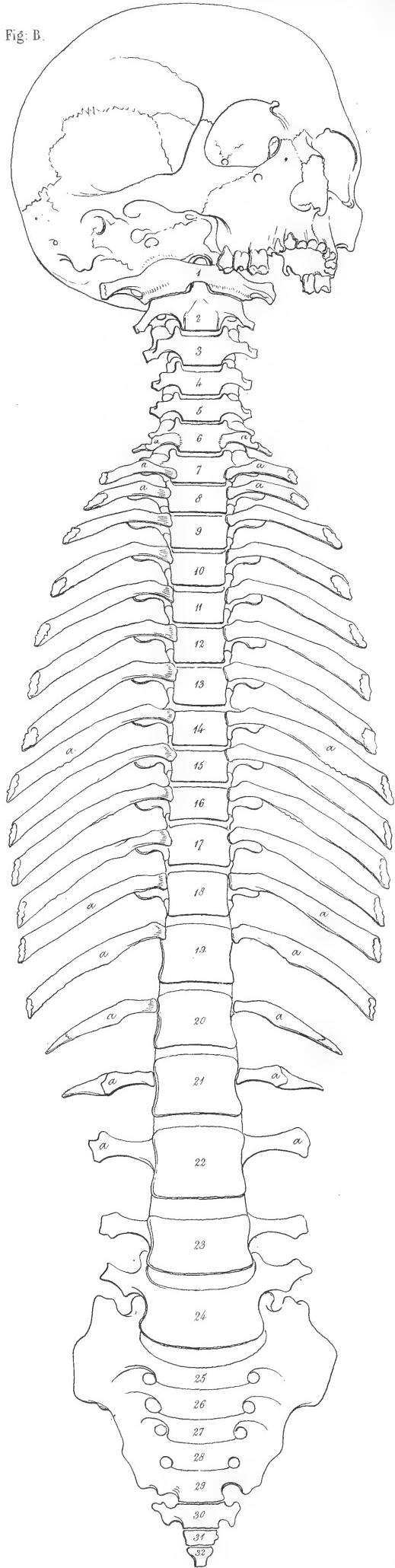
Plate 28.

Fig: A.

Fig: B.

Joseph Maclise delt

London: Taylor & Walton, Upper Gower Street.

Hullmandel & Walton Lithographers.

REMARKS ON THE FIGURES OF PLATE XXVIII.

THE LENGTH OF A THORACIC REGION OF SERIES DEPENDS UPON THE NUMBER OF PERSISTENT ARCHETYPES AND THIS DETERMINES THE LENGTH OF THE CERVICAL AND LUMBAR REGIONS OF VERTEBRAL QUANTITIES.

DIVERSITY follows the degradation of form, and hence, as it depends solely upon the negation or subtraction of quantity it cannot be regarded as an ens. Proportionals are positive quantities, and as such relate to each other, (being the parts of an integer,) and, therefore, analogy binds them together in one collective series. But proportionals not being equals as to quantity, is that very state which introduces amongst them the negative or special condition of development. Now, the comparison of proportionals must lead to a knowledge of that whole quantity from which they have been proportioned, and this is the object of the present argument. Through the medium of our comparisons of proportional quantities, we press forward to the recognition of that original or archetype whose figure suffers metamorphosis. And with this end in view, we merge, for the present, the questions of uniformity and of diversity visible between proportionals, in the paramount subject or being of that whole whose metamorphosis yields all other forms manifesting the proportional analogy and the proportional diversity. For the comparison of unequals has never rendered them equal, nor do we here attempt to interpret them as equal to each other, our purpose being only to prove that they are proportionals of a whole. 'Tis granted that the serial quantities of the mammal axis are proportional analogues of each other; but still we may pass onward to the question whether they present to us in this condition as being the proportionals of archetype plus models. 'Tis also fully granted that these mammalian serial forms of the spinal axis are diverse to each other by inequality of quantity; but still we may seek the cause of this inequality or diversity, and question Nature as to whether this appearance be resulting by the law of metamorphosis or proportioning from the plus archetype skeleton.

Amongst the units of serial order we discern that all variety is produced by the law of proportioning the minus quantity from the plus. Consequently, when we find that any unit of the spinal axis, which is ordinarily in minus quantity, does now and then instance the plus quantity, then we are led to interpret this condition of development to be, not anomalous to the archetype plus or to the vertebral minus, but only as anomalous to the fitting proportions of the special skeleton. The cervical or lumbar vertebræ, producing costæ for example, may be regarded as proportionals of the costo-vertebral archetype, as well as the cervical or lumbar vertebræ, which have only the autogenous pieces of the costæ.

Now, for the same reason, fig. A, whose thoracic quantities commence at the unit marked 8 *a*, and terminate at the unit marked 18 *a*, (the lumbar region numbering six vertebræ,) will be read and understood as being various to fig. B, whose thoracic series commences at 6 *a*, and terminates at 21 *a*, (both the cervical and lumbar spine having less than their proper number of vertebræ,) various, we say, only by the like rule of plus rendered minus.

When the number of plus thoracic quantities is reduced, we see that, consequent upon this subtraction, the cervical and lumbar minus regions are increased in their number of vertebræ; and when, on the other hand, the number of thoracic quantities exceed their ordinary number, then we see that the increase of a thoracic series is at the expense of a lumbar or cervical spine. This fluctuation as to vertebral number in each of the regions of spinal series is altogether owing to the numerical place of that unit of series whereat Nature suffers the plus quantity to persist, or where she wills that it shall be minus, that is to say, of vertebral proportion.

And therefore it is that we have numbered all the

spinal units of figs. A and B in their serial relation, from the atlas above to the last caudal bone below, taking them to be in both figures, but as the varied proportionals of such a quantity as that marked 14 a, in mid thoracic region; for it is most true that the cervical or lumbar spine is only various to the thoracic quantities as minus is to plus, the one region of series being so blended with that which precedes and succeeds itself, that it is impossible to make any other distinction between them than that of gradation.

And, admitting that gradations or proportionals constitute the only known difference between the cervical or lumbar regions, when compared with the thoracic region of the same series, we then see no reason why the same law of proportioning, which can practise to infinity, may not have produced the terminal caudal nodule, marked 32, in series, from the full quantity, such as that marked 14 a, in the centre of the thorax.

Henceforth we shall continue to number all the units of the serial axes in the same order as seen in the figures opposite, and for this reason, viz., we shall then see that the same numerical unit will present itself in different individuals, either as a plus costo-vertebral quantity or as a minus vertebral proportion, proving that the same law which renders plus quantity minus in the one spinal series, performs the same task in other skeleton species, and follows the law of species, or, what is the same thing in effect, precedes the law of species, both laws being inseparable.

We say that the law of proportioning minus quantities from plus quantities, is as inseparable from the law of species as the ens is inseparable from itself, and for this reason, viz., that when from one of two plus analogues, such as costo-vertebral quantities, Nature subtracts the costæ, variety or species is the consequence of that subtraction, and hence we have the vertebral figure as the proportional or species of the costo-vertebral form. If such be the law of form the like must be the law of species also; for subtraction from plus being the law in operation, and species being consequent upon this subtraction, *ergo*, the species is the result of subtraction, which is the law of form, *ergo*, species and subtracted quantity imply the same meaning, and, notwithstanding the paradox, we say that this species is *an entity in seeming* by being *a nonentity in fact*, for it owes its presence to the rule of comparison, and reigns between $a-b$ and $a+b$.

Now not to depart loosely from the facts before us, we shall observe that fig. A is to be accounted as a species in comparison with fig. B, for reasons as strong as those which give a license to us in establishing speciality between two or more skeleton forms of the lower animals. If plus and minus quantity are all the differences which mark any two species of skeletons, we likewise find the same difference to prevail between two individual skeleton forms of one and the same species, such as A and B. If the difference be not sufficient to characterise absolute species in the latter case, neither can it be thought sufficient in the former case. If, on the other hand, the difference be

thought enough to establish distinctiveness between two of the inferior animals, then must it follow that the like difference, existing between two human figures, sunders them also as species. But this will scarcely be acknowledged by the anatomist.

However, as it must be already fully manifest that the law of species is only another name for the law of form, and as both names are but the mere abstract terms which we apply to comparable entities produced as the creations of one and the same operating force in Nature, so will it be always safer to form opinion according to the presential condition of the *Natura* herself, than upon even the choicest nomenclature whereby we label her facts. And herewith we apply ourselves to question that act of Nature from which fig. A is produced in the presence of fig. B, while both forms are standing as creations to which we can neither affix the name of absolute difformity or of absolute uniformity. What is the law under which both have had their present characters?

This law is demonstrated through the actual condition of those plus and minus serial quantities which we find constituting either spinal axis. This law is indicated through the series of fig. A, or through that of fig. B, separately contemplated, and hence it is that we again discover it between figs. A and B comparatively viewed. For the law of proportioning minus from plus quantities, (the vertebra of cervix or loins from the costo-vertebral archetype,) and by which fig. A presents to us as it is, is the same as that law which also creates fig. B as it presents, for the one form is only differenced from the other by varying degrees of subtraction; and if seven costo-vertebral archetypes have suffered metamorphosis for the production of the cervix of fig. A, we find that only five or six of such archetypes have undergone metamorphosis for the cervical region of fig. B, and this is the sum of their cervical difference. Their lumbar difformity occurs by the operation of the self-same process of proportioning; for as there can scarcely be any reasonable doubt raised against the interpretation that the lumbar series of fig. A is a creation occurring by the metamorphosis of six costo-vertebral quantities down to the points of the pieces marked a, neither can it be denied that the lumbar region of fig. B is a creation resulting by the metamorphosis of costo-vertebral archetypes in so graduated a condition that it is impossible to define the limits which separate the thoracic from the lumbar quantities.

Now it will be remarked that the comparison of fig. A with fig. B, teems with the interpretation that the latter form is a nearer approach to plus uniformity or the serial order of archetype costo-vertebral quantities than that which fig. A gives instance of; and while we examine into the causes of this condition of development characterising fig. B, we find that it has occurred by the persistence of costal quantity upon those serial units marked 6 a, and 7 a, at the cervical region, and also by the like persistent presence of the costæ on the units marked 20 a, and 21 a, at the lumbar region. We therefore ask whether there can be any other reading sufficient to account for the minus

condition of fig. A, and the plus condition of fig. B, than what we offer in the following mode, viz., that the process of degradation or subtraction from a plus uniform series of uninterrupted thoracic quantities, has not taken place to the same degree for the creation of fig. B as it has done for fig. A, and that therefore it happens that the serial quantities of fig. B are in excess, whereas those of fig. A are in defect; from which facts it must also follow that fig. B is a nearer approach to the original or prime model of serial uniformity by the very creation of cervical and lumbar ribs, than fig. A, where these "anomalies" have been altogether subtracted. And, therefore, we repeat in reference to the difference * which distinguishes fig. A from fig. B, that "verè scire, esse per causas scire." And if we remark that to know truly the origin of cervical and lumbar ribs is to understand that they are parts proper to the archetype or whole † skeleton quantity which we are proceeding in search of, we do so only under the license of a mode of comparison which we have sought for in vain through all the store of the British Museum Library, or that of the Bibliothèque du Roi. If their interpretation be not here, it certainly is not to be found there, and if it will be said that it matters little to "the practical" whether it may not be found either here or there, we shall not, at present, engage to move a contrary opinion, even though the Bœotian or the Osiris priest, dictating the recantation to the astronomer of Pisa, could scarcely find, upon the scale of *mens*, a more chilling *zero* whereat to limit inquiry,‡ than what this pursuit of *the practical* ordinarily realises.

* " Datæ autem Naturæ formam, *sive differentiam veram, sive naturam naturantem, sive fontem emanationis,* (ista enim vocabula habemus, quæ ad indicationem rei proxime accedunt,) invenire, *opus et intentio est humanæ scientiæ.*—Bacon, *Novum Organum Scientiarum,* Aph. 1, lib. ii.

† " 'Tis the sublime of man,
Our noontide majesty, to know ourselves
Parts and proportions of a wondrous whole!
This fraternises man."—*Coleridge.*

‡ " Homo, naturæ minister et interpres, tantum facit et intelligit, quantum, de naturæ ordine, re vel mente observaverit; nec amplius scit, aut potest."—Bacon, *Novum Organum Scientiarum,* Aph. 1, lib. i.
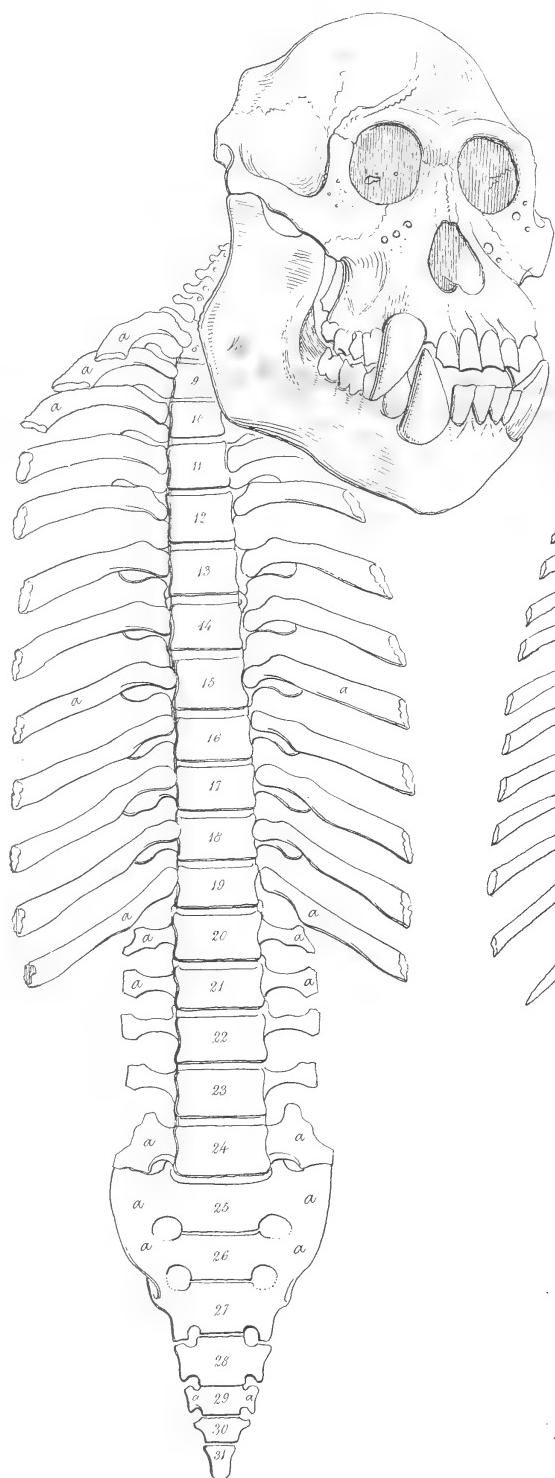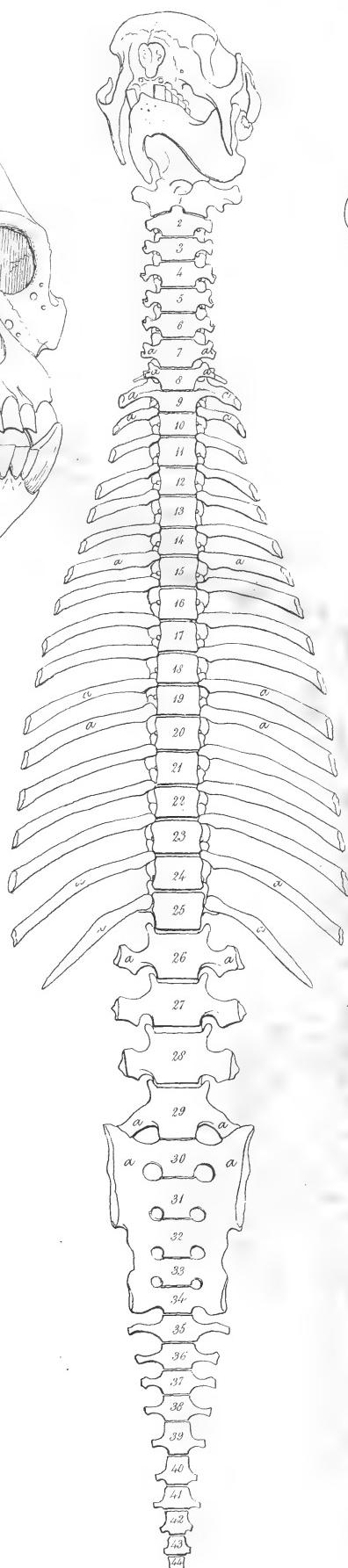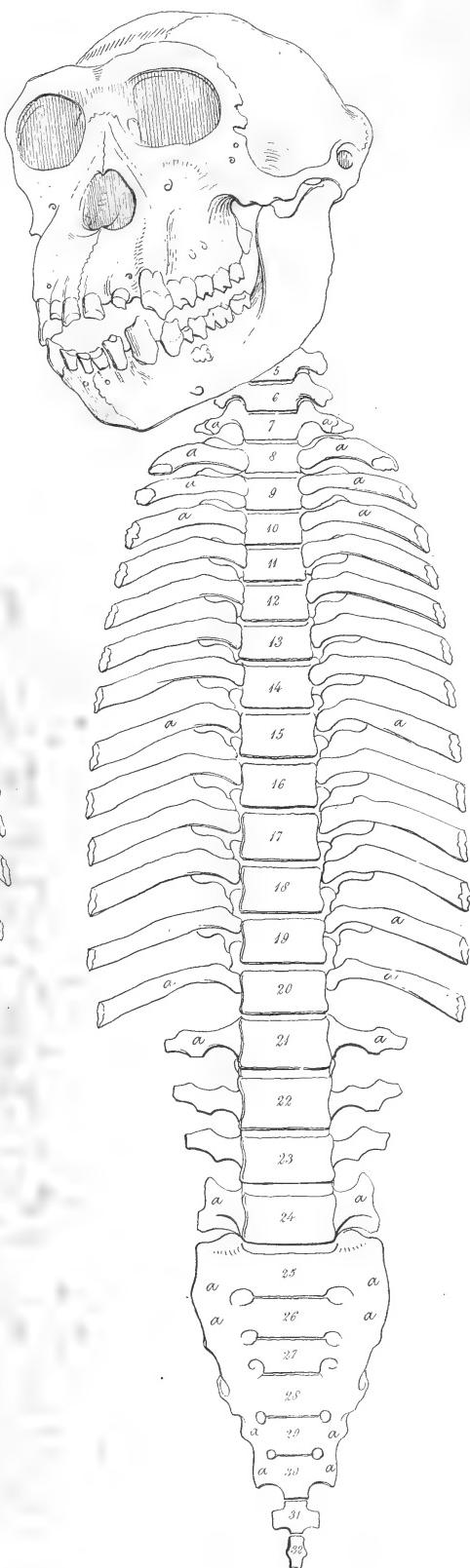
Plate 29.

Fig: B.

Fig: A.

Fig: C.

REMARKS ON THE FIGURES OF PLATE XXIX.

THE NUMERICAL ENTIRE LENGTH OF EACH MAMMALIAN SERIAL AXIS VARIES LIKE THE NUMERICAL LENGTH
OF ANY REGION OF THOSE AXES.

NUMBER is serial and illimitable. The laws of proportions and progressions are likewise illimitable. The mammal spinal series being one of proportional quantities, is also seen to be variable, both as to serial number and serial proportioning. Uniformity as to existing quantity cannot therefore be said to characterise the mammalian axes either generally or individually contemplated. If two or more skeleton serieses are seen to vary, so likewise is the one skeleton series seen to vary. If neither the entire numerical length of series or any one of its regional divisions be produced of set and fixed number for a plurality of animals in the same class or the same species, the same may be said with regard to the individual, for it evinces through its several phases of development a variation from minus to plus quantity. Uniformity, absolute and unexceptional, characterises the series of integers written thus, 9, 9, 9, 9, 9, 9, and if these be extended *ad infinitum*, still they will maintain their linear uniform meaning. To imagine this serial line of infinite uniformity, is also to create the ideas of its possible infinite proportional variety, for if the creation of 9 may be serially succeeded by 9 to infinity, so may the infinity of this series be infinitely varied by the subtraction of 9, and hence we can conceive any proportional length of such a series. Such are the varieties or proportional serial lengths which vary all skeleton serieses from occiput to caudex. But as the number 9 is an integer, and will if repeated in series produce a uniform series of integers, so will the costo-vertebral quantity as a whole produce, when repeated in series, the plus uniform order of such structures from origin to termination of the line. The mammalian serial axis is not thus produced, because metamorphosis, or the subtraction of quantity, has (under the eye and government of design) reduced one region of such an original plus series to cervical fitness, another region to lumbar character, and another region to the extreme degradation of caudal quantity, while the thoracic series persists in its original plus quantity. The serial costo-vertebral quantities, like the serial integers, 9, 9, 9, &c., are subjected to the law of proportioning, and thus original plus uniformity is struck proportionally various, according to the required design.

Hitherto we have only compared the human skeleton axis to itself, and so far as we have proceeded we have seen that the serial order of the units constituting the human spine proves those units to vary amongst themselves, simply as plus and minus quantities. But the main object of this comparison was to have it understood that each of the minus or vertebral units had been metamorphosed from their own plus costo-vertebral quantities, and under those ideas we have sought to interpret the occurrence of such creations as cervical and lumbar ribs.

The framework of man is comparable to that of the lower animals. We have only to anatomise this fact in order to know it, and to know also that the law of Nature is one and the same in the creation of all animal beings, the only difference between them as corporeal structures being that which exists between plus and minus quantities.

Animal bodies are one and all products of the same law of development. A Newton, a Leibnitz, a Geoffroy, or a Cuvier, could not deny that their own corporeal frame-

works bore an unmistakable similitude to that of an orang-utan, a chimpanzee, a mandril, and a baboon. The paragon of the human ΜΟΡΦΗ was confessed by them to stand beside its anthropomorphous satire; but it was by the very acknowledgment of this fact, and the recognition of a law in Nature, that they themselves described the well-marked line which separates the human intelligence from that of mere brute instinct. The motive marks the difference. For if a list of all the transcendent secrets of anatomical philosophy were inclosed within the compass of a cocoa-nut, and rolled, like the apple of contention, in amidst the assembly, consisting of these eight personages, we can very easily guess the motive which would actuate the quadrumanous species on the one hand, and the biped species on the other, to break open the concealed contents. But however distinctive these beings in this psychical particular, still we cannot deny that fig. A has been cast after the same mould as the type human, and presents itself as a created illustration of the fact that between species and species, as between the sublime and the ridiculous, there is a point of fluxion which masks the differential line.

Fig. A represents the skeleton axis of the orang-utan (simia satyrus), and if there be any truth in the foregoing interpretation of the units of the human spine, the same interpretation applies here also.

Fig. B is the front view of the skeleton axis of the sloth (bradypus tridactylus), a mammalian skeleton, in which we find that the *nine* first units have been rendered minus for the cervical region, a fact which, however unusual its occurrence in the class mammalia, may bear of interpretation according to foregoing remarks.

Fig. C shows the skeleton axis of the chimpanzee (simia troglodytes), and we at once discover it to be a form fashioned after the same type as that of the human osseous framework.

Fig. B differs in the cervical region of the serial axis from figs. A and C by the plus amount of two vertebræ. But we already understand that the vertebral body is a proportional of the costo-vertebral quantity, and hence all that requires to be said of this singularity of form in the cervical region of the sloth's skeleton is, that nine costo-vertebral units of series, instead of seven, have undergone the rule of minus proportioning.

In figs. A and C the cervical region of the serial axis consists of seven vertebral quantities, but it may be reasonably supposed that even these quadrumanous species are subject to the occurrence of cervical ribs, thus occasionally shortening the cervical spine, as in the human form. In fig. C the unit 7 *a a*, shows something of this sort.

The thoracic region of series in figs. A, B, and C is seen to develope variable quantities. Fig. A is developed according to that numerical plan usually found in the human skeleton. Its thoracic series of archetypes commences at the eighth unit and terminates at the nineteenth. Its lumbar spine commences at the twentieth and ends at the twenty-fourth. But the twentieth unit of series, which is of lumbar proportion, in fig. A, is seen to pro-

duce the costæ in fig. C; however, since in fig. A the unit 20, is a proportional of the unit 19, so is the unit 20, of fig. A the proportional of the unit 20, in figs. C and B.

In these figs. A, B, and C, the same units of series bear the same letters or numbers, and a comparison of the units of either figure will express the law of proportioning, metamorphosis or modification.

In these three figs. A, B, and C we find that the spinal series is developed in unequal numbers of units, but since whatever be the numerical position of any unit of series, or whatever be its modification, it still may be regarded as a proportional of such a form as 20 *a*, fig. B, we then understand how series may be terminated at any unit which the law of form shall metamorphose to caudal quantity or minus condition.

Each region of the skeleton series terminates by the same process which gives the entire finite serial line its special length. The caudal quantities we here regard to be the smallest proportionals of the costo-vertebral archetype series, and hence the length of every skeleton axis is determined by the extreme degree of metamorphosis to which the archetype is subjected. When we say that $9-8=1$, we apply this fact to the interpretation of that law of design which produces fig. A, or B, or C, having an archetype quantity in the thoracic region of series, and the smallest proportional of such an archetype in the caudal region of the same series; and hence we infer that the thoracic quantity 15*a*, of fig. A, B, or C, minus a certain quantity, will equal the ultimate caudal bone of either fig. A, B, or C. But as we find that this extreme degree of subtraction does not take place upon the same numerical unit, destined to become an ultimate caudal ossicle, so do we discover that the serial spinal lengths vary accordingly. For the finity of the serial axis fig. A is marked at the 31 numerical unit, whereas in fig. B it is reckoned at 44, and in fig. C at 32.

Now we have already observed that even the human serial axis terminates at numerically various units, as well for its regions as for its entire length. We cannot assert of the human cervix that it invariably ends at the seventh unit, nor of the human thoracic series that it constantly ends at the nineteenth. Neither can we say that the human lumbar region terminates at the twenty-fourth unit, and it is also true that the terminal caudal ossicle of the human spinal series is a numerically different unit in several human skeleton figures. We doubt not that the like numerical variations as to regional lengths might be also observed through the species of fig. A as well as through that of fig. B or C. And it is a certain fact that the comparison of these three forms, A, B, and C, with each other, reveals the very same differential law whereby they are varied to one another, simply according to the numerical position of that plus costo-vertebral unit which has undergone cervical, lumbar, sacral, or caudal modification.

As we find that the proportionals of one series or skeleton axis admit of comparison, and the interpretation that the lesser unit is a quantity metamorphosed from such as the greater, so shall we meet with further proof of

this law when we compare the several conditions in which the same numerical unit presents in different animal forms. For if there be truth in the reading that the unit marked 20*a*, (a first lumbar quantity) in fig. A is but a proportional of such another quantity as that marked 19*a*, in the same series, so do we meet with a further illustration of the fact when we compare 20*a*, of fig. A with 20*a*, of fig. C, and next with 20*a*, of fig. B, for these also prove the same law of their proportional creation.*

While the degradation from plus to minus quantity appears to be the law of skeleton formation, we hence can produce evidence of this simple operation as well from the comparison of those serial proportionals which constitute the one skeleton axis as from a more extended comparison held between the same numerical units of three or more distinct animals. And in addition to this we remark that if in fig. A those units marked 19*a*, 20*a*, 24*a*, and 31, can reasonably be regarded as the proportionals or decreasing series of such original quantities as those ranging between unit 8 and unit 18 of the thorax, then may we furnish ourselves with as perfect an idea of a skeleton prime model of unity, or the plus archetype series, as if we had subjected to the same rule of comparison the entire graduated scale of an animal kingdom.† For while we advance the reading that any one of the minus units of fig. A is a proportional metamorphosed from quantity such as unit 15*a*, of the thorax, then this condition of development cannot possibly be contemplated isolatedly, from the fact that the original series was composed of such quantities as unit 15*a*, and this is uniformity.

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* " Nous avons vu plus haut que les premiers qui tombent dans l'erreur sont ceux qui cherchent à faire cadrer immédiatement un fait individuel avec leurs opinions ou leur manière de voir. Nous trouverons au contraire que ceux qui savent étudier une observation, une expérience, sous tous les points de vue, la poursuivre dans toutes ses modifications et la retourner dans tous les sens, arrivent aux résultats les plus féconds." —Goethe, *Œuvres d'Historie Naturelle*, Introduction, p. 11.

† L'Echelle de la Nature se construit donc en passant du composant au composé, du moins parfait au plus parfait."—Bonnet, *Contemplation de la Nature*, chap. xiii.
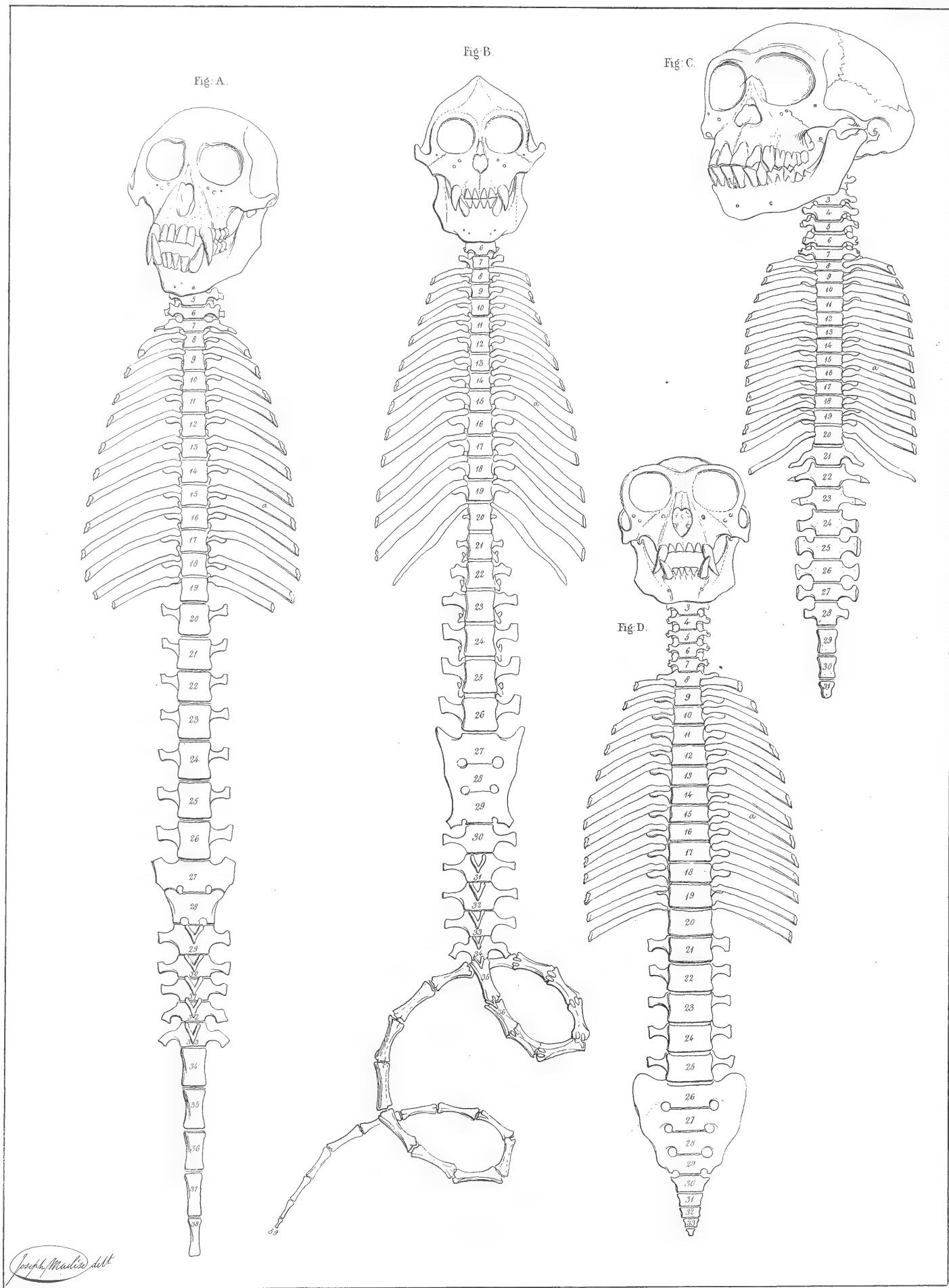
Plate 30.

Fig: A.

Fig: B.

Fig: C.

Fig: D.

Joseph Maclise delt

REMARKS ON THE FIGURES OF PLATE XXX.

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ARCHETYPES which persist in full quantity, and archetypes which have undergone metamorphosis, and now present as proportional quantities, are those figures which constitute the mammalian-serial axes. The mammal series is a design by the loss of quantity, and this quantity is proper to the plus costo-vertebral series. It is the law of proportioning or metamorphosis which has degraded the plus serial originals, and which are now presented to us in proportional variety, from being once absolute archetype uniformity. The numerical proportional length of the mammal serial axis mainly depends upon the numerical situation of that archetype unit of series, which having undergone the greatest amount of subtraction, exists as it were on the extreme verge of entity, and next to the state of nihil. The ultimate caudal nodule is the vanishing point of series, but the numerical position of this point is by no means fixed and invariable for even one species, much less for two or more species. The caudal prolongation is that region of the serial proportional axis which varies most as to numerical length, and it is impossible to determine its precise limits in any animal. When it is described as commencing immediately after the last sacral vertebra, and as terminating at the last caudal bone, this account does not pretend to assign to it a fixed numerical length : moreover, it is not the less true that any other region of series is fluctuating in the like inconstancy of number, and therefore it is that uncertainty attends all particular descriptions of the mammalian serial axis, because it is a series of proportional quantities which give instance of the infinitude of minus variation, and cannot be encompassed by any other mode of description save that of generalisation.

In the serial spinal axis we discover that the units suffer modification from plus quantity to minus quantity. Thus a lumbar vertebra is minus compared to a plus costo-vertebral archetype, and so is a terminal caudal ossicle minus compared with the lumbar vertebra. For which reason the caudal quantity must also be interpreted as minus the thoracic quantity, and hence we interpret that each region of spinal series terminates and commences at those units which happen to be subjected to that degree of modification which each spinal region instances ; hence, also, each spinal series may be interpreted as terminating at that unit which is an example of the lowest degree of quantity, such as we find in a terminal caudle ossicle. Now from this it is clear that any unit whatever of series, such as thoracic quantity, would, if subjected to the same degree of metamorphosis, which at one place fashions the cervical vertebra, at another the lumbar vertebra, and at another the caudal vertebra, furnish the like form of quantity, such as we find in the cervix, loins, or caudex.

For example, when we say that fig. A is a serial axis

terminated below, at caudex, then we would have it to be understood that this last caudal unit marked 38, fig. A, is a proportional of its own archetype quantity, which may be said to equal the unit marked 15 a, of the thoracic series, and in this reading we endeavour to account for the fact that the same numerical unit of separate axes is seen to present the like modifications from plus to minus quantity.

The opposite figures represent various species of the monkey tribe, and we have marked by digital numbers all the units of each serial axis, counting from the first unit succeeding the occiput to the terminal caudal ossicle below. Every unit bearing the same mark, in each skeleton axis, is seen to present no other difference than that consequent upon the law of proportioning.

In fig. A we say that the unit marked 20, is a proportional of such a unit as that marked 19, above it. If this be true, then we say that fig. A, such as it appears in creation, is as a special modification planned from a series of thoracic archetypes, holding a serial order from occiput to the other extreme of the same series. It is true that

we do not now see fig. A to give example of such an archetype series; but it is also most true that fig. A, such as it stands, presents no other variety to this archetype series than such as the law of proportioning could fashion out of this series. Now, whether this interpretation be true or false, still it cannot be denied that the unit 20, of fig. A commences the lumbar spine here, and that the same numerical unit of figs. B, C, and D, is seen to terminate the thoracic series in them. The only difference, then, between the units 20, as they happen in each series, is, that in one place the unit bears costæ, whereas in another it only bears the autogenous elements; this difference being only plus and minus. But let us not forget that this unit marked 20, in fig. A, is subject to the same plus or costal anomalies which we find it to present in the human skeleton. The unit 20, of fig. A, is not always of lumbar cast, even in that very same species, for it now and then developes its autogenous elements to the plus form of lumbar ribs.

In fig. A we also find that the unit marked 26, terminates the lumbar spine here, and also presents the like character in fig. B.; but in figs. C and D, the unit 26 is moulded to sacral form. In fig. B we have the longest serial axis, and the greatest number of serial units. In this figure B we discover that the unit named 33, marks the terminal point of the caudex of fig. D. In this fig. B, again, the unit marked 31, shows the point of serial termination for fig. C, and this leaves it to be inferred that the smallest minus proportional of the archetype quantity is that condition of development which finishes series in all skeleton axes, and just as 9, 8, 7, 6, 5, 4, 3, 2, 1. But we should remember that $1 + 8 = 9$, as well as $9 - 8 = 1$ which is the same as saying that 1 is a proportional of the integer 9.

Now, as it becomes the first imperative duty for any one who proposes an innovation in science to determine well the boundary line between right and wrong, between the possible and the impossible, between the simply natural and the miraculous, so does his second duty seem not the less imperative with regard to fixing the precise meaning of the terms which he makes use of for the development of the subject in hand. The majesty of science resides altogether in the respect for truth, and this is a proposition which strikes deeper root when it shall happen to be demonstrated *ad impossibile*. For, knowing that the *majesty of Truth is the person of Nature*, which is a self-evident axiom, then if we assume that *the majesty of Truth is not Nature*, but some figurative phrase which is *nihil*, and consequently inappreciable by sense, and that we designate this *nihil* or *species* as omniscience, omnipresence, omnipotence, those names being strictly applicable to *presential natura* —in such case, if any one were to stand up amongst us and say that we are simply investing *nonentity* or the *invisible* with the lawfully inherited attributes of *visible entity*, or the *natura naturans* and *naturata*, and that, therefore, the attempt to demonstrate the thing which *is not* does but render more evident the thing which *is actually*, perhaps there is not a physiologist, possessing a healthful sympathy

and bearing, who will gainsay and immolate the speaker of that sentiment, but, if such be his infirmity, will rather staunch his wounds than goad them to festering. We are simply alluding to the comparative designs of the opposite figures, and considering these designs through the views of Geoffroy and unity, as martyred to the interests of Cuvier and species. And hereupon we ask for the precise definition of the word unity, as characterising the absolute sameness of those figures, as well as the precise meaning of the word species, which would imply their absolute distinctiveness.

In answer to this demand for a precise definition of the condition of species as opposite to the condition of unity (both of which conditions, at the same time, seem to characterise figs. A, B, C, and D,) we remark here that it is totally impossible to yield that definition so long as figs. A, B, C, and D continue to be regarded in any other sense than as the proportionals of a whole. In making this assertion, we do not issue it as if it were the bull of a Palatine, against which every rational appeal is to fall like a barbless arrow from a seven-fold shield, but we submit it to the judgment of all who are disposed to try the question, and we offer the reasons of our opinion as follow.

Creations are given quantities and may be proportional, as well as of whole conditions. When we compare whole quantities of the same cast, their absolutely uniform character admits of no dispute, $a + b$ and $a + b$ are absolute samenesses, and the repetition of $a + b$ may be produced of a continuous length sufficient to belt the whole rotundity of the globe in a circle, or even sufficiently extended in a right line so as to transfix Herschel, but still the series of whole quantities would retain uniformity. This is indisputable. But finity or lengths of varying proportionals are the designs of Nature, and consequently she presents us with the given finite quantities of $a + b$ succeeded by $a - b$, and hence we infer that the way of her design is the subtraction of quantity. Now, the comparison of $a - b$ with $a + b$ is that which involves the opposite questions of unity and of species. On the one hand we have the analogists, neglectful of defining their meaning as to the term uniformity, and vainly attempting to demonstrate the equality of a whole and a proportional of that whole, such as $a + b$ and $a - b$, whereas on the other hand we find the specialists as vainly endeavouring to define the absolute difformity between the whole and the proportional of that whole, such as $a + b$ and $a - b$, and hereupon we say that the question of unity and of species will never close so long as the argumentators themselves occupy the hiatus or breach of continuity; for while they themselves, like wedges, cause the gap, it therefore becomes of little use to them to preach the union of sides.

The minus quantity not being equal to the plus quantity, is therefore not uniform with the plus quantity, and therefore, when the analogist asserts "ab uno disce omnes," pointing to a proportional as equal to a whole, he belies the entity of Nature, and at the same time frustrates his own argument, and this is the instrument with which the specialist arms himself. But this instrument, which the specialist uses against the analogist, though it may be

fatal to the opponent, offers but a fragile support to the assailant's own cause; for though this latter may demonstrate *error* by contrast with *fact*, still he does not convert *what is error on the one side of the question into a truth on the other*; by which we mean, that though the specialist may rationally deny the existence of absolute uniformity or equality between two or more skeleton fabrics, still he fails to give their species or minus quantity any other absolute character than that of being a proportional of plus unity. And hence springs the necessity of establishing the character of a whole quantity, the subtraction from which is the creation of species. The proportional is, no doubt, minus something which the whole possesses, and therefore, if the proportional, being minus some quantity, is hence to be designated *a species*, we also herefrom infer that the origin of species is in subtracted quantity.

Species, therefore, resides in the negation of that quantity which causes unit 20 of fig. A to be proportionally different to unit 19 of the same series, or to unit 20 of the other series of figs. B, C, and D. The costo-vertebral quantity is the whole, and the first lumbar vertebra is the proportional of such a whole, and it is this same law of proportioning which yields figs. A, B, C, and D as the various finite lengths of an original series of costo-vertebral archetype quantities. The caudal termination is the vanishing point of converging series, and is consequent upon the subtraction of quantity from a plus uniform continuous series of thoracic figures. The paces of design will be read accordingly, and the length of each caudal region, whether we contemplate it *en sa cachette* within the anatomy of the incarnate divinity of the type Ανθρώ-πϊνος,* or whether we view it openly measurable in the neighbouring brute type Ανθρωποειδὴς,† still the only ascertainable difference that can be said to prevail is that of $a-b$ in presence of $a+b$, nor could a Wolfius, a Des Cartes, a De Moivre, or a Newton describe the creation mathematically otherwise.

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* " *L'étonnante analogie* qui se trouve entre la structure du corps humain et celle des quadrupèdes, des oiseaux, et des poissons."—" On peut changer une vache en oiseau, *un quadrupède en homme*."—CAMPER, *Deux Discours sur l'Analogie qu'il y a entre la Structure du Corps humain et celle des Quadrupèdes, &c.*

† " Mais, si l'orang-utang n'est point un Homme, il en est au moins le Prototype le plus parfait qui soit sur la terre."—BONNET, *Contemp. de la Nat.*, chap. xlvii.

Plate 31.

Fig. A.

Fig. B.

Fig. C.

Fig. E.

Fig. D.

Fig. F.

Fig. H.

Fig. G.

Fig. I.

Fig. M.

Fig. K.

Fig. L.
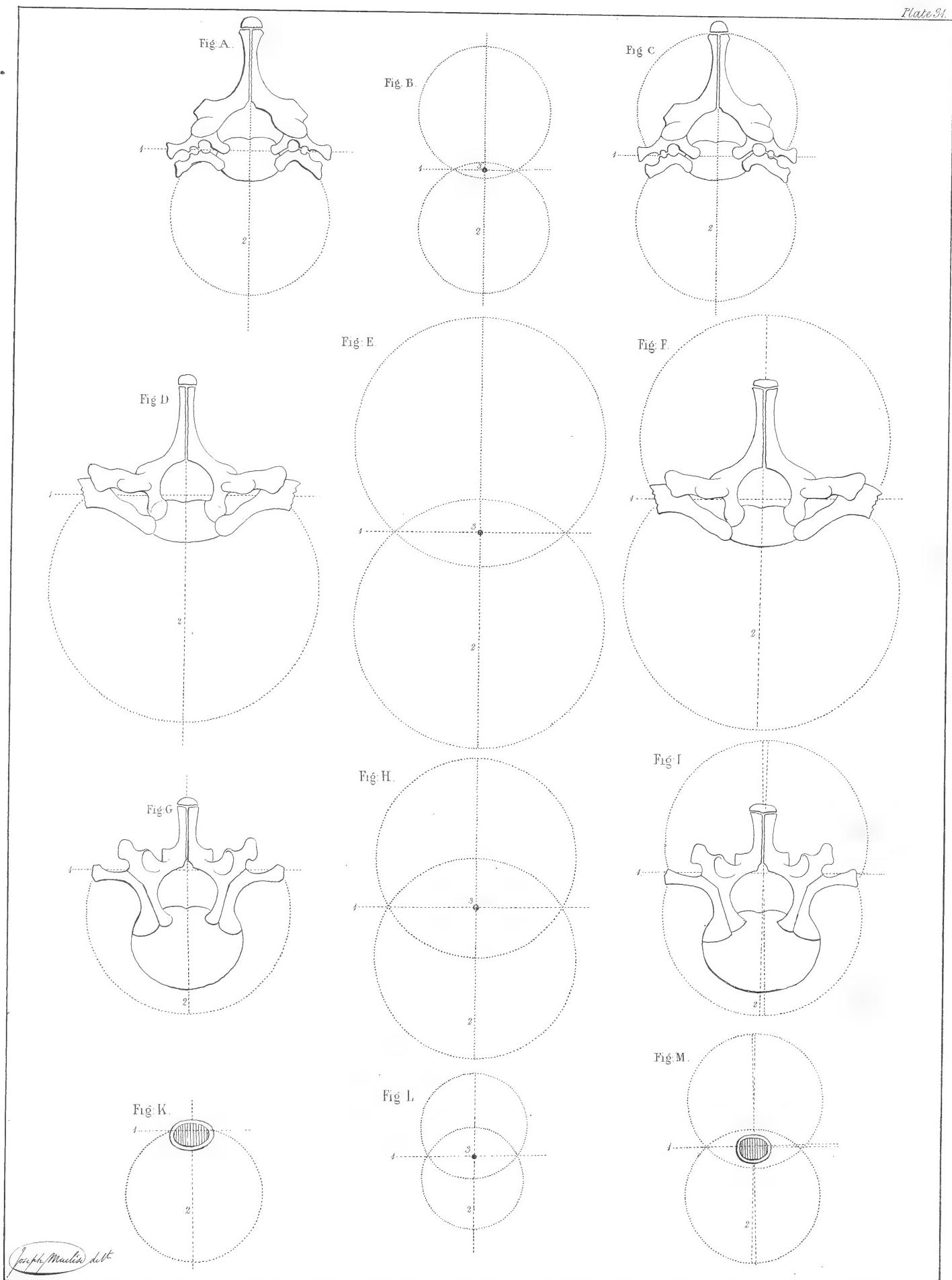
REMARKS ON THE FIGURES OF PLATE XXXI.

THE COSTO-VERTEBRAL FIGURE HAS A BILATERAL BUT NOT AN ANTERO-POSTERIOR SYMMETRY. THE DUPLI-
CATION OF THE COSTO-VERTEBRAL FIGURE GIVES BOTH CONDITIONS OF SYMMETRICAL CLEAVAGE.

WHOLE quantities of form are duplex. The circle is a duplicate of the semicircle, and that whole figure which consists of two tangent or secant circles is a duplicate of the circle. Any right line which shall pass through the centre of the circle will divide it symmetrically. The circle is a symbol of complete unity, symmetry is its attribute, and homology is its characteristic ; its halves are homologous, and so likewise are all its segments, provided they be cut of equal bases. When we draw two tangent circles, and view both as constituting an entire form, we find that this figure is also capable of symmetrical cleavage by two lines intersecting each other at right angles. The tangent circles are cleft bilaterally symmetrical by that perpendicular line which passes through the centres of both circles. And this figure of tangent circles is likewise cleavable into antero-posterior symmetrical halves by that transverse line which passes through their secant points. Now, when we compare the costo-vertebral figure with that of the secant circles, it will be seen that the former differs from the latter by the want of antero-posterior symmetry, whereas both forms retain the common feature of bilateral symmetry. The costo-vertebral form is rendered bipartite by that line of cleavage which passes through its spinous process behind, and its sternal piece in front ; but the line of transverse cleavage carried through its vertebral centrum will prove that the dorsal and ventral structures are unequal quantities. The neural or dorsal arch is minus, while the costal or ventral arch is plus.

In the opposite figures we have drawn comparison between the dorsal and ventral aspects of the several classes of vertebral quantities, and by the comparison to prove this fact, viz., that in the mammalian skeleton axis the vertebral form is prone to describe plus variety by producing the autogenous pieces through a ventral circle. The neural arches at dorsum enclose space all through the spinal series excepting at the caudal region, where minus proportioning is at its lowest extreme. But the costal or ventral arches of the thoracic units enclose space which is not found to be similarly embraced by the units of a cervix, loins, or sacrum, excepting in those few cases where the cervical or lumbar vertebra developes anomalous costæ. When those cervical or lumbar costæ are produced, then they imitate the thoracic quantities in enclosing thoracic space ; but when the lumbar or cervical units do not develope costæ like a thorax, then they may be said to be minus the costal structures, by which we are given to understand that these structures have been subtracted from them.

The cervical vertebra fig. A is symmetrically cleavable by the line 2, but not by the transverse line 1 ; and even when fig. A describes the ventral circle, still the line 2 cleaves the whole figure into equal sides, though the line 1 would still divide the form transversely into unequal quantities. Still we must confess that when the vertebra performs the ventral arch, it approaches in some degree to the equation of dorsal and ventral form. Fig. B shows how two circles placed one above the other would form an entire figure, capable of being cleft symmetrically by a line passing either transversely or perpendicularly through the centre 3 ; and in fig. C we find that if the autogenous elements described the ventral or costal circle, whilst the neural arches suffered expansion to the dorsal circle, then the vertebra would simulate the form of double circles, and be capable, like this form, of both modes of symmetrical cleavage, either by the transverse line 1 or by the perpendicular line 2 ; and upon this the question may be asked, is there a vertebral quantity in any skeleton axis, fossil or recent, produced in such condition that it could be cleft from back to front and from side to side symmetrically ? If there be in all creation such an archetype quantity, then fig. A is a proportional of such another quantity.

And as figs. D and G are equal to fig. A, so must they

be also named the structural minus proportionals of such an archetype as shall be found symmetrically produced as to back and front as well as side and side. We know that fig. D is a proportional of the thoracic plus quantity. We also know that figs. A and G, the cervical and lumbar vertebræ, are proportionals of the like quantities, for their anomalous costal growth prove it. We also infer, from the general line of serial proportional quantities, that fig. K, the caudal centrum, is a proportional of the like thoracic quantity. If, then, fig. D be the proportional of the existing thoracic archetype, as seen in mammal skeletons, and this archetype itself be the proportional of some fuller quantity hereafter to be named, so may we conclude that figs. A, G, and K are also the proportionals of this same fuller quantity.

But the present object is to prove that in the mammal skeleton axis the thoracic quantity stands as the archetype of such a series.

What figs. B and C explain in reference to fig. A, is also expressed by figs. E and F of fig. D, and by figs. H and I of fig. G, and by L and M of fig. K.

Now as we have before said that it is absolutely impossible for the anatomist to develope the idea of osteological unity or the whole quantity by any mode of measurement to which he subjects the actual condition of forms which he does not understand to be as proportional quantities, so must it also be evident that under this mode of comparison carried upon parts, he can never appreciate the full sum of design as fashioned by the hand of Nature. The osseous quantity, wherever it happens in series, furnishes a self-evident proof of its mechanical design; but this is not all which comparative science demands in illustration of the law of form. The vertebral quantity is acknowledged to be a mechanical fitness, and the descriptive anatomist gives it a name accordingly; but the comparative anatomist rejects that barren mode of contemplating the ens, and after having filled the ear of scientific Europe with "the vertebral theory" and absolute uniformity, he leads us only half way up the Parnassus height, and from thence he fires his poetic shafts into the thin ether of empyreal transcendency, and generalises upon an ideal figure which he calls "typical," but which figure is still an unknown quantity, immeasurable, undefinable, an arbitrary rule, false in its application, vague, void, unfixed, unlimited, and changing with the law of metamorphosis as with the borrowed traits of colour, a form which is called unity or the vertebral type, but which may as well be called nonexistence, forasmuch as it is nowhere to be found described upon the anatomical chart in fixed character, if it have any such character at all.

The abstract term of unity can claim no relationship with the science of anatomy, unless as appended to the anatomical figure which may be demonstrated as an abstract or whole quantity, and where is this demonstrable whole quantity to be found? Is it to be seen in the form which we commonly term the vertebra? It would be no less absurd to read it in the form which we ordinarily name the costa. And consequently, since it is not to be found in either the vertebral or the costal quantity separately considered, the only resource which we have remaining is to seek for it in the combined relationship of both these parts, which we hold to be naturally inseparable from each other.

It is true that semicircles, though standing separately, still argue the existence of the whole quantity or circle, and it is no less true that the vertebra and costal pair naturally cleave towards each other descriptively of a whole or entire design. Therefore when we meet with the separate semicircle (as this will invariably describe its counterpart), so do we spontaneously create the presence of the entire circle, and it is even so with the separate vertebra or the separate rib, for we hold it to be impossible to know either one part or the other without knowing their combined structural entirety. It is the measure of reason to compare all relationary parts for the sole purpose of ascertaining the span, capacity, and full meaning of the whole. The part has no meaning in itself considered separately from the other parts which furnish to it its proper character and function, for the character of the part is, that it is *the part of a whole* quantity, and the function of such part is one which it bears in common with all other parts naturally related to itself. The thoracic costa is without either character or function, except we read it in connexion with the dorsal vertebra, and this again is without character or function, except we consider it relatively to the costæ. Since, therefore, these parts mutually lend interpretation to each other, so do they naturally combine to figure forth a whole design, and to this design we here give the name *costo-vertebral*, as being a whole quantity met with in the thoracic series of the skeleton figures of terrestrial animals.

And while we measure the design and structural quantity of this costo-vertebral figure, we find that all those minus quantities which stand in serial order with it can be referred to some proportionals of it, and therefore it is that we call it plus unity, that is to say, the whole standard figure, such as we represent it in fig. D, performing the ventral circle. To fig. D, the thoracic costo-vertebral quantity, we refer fig. A, the cervical vertebra, either as it now presents in minus condition or as it occasionally presents with costal "anomalies." To fig. D we also refer fig. G, the lumbar vertebra, either as it now stands in series, or as it sometimes presents itself with costal "anomalies." And to fig. D we in like manner refer fig. K, as being a caudal proportional metamorphosed from such another plus quantity as fig. D.* We have drawn the ventral circle

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* "Nor is it easy, when such a difference arises, to settle the point, if the excess or diminution be not glaring. If we differ in opinion about two quantities, we can have recourse to a common measure, which may decide the question with the utmost exactness; and this, I take it, is what gives mathematical knowledge a greater certainty than the other. But in things whose excess is not judged by greater or smaller, as smoothness and roughness, hardness and softness, darkness and light, the shades of colours, all these are very easily distinguished when the difference is in any way considerable, but not when it is minute, for want of some common measures, which perhaps may never come to be discovered."—Burke, *Philosophical Enquiry into the Origin of our Ideas of the Sublime and Beautiful*, Introd. on Taste.

for figs. A, G, and K, after the same manner as the costal circle of fig. D, and we hence proceed to prove that figs. A, G, and K are minus quantities of such another quantity as that of fig. D, and also to prove that in this reading alone is enshrined he idea of unity so far as regards the skeleton axes.

When we refer the vertebral proportionals to the costo-vertebral whole, we then learn to estimate fully the condition of form which is minus by design, and also the condition of form which is plus by design. But as the mere mechanical design of a vertebral quantity in one region of series, and the mechanical design of a costo-vertebral quantity in another region of the same series is a consideration altogether separate from the present theme, which proceeds to the recognition of whole quantities, and to the knowledge of that law which degrades these to proportional quantities, so for this reason we say that the idea of uniformity can never be developed until we know the originals of all the minus figures of series.

We say that the comparison of all the plus and minus quantities of series, considering these as mere mechanical designs, can never teach us the mode and operation of a law of development, and this is self-evident, for the comparison of a cervical or lumbar vertebral design *as such*, with the thoracic design considered *as such*, will still never teach us the mode of creation whereby these several quantities occur in series. On the contrary, we shall find that in the knowledge of the law of formation, which yields the several regions of series alternately of minus and plus character, is contained the full estimate of the mechanical fitness of such a creation, and in addition to this we repeat that in the reading which regards the minus quantity as being the proportional metamorphosed from such another plus quantity as we find in the thoracic region of the same series, is centered the idea of original plus uniformity.

For suppose that we continue to assent to the dry rules of descriptive anatomy, which likens the mechanical design of fig. K, the caudal bone, to a κοκκυξ, and that we carry out the rule of such comparison by likening fig. D, the thoracic figure, to a chariot-wheel (the latter comparison being as much to the purpose as the former, though we plainly confess that the invention of a Caffre or a Kamschatkadale could scarcely jabber in a nomenclature more irrelevant to Nature's law and science), then it is plain that fig. K as the cuckoo's beak, and fig. D as the chariot-wheel, can never yield to us the knowledge of a law of formation, the idea attending such comparison being no less foreign to the majesty of truth and nature than when the sentient matrons of old Rome, believing the female moon at eclipse was in labour, undertook the midwife's office, and eased her throes with the din of brazen instruments and the loud shouts and jargon of their sympathetic noise or nomenclature.

The comparison of proportionals with the whole quantities gives the combined evidence of a law, and at the same time illustrates the track and passage of that process which furnishes the design minus, in series with the design plus.* When we understand that the minus quantity is a creation by the subtraction of elemental parts proper to the plus quantity, it will matter little whether we sound the name of the minus figure from the head of a kettle-drum, or the name of the plus figure from the mouth of a bugle, provided we still remain mindful of the fact or law which yields them as creations in the same serial order.

And as we here conceive that the idea of serial uniformity can only be developed according to the interpretation that the plus figure performing the costal circle like fig. D, contains all those several quantities which have been proportionally metamorphosed from the plus originals of figs. A, G, and K, which lost quantities we have indicated in the ventral circles drawn from figs. A, G, and K, so do we assert that their several minus designs will be best understood by comparing † them with their original plus quantities, which may be said to equal fig. D, the costo-vertebral archetype, such as it stands, viz., a form bilaterally symmetric, but not antero-posteriorly symmetric, which latter circumstance we believe to have occurred by the metamorphosis of dorsal quantity, but of this hereafter.

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* " Excellence in every part, and in every province of our art, from the highest style of history down to the resemblances of still life, will depend on this power of extending the attention at once *to the whole*, without which the greatest diligence is vain."—Sir Joshua Reynolds' *Discourses*, discourse xi.

† " Scientia et potentia humana in idem coincidunt, quia ignoratio causæ destituit effectum. Natura enim non *nisi parendo* vincitur : et quod in contemplatione instar causæ est ; id in operatione instar regulæ est."—Bacon, *Novum Organum Scientiarum*, aph. iii., lib. i.
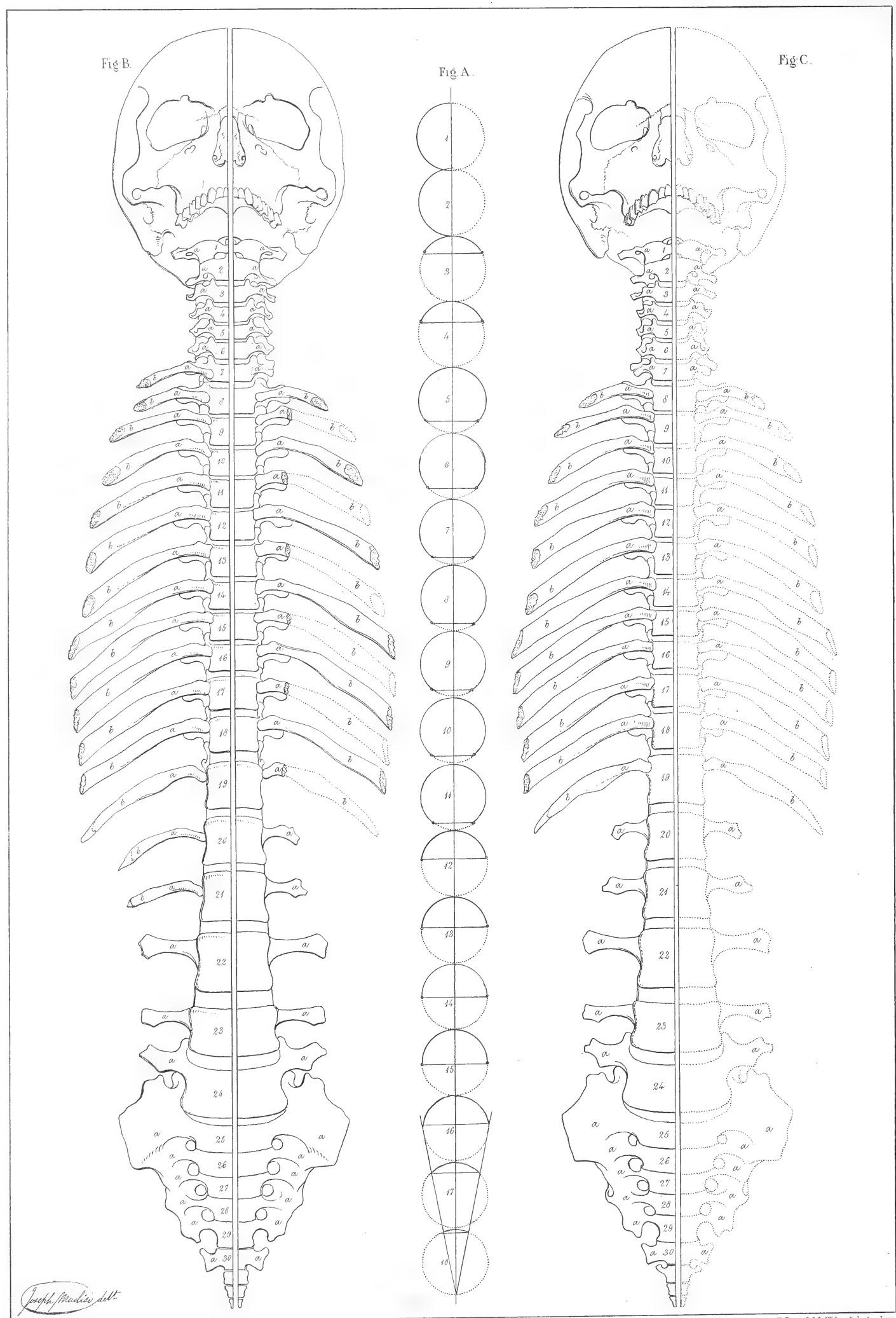
Plate 32.

Fig B.

Fig A.

Fig C.

Joseph Maclise delt.

London: Taylor & Walton, Upper Gower Street.

REMARKS ON THE FIGURES OF PLATE XXXII.

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THE MAMMALIAN SPINAL SERIES POSSESSES IN GENERAL A BILATERAL SYMMETRY, ALTHOUGH THE UNITS OF SERIES ARE IN PLUS AND MINUS CONDITION, AND THE EXCEPTIONS TO BILATERAL SYMMETRY ALWAYS OCCUR AT THE MINUS REGIONS.

CAUSE and effect cannot be contemplated independently of each other. The antecedent holds the consequence in obedience to itself, and the knowledge of a cause is therefore equal to the knowledge of the effect of such cause, for if $a+b$ be known as a given quantity, and $a-b$ be known as another, then we understand by the comparison of both these quantities in what degree they are similar, and in how far they are various. We learn that $a+b$ in the presence of $a-b$ are two creations occurring by cause and effect; for $a+b$ is a quantity by reason of the addition of b, and this is a cause, whereas $a-b$ differs from $a+b$ by reason of the subtraction of b, and this is an effect. Now for that matter, the cause may be said to be the same as the effect, so intimately are they bound together; for if we add b to a, this addition is cause and effect at the same time; and otherwise, if we subtract b from a, then such subtraction stands both for cause and effect equally. Effect follows cause just as the shadow follows substance while the light shines upon that substance; and from this it will be inferred that light, substance, and shadow mutually combine, as well for the existence of effect, as for the existence of cause, since it seems true that light without substance can never produce a shadow, any more than substance can effect it without the light. The serial order of plus and minus quantities represents in somewhat the same mode this independent mutuality of cause and effect; for while subtraction from plus is at the same time the cause and effect of a minus figure, so will that cause and effect take place to no purpose (so far as regards our own appreciation of the process) if we do not bring the full light of comparison to demonstrate the law of nature thus operating. If from the quantity $a+b$ we can subtract b, and thereby produce $a-b$ as an effect, then we assert that such effect cannot be viewed irrelatively of the cause which, by the addition of b, can again reinstate the whole quantity, or $a+b$. And if this operation may be observed in Nature, then may we infer that she is at the same time both cause and effect by process of subtracting from plus quantity, and thereby becoming creative of minus variety, which variety must consequently be understood as having been degraded from whole quantities, which latter can only be the absolute serial uniformity. The cause of variety is the subtraction from plus uniformity, and therefore the cause of uniformity is the persistence of whole quantities.

Serial and symmetrical homology is the character of the mammal skeleton axis. The one side is simply a repetition of the other, and any one unit of thoracic series would be repeated by the form preceding and succeeding itself, were it not that the law of serial degradation interferes with serial plus repetition. So would any one unit of the serial axis, from first to last, fully represent all the thoracic units, but for this law of proportioning; which strikes certain members of those serial units here and there in minus form, through the spinal axis, and hence arise those regions of series named cervical, lumbar, caudal, &c.

A series of circles such as that described by fig. A, possesses this plus uniform character of serial and sym-

metrical homology.   The perpendicular median line, if carried through the centres of all those circles, would cleave the whole series into a double line of semicircles, thus proving the fact of symmetry, and as we see that every circle of the same series is the repetition of that which precedes and succeeds itself, so are they, one and all, plus serial homologues.

It is also true of fig. A, that whatever be the degree of metamorphosis practised upon each circle of the series, provided this metamorphosis takes place equally at both sides of the median line, this line will still divide the series symmetrically.   Thus the median line equally divides the segment of the metamorphosed circle 3, and the semicircle of the metamorphosed circle 14.   Even when we proportion various segmental quantities from circles, as seen at numbers 16, 17, and 18 of the series, still, provided such segments be cut in reference to median cleavage, the same median line will render all the quantities, circles, segments, and semicircles, all equally bipartite so far as regards bilateral symmetry.   'Tis true that the symmetrical quantity of the segment will not equal that of the symmetrical semicircle, but 'tis also true that, whatever be the variety as to quantity, the law of symmetry still prevails.   The reason of this is, that every proportional quantity of the series is the proportional of the circle, and the circles are all plus homologues, both in quantity and every other character.

Again, in fig. B we likewise see that the law of serial and symmetrical homology prevails.   The entire series is cleavable at the common median line from the vertex downwards, through the cervical quantities, through the thoracic archetypes, through the lumbar quantities, and through those of sacral and caudal character.   Even the last caudal nodule is cleft symmetrically by this common median line, and the reason is, that it bears the same proportional relation to the thoracic archetype quantity of its own series as the segment of the circle, 18, fig. A, bears to its archetype circle, described in dotted line.   Even as the inverted triangle proportions varying quantities from the circles 16, 17, and 18, of fig. A, so does the law of proportioning fashion, from out of archetype skeleton quantities in serial order, the graduated units of a sacral and caudal series for fig. B or C.

By the law of serial homology we are enabled to fill up space where quantity is lost.   If we omit the rib between two other ribs in series, these latter, whilst left standing as nature produced them, will inform us of the lost costal quantity between them.   In fig. B, we take three thoracic quantities, such as 12, 13, and 14, we metamorphose the rib of 13 at the point a, right side, but if we again would create the idea of that lost quantity we are then enabled to do so by drawing analogy with the rib of the unit 12 above and that of the unit 14 below, or even its place might be fulfilled by re-creating it after the plan of its fellow of the opposite side.   So, unit 13, minus the left costa, may have this quantity re-established according to the serial costa above and below on the same side, or according to the symmetrical costa opposite

to it, and this law prevails for all units of the thoracic series.

Now the law of serial and symmetrical homology may likewise extend our ideas so as to fill up lost quantity either in the cervix or loins, as well as in that hiatus occasioned in thoracic series by the omission of a costa between two others.

On one side of fig. B we omit alternate costæ from the thoracic series.   The units marked 9, 11, 13, 15, 17, and 19, show that their costæ on the right are metamorphosed at the points a, a, a, &c.   (The dotted forms here and elsewhere, it should be remembered, indicate lost quantity.) So we say, that if we happen to have presented to us a skeleton whose alternate costæ were thus metamorphosed, and that we were required to re-establish the costal forms according to their original normal type, this might be performed with unerring rule according to serial and symmetrical law, even if we were in want of another complete skeleton form to imitate.   For, although the right costæ be lost from the units 9, 11, 13, 15, 17, and 19, still their analogues are existing at the same side on the units 8, 10, 12, 14, 16, and 18, and their analogues are also standing in complete series on the opposite side; hence, we say, that an observation of the law of serial and symmetrical homology, aids the mind in recreating lost quantity, whereby we re-establish plus serial uniformity; for, taking any unit of thoracic series which may have been rendered minus a costal form, (the unit 13 for example,) we then interpret that unit 13 is minus the right costa from the point a, and this lost form was, without doubt, the homologue of the right costæ of units 12 and 14, or of its fellow at the left side; thus the rule of analogy becomes a creator of ideas regarding lost form.

The form which is lost at the cervical, lumbar, sacral, and caudal regions of series, can also be filled up according to this same law of serial and symmetrical homology.

Fig. B presents to us, on the left side, (the right and left side of series is spoken of in reference to ourselves,) a serial order of articulating costæ from unit 7 to unit 21, thus abnormally extending into the cervical region, and into the lumbar region of series; but on the right side the costal series of fig. B terminates at the normal points, commencing at unit 8, and ending at unit 19.   Now we venture to assert, that any one who would contemplate this condition of development in fig. B, cannot refrain from coming to this conclusion concerning it, namely, that unit 7 in the cervix, which has a left costa, must have lost the analogue of the right; and also that since units 19, 20, and 21, of the lumbar spine possess the left costæ, so must they also have lost their analogues of the opposite side.   Thus it is, that, by symmetrical law, we give costal forms to the cervical and lumbar regions.   And the same may be done by the law of serial homology as follows :—

In fig. B, unit 8 bears symmetrical ribs like unit 9, below.   But above the unit 8 we see that unit 7 bears only one rib, having lost the opposite homologue, no element of which remains excepting the autogenous piece a.   Again, unit 6 has lost both costæ, the autogenous pieces, a a, of

which still persist on both sides. Now, if it be asked what is the difference between the forms of units 6, 7, and 8, the answer can be no other than that they are proportionals of such as the full costo-vertebral quantity of unit 8. And this is all the admission required in support of the present argument, which is to prove that the cervix and loins of series are minus quantities of such archetypes as the thoracic costo-vertebral forms, and that if it were required to re-establish the lost quantities at cervix or loins, it may be correctly done by producing their autogenous elements, *a, a, a,* to full costal forms, such as those marked *a, b,* in the thorax. The cervical ribs are the natural equations between minus and plus quantities.

Fig. C represents the symmetry of the serial axis. We see that even if the left half of series were separately presented to us, a simple repetition of it on the right side would create the complete form of symmetry. And so we may infer, that a simple serial repetition of thoracic form through the cervical, lumbar, sacral, and caudal minus regions, would create a thoracic series, complete from occiput to the other extreme. As the figure at present stands, we find that the costal pieces marked *a, a, a,* &c., all through the series, indicate homologous elements varied only as proportionals. The pieces at cervix, loins, sacrum and caudex, which are marked *a, a, a, a,* &c. are simply minus proportionals of the thoracic rib marked *a b, a b, a b,* &c.; hence we say, that a cervical, lumbar, or sacral vertebra, plus the quantity *b,* would equal the thoracic costo-vertebral archetype; and under this interpretation we are only advancing an opinion according to facts; for do not the cervical and lumbar ribs fully coincide with this opinion, as affording natural proof that the minus quantities of cervix and loins are prone to plus increase?

The object of our comparisons, therefore, being the whole series of plus uniform creations, we lead onwards to this end under the guidance of the three combined laws of symmetry, series, and proportioning. And we find that fig. B or C is the natural produce or effect of those three antecedent laws or causes. Judging of the effect by the cause, we learn to estimate the actual condition of the creation, and while we see every reason to interpret that the minus quantities of cervix, loins, or sacrum, are several designs by the loss of quantity, we also infer that the

thoracic series is a design by the persistence of plus quantity. Whereupon we also infer that the law of form is the subtraction of quantity from some region or regions of a plus series, and that as this law may be taken for the cause, so may fig. B or C, as a series of plus and minus quantities, be regarded as the effect of this law.*

As bilateral symmetry is the effect of the repetition of a side, so may this repetition of sides be accounted the cause of the symmetrical effect. Again, as the line of serial homologues is the effect of a serial repetition of quantity, so may this repetition in like manner be named as the cause of serial effect. Lastly, as figs. B and C, although instancing bilateral symmetry, are not creations of plus serial uniform quantities, such as stand in the thorax; and as this proportional inequality † happens by a rule of degradation or metamorphosis; so may we infer that this degradation or subtraction from plus uniform figures is the cause why a cervix or loins happens in series with a thorax. This law of serial proportional degradation takes place symmetrically; and hence it is that every serial quantity, whether of cervix, loins, sacrum or caudex, as seen in fig. C, stands as a symmetrical proportional. Where this law of proportioning has not acted symmetrically, we find that one side is plus and the opposite side is minus,‡ as seen in fig. B. And where this law of proportioning minus from plus quantity does not act in reference to the same units of the human serial axis, we find, as consequence, that the cervix and loins retain their costal quantity, which is the cause why the thoracic plus series has extended itself. Or otherwise, that where the law of proportioning has degraded certain units of the normal number of the thoracic series, this, in its turn, is followed by the effect of extending the minus cervical or lumbar regions with respect to "supernumerary vertebræ." Thus cause and effect are plainly manifested through the combined evidence of all conditions of serial creations, and it is by their mutual comparison that we attain to a knowledge of the law which yields them as they stand. Plus uniform series is the quantity operated upon, and until we ascertain its exact dimensions we can never follow the track of that law which varies it through the infinitude of minus characters.

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* "Tout est systématique dans l'universe ; tout y est combinaison, rapport, liaison, enchaînement. Il n'est rien qui ne soit l'effet immédiat de quelque chose qui a précédé, et qui ne détermine l'existence de quelque chose qui suivra."—Bonnet, *Contemp. de la Nat.*, part 1, chap. vii.

† "Inter *prærogativas instantiarum* ponemus loco octavo *instantias deviantes!* errores scilicet naturæ, et vaga, ac monstra ; ubi natura declinat et deflectit a cursu ordinario. Differunt enim *errores naturæ* ab *instantiis monodicis* in hoc, quod *monodicæ* sint *miracula specierum,* at errores sint *miracula individuorum.* Similes autem fere sunt usus ; quia *rectificant intellectum adversus consueta, et revelant formas communes,* neque enim in his etiam desistendum ab inquisitione, donec inveniatur causa hujusmodi declinationis. Veruntamen causa illa non exsurgit ad formam aliquam proprie, sed tantum *ad latentem processum ad formam. Qui enim vias naturæ noverit, is deviationes etiam facilius observabit ;* at rursus, *qui deviationes noverit, is accuratius vias describet.*"—Bacon, *Novum Organum Scientiarum,* lib. ii., aph. xxvii.

‡ "The right and left parts, therefore, are nearly similar, and the same, but the inferior are dissimilar to the superior parts ; except that the *inferior correspond in a certain proportion to the superior.*"—Aristotle, *History of Animals,* Book i., page 24.
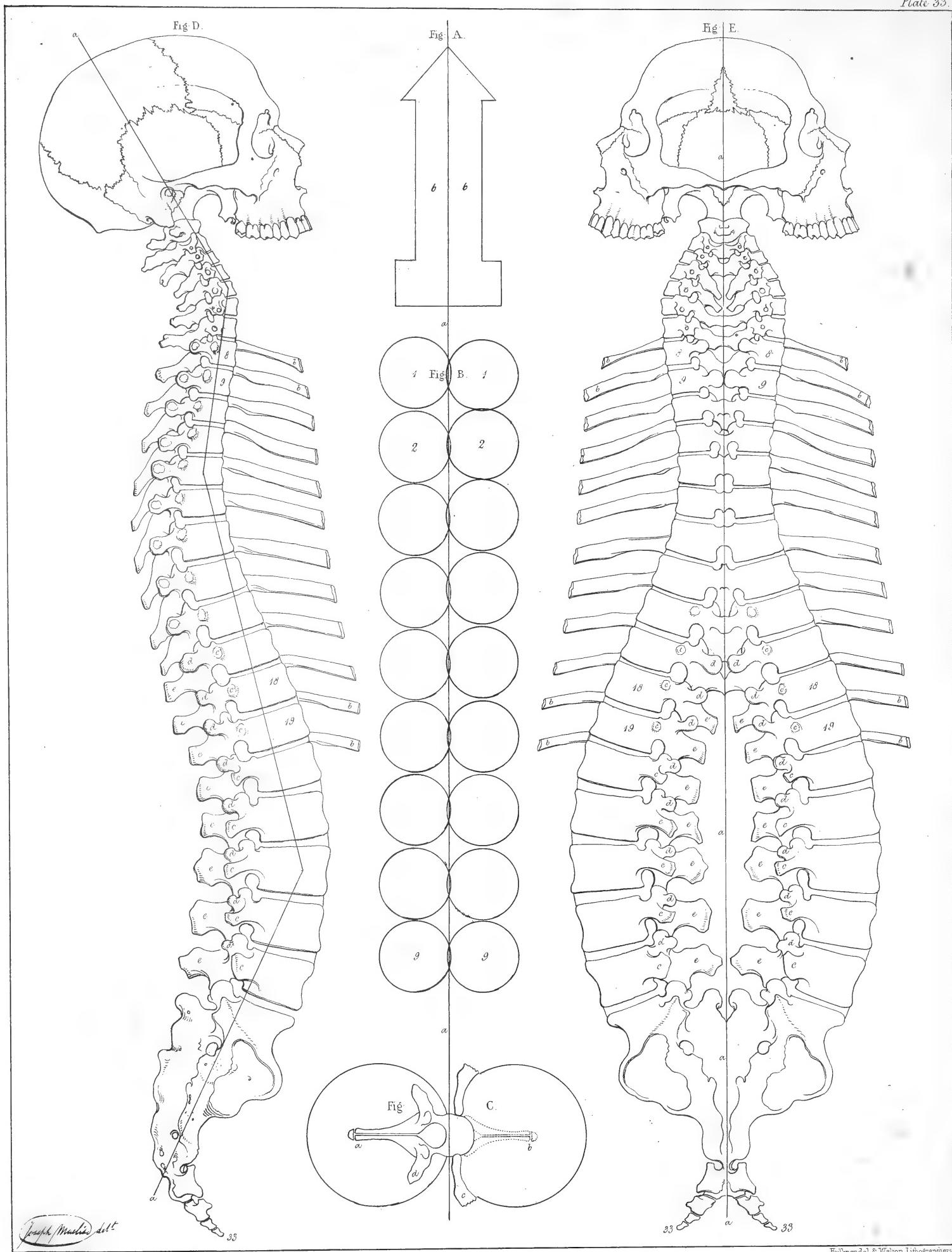
Plate 33.

Fig. D.

Fig. A.

Fig. E.

Fig. B.

Fig. C.

Joseph Maclise delt.

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REMARKS ON THE FIGURES OF PLATE XXXIII.

THE DUPLICATION OF THE VENTRAL FACE OF THE MAMMALIAN SERIAL AXIS YIELDS A WHOLE STRUCTURE OF ANTERO-POSTERIOR AS WELL AS BILATERAL SYMMETRY.

COMPARISON, which is conducted in search of a law of formation, may assert the right of considering its subject under all modes of development which can possibly happen within the compass of natural operation. When we find that bilateral symmetry is the effect of the repetition of a side, we then reasonably interpret that repetition is the simple cause of bilateral symmetry. When, on the contrary, we remark that antero-posterior symmetry does not characterise the form, we then may (even while we acknowledge the mechanical design of such a figure) still question the cause of this antero-posterior asymmetric effect, and upon finding that the anterior aspect is plus, while the posterior aspect is minus, we, under this evidence, attribute the effect such as it is, to the cause such as it appears to be, and hence interpret that antero-posterior symmetry may be wanting in consequence of quantity having been subtracted from posterior structures. In Nature there happens no one instance of a mixture or combination of incongruous or absolutely dissimilar elements. The variety which occurs amongst entities of the same system or order, is always occasioned by the metamorphosis of quantity, which, when it appears to interrupt the law of order or symmetry for particular fitness, may hence be accounted the natural cause of the condition of asymmetry. Now it is true that the skeleton serial axis although manifestly asymmetric as to ventral and dorsal faces, still instances this condition of development through plus and minus quantity; for which reason, we say that it is not possible rationally to deny that the minus face or dorsum may be various to the plus face or venter, simply as the effect of lost or subtracted quantity.

In fig. A we represent a symmetrical form. The one side b, is a repetition of the other side b, and consequently the median line cleaves the form symmetrically.

In fig. B we represent a symmetrical series of circles in double row, and we see that circle 2 is the symmetrical homologous opposite of circle 2, and is at the same time the serial homologue of circle 1. So is circle 9 the symmetrical opposite of circle 9, and also stands as the serial homologue of circles 1 and 2. If this symmetrical order of homologous forms were continued *ad infinitum*, still the character of series would never change; and even if their serial order, thus extended, were carried through the regions of space, still the median line a, a, when passing through their secant points, would divide the series symmetrically.

In fig. C a vertebra is represented, but the median line a, which would divide figs. A and B symmetrically, is seen while passing through the centrum of fig. C, to divide this structure into unequal quantities. Thus on one side of the median line would happen c, the costal piece articulating with a moiety of the centrum; whereas on the other side of the median line, would happen d, and a, the transverse process and neural arch. If, however, we repeat the dorsal structure a, in the ventral structure b, we then see that the repetition of form would create the character of symmetry in this fig. C. If again, we describe from the costal pieces c, the ventral circle which they themselves usually describe, and if we afterwards repeat this ventral circle at the dorsum, then the median line would separate homologous circles. Perhaps it may some day appear that the archetype form of a spinal axis is a quantity capable of being thus cleft into symmetrical halves, and that the structure which we now name vertebra, is a modified proportional of the same archetype.

Now fig. D is still not capable of being cleft symmetrically by the line a, carried through it so as to divide the

ventral from the dorsal face; for, as we see, the ribs
b, b, b, b, would happen in front, whereas all the neural
arches, &c., would fall behind. It is a remarkable fact,
however, that those neural arches hold a continued serial
order from occiput to caudex behind this median line,
whilst in front of the same line we find that the serial
ribs are created in only one region of the spinal axis,
the first rib *b,* projecting from unit marked 8, and the
last rib *b,* jutting from the unit marked 19. However, even
if we drew plus costal quantity in those regions of spinal
series where they are now lost by design and for fitness,
still the cleaving line *a,* would separate back from front,
as unequal forms.

In fig. E we have the repetition of D, and as is usual
with all double forms placed in juxtaposition, we see
the creation of perfect symmetry. We now find that
not only is the one side of fig. E perfectly homologous to
the other, but every elemental piece developed in one side,
has its counterpart in the opposite side. The two first
thoracic units marked 8 *b,* and 9 *b,* have their homologues
opposite to them, and when we would restore lost costal
quantity in the cervical region on one side of the form,
the law of symmetry itself invites to a restoration of the
like quantity at the cervical region opposite. The two last
thoracic units, marked 18 *b,* and 19 *b,* in like manner have
their symmetrical opposites; and for the same reason the
restoration of lost costal quantity at the lumbar, &c.,
regions would require the restoration of the like forms
opposite.

All which we shall at present say regarding fig. D, is
that transverse cleavage by the line *a,* sunders the form
into unequals; whereas the repetition of this figure at
E, renders the combined structure cleavable into sym-
metrical sides by the median line *a,* passing through the
region of median fusion.

Perhaps, therefore, it may hereafter appear that fig. D
is a special design, fashioned as minus quantity from an
archetype structure which shall appear capable of being
severed symmetrically by both transverse and antero-
posterior median cleavage, metamorphosis being the process
under whose influence fig. D now stands created in dorso-
vertebral asymmetry.

And while it becomes evident on all sides of us, that
metamorphosis or the subtraction of quantity is that
moving agent and cause of all effect or variety in Nature;
and moreover, while through comparative rule we have
manifested to us that this operation, infinite in possible
causation, overwhelms all human account with its infini-
tude of result or consequence; what then ought to become
the definite purpose of our comparison? Should it not be
so conducted as to enable us to rein in plurality or specific
variation with the abstract or general rule by which we
may encompass not only those varieties which have had
creation already, but even those which could have been pro-
duced, whether fittingly or otherwise, under the operation
of the same law of metamorphosis? While it is most
true that even two human skeleton figures vary as to exist-
ing quantity in consequence of the law of increation or

metamorphosis of some plus fabric; while it is moreover
true that even the one skeleton axis is a creation rendered
fitting by the very fact of quantity having been subtracted
from those regions of series which we now name cervical,
lumbar, sacral and caudal; and in addition to this evidence
while we may understand how a still greater amount of
quantity may also pass into increation by the like process,
whether by design or by accident, (for special variation
alike applies to both conditions); then we may assert that
it is not for the crowded chronicle of special and various
facts, that comparison is to undergo the tedious labour to
no end, but its duty and its aim should rather be to ques-
tion Nature for the revelation of her law, and to retrace
all her evidences or effects back to their source, which is
unquestionably to be accounted as some plus or archetype
created sum of limited dimensions, and simple, uniform,
and symmetric character, which is liable to be varied
infinitely according to the infinite degrees through which
metamorphosis can pass.

The plus series of quantities represented in fig. B, is
in the condition of absolute uniformity, and the line *a,*
which cleaves it into symmetrical and equal sides, conducts
the eye through series without interruption. But while
we know that the serial uniformity of fig. B mainly
depends upon its plus condition of repeated circles, we
may also readily fancy how a metamorphosis could change
such uniformity into difformity by the process of sub-
tracting from various regions of the series, various quan-
tities such as segments of unequal bases. The comparison
of fig. B with itself, that is to say, with itself through all
the infinity of variation to which it may be subjected by
the subtraction of quantity, who shall undertake to record?
Is it not sufficient to know the possibility of this mode
of variation without undergoing the fruitless labour of
taking account of it by the differential method? When
we already read in the plus sum of fig. B as uniformity,
the immeasurable sum of fig. B, passing through a meta-
morphosis, may we not account fig. B as the archetype or
original quantity, which, like a generalisation, contains all
special or minus particulars? If we can vary the series
of fig. B by subtracting quantity from one or more regions
of itself, and yet continue to acknowledge this new and
minus figure thus produced, to be but as a proportional of
the plus archetype originally standing, then it must appear
that the plus condition of fig. B is the only absolute uni-
formity from origin to termination, for evidently the
smallest segment which shall be cut from any one of those
serial circles which now present to us, will vary their serial
uniformity.

Serial uniformity does not characterise fig. D from
origin to termination of that line which it describes, for
the thorax is developed in plus quantity, whereas the
cervix, loins, sacrum, and caudex, instance the minus
variation. Therefore, while we acknowledge that propor-
tional variety attends those minus regions of fig. D, we
may hence conclude that the figure, such as it is, has been
metamorphosed from a plus serial form which is without
any minus region, hiatus, or break in its continuity.

Neither does antero-posterior symmetry * characterise fig. D, for the dorsal face is minus, and the ventral face is plus; and hence there is every reason to conclude that asymmetry with respect to dorsum and venter, is the effect of the metamorphosing act of subtracting quantity. Now as every minus quantity which results by the subtraction from a plus sum must consequently refer to its original or whole quantity, in the same manner as $a-b$ refers to $a+b$, so shall we pursue the chainwork of this evidence of proportional degradation, and pace with it as by the guiding conduct of Ariadne's thread, till from the lowest extreme of minus variation, we rise in gradual progression through increasing series to the opposite plus extreme, and find located there the whole quantity of absolute, uninterrupted, serial uniformity and symmetrical cast.

The evidence of an infinite variation of anatomical facts has ever been repellent to the thinking mind of the philosophical interpreter. Generalisation and the abstract view, is that medium through which the philosophical anatomist has been compelled to regard the infinitude of special detail; the mental otium is marked by the idle detail of special variety; † for there is nothing easier than to observe the fact that two or more quantities differ, whereas, on the contrary, the mental labour is characterised by the calculation as to *how those quantities happen to be differenced*,‡ and in this consists the knowledge of a law.

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* "Man, however, has the parts of his body distinguished by the superior and inferior, *the anterior and posterior*, and the right and left. The right and left parts therefore, are nearly similar, and the same, except that the left parts are more imbecile ; *but the posterior are dissimilar to the anterior*."—Aristotle, *History of Animals.* Book i., page 24.

† "Il suffit pour cela, de parcourir les livres et les cabinets d'histoire naturelle, et d'admettre, comme caractères spécifiques, toutes les différences, soit dans la grandeur, dans la forme, ou la couleur, *et de chacune de ces différences quelque legère qu'elle soit, faire une espèce nouvelle et séparée de toutes les autres ;* mais, malheureusement, en augmentant ainsi très-gratuitement le nombre nominal des espèces, on n'a fait qu'augmenter en même temps les difficultès de l'histoire naturelle, dont l'obscurité ne vient que de ces nuages répandus par une *nomenclature arbitraire, souvent fausse, toujours particulière, et qui ne saisit jamais l'ensemble des caractères ;* tandis que c'est de la réunion de tous ces caractères, et surtout de la différence ou de la ressemblance de la forme, de la grandeur, de la couleur, et aussi de celles du naturel et des mœurs, qu'on doit conclure la diversité ou l'unité des espèces."—Buffon, *Oiseaux*, tome i., page 71.

‡ "It is a remarkable circumstance how much labour it costs to establish with clearness a single fact of philosophical anatomy. No one can form an idea of this unless by devoting himself to this kind of research. We may pass, not only hours or days, but even whole weeks before the skull of a fish, and contemplate with surprise this quarry of calcareous stalactites, without arriving at the knowledge of the why, the where, or the how."—Oken, *Isis*, 1818 ; pages 512, 5129. See also, *Lehrbuch der Naturphilosophie*, Jena, tom. iii., p. 61.
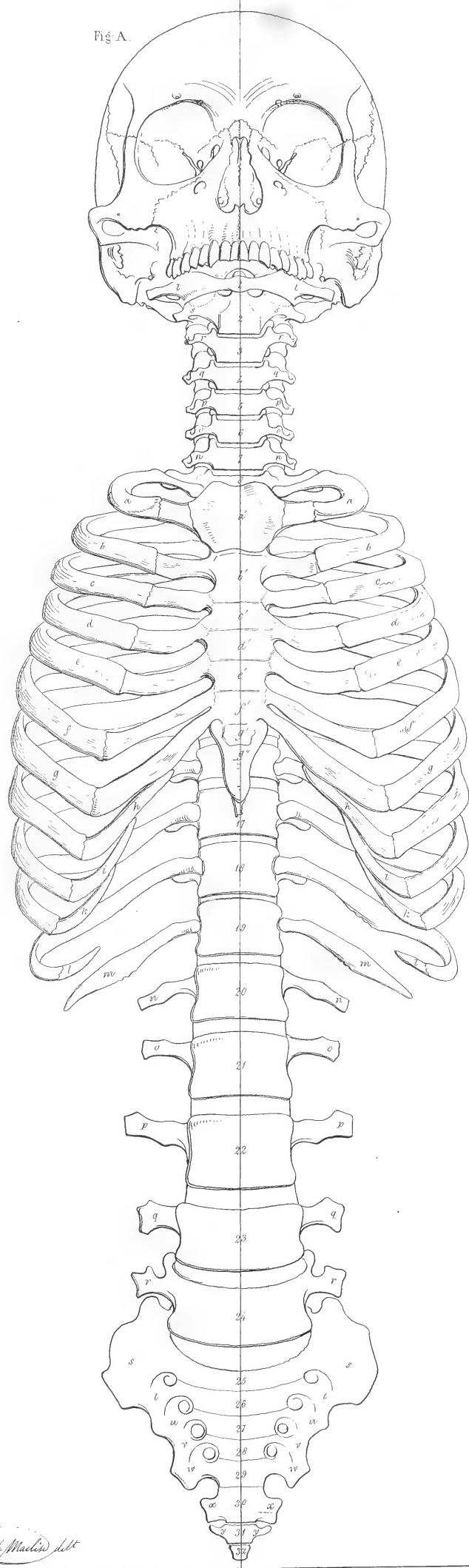
Plate 34.

Fig. A.

Fig. B.

Joseph Maclise delt.
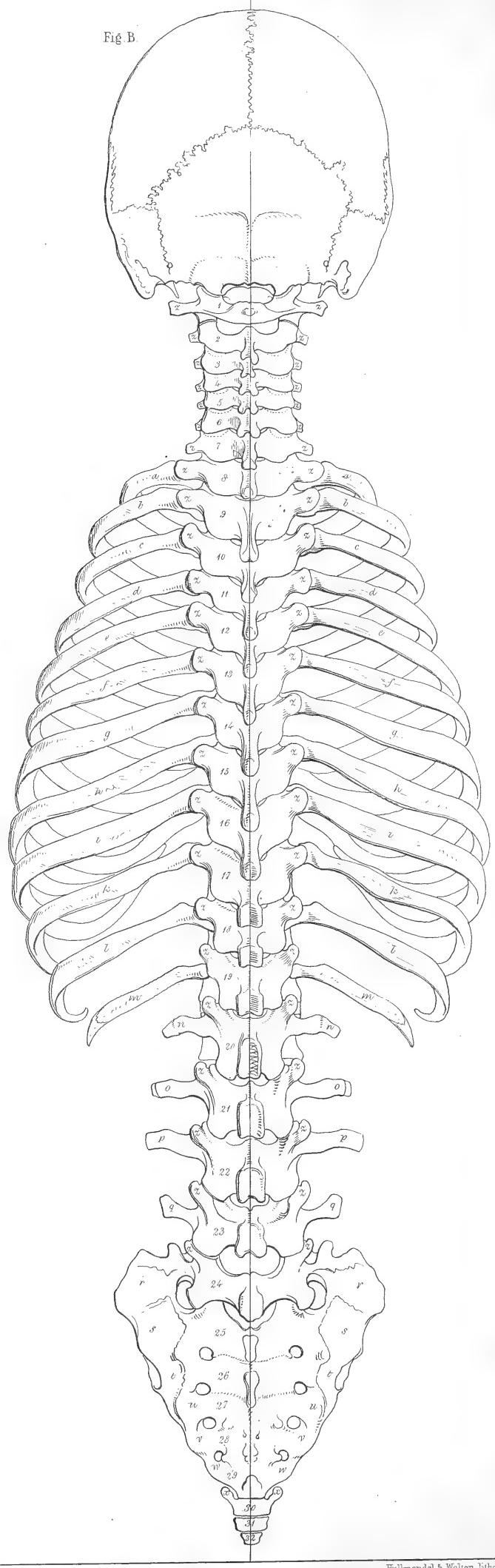
REMARKS ON THE FIGURES OF PLATE XXXIV.

THE MINUS AND PLUS QUANTITIES OCCUPY THE SAME MEDIAN LINE, AND HENCE ARE BILATERALLY CLEAVABLE BY THAT LINE.

CREATION is serial and graduated. Examples of sudden transformation are nowhere to be found. In Nature all proceeds by easy degrees, and her linear series is an actual evidence of her mode of creation. The serial line of an entire animal kingdom is one of gradation, and the slow moving process of metamorphosis by infinitesimal degrees of change, demonstrates the solemn majesty of Nature's paces. The serial order of the phantasma—time, points to its embodied symbol in the serial order of created form, for as the present moment follows the last and is succeeded by the next without perceptible change, so does any one form of series stand related to two others placed immediately on either side itself, without any perceptible manifestation of specific variation between them. Striking contrasts are only to be found between individuals which occupy the extremes of the serial line. The polype and the elephant are examples of this broad contrast between entities which stand at opposite extremes of the continued but graduated chain of animal nature. The mammalian skeleton series is a brief abstract representative of the same law of Nature, and may be contemplated as an emblem or type created under the operation of the same universal process of gradation. The continuity of the animal chain is maintained throughout without *saltus* or hiatus, and as we follow it from excess to defect, we mark that it vanishes by slow degrees till it becomes lost in the invisible microcosm. A slow gradation from plus to minus quantity characterises the skeleton series also, and as this process takes place symmetrically, it leaves the minus form in possession of the same median line which the plus figure elsewhere occupies. The last caudal quantity is bicleavable with the same line which severs through its centre the thoracic costo-vertebral archetype.

The mammalian skeleton axis is still symmetrically developed, even when its thoracic units describe the thoracic circles from the median line posteriorly to the sternal median line in front.

In fig. A the median line is seen to divide the entire serial structure from vertex to the last caudal bone, and although the line is seen to pass through osseous quantity in front of the form (such quantity as sternal structure) which exists at the thoracic region, and is lost at the cervical and lumbar regions of series, still this does not interfere with the symmetrical fact of skeleton design. For still the thoracic quantities appear symmetrical, having every elemental part of one side repeated on the opposite side, and the same common median line which symmetrically severs the thorax from the sternal front to the vertebral dorsum, is seen to pass through all these minus regions of series which are named the cervix, loins, sacrum, and caudex.

The same median line which passes through the centre of created thoracic quantity, passes also through the centre of the cervical and lumbar, &c., regions, where quantity is known to be lost. What is the meaning of this? Surely it can be no other than that those minus regions of series named neck and loins have had their costal quantities subtracted from them, for even now the common median line of series divides all regions of that series, whether plus or minus, into symmetrical sides; nor would this character of bilateral symmetry be lost, even if

thoracic units persisted through all the length of series, from the occiput to the other extreme. When once we admit that quantity has been subtracted from any region of series, and at the same time know the form and character of that lost quantity, then we say that this idea is equal to the actual restoration and presence of such quantity. If, for example, we say that a cervical or lumbar region of series is minus the costal appendages, such as we see persisting in the thoracic region of series, then we create for ourselves, by the rule of analogy, ideas of the lost quantity, as positive and salient as if we still viewed those costal circles still standing at the cervix and loins. Now the law of metamorphosis is one which proportions variable quantities from the original archetype series ; and therefore those minus proportionals of series refer severally to those original serial archetype quantities of which they are the proportionals.

In fig. A we see the archetype quantities persistent at the thoracic region of series. Those thoracic circles which meet at the sternal line in front, are examples of the complete archetype quantities, and we have marked them consecutively from a to g. After the archetype g, and from this down to m, we have the proportional quantities or asternal costæ appended to their several vertebral pieces ; the order is from plus to minus, and in this order we find that the full thoracic costo-vertebral archetype marked g, declines serially into the lumbar unit marked $20\,n$. The transition from thoracic to lumbar quantity is much more gradual than that from thoracic to cervical quantity, as it ordinarily takes place ; but we should not forget that occasionally the occurrence of cervical asternal costæ renders the transition from thorax to cervix as gradual as that from thorax to the lumbar spine.

In fig. A all the forms lettered from a, to y, on both sides, may be regarded as proportional quantities ; and for the same reason the costal pieces marked n, o, p, q, r, in the lumbar region of series, are to be read as the proportional homologues of the pieces bearing the same letters in the cervical region, consequently those pieces of either region may be named the proportionals of the thoracic quantities.

Fig. B represents a posterior view of fig. A, and exhibits symmetry throughout the entire form, as well as the repetition of every elemental part of one side at the opposite side. All the costal structures, whether complete or proportional, we have lettered from a to x, on both sides. All the exogenous transverse processes throughout the spinal series, bear the mark z. In this posterior view of the skeleton axis, the costal autogenous pieces of the cervix are hidden from view, being anterior to z, the exogenous points.

The median line of fig. A cleaves the sternum symmetrically from the first piece a' to the ziphoid cartilage g'', and is prolonged downwards over the ventrum in the direction of the linea alba.

Now with regard to those forms or quantities which, occupying the same serial order, manifest no other variety amongst themselves save that of a proportional gradation, we will observe that the creation, such as it presents itself, may be contemplated variously, according to the views

proposed to be developed thereupon ; and first we remark, in reference to the fact of serial degradation, that it is already so self-evident as to require no further comment. The fact needs no illustrative argument in order to prove it to be more true, for we at first sight acknowledge that design has created those serial units marked $18\,l$, $19\,m$, and $20\,n$, of figs. A and B as proportional quantities. And therefore, as throughout the whole serial graduated line of figs. A and B this same proportional variety may be observed, so must it be concluded that plus and minus quantities constitute all the actual difference between them, whether generally or particularly considered.

Symmetrical cast is also that condition of formation which all the serial quantities of figs. A and B possess in common. This is another well-marked fact, and we find that it relates those several quantities to each other despite the condition of plus and minus variation. Upon the positive reality of both of these orders of development : viz., that of proportioning and of symmetry, we remark that when they shall be once well recorded they need not be further illustrated. Nor do we here prolong our comment upon the already striking evidence of both these conditions of cast under which figs. A and B have been created, but our main object is to prove that there is existing in nature that whole or archetype quantity, of which figs. A and B may be regarded as proportionals, and that in the demonstration of such whole quantity exists the full evidence of the law of formation. For we hold it to be of lesser moment simply to have observed that figs. A and B are proportional series, whose units are still governed by the law of symmetry, than to have demonstrated to us, upon the basis of analogical reasoning, that those figures have been designed by the degradation of an original plus and symmetrical series, since through this reading alone, we may rise to the knowledge of *how the law of nature has acted in the creation of figs. A and B*. To this end, therefore, our observations shall proceed ; and while we know that Truth is somewhere behind her cloud, although out of view, we shall send the Herald of Comparison to make search for her, and sue her to reveal herself in company with facts of form undeniable, because obstructive, material, and impassable.

When we say that between $a + b$ and $a - b$ there happens a certain difference as to quantity, this fact is self-evident, for the former is plus and the latter is minus, just as plainly as 2 is greater than 1, nor can the " differential calculus " work within us a clearer perception of the simple fact than what we at first sight spontaneously acknowledge to. But simple though this fact (isolately considered) may seem, yet still there springs from it the long train of a system such as may be found everywhere in nature, progressing *gradatim* from the *simples* to the *compound*, and the exact analysis of this latter is only to be ascertained in the essential character of the former. The compound entity is a conglomerate of simples, and, like an integer, contains those simples ; or may be again disintegrated so as to yield them separate, as they once were previously to cohesive combination. If one added to one makes two, so will one subtracted from two leave one. Concerning this fact at least there is no chance of losing one's footing, and of falling into

the Academic absolute *acatalepsia*; and we believe that since even Pyrrho himself could not doubt the assertion that, if from two we subtract one and find that one remains, so may we consider this remainder one to be the proportional of two, as it formally existed. Our reading of comparative osteology we would endeavour to present here as free of mystery as the above rule; and when we say that unit $20\,n$ of figs. A or B is a proportional of such another quantity as unit $19\,m$, of the same figures, then, as there can be no reason to deny that units $20\,n$ and $19\,m$ are both proportionals of such as unit $15\,h$, so must the ideas (tracking the serial order of nature) arrange themselves in the serial order of truth, as certain as the actuality of created form itself. And of such an order of truth springs the idea of uniformity, under the interpretation that all those serial quantities which are minus compared with $15\,h$ are the metamorphoses of such quantities as $15\,h$. Under this reading we do not assert *ad impossibile* that all the serial quantities of figs. A and B are *actually* equal to one another, but only that such as they stand they may be accounted the degraded proportionals of such plus quantities as *were once equal*, and that this comparison of serial quantities, which leads us to form the idea of original plus uniformity regarding figs. A and B, finds further support in universal comparison carried through an animal kingdom.

A graduated or converging series is that design which characterises figs. A and B. The same order of series is rendered evident in the designs of all the skeleton axes throughout the animal scale, with this exception: viz., that the same numerical units of series in each skeleton axis do not present the same degrees of metamorphosis or subtracted quantity. In this latter particular they vary from each other, and owing to this simple law of variation we find that all their manifold designs result. According to this rule of varying degrees of metamorphosis being practised upon varying numerical units of series happen figs. A and B, held in comparison with all skeleton axes of human and anthropomorphous type. The anomalies of serial quantities simply occur as excess and defect; and, therefore, we proceed to inquire what is the plus excess or prime model of skeleton quantity? What is the archetype plus sum compared to which all minus quantities shall evince their infinite degrees of design, whether as proportionally fitting or proportionally "anomalous."

The skeleton axis of serial quantities is like a series of the digital numbers.* Converging series is a creation by graduated subtraction, performed upon absolutely equal serial quantities; and to express our ideas of this law of creation in the simplest way possible, we shall remark that the comparison of the converging series 9, 8, 7, 6, 5, 4, 3, 2, 1, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, &c., with the uniform plus series 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, illustrates the mode of comparison which we hold between figs. A or B, (as constituted of a converging or proportional series of quantities,) and that plus uniform series of thoracic or costo-vertebral archetypes which is in nature, and compared to which we consider figs. A or B as minus designs. Our reasons for this opinion are as follow:

We symbolise the serial order of those quantities of figs. A or B thus—5, 5, 5, 5, 9, 9, 9, 9, 9, 9, 5, 5, 5, 5, 4, 3, 2, 1, $\frac{1}{2}$. In this series we discover variable quantities to exist, they are simply plus and minus quantities, and are evidently proportionals standing separately in series; and, therefore, as they are distinct entities, so must they be regarded as distinct proportionals of distinct plus quantities. Thus when we regard 5 to be the proportional of 9, we can only view it as the proportional of such as 9, for the quantity 5 being created in series separate to 9 cannot be accounted as part of 9, but only as part of such as 9. Hence, when we find 5 serially following 9, we compare 5 in one place with 9 in another place, by saying $5+4=9$ just as $9-4=5$, from which we infer that the quantity 5 is a design by the subtraction of 4 from its original quantity: viz. 9; and for the same reason we infer that each of the quantities 5, or 4, 3, 2, 1, $\frac{1}{2}$, which happen in series with 9, are the several proportionals of such originals as 9. Consequently, when we compare the series 5, 5, 5, 5, 9, 9, 9, 9, 9, 9, 5, 5, 5, 5, 4, 3, 2, 1, $\frac{1}{2}$, with the original plus series from which it has been metamorphosed, we may describe this plus series as 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, &c., and this is uniformity unexceptionable.

Now in the series 5, 5, 5, 5, 9, 9, 9, 9, 9, 9, 5, 5, 5, 5, 4, 3, 2, 1, $\frac{1}{2}$, by which we typify figs. A or B, we draw the series of 5 as descriptive of the cervical quantities, the series of 9 as an example of thoracic plus quantities, the series of 5 succeeding 9, as emblematical of lumbar quantities, and the converging series of 4, 3, 2, 1, $\frac{1}{2}$, as representing the sacro-caudal series. And, by the above rule, as $1+8=9$, as $2+7=9$, as $3+6=9$, as $4+5=9$, so $5+4=9$. Therefore, we conclude that a caudal ossicle, a sacral, lumbar, or cervical vertebra plus a certain amount of osseous quantity† to be found in the costo-vertebral archetype will severally equal this archetype; *ergo*, those archetypes are to be accounted the plus absolute uniformity, and compared with which we understand not only the actual or presential design and fitness of figs. A or B, but we also comprehend the natural process of their creation.

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* "Si dans l'immense variété que nous présentent tous les êtres animés qui peuplent l'univers, nous choisissons un animal, ou même le corps de l'homme, pour servir de base à nos connaissances, et y rapporter, par la voie de la comparaison, les autres êtres organisés, nous trouverons que, quoique tous ces êtres existent solitairement, et que tous varient par des différences graduées à l'infini, il existe en même temps un dessein primitif et général qu'on peut suivre très-loin et dont *les dégradations sont bien plus lentes que celles des figures* et des autres rapports apparentes."—Buffon, *Uniformité du Plan général de la Nature*, tome vii., p. 24.

† "Puisque la marche de la nature se fait par des dégrés souvent imperceptibles, et par des nuances toujours les moindres possibles, toutes ses productions se tiennent les unes aux autres d'aussi près qu'il se peut, quoique la somme des différences accumulées le long de l'échelle universelle des êtres puisse répandre du doute et de l'incertitude sur la liaison des plus élevés avec les plus bas."—Robinet, *Vue Philos. de la Gradation naturelle des Formes de l'Etre*, chap. i., p. 2.

Plate 35.

Fig. A   B   C   D

Fig. E   F   G   H
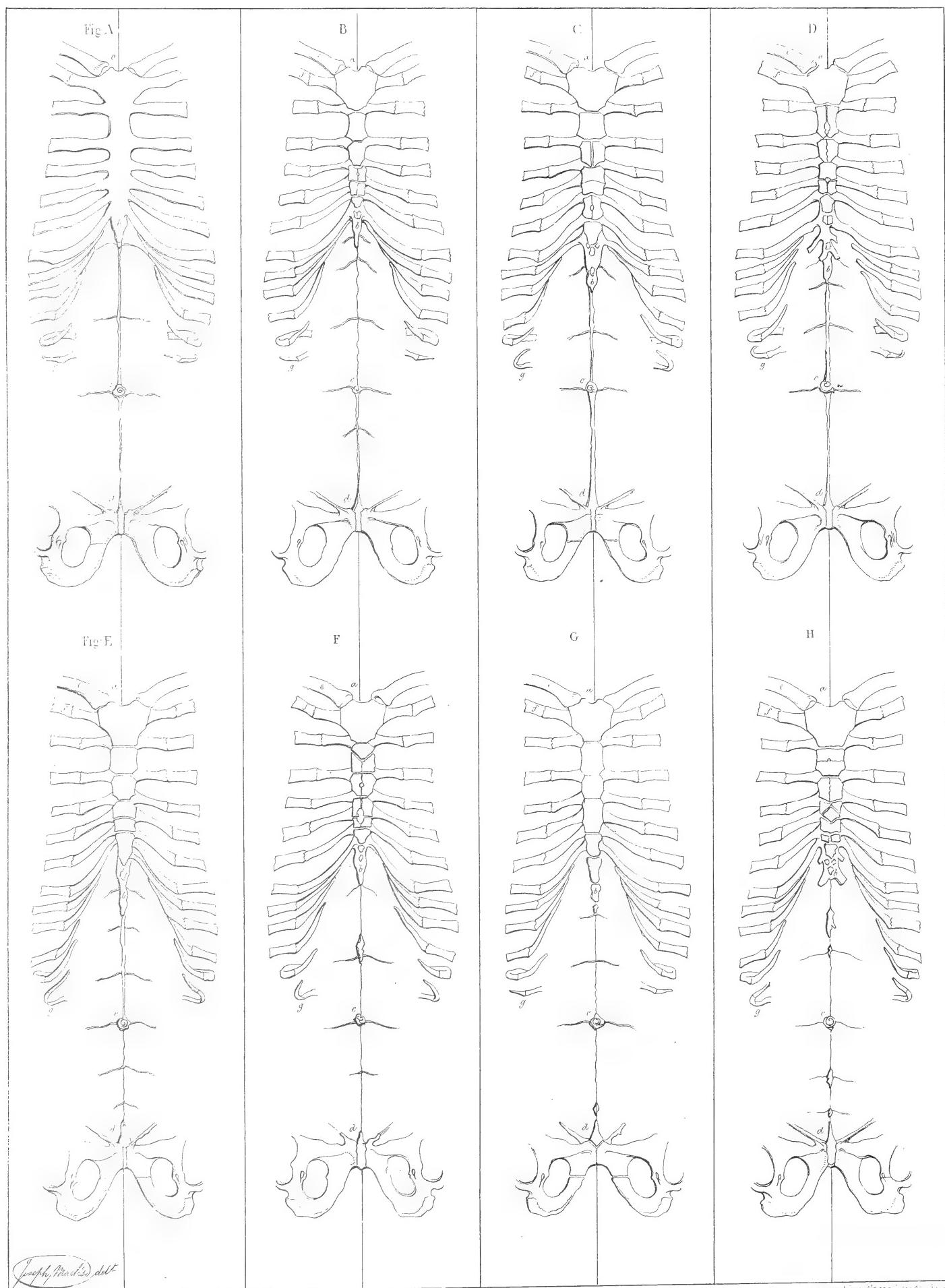
REMARKS ON THE FIGURES OF PLATE XXXV.

THE VENTRAL AND THORACIC REGIONS OF SERIES ARE COMPARED TO EACH OTHER, AS BEING DESIGNS IN MINUS AND PLUS QUANTITIES.

INCREATION stands opposite to creation, just as vacuum is opposite to matter. And as presence and absence, or entity and nonentity, cannot hold, at one time, the same situation, any more than two entities can, at one and the same time, occupy the same place, so will it be equally vain to describe them as one and the same thing or condition. But the law of series which developes entities, as graduated figures or plus and minus quantities permits us to recreate, at least in idea, the presence of lost quantity, and certainty awaits this method of anatomical comparison, forasmuch as it assimilates to mathematical rule. For though we cannot rationally say that the place which a+b now occupies is also receiving another quantity equal to $a+b$, still, we may clearly understand, that, between $a+b$ in one place and $a-b$ in the next place, a certain quantity is lost, which quantity is the difference between them; that is to say, the quantity b lost to $a-b$. Design may, therefore, occur by reason of quantity lost, as well as by quantity present, and the simple comparison between $a+b$ and $a-b$ proves it; whereas, in this very proof, we have drawn an equation between the difform and the uniform, between the quantity $a-b$ and $a+b$. For we contend that it is impossible to estimate the present inequality of $a+b$ and $a-b$, independently of their assumed equation, or $a+b$ contrasted with a+b. The ventral region of series is minus the costal quantities, while the thoracic region is plus those quantities; and, therefore, we conclude that the venter is a design by the loss of costæ; whereas the thorax is a design by the presence of costæ; whereupon we remark, that the idea of lost quantity, and the design thereby occurring, is one which stands in as bold relief as the idea of such quantity actually present, and also attended with design. If the ventral region did not bear evident traces of those costæ, of which it is now minus, still serial order would create, in us, the idea of the same, for the venter holds serial relation with the thoracic costæ, and the comparison of both regions gives the full account of their present designs, together with the manner in which the law of form has operated for their creation.

Whilst we consider the skeleton archetype to be a series of thoracic quantities, such as the seven first costo-vertebral-sternal structures, which describe complete circles from the spine behind to the sternum in front, we must then interpret the cervical and abdominal regions of series to be those whereat Nature, in furtherance of her design, has subtracted both sternal and costal quantity from series, and at which very places, otherwise, if fitness had demanded, those same structures might still have persisted. In proof of this interpretation, the question naturally suggests itself, do we find any traces of the costal and sternal quantity in the regions of the cervix and abdomen? We do, undoubtedly.

From the sternal median line in front of thoracic persistent osseous quantity, there extends a fibrous band, named *linea alba*, which marks the ventral median line, and from this we see, projecting laterally, the fibrous traces of ventral costæ, which now bear the name of *lineæ transversæ*. There can be no doubt that these linea alba and lineæ transversæ repeat over the abdomen those structures which take serial order in front of the thorax, under the name of sternum and costal cartilages. The ossific process takes place in three stages; the primary stage is ligamentous, the second cartilaginous, the third osseous. Every skeleton piece, which now presents as cartilage, has

been, at a former stage, of fibrous structure; and every skeleton piece which now presents as bone, has been, at one stage fibrous, at another stage cartilaginous.

That anterior median line expressed by the sternum and linea alba, presents, in several regions of its length, those three phases of transitory creation. In the thorax it is osseous; at the region of transition from thorax to abdomen it is cartilaginous; in the abdomen it is fibrous, and it stretches from the last sternal piece to the symphysis pubis, thus relating the pubic structure to the thoracic quantities, and, as it were, pointing silently to some, as yet unexpressed, sentence of anatomical design, fashioned from serial archetype uniform quantity, by the simple law of metamorphosis or proportioning.

The sternal structure is one which instances an almost endless variety as to the number of its elemental or formative pieces, as will be seen, for all the opposite figures show that the sternum is not developed alike in any two amongst them. Whilst we find that such variety attaches to the sternal structure as developed even in one species, it may easily be guessed how endless a variety prevails as to the mode of development of the sternum for all other species of animals. A generalisation of the sternal forms, such as they are, can alone give us any insight into their nature. But as the sternal median line expresses a sentence of design which is beyond the limits of the present subject, so shall it remain, and all the remark which we shall here make respecting it is, that the linea alba is a continuation of it over the animal venter, and that we have discovered in the linea alba various islets of cartilaginous structure and even osseous deposit, thus simulating, in some measure, the thoracic sternum.

In all the opposite figures, the median line a, bisects the sternum from this point to the xiphoid cartilage b, and thence passes through the linea alba to the umbilicus c, and thence to the pubic symphysis d, which it also bisects after the manner of a sternal cleavage.

The opposite figures, therefore, clearly manifest the fact that the fibrous linea alba is a continuation of the sternal median line, and this also allows it to be inferred, that the pubic bones hold serial order with the thoracic costæ, between both of which structures occur the lineæ transversæ.

The opposite figures likewise shew that e, the sternal end of the clavicle, holds a serial relation with f, the first rib, and from f, to g, all the thoracic costæ stand in series as proportional quantities. From g, to the pubic arches occur the serial order of lineæ transversæ. Let these facts be added together, and the product of the addition must be that Nature expresses a certain serial relation between thoracic, ventral, and pubic formation.

The number of thoracic costæ is not fixed and invariable, neither is that of the lineæ transversæ intersecting the abdominal region.

When we would follow the design of Nature, and appreciate the miracles of effect, produced by the simplest mode of causation, we have only to contemplate the gra-

dation of serial order, or the thing $a+b$ followed by the proportional $a-b$, between which quantities comparison will demonstrate the teeming evidence of design, as reigning all along the graduated line of figures, whether in one region they stand plus and equal, or, in several regions, they present as minus and various. For it is fully manifested that Nature operates to fitting results, as well by the absence as by the presence of quantity, and this mode of development is best proved by our supposing quantity to exist were she has designed that it shall not exist, (as, for example, the costal forms at cervix or loins,) or conversely, by our supposing it to be absent where she has ruled that it shall be present (as, for example, the thoracic region minus the costæ), in which case it could no longer bear the name of thorax.

The existing proportional series, as being the creation of natural operation, is the fitting design, and we may the more clearly estimate that fitness, as occurring by lost quantity, when we shall imagine the presence of the quantity which is lost. For while there is every reason to believe that lumbar vertebræ are the minus quantities proportioned from their plus costo-vertebral forms, we then give full value to the potency of ventral design only by contrasting the costal presence with the costal absence, or unfitness with fitness, that is to say, an absolute serial uniformity, supposed to exist where the proportional or graduated variety can alone fittingly exist.

The ens present where it should be absent is as evident an unfitness as the ens absent where it should be present. This error is never committed under the rule of natural development, and yet it is upon the very possibility of its occurrence that comparative science is to base its study of uniformity. For while it is evidently the process of Nature to annihilate costal quantity from the lumbar vertebræ, in order that the parturient venter shall have free motion, during the act of genesis and the creation of the analogue, so we conclude therefrom, that the thoracic series of uniform archetypes, which is the prime model, and which we may conceive to be continuous throughout, from first to last of the serial line, has undergone metamorphosis at the ventral region, and thereby answered the required design. This design is consequent upon the occurrence of a hiatus in series, and we call that hiatus the venter which still bears fibrous traces of lost osseous or costo-sternal quantity.

In figs. A, B, C, D, E, F, G, H, we view the thoracic series terminating where the ventral region commences; and this is equal to the assertion that the thorax and venter form one continuous surface, enclosing one general cavity from the cervix above to the pelvic arch below *. Throughout this general enclosing surface or periphery, whether of the recent body or the recent skeleton form, we cannot discover any natural boundary, as separating one region from the other, except that which occurs between plus and minus quantity. The muscular partition, or diaphragm, can with no more reason be said to draw the line of distinction between the thoracic and ventral regions, than can the interventricular

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* " The thorax being denominated that cavity which extends from the neck to the pudenda."—Aristotle, *History of Animals,* book 1, p. 16.

septum be named as separating the heart into two absolutely difform organs. Or, if we say that the duplex heart, like the thoracico-ventral cavity gives example of how duality becomes fused into unity, then we call such a creation unity in either case, whether it existed formerly as dual or not.

But at present we are only remarking upon the skeleton quantity, and, in reference to this, we observe, that the number of costæ is not constant even in the human skeleton,* and that, between thoracic series and the pubic arch, exists a hiatus in general series, caused by the loss of costal parts. This *hiatus* is *the ventral region*, and in it we trace the fibrous analogues of sternal and costal structures, at the same time that we see it to be bounded laterally by asternal costal forms, which, (from *b*, to *g*, in each of the opposite figures,) pointing towards the ventral median line, or linea alba, manifest a graduated failure of quantity in reference to this line. And taking thoracic costal series as the plus standard of comparison, and as meeting at a sternal structure, we observe that the asternal or ventral series, being minus quantities, do not, for this reason, meet at a ventral sternum, and that the venter is a design accordingly. For if the asternal costæ persisted in plus quantity, the ventral region would not exist. In short, if absolute plus uniformity, which we take to be the prime model, existed in figs. A, B, C, D, E, F, G, H, they would fall as far below the standard of fitness, by having a costal series extended over the abdominal region, as if the now persistent thoracic series had also undergone the like metamorphosis, and presented in ventral character for a human form.

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* The doubt, which is expressed in the following quotation, as to the number of ribs developed in the human skeleton, is owing to the circumstance of human anatomy not having been studied by the ancient Greeks.† But it may also be here remarked, that, even to the present day, now that special anatomy has obtained the fullest account of all the possible facts of ossific formation which have ever been developed upon the human type, still it remains impossible for the anatomist, whether special or comparative, to say, with certainty, how many costal forms of sternal or asternal character stand created within any living human figure. The same doubt attaches to the number of serial quantities, whether of the entire axis or of any region of that axis. Nor can the anatomist, whether special or comparative, ever hope to clear away the mystery which envelopes these facts of creation, except by a generalisation Aristotle, the founder of generalisations, has observed as follows :—" Underneath are the loins, which are opposite to the belly ; but the ribs, which are, on each side, *eight in number*, are common to both the superior and inferior parts, for, with respect to what is reported of the Lychnians, that they have only *seven ribs*, we have not heard this asserted by any one who is worthy of belief."—*See History of Animals*, book 1, p. 23.

† " Thus, therefore, the parts in the external superficies of the human body are arranged, and as we have said, they are especially denominated and known from custom. The contrary, however, is true of the inward parts ; for, of all the parts belonging to man, they are the most unknown, so that it is necessary to survey them by referring to the parts of other animals to which they are similar."—Aristotle, *History of Animals*, book 1, p. 29.

Plate 36.

Fig A.   B   C   D

Fig E.   F   G   H
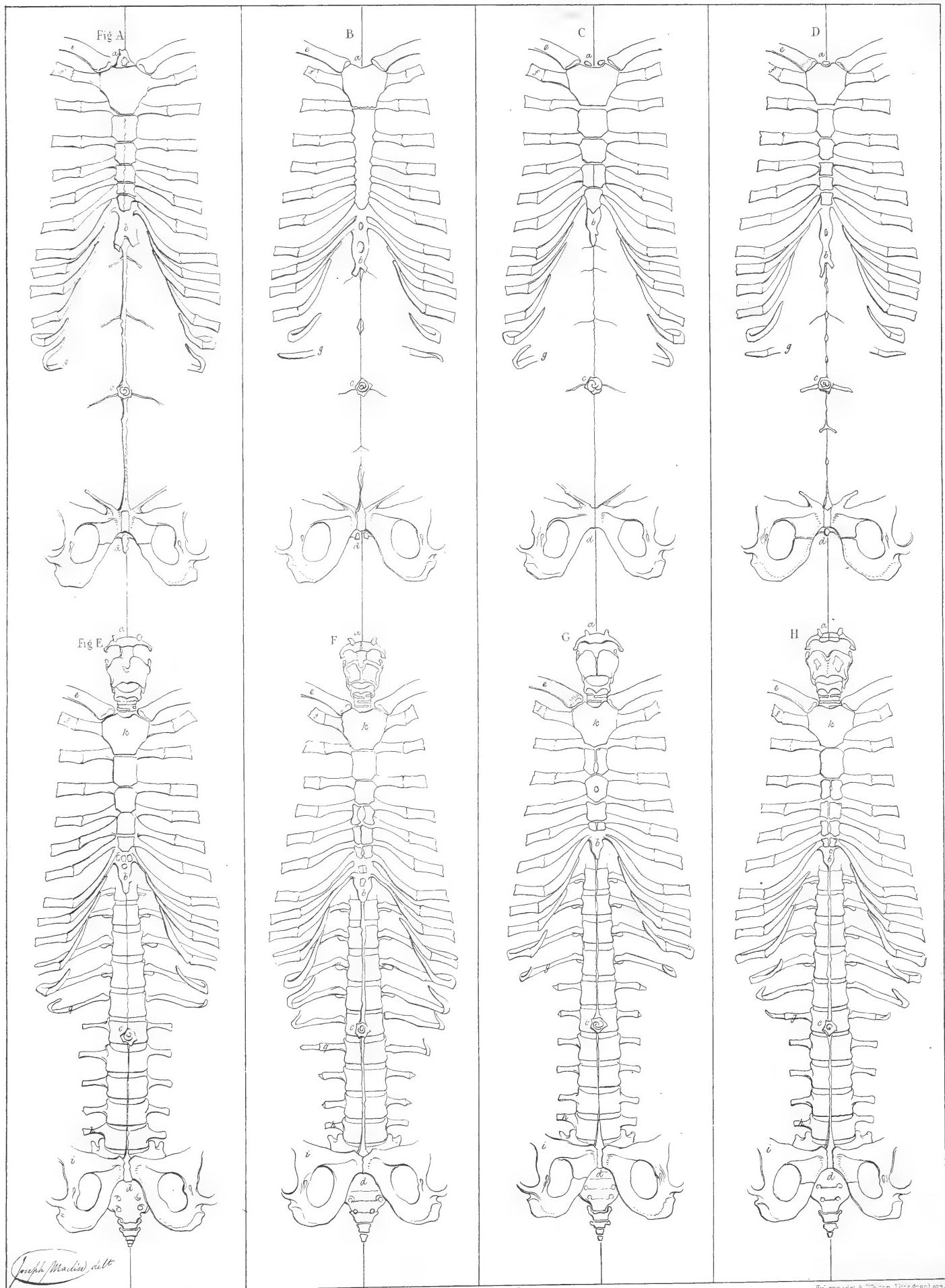
REMARKS ON THE FIGURES OF PLATE XXXVI.

THE VENTRAL AND CERVICAL REGIONS ARE HIATUSES CAUSED BY SUBTRACTION OF QUANTITY FROM THE PLUS SERIES.

SUBTRACTION from plus quantity is attended by the addition of design and fitness. Where Nature produces a hiatus in series, she fills it up again by functional perfection, and hence may be said to give design a place and habitation by the very act of rendering form annihilate. Serial uniformity, absolute and unexceptional, cannot, therefore, characterise any skeleton figure which is functionally and fittingly developed; for as by the absence of quantity hiatus is produced in series, and as design consequently occurs, so may we readily conclude that the actual condition of an uninterrupted plus uniformity would be the very annihilation of design. Standard archetype uniformity will hence be sought for in vain amongst those figures which are designs by the very absence of serial quantity. Design being ubiquitous by the operation of a transcendent law of metamorphosis, it must, therefore, follow, that uniformity or plus continuous equality cannot be ubiquitous; for we may as reasonably conclude that the plus uniformity and minus variety cannot characterise the same entity at one time, as that this ens cannot occupy two places at the same time. For the like reason we say, that where design is, absolute uniformity cannot be; and as design is regnant universally, so must the fact be evident that perfect serial uniformity cannot have any place in Nature, nor has any anatomist ever found it, neither can he ever hope to find it, so long as design is the product of metamorphosis; and yet it is for standard uniformity that we ourselves are seeking at the very same time that we confess it to be non-existent; thus apparently making the paralogism in our inquiries. But to explain ourselves openly we say, that though perfect continuous uniformity from origin to termination of any one skeleton line or axis can no where be found, in consequence of design following the track of metamorphosis, yet *it is* discernible amongst the skeleton pluralities, and may be produced as an abstract standard figure, created as it were upon the ground of analogy, and gathered together by the agency of comparison.

Compared with the thoracic serial quantities, the cervical and abdominal regions of the skeleton form must be interpreted as minus. All three regions of series, when compared with each other, will therefore lead to the interpretation that an abdomen and cervix are designs by lost quantity, and consequently that a thorax is a design by the persistence of full quantity. The quantity which is lost in one region of series is therefore to be called after the same name as that which still persists at another region of the same series; and from this it must be inferred that the metamorphosis of archetype quantity, such as we find in the thoracic region, is that law which yields the abdominal and cervical specialities. This, therefore, is equal to the fact that the original or archetype series is thoracic from occiput to the other extreme; and this is the prime model of Nature, from which she plans her special designs. Those designs are simply the result of the law of proportioning, subtraction or metamorphosis. This is the teleological law, and, being one which Nature herself describes, cannot be accounted rebellious to Nature, or the Creator Naturæ.

The sternal structures in all the opposite figures still prove inconstancy as to the number of their formative nuclei. Surmounting the first sternal pieces of figs. A, C, and D, will be seen certain osseous nuclei which prove that this extremity of the sternal structure is liable to

genetic or plus variety; even as the opposite extremity of the sternum, which, where it joins the linea alba by the xiphoid cartilage, presents all sorts of genetic changes.

In all the figures it will be noticed that the median line passing from *a*, through *b*, through *c*, to *d*, the subpubic region, is a line within whose range numberless varieties of nucleary deposit is occurring; and this is so true that the human anatomist has long since owned to the fact, that no one description of sternal form and development is sufficient to include all its varieties of cast.

The common median line in front traverses the thoracic sternum, the abdominal linea alba, and the pubic symphysis. Within this line variety, as to nucleary deposit, is constantly occurring. From *a*, the episternal ossicles, to *d*, the subpubic osseous nucleus seen in figs. A, B, and D, may be noticed a range of line subjected to manifold genetic changes; and the only reason which can be assigned for this is that it is a region where quantity has been subtracted for special modification, and hence is liable to all those plus "anomalies" of skeleton deposit which may have creation between the lowest minus quantity and the highest condition of plus archetype structure. From the abdominal region of series original skeleton quantity has been subtracted. Of what cast of form is that quantity which has been subtracted? It can be no other than that of costo-sternal type, and if this assertion cannot be upheld by the rule of serial and symmetrical homology proper to the human skeleton axis, then other proofs may be had, in which that quantity which we have said is lost at the abdominal region of the opposite figures, is actually persisting at other skeleton venters. For the present, however, we will not pass beyond the demonstrable subject of the accompanying drawings, nor attempt to stretch farther into the law of skeleton formation than simply to state in this place that the human abdomen results in skeleton series by the metamorphosis of certain skeleton archetypes, and that the "anomalies" of form which are constantly occurring at the median line in front are all explicable and included by this interpretation.

In figs. E, F, G, and H, will be also noticed the fact that the sternal structure still presents varieties as to nucleary development. Likewise that the hyoid apparatus is produced above the sternum in the cervical region, and that it falls within the range of the median line of cleavage. This common median line passing downwards from the point marked *a*, in figs. E, F, G, and H, would first cleave the hyoid bone through its body, next the thyroid figure, also through its centre, next the cricoid form through its mid region, and then would cleave the sternal centre from *k* to *b*, and continue its passage through the linea alba to the navel *c*, and the pubic symphysis *d*. Thus, all regions of this common median centre in front, and all structures, whether plus or minus, which appear within its range, are rendered bipartite by the one act of sundering, just as completely as if those several regions and created structures presented of one appearance, and that no other condition of variety disconnected their enchained relationship than that of plus rendered

minus. Be this as it may, however, the above reading can only be offered in this stage of the argument as a mere suggestion, for we are as far from stating that the hyoid apparatus is exactly homologous to a sternal structure in the human body, as we are from regarding the lineæ transversæ and linea alba to be the complete homologue of either of the above. But it will be at least granted that the common median line bisects all the forms which take serial order from the symphysis maxillæ to the symphysis pubis, and also that if, at present, reason forces us to admit that absolute identity cannot be proved between the hyoid apparatus and the sternal structure, still we must also acknowledge to the truth, that the hyoid apparatus is not in all cases similarly developed, neither can the sternal structure be said to be developed in all cases alike.

We must also admit that the several sternal pieces from *k*, to *b*, in fig. H are not absolutely identical with each other, nor can the sternum of fig. H be called the homologue of that in fig. G, or F, or E.

Neither can it be asserted that the linea alba and lineæ transversæ of fig. D are homologous to those seen in fig. C, or B, or A. In the abdominal median line of those several figures from the xiphoid cartilage marked *b*, to the pubic symphysis marked *d*, occurs the umbilical knot *c*, always at the same locality; but from this common centre *c*, to the sternal point *b*, above, and to the symphysis pubis *d*, below, there happen many genetic difformities, both as to the number of the fibrous transverse lines, cartilaginous, and osseous deposits. If, therefore, there would seem to be at present good reason for denying the absolute identity between hyoid and sternal pieces, so would there seem to exist as good a reason for denying the absolute identity between those structures which at present bear the common name of hyoid apparatus, or those which are called sternal, or those which are named abdominal fibrous intersections.

But as we have before observed that all creations of minus apparatus which appear at a region from whence quantity has been subtracted from the plus archetypes of the serial axis may perform all modes of variation as to quantity between the extremes of plus and minus development, so must it at once appear impossible to read an absolute homology as to the quantities proper to those several structures; and this is the actual state of all structures happening at the median line in front.

In figs. E, F, G, and H, we have represented the plus and minus varieties of the costo-vertebral units constituting the serial skeleton axis. Those varieties are proportionals of the thoracic archetype quantity. From *f*, the first thoracic rib, to *g*, the last asternal rib, and from this latter form to *h*, the autogenous costal piece of the lumbar unit, we easily discover the law of metamorphosis or proportioning. Granting, therefore, that *g*, and *h*, are minus proportionals of the full costo-vertebral thoracic quantity to which *f*, belongs, it must result that when we equate *g*, or *h*, with *f*, that is to say, minus with plus, we are actually creating, by this very process of reasoning,

those costal structures of which the abdominal region is now wanting; and to this the abdominal region itself bears its own testimony, for it shows traces of a sternal structure in the linea alba, and traces of costal forms in the transverse intersections.

Figs. E, F, G, and H show varieties as to the number of ribs which meet the sternal median structure in front, and varieties also as to the number of the thoracic costæ themselves, from which it must be concluded that the length of a thorax is mainly dependent upon the number of ribs which persist for the lumbar units of series, and also that the length of a loins depends upon the metamorphosis of costal forms.

In figs. E, F, G, and H, the clavicle, e, holds serial order with the first rib, f, and with the pubic bone, i. We now perceive that between e, the clavicle, and i, the pubic bone, happens the thoracic region as the persistent plus serial quantity, and the abdominal region where such a plus has been subtracted.

Now, as we have before said, that, between plus quantity and its proportional standing in the same serial order, presides the spirit of design, so do we proceed to confirm those views by demonstrating that the proportional is a design by the loss of that very quantity which we find elsewhere in the plus form. And with this understanding it will at once appear evident that we still bound ourselves within the limits of the remark above made, viz., that where design exists, by reason of subtracted quantity, so therefore, will it be in vain that we make search for absolute serial uniformity, as characterising *the presential state* of any one skeleton axis; at the same time that the order of graduated series is still developing the idea of this uniformity, and actually contrasting the present minus design with its original, but now non-existent, plus condition.

Endeavouring, therefore, to furnish support to our opinion by facts, and speaking through those facts, and not through mere sounds of speech, we may observe that, while a Thersites can defy a Plato, a Galileo, a La Place, or a Newton,* to demonstrate equality and absolute uniformity between the present condition of the quantities $a-b$ and $a+b$, so may a Thersites again defy them to explain the existence of any other species or difference between those quantities, save that of b, existing for the one and non-existing for the other. It is by the loss of costal quantity at the lumbar region of series in figs. E, F, G, H, that we have the venter as a minus design or hiatus in skeleton plus series,† whereas it is by the persistence of the like costal quantity for the thoracic region of series that we have that plus thoracic design; and therefore the knowledge of the quantity lost is equal to the knowledge of the quantity present, both of which establish the ideas of serial plus uniformity, which then is taken as the standard of comparison whereby the transcendency of design may be fully estimated.

* The uniformity which is spoken of in the following terms cannot stand for more than its actual value, that is to say, as being only expressive of the law of symmetry which still presides over the line of serial proportional quantities. " Tam miram uniformitatem in planetarum systemate, necessario fatendum est intelligentia et concilio fuisse effectam. *Idemque dici possit de uniformitate illa quæ est in corporibus animalium.* Habent videlicet animalia pleraque omnia, bina latera, dextrum et sinistrum, forma consimili : et in lateribus illis, a posteriore quidem corporis sui parte, pedes binos ; ab anteriori autem parte, binos armos, vel pedes, vel alas, humeris affixos : interque humeros collum, in spinam excurrens, cui affixum est caput ; in eoque capite binas aures, binos oculos, nasum, os et linguam ; similiter posita omnia, in omnibus fere animalibus."—Newton, *Optices, sive de reflexionibus, &c.* Edit. secunda, 1719, p. 411.

† " Mais la beauté de la nature, qui veut des perceptions distinguées, *demande des apparences de sauts* et pour ainsi dire *des chutes de musique dans les phénomènes*, et prend plaisir de mêler les espèces."—Leibnitz, *Œuvres Philosophiques, nouveaux essais sur l'entendement humain*, liv. iv., p. 441 : Amsterdam et à Leipzig.

Plate 37.

Fig A.

B.

C.

Fig D.

E.

F.

Fig G.

H.

I.

Fig K.

L.

M.

Fig N.

O.

P.
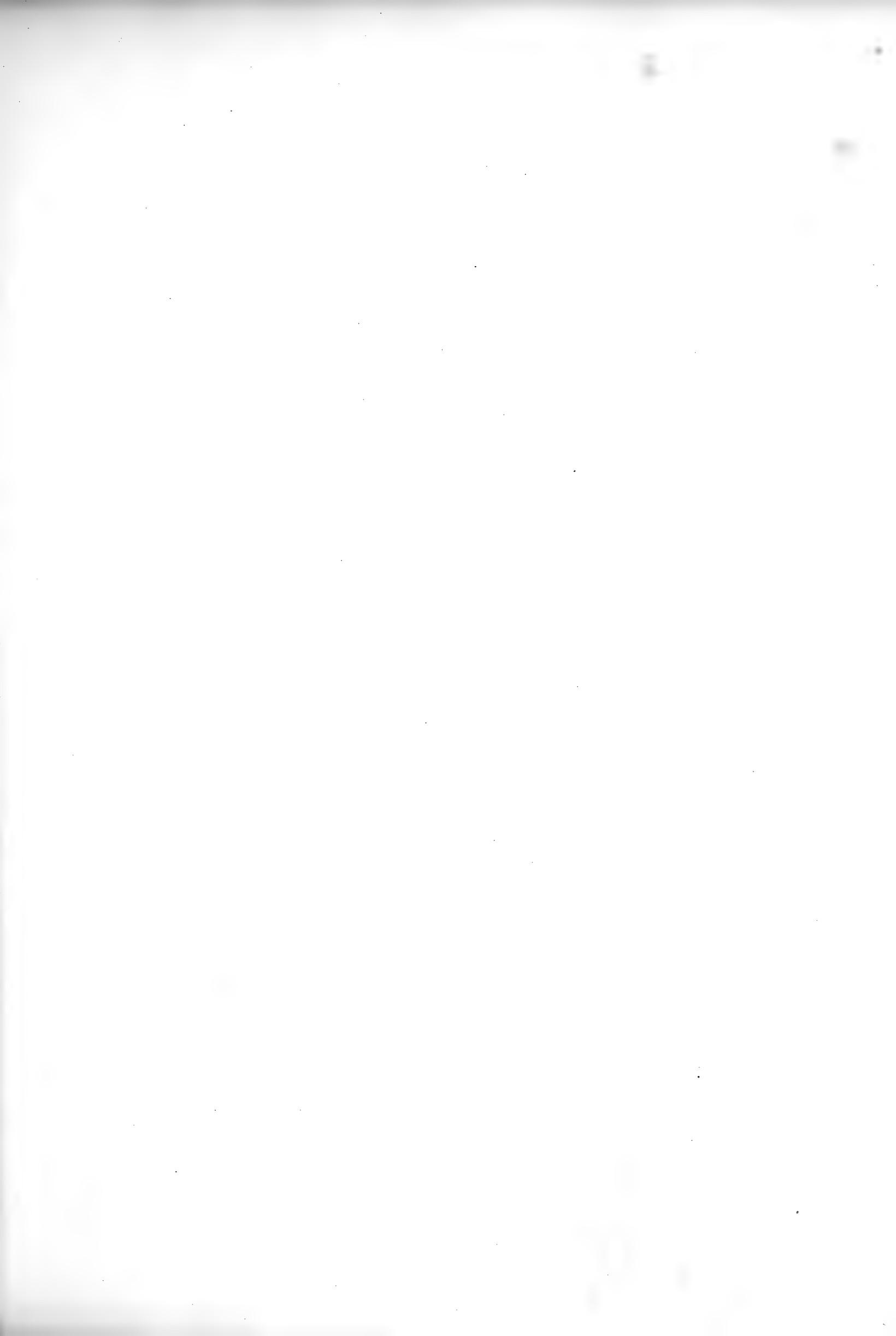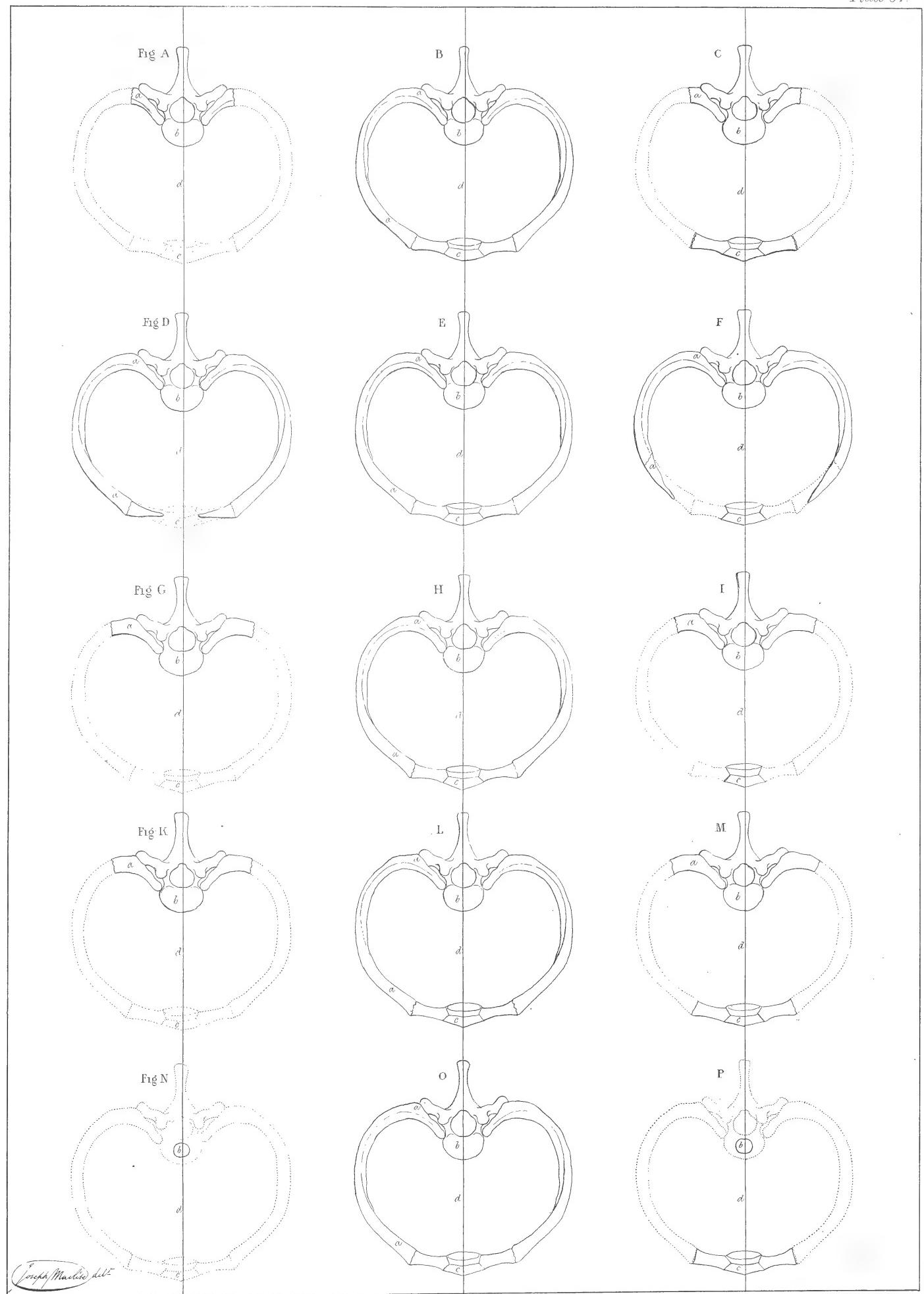
REMARKS ON THE FIGURES OF PLATE XXXVII.

THE THORACIC ARCHETYPE UNDERGOES A GRADUATED METAMORPHOSIS OF QUANTITY.

PLUS quantity or unity is the interpreter of minus quantity or variety. The design apparent in the plus figure illumines the design which characterises the minus figure. And because those figures of plus and minus quantity manifest a relationship to each other as quantities, so do they mutually interpret the functional fitnesses of each other as designs. The plus or archetype unit of series may undergo all the degrees of metamorphosis or proportioning, of which all minus quantities standing in the same graduated series with itself are themselves the examples. This plus unit of series is like an integer, as being the collective symbol of plurality; it is like a noun of multitude, expressive of the whole sum of its simples or individuals. It is a mark or form drawn by the designing hand of Nature, and, as being her own creation, is the proper emblem of herself. It is the circle, the inclosing line, beginning and ending in itself, and all which it embraces within its circuit constitute its parts. It is the thing inclosing all things, and therefore all things or parts which it does inclose or sum together as a whole quantity constitute it as the plus created entity. The parts which fashion this circle or emblem of infinity cannot escape from it or from themselves, except through the porch of increation. There is no other means of egress for any part or parts which this circle spans, except that of metamorphosis. Its several parts or proportionals may be subtracted, and by this subtraction of quantity proper to the circle this latter may undergo a change; but while we know that it is the circle which has suffered this change, causing hiatus in its once created entirety, so does it become as impossible to annihilate the idea of the circle or whole quantity, as it is to form any true idea of what does not relate of the entity of this circle, natura or quantity. The whole quantity at present persistent as to all its parts, contains in itself the entire history of the serial proportionals; for as this whole quantity is a plus ens, containing all the minus proportionals of itself, and as those proportionals relate of itself and of nothing else but itself, the entirety, so must all the like proportionals which stand in series with this circle or whole relate severally of all those circles of which they are the parts or proportionals. Those circles constitute the plus and absolute uniformity of series.

No anatomist has ever yet seen that unit of the serial skeleton axis which the human anatomist has named the dorsal vertebra, produced separately from the thoracic costæ. The name "dorsal vertebra" is altogether inseparable from the name "costa," and when the human anatomist describes the dorsal vertebra as a spinal unit *per se*, the costal appendages as forms developed *per se*, and the sternal figure as another structure requiring separate description; when he thus neglects to interpret the connected three as a whole quantity, as a complete design, for the fashioning of which whole either element is altogether subservient, or else is unintelligible considered of itself—then it is that he may be said to fall as far short of recognising the design of Nature in this particular, as if he separated a carpal and phalangeal ossicle from the skeleton hand, laboured out an isolated description of each of these elements, and told the long account of all their modes and measurement as quantities, without ever

reminding us of the surpassing plan of that whole structure, the human hand, of which they are the parts.

The dorsal vertebra implies the presence of a costa, as much as a carpal bone suggests the idea of the human hand. When the anatomist separates the part from the whole, and describes the part irrelatively of the whole, then he must speak irrelatively of design, for design is the constant attendant upon whole quantities where Nature thinks fit that these shall appear in full condition. When the anatomist dismembers those whole quantities which Nature has created whole for the purpose of expressing the whole sentence of design, then he may be said to wreck the design of Nature, and to lose sight of her meaning. The anatomist may be said to disconnect design when he separates a dorsal vertebra from its costæ.

The thoracic costo-vertebral figure is plus quantity, and we have seen that it contains a proportional homologous to any minus unit of the cervix or loins. We have seen that the autogenous elements of a cervical or lumbar vertebra were proportionals equal to the costal heads of a thoracic costo-vertebral unit. Hence it must appear evident that if we describe a dorsal vertebra without its costæ, we have, in fact, as little right to do so as we would have in describing a lumbar or cervical unit without its autogenous costal pieces. Be it granted, therefore, that where Nature creates the whole or archetype quantity in one part of series, we should not presume to spoil her design by any dismemberment of our own. As Nature creates the form so let it stand, for every human touch will only make a riot against her order. As we find Nature so are we to interpret her. Her whole quantities express their own full meaning. Her minus proportionals express their own meaning also, and as we find minus to be a proportional of plus, both conditions of development holding the same serial order, the vertebræ of cervix or loins holding series with the costo-vertebral archetype, so must the comparison of minus with plus and the equation of the one quantity with the other, interpret the law whose simple operation in furtherance of the design is by the metamorphosis of plus quantity through all degrees of minus proportioning.

As the dorsal form of costo-vertebral quantity contains proportionals equal to any other unit of series, so we have indicated in the opposite figures that law of proportioning which could render this full archetype of the thoracic region of series equal to any minus quantity holding serial order with itself.

The dotted lines in each of the opposite figures express the quantity lost by metamorphosis. In each of the figures the whole quantity is indicated by both the continuous and dotted lines.

Fig. A is a thoracic archetype, a whole quantity; a circle bounded behind by b, the vertebral piece, on either side by the costa, and in front by c, the sternal element. The centre of this circle is d, and metamorphosis obliterates the form from c, the sternum, back to a, the costal heads. Supposing this to have taken place, and that we now only find the vertebral proportional $a\,b$, to persist, still we cannot be unmindful of the archetype quantity from which it has been metamorphosed. It is a propor-

tional of such as fig. B, and still holds serial order with the homologous proportional of fig. B, which is the persistent archetype quantity.

Fig. C is another whole quantity similar to fig. B. Metamorphosis obliterates the costal sides of fig. C, leaving at dorsum $a\,b$, the vertebral piece, and c, the sternal element, with the costal cartilages persistent in front, but still both these pieces are parts of fig. B, the whole.

Fig. D is the same quantity of an archetype from which the sternal element c, has been subtracted, but taking the form which persists, with the element subtracted from it, a whole quantity is then summed up which equals E the archetype. So likewise does fig. F when we understand that it is the quantity between a, the extremity of the costa, and c, the sternal piece, which has suffered metamorphosis or subtraction.

Fig. G, again, when considered plus all that quantity ranging between a, the rib, and c, the sternal element, equals H, whose entire quantity persists. And fig. I, now minus all that quantity between a, the rib, and c, the sternal piece, would, if all its archetype structure stood created, equal H as completely as the others. Fig. K, plus all those parts of which it is now minus, would equal L, the archetype; and, in like manner, fig. M, whose sternal and vertebral elements alone persist, would, when plus the costæ which are now wanting, equal the archetype L.

The subtraction of quantity from an archetype has no limits on this side of absolute annihilation, and so fig. N may be metamorphosed to the elemental nucleus b; but as b holds series with the centrum, b, of all the other archetype figures, it is for this reason that it must be interpreted as the last remains of its own archetype quantity, which equals fig. O, the persistent archetype structure. Lastly fig. P, which has suffered degradation in all its regions except at c, its sternal piece, and b, its centrum, would, if all its original quantity remained, equal fig. O, the same existing archetype.

In all the opposite figures it will be seen that the part is related to the whole. That the whole is unity and the archetype. That variety is consequent upon subtraction from full quantity, but that all variety of parts is nothing more or less than some regional element of the archetype.

It is also to be seen in those figures, that the parts of the archetype which persist after the metamorphosis of the other elements, still hold series with their counterpart structural elements in the fully created archetype. Thus the elemental parts b, and c, of fig. P, which alone remain out of the whole quantity, still hold serial order with the elements b, and c, of fig. O, whose entire quantity exists.

And the common median line passes through the same structure in all the archetypes which persist uniform with each other. This line cleaves similar parts in figs. B, E, H, L, and O; and so likewise may this line be said to cleave the ideal archetypes when it passes through the persistent proportionals of figs. A, D, G, K, N; for those proportionals can come of no other form than that of the archetype quantity. Neither can the persistent elements

of figs. C, F, I, M, P relate to any other entirety or whole than such as B, E, &c.

When we know of the archetype quantity, having once seen it in its full dimensions, then we can easily estimate what is the sum of that quantity which is lost to any of its proportionals: thus a knowledge of the quantity which is metamorphosed is equal to a knowledge of the like quantity actually persistent; for if b, of fig. N, still holds serial order with b, of fig. O, then the former is a proportional of lost quantity, which may be said to equal the existent quantity of the latter; and this is uniformity, and the only one which can be possibly established between quantities which are created plus in one region of series, and minus in another region of the same series.

Uniformity can alone characterise the series of archetype or whole figures. Such plus uniformity or unbroken order prevails for the series of quantities marked B, E, H, L, O, and the proportional variety which, through metamorphosis, those figures can yield, are such as we have drawn on either side of them. But whatever be the proportional variety of the series A, D, G, K, N, or the series C, F, I, M, P, compared with the persistent series B, E, H, L, O, it is sufficient that we know the originals from which metamorphosis has planned them as minus quantities. Nature is order, even through her law of metamorphosis.

The costo-vertebral circle, B, undergoes a metamorphosis* or loss of quantity for the minus designs of A and C. This is a fact, and as such it manifests of itself its own interpretation. The unity or whole quantity of fig. B is subjected to a subtraction of certain elemental parts proper to its own plus character, and it is by the loss of such elements that figs. A and C are created. We call figs. A and C special designs when we compare them with each other, or with fig. B: we found this word species upon the apparent difformity or inequality of quantity proper to each figure; and we mark their several characters as distinct, because comparison demonstrates that all three are not furnished with the same amount of created parts. We grant their inequality as to quantity, and we also grant that the name species may be properly founded upon this inequality. But still we seek to know whether or not these figures A, B, and C, which are created unequals, and named as species, merit this name by any other consideration or cause save that of subtracted quantity. Evidently they do not. For, evidently, fig. B is a whole quantity persisting, complete in all its proportionals, and, as such, may be viewed as capable of furnishing (by process of metamorphosis) figs. A and C as minus quantities. Evidently, also, figs. A and C, as being minus quantities to which we affix the name species, refer themselves severally to their own originals or whole quantities,† which may be said to equal the persistent whole of fig. B, and therefore species is owing to the loss of quantity.‡

This loss of quantity, which renders figs. A and C as species compared with fig. B, happens by the fixed order of the law of metamorphosis. Under the operation of this law, the parts which persist for figs. A and C retain their own proper character and *serial position* exactly as we find them in fig. B, the whole quantity. And it is equally true that the lost parts of figs. A and C have not their proper places in serial order occupied by any other dissimilar and newly created element. The metamorphosed quantity of figs. A or C is represented in fig. B. Fig. A, a minus quantity, stands related to fig. B, just as 5 does to 9; for fig. A is a proportional of fig. B just as 5 is of 9, and $5+4=9$. This idea may be carried through the comparison of all the plus and minus quantities figured opposite. And the law of form, in which is centred the law of species, will be plainly indicated when each minus quantity in series shall be referred to its own archetype or plus quantity, for the series of plus forms, B, E, H, L, O, constitute absolute uniformity, as containing the proportionals.

* The harmony of *an entire* cannot possibly be conceived but in as much as it *consists of identical parts, modified by very delicate gradations.* Related at the basis to each other, those parts appear to grow various to infinity, to place themselves even in opposition, so far as regards their configuration, their destination, and their action. It is thus that Nature creates by the modification of similar organs, and interlaces, one with the other, systems the most different, which, however, do not cease to manifest an affinity still. In the meantime, metamorphosis performs for two different effects in perfect animals. On the one hand, as we discover in vertebrate forms, the plastic force modifies identical parts after a certain plan, and in a manner the most constant—a circumstance which establishes the possibility of a general type ; on the other hand, *the parts comprised in this type change continually in all animal species,* without, nevertheless, being ever capable of obliterating their common character." —Goethe: see the "*Researches on Comparative Osteology.*"

† "Denique multum utilis est in quamplurimis sagacitas quædam in conquirendis et indagandis conformitatibus et similitudinibus physicis." —Bacon, *Novum Organum*, lib. 2, aph. xxvii.

‡ "Quoiqu'il y ait des cas où l'on *observe une sorte de dégradation et de passage d'une espèce à l'autre qui ne peut être niée.*"—Cuvier, *Le Règne Animal, &c.*, tome 1, page xxi.

Plate 38.

Fig:A.

B

C

Fig:D.

E

F

Fig:G

H

I

Fig:K.

L

M

Fig N

O

P
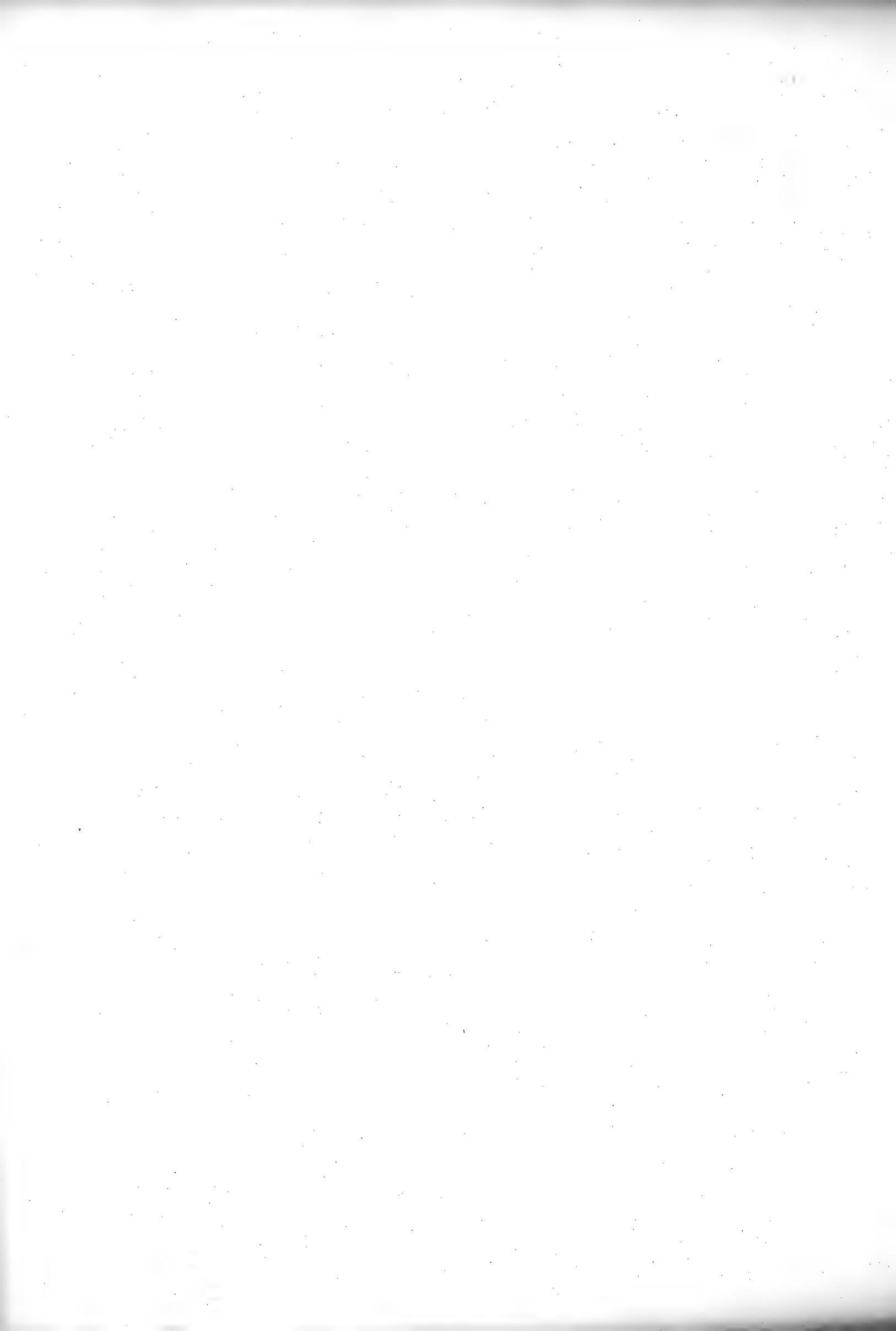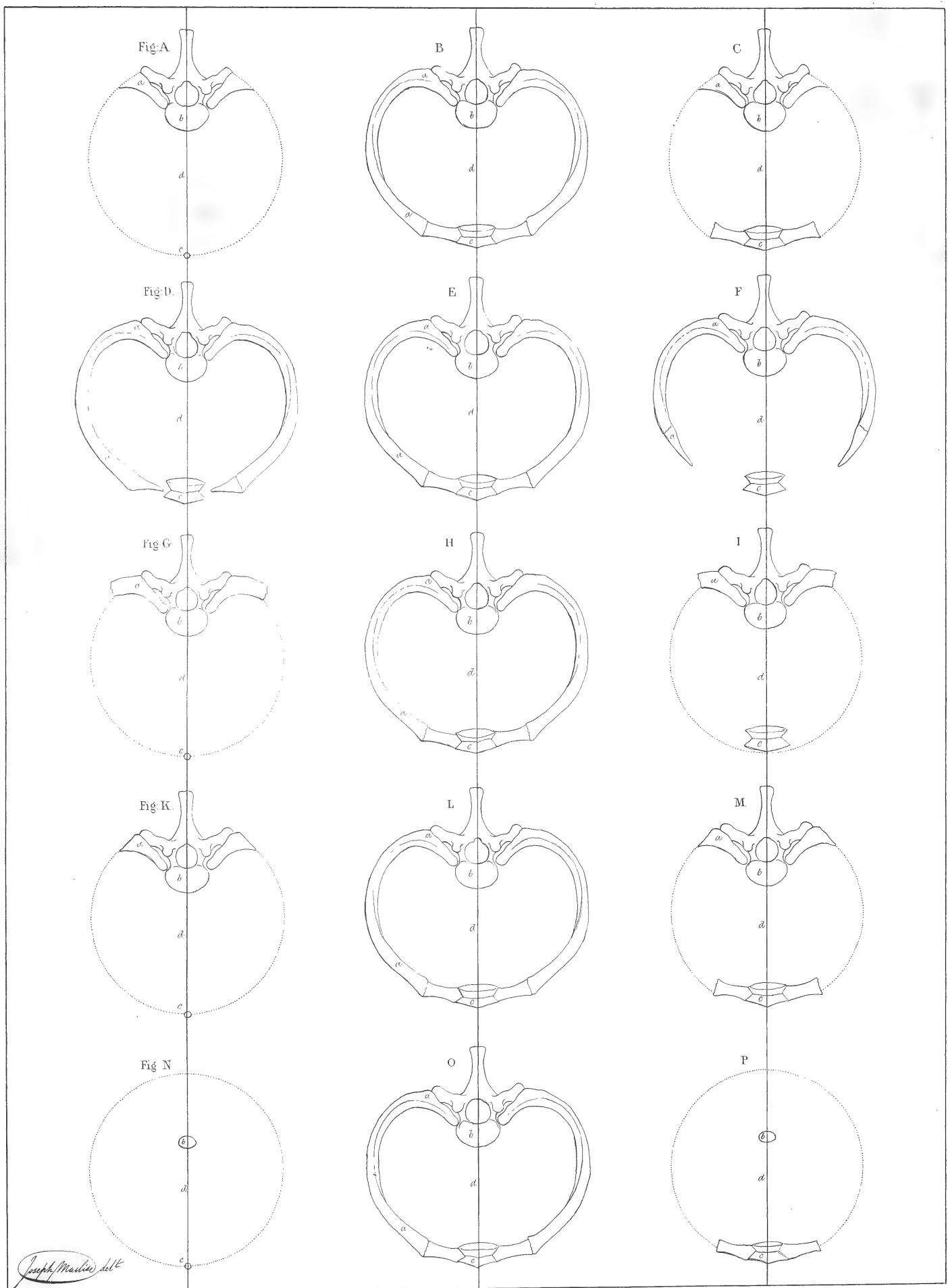
REMARKS ON THE FIGURES OF PLATE XXXVIII.

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THE THORACIC ARCHETYPE, AS CONTAINING ALL ITS OWN PROPORTIONALS, HOLDS WITHIN ITSELF THE EQUALS OF ALL SERIAL PROPORTIONALS.

MINUS quantity, having its homologue in a part of plus quantity, refers to plus for an interpretation of the mode of its own present minus condition. Every serial quantity which manifests itself as being a lesser thing, may be said to ask the question of what greater or plus ens it is the part. Evidently, the lesser quantity can with as little reason be regarded the equal and homologue of the greater quantity, as it can be said to contain the greater. But judging of it, the lesser, according to the presential and actual facts of creation, and without attempting to outstep those facts, we may very safely regard the ens which is minus in series, and which has its counterpart in the proportional of the plus unit elsewhere existing in that same series, to be the proportional of its own plus quantity, which is not now persisting because of metamorphosis and the fitness which requires the minus design. Now, it is not less evident that the minus unit refers to its counterpart in the plus unit, than it is that the plus unit may be itself degraded so as to equal the minus quantity. And therefore, as it is possible to conceive how plus quantity can undergo metamorphosis, and thereby equate itself with minus quantity, so it cannot be thought unreasonable to suppose that all those serial quantities which we find at present in minus condition, have actually been metamorphosed from serial plus originals, all equal to one another ; and this is the idea of uniformity.

Fig. A is a thoracic proportional of such another archetype as fig. B ; this is self-evident : consequently, therefore, when we find fig. A holding series with its counterpart proportional of fig. B, we are then led to interpret fig. A to have suffered metamorphosis as to all that quantity by which it is minus to fig. B, and hence a comparison of both figures will cause us to equate the lesser quantity with the greater, and so to draw the circle from the costal element a, of fig. A, to the sternal point c, of the same figure. In fig. C we find two elemental pieces standing separate from each other. The piece marked a, b, still stands in series at the dorsal median line, whilst the piece marked c, holds series with the sternal structures ; both these pieces bear the same relation to each other as the similar pieces of fig. B ; consequently we draw the circle which connects the now separate elements of fig. C, and thereby notice how much quantity has been metamorphosed. Fig. C compared with fig. B is minus the rib ; hence the pieces marked a, b, and c, in fig. C are now appearing as separated structures.

Fig. D is likewise a modified proportional of the archetype fig. E. The elemental quantity left remaining to fig.

D is to be found in fig. E ; the only difference apparent between both quantities is, that a slight subtraction of quantity has separated the rib a, and the sternal piece c, in fig. D ; and fig. F is only various to the archetype quantity E by the simple subtraction of a quantity between a, the costa, and c, the sternal element of fig. F. Evidently it is by metamorphosis of quantity that c, has been separated from a a, of fig. F.

Fig. G compared with fig. H proves that G is a proportional of H ; again, fig. I, whose separated elements marked a, b, and c, we have united by the circle, proves itself to be a form metamorphosed from such a quantity as the archetype H.

So, likewise, fig. K is a proportional of the archetype quantity fig. L, and in the same reading fig. M may be included, for the now separated pieces, a, b, and c, of fig. M may be connected by the circle, just as the costæ of fig. L connect its proportionals marked a, b, and c.

Even fig. N is a proportional of an archetype quantity equal to fig. O, for though the nodule b, of fig. N alone remains after the metamorphosis of the archetype, still this nodule is homologous to and in series with the part

marked b, of fig. O. In like manner fig. P, whose archetype quantity has undergone metamorphosis in all its parts, excepting the central nucleus b, and the sternal element c, may still be referred to fig. O, within whose persistent whole quantity the remains of fig. P find their homologues.

Now, fig. A is a proportional quantity equal to any cervical vertebra, so is fig. D equal to the eighth thoracic quantity, so is fig. G equal to any lumbar vertebra, so is fig. K equal to a sacral vertebra, and so is fig. N equal to a caudal nodule. While, therefore, we have every reason to interpret figs. A, D, G, K, N, to be proportionals of such archetype quantities as figs. B, E, H, L, O, so may we be allowed to interpret all the units of the mammalian skeleton axis, from occiput to the caudal extreme, as being the proportionals of their several archetype quantities, each of which may be considered equal to any of the serial figures marked B, E, H, L, O; hence, as all the series of archetype quantities prove the condition of serial uniformity, such as we find in figs. B, E, H, L, O, so must this be regarded as archetype unity, the proportionals of which quantities establish the variety or species found in the skeleton series such as nature has created it.

The part is not equal to the whole. Fig. N reduced to the nucleus b, is not, now, equal to the whole quantity fig. O, but still we may understand that fig. N has been metamorphosed from a quantity equal and homologous to fig. O. With this interpretation we follow the law of unity, rendered proportionally various or special under the operation of the law of metamorphosis. And while we grant that special variety is the product of metamorphosis or the subtraction of quantity, who is there that will (after owning to this self-evident and demonstrable fact) rein in inquiry at the point of this admission, and contentedly pursue the theme no further? The admission that a lesser form is some part of a greater figure or quantity, self-generates its own train of relationary ideas, and it becomes absolutely impossible to suppress the birth of them.

When we have reason to believe that the entity is a proportional of some greater form, it is not possible to separate that idea, as being present with us, from the idea which is absent to us. To acknowledge that the proportional is the proportional of some unknown whole quantity, may be regarded as a positive idea, referring to an idea negative; and the positive idea professes

its own appetency for the restoration of the negative or lost idea. The part is the part of a whole—then what is the nature of the whole?

The progress of all inquiry is conducted either through an imaginary cycle or through a right line of finite dimensions. It moves either through the orb which begins and terminates in itself, or through the linear series, which owes its finity to the law of gradation or the metamorphosis of quantity. Whatever be the truth or falsity of this remark with regard to other themes, it is undeniable that the science of anatomical comparison conducts the ideas through these two modes or courses. The opposite figures are proofs in form of the same ideas expressed in sound.

We take fig. A as a given quantity or form, to which we affix a name, as expressive of one or more ideas which it originates within us. This name expresses an idea, and this idea is based upon comparison; for at the same instant that we notice fig. A we liken it to something else, and this idea is either sense or nonsense, according to the similitude or the difference apparent between both objects. If we liken fig. A to either the head of a crosier or the handle of a Crusader's sword, this comparison is mere nonsense when weighed in the presence of the law of its formation. But if we study and observe fig. A through all its increasing phases, and, time after time compare the ens to itself, we will observe, that, like the crescent moon, it fills its horns, and proves itself, as it now stands, to be a proportional of the circle, the orb, or whole quantity. All the stages of its plus increase describe the progress through the cycloid, and all the stages of its wane, from the full measure of its apparent quantity in fig. B, still describe its declining figure to be none other than as the proportional degraded from a whole quantity.*

While it is in the cycloid that we sum together all the ideas of that law of metamorphosis which the proportional quantities through the series of A, D, G, K, N, on the one hand, and the proportionals of C, F, I, M, P, on the other, instance with regard to the plus series of figs. B, E, H, L, O, then we may contrast this latter series, as being uniformity, with the proportional series as being diversity, species, or the products of archetype plus uniform originals. In this comparison the law is rendered apparent, and diversity is proved to be a proportional of cycloid unity.†

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* " Quicquid enim unit naturam, licet modis imperfectis, ad inventionem formarum viam sternit."—Bacon, *Nov. Org. Scient.*, aph. xxvi.

† "L'ensemble de tous les ordres de perfections *relatives*, compose la perfection *absolue* de ce tout. L'unité du dessein nous conduit à l'unité de l'intelligence qui l'a conçu. L'harmonie de l'univers, ou les rapports qu'ont entr'elles les diverses parties de ce vaste edifice, prouvent que sa cause est *une*. L'effet de cette cause est *un* aussi. L'univers est cet effet."—Bonnet, *Contemplation de la Nature*, part 1, chap. iii.

Plate 39.

Fig A

B

C

Fig D

E

F

fig G

H

I

Fig K.

L

M

Fig. N

O

P
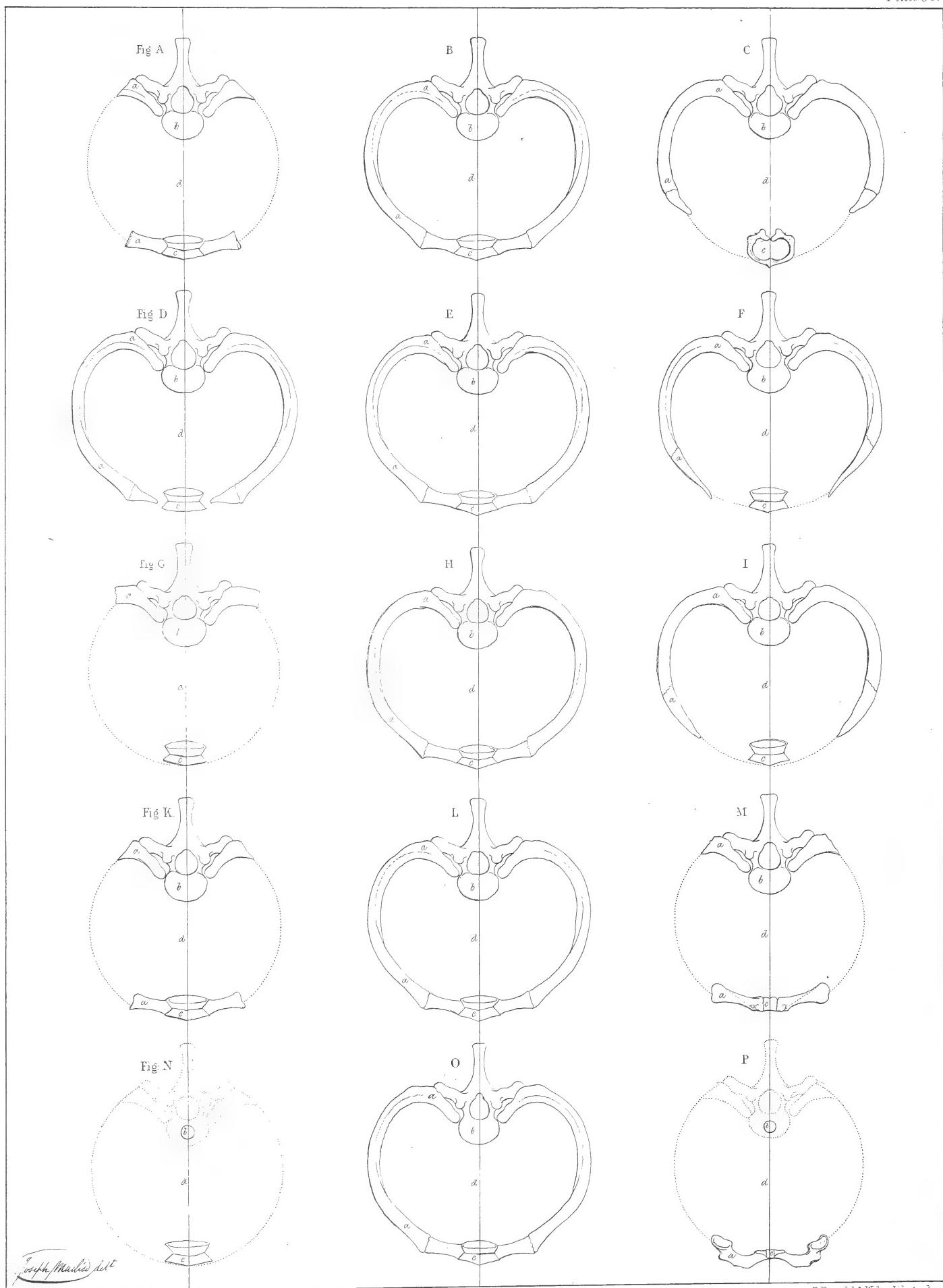
REMARKS ON THE FIGURES OF PLATE XXXIX.

WHERE THE THORACIC ARCHETYPE PERSISTS IN SERIES THE MINUS VARIETY DOES NOT EXIST. BUT WHERE THIS LATTER OCCURS IN SERIES, THERE THE FULL THORACIC ARCHETYPE IS WANTING.

NATURE, like an intelligence, adapts her own person to suit with all exigencies. Pressing necessity or real occasion causes her person to yield place. When her integrity or unbroken whole obstructs the moving principle of design, she, in her entity or entirety, submits herself to metamorphosis; and where she once stood in full quantity she now manifests herself as proportional variety. Necessity is the law which governs Nature. Design is a necessity, and as it becomes impossible to demonstrate the *nihil frustra*, so is it also impossible to demonstrate that existence or entity in Nature which is not the liege subject of sovereign and all-potent forethought. Nature as entity or the measurable, mathematically demonstrable body, is impressionable, and her plastic mould bears out in bold relief the stamp of a design. Design is existent in and upon the body of Nature. Who shall undertake to demonstrate design, or the author of design, apart from Nature?

The vertebral pieces marked $a\ b$, of fig. A is equal to a cervical quantity. But we see that the pieces $a\ b$, of fig. A together with the piece marked $a\ c$, of fig. A are both found in the archetype quantity fig. B, and therefore it is that we say fig. A in both its existing elements is a proportional of fig. B, and so we have connected the anterior and posterior elements of fig. A by the circle, thus equating it with the whole quantity fig. B. Now fig. C is a cervical form whose autogenous costal elements a, have been produced through the circle further than we ordinarily find them, and at the median line in front of fig. C we find an elemental piece of the hyoid apparatus marked c, therefore we have drawn the circle complete from the costa a, to the piece c, and thus equated fig. C with the whole quantity of fig. B the archetype.

Fig D is the eighth thoracic quantity, its costæ a, are separated from the sternal piece c, by subtraction of elementary part, but still fig. D refers to its counterpart fig. E, and so in like manner does fig. F, the ninth thoracic quantity, whose costal arms a, are separated from the ziphoid sternal piece c, by the like subtraction of elemental substance.

Fig. G is equal to a lumbar form, in front of which happens the piece c, produced at the ventral median line. The circle connects these separate pieces, and so fig. G is equated with the archetype H. Now fig. I is a lumbar form whose autogenous elements a, have been produced through the circle farther than usual, thereby approaching to the ventral median line where we find the piece c.

The circle in like manner connects these separate pieces, and thus equates fig. I with the whole quantity fig. H.

Fig. K is equal to a sacral vertebra, and the circle connects the anterior piece $a\ c$, with the posterior piece $a\ b$, thus equating it with fig. I, which is the archetype, and contains elements homologous to those persisting in fig. K. Again in fig. M we see a sacral form, the autogenous pieces, a, of which may be connected by drawing the circle towards the median line in front, where we find $a\ c$, the pubic bones.

Fig. N, as to its elemental quantity marked b, equals the last caudal nodule; the element b, holds series with the centrum b, of fig. O, and therefore it is that we have described in connection with b, of fig. N that archetype quantity of which it is minus. Fig. P. likewise is a caudal quantity; the elemental nucleus b, has described around it that original to which it refers; and so when we draw the circle after the manner of fig. O we then meet, at the median line in front, the piece marked $a\ e$, which is the Ischiadic bone.

In all the opposite figures, the homologous elemental pieces bear similar letters, and it will be seen that the common median line cleaves the pieces marked b, and c, through their centres; also that whatever be the amount of metamorphosis to which the archetype quantity has been subjected, still the proportional b, is seen to hold serial order with b, and the elemental structure marked c, stands in series with c; so likewise does the costa a, happen in series with a, whenever the costa is persistent; and even

where it is wanting, still the ideal circle passes through that space which is proper to it alone.

Nature is order, serial order; and when she metamorphoses any region of archetype quantity she never introduces into that space any form of absolutely dissimilar kind. Where a rib is wanting between two others of series we never find its place occupied by a vertebral structure; when a vertebra is wanting in series, we never find a rib occupying its place, consequently all structures through which the anterior and posterior median lines pass must be regarded as serial relatives, each structure being some part of an archetype, such as fig. B.

In drawing the opposite figures our object has been to represent whole quantities, and the proportionals of these in the same comparative estimate, whereby the law of design may be comprehended under our notice. This law, we have endeavoured to show, operates for design by the subtraction of quantity from whole serial figures; and hence that the serial quantities are now presented to us in plus and minus variety. This variety is caused by metamorphosis; and the effect of this process is design. The serial whole and uniform quantities are represented by figs. B, E, H, L, O, whereas the serial minus and various quantities are those which present in the characters of figs. A, D, G, K, N, and figs. C, F, I, M, P. Those minus quantities have been severally referred to the plus quantities, in order to prove that they themselves are the proportional varieties of such plus originals; under which interpretation their actual minus condition may be best explained.

Now the collective regard and connected comparison of the triple series of the opposite figures will at once determine the choice as to that form which presents in whole condition, and which consequently shall, with most propriety, bear the name of archetype. This whole quantity evidently cannot be found throughout the serial line of figs. A, D, G, K, N, or the series of C, F, I, M, P, for all these figures vary as to quantity, and still may be severally compared to the series of figs. B, E, H, L, O. The vertebral piece $a\,b$, of fig. A, together with the sternal piece of fig. A, are both to be found in the whole quantity of fig. B, and evidently the figure which we ordinarily term vertebra is only a proportional of such as fig. B, which describes the circle from dorsum to sternum. And while we find that both the sternal and vertebral pieces of fig. B are produced as integral parts of this whole quantity, and also that, by the metamorphosis of its costæ, it would then represent fig. A, whose vertebral and sternal pieces we find separate from one another; it must hence be fully apparent that fig. B is the original or plus archetype quantity of fig. A, and also that the presential minus character of fig. A is chiefly owing to the subtraction of costal quantity. Hence we say that as fig. B passing through various degrees of metamorphosis may from time to time represent any serial quantity of figs. A, D, G, K, N, or of C, F, I, M, P, so for this reason may we understand that the originals of these latter are such as the series of whole quantities figured in figs. B, E, H, L, O, and therefore that B, E, H, L, O are the only quantities which can represent serial uniformity.

We call fig. B unity,[*] because it is a whole quantity or integer complete, continuous throughout its periphery, and as perfectly enclosing space as the circle. As a whole quantity fig. B may be said to contain [†] and express the several minus varieties of figs. A, D, G, K, N, and also of figs. C, F, I, M, P. As a whole quantity fig. B binds together [‡] and amasses all the particular and various proportional quantities of figs. A, D, G, K, N, and figs. C, F, I, M, P, and moreover expresses the law of their proportional variety and consequent designs. In fig. B we view the prime model, which undergoes metamorphosis of quantity for proportional variety. And in this metamorphosis of fig. B, which can produce any proportional variety between the extremes of plus and minus, we track the progress of design and the process of Nature. The repetition of fig. B in series is equal to the series of figs. B, E, H, L, O, which is absolute serial uniformity.

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[*] *Unitas est* sine commissura *continuatio* et duorum inter se conjunctorum corporum tactus.—Seneca.—*Natur. Quæst.*, lib. xi.; *Bibl. Class. Lat.*, Lemaire, vol. lxxxvii.

[†] The great advantage of this idea of *a whole is*, that *a greater quantity of truth may be said to be contained and expressed in it.*—*Sir Joshua Reynolds's Discourses*, Discourse xi.

[‡] *Tout phenoméne dans la nature est lié à l'ensemble;* et, quoique nos observations nous semblent isolées, quoique les experiences ne soient pour nous que des fait individuels, il n'en résulte pas qu'elles le soient réellement; *il s'agit seulement de savoir comment nous trouverons le lien qui unit ces faits* ou ces evénéments entre eux.—Goethe. *Œuvres d'Histoire Naturelle*, Introduction, p. xi. *Traduits par Martins.*
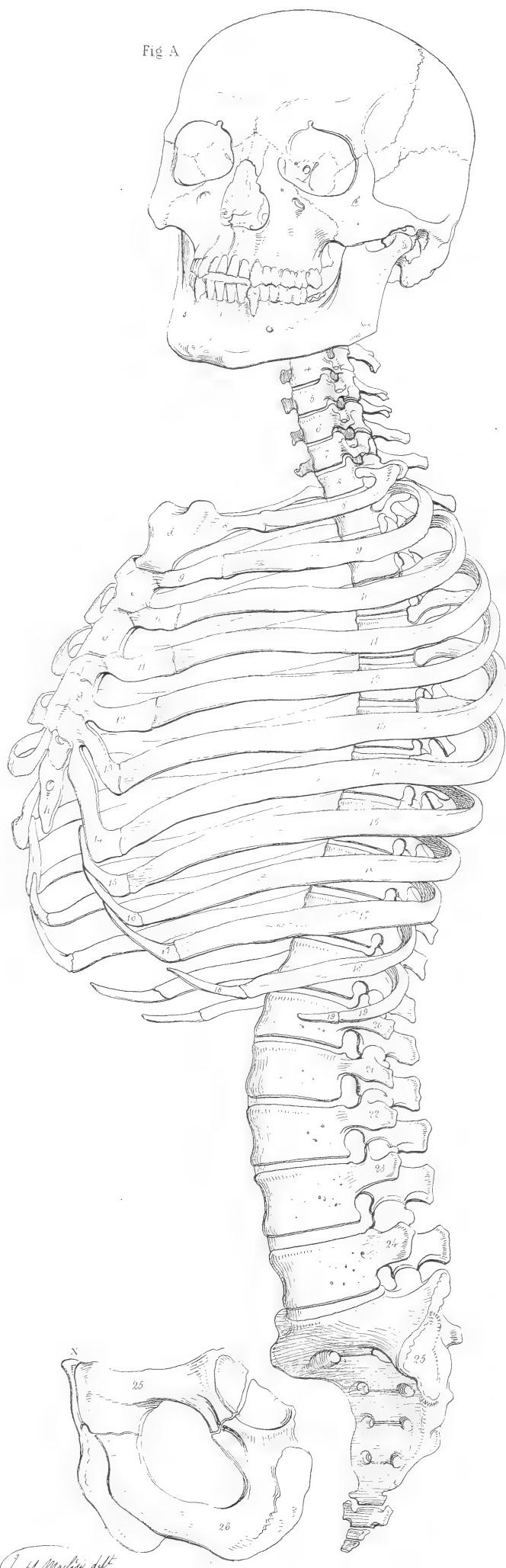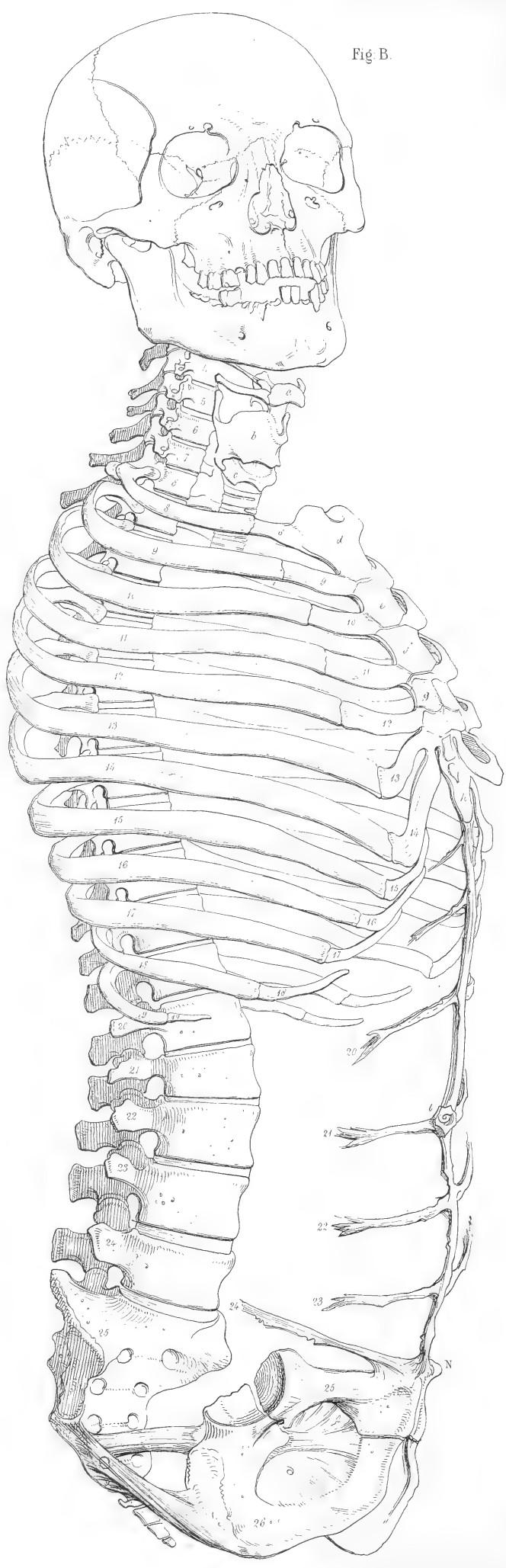
Plate 40.

Fig A.

Fig B.

REMARKS ON THE FIGURES OF PLATE XL.

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THE ARCHETYPE COSTO-VERTEBRAL SERIES UNDERGOES A STRUCTURAL METAMORPHOSIS AT THE CERVICAL, VENTRAL, AND PUBIC REGIONS.

PHYSICAL laws are evidences of the continuity and sameness of operation; and express, in abstract or general terms the force or agency which yields a plurality of facts, creations, or phenomena, in sequent and relationary order. These facts, having an analogy or conformity of character, express by their own common nature the common law which has yielded them as creations. The similitude apparent between the units of a plural number indicates the uniformity of the creative force or law. Skeleton series is a collective or plural condition of development, and all those units of which it is comprised yield an evidence of a common law presiding over them, through their continuous order, from first to last. This law is the subtraction of quantity from few or many of those original plus units which constitute series, and it is observed that design moves after this operation in equal paces. The subtraction of quantity is never carried beyond what the design requires; and consequently, the design is the exact measurement of the degree to which metamorphosis has taken place. Metamorphosis is the cause, design is the effect, and both cause and effect yield the phenomenon or appearance. The antecedent is equal to the consequent in all things. The shadow of a sun-dial is the sure index of Sol's station and the time. Metamorphosis is a law no less indicative of the graduated and serial progress of the sun of design. A serial creation of plus quantities, when submitted to the law of graduated metamorphosis, is rendered in graduated condition, and thereby expresses how far this law has operated, as also how the design has occurred. Hence, plus series being the ens of original standard quantity, we may regard metamorphosis as an antecedent force, or law, whose progress in proportioning strikes out the equal ratio of design. Original plus uniformity is that standard whereunto all minus variation and design is to be referred for explanation.

The whole quantities are thoracic. The minus proportionals of such quantities are those which we find in the cervix, lumbar spine, sacral and caudal spine. The law of proportioning is the law of formation, and the skeleton figure, such as we find it, is the result of this same law.

In fig. A, all the cervical units marked 1, 2, 3, 4, 5, 6, 7, are the proportionals of such serial archetype units as those marked 8, 9, 10, 11, 12, 13, 14, these latter are the completed persistent archetype quantities which describe the circle from the dorsal to the ventral median line. Of such quantities as these have also been proportioned the asternal forms marked 15, 16, 17, 18, 19. These are the asternal thoracic proportionals, which mean nothing more or less than that they are minus the sternal quantity. Again, in the lumbar units marked 20, 21, 22, 23, 24, we still read the proportional quantities of such archetypes as 8, 9, &c. And in the sacral units from that marked 25 to the last caudal ossicle, the same law of proportioning has fashioned them from the like archetype originals. Those archetype quantities are uniform. These proportional quantities of such archetypes are only proportionally various to them and to each other.

In fig. A we therefore interpret that the cervical hiatus which occurs between the lower maxilla and the first costo-sternal piece marked 8 d, has been thus rendered void by the annihilation of skeleton costæ. Again, in that space which ranges between h, the ziphoid cartilage, and n, the pubic symphysis, the like void happens by reason of the lost costal quantities. The cervical and ventral regions of series are minus. Minus what forms or quantities? Minus such costæ as persist at the thoracic region of the same series. From plus to minus therefore we track the law of design.

The sacral quantities of fig. A are also minus quantities compared with the thoracic archetypes. Standing anterior to the sacral proportionals, we find the pubic and ischiadic arches just as the costæ themselves arch anterior to the dorsal vertebral proportionals. Now we see that all the

vertebral quantities hold together in dorsal series. Likewise we find that the costal arches hold their own lateral serial order. Between serial vertebræ there happens no hiatus. Between serial thoracic costæ no hiatus occurs either. But between thoracic costæ and the maxilla above them, happens the cervical gap in series, such as we find it also between the thoracic costæ and the pubic arches where the ventral gap or hiatus happens. Do we find in the recent form any traces of those costo-sternal quantities which may be said to have suffered metamorphosis at cervix and venter? Fig. B answers this question, and Nature herself responds to the same.

In fig. B, at the cervical region, where we already know that costal quantity has been subtracted in furtherance of the special fitness required for human formation, we there discover the hyoid apparatus—the principal organ of voice, and one which is also subservient to respiration. Costal quantity has been metamorphosed, and laryngeal quantity stands in its place. What then is the interpretation? Is it that the latter has been modified from the former?

In fig. B, again, at the ventral region where costal quantity has been also subtracted in accordance with special fitness for the parturient or digestive functions, together with mechanical design, we find the ventral walls intersected with fibrous bands which pliantly brace together those yielding structures composing this locality of series, and that these bands actually figure before the eye the very sentence of costal metamorphosis. The *linea alba* continues the *sternal median line* through the abdomen, and becomes fixed to the symphysis pubis, whereas the *lineæ transversæ* hold series with the *thoracic costæ*, and sketch the continuation of such series through the abdomen as far down as the pubic arch which bounds the costal series below.

We may observe, therefore, in reference to fig. B as it stands, that laryngeal quantity appears at that locality where costo-sternal quantity is subtracted. We notice, also, that sternal quantity closes in before the costal quantity, which persists for the thoracic region of series. We also observe, that at the abdominal region from whence costo-sternal quantity has also been subtracted, appear the fibrous bands named linea alba and lineæ transversæ; and again that opposite to the sacral position where costal quantity has also suffered metamorphosis, appear the pubic and ischiadic arches. What then are the inferences to be drawn from this serial order of metamorphosed original and of recreated special structure? If the anatomist is led to conclude from the rule of serial creation, that it is original plus uniformity which has been subjected to mutations such as are required for special plan, and that what was once, *in archetype condition, a continued series of costo-vertebral circles,* does now present certain *alternating minus specialities of formation,* such as a *laryngeal minus apparatus* marked *a, b, c,* succeeded by a *costo-sternal plus apparatus* marked 8 *d,* 9 *e,* 10 *f,* and this succeeded by an *abdominal minus series* marked

20, 21, 22, 23, 24; this again, succeeded by a pubic apparatus marked 25, 26—when such serial order invites to comparative interpretation, we may venture the opinion that this interpretation cannot be rendered otherwise than as the work of Nature speaks her own law, namely, that original full quantity has suffered metamorphosis, and that the plus costo-vertebral archetypes have been rendered specially minus in several localities of series.

The comparative research carried through the animal kingdom, will shew ample reason for applying to the specialty of fig. B the following reading, viz., that as the costo-vertebral persistent archetypes lettered 8, 9, 10, &c., refer to the sternal pieces *d, e, f, g, h,* and as both complete the serial circles or entireties, so do the cervical-vertebral proportionals, 4, 5, 6, 7, refer to the laryngeal pieces *a, b, c,* and speak of the law of metamorphosis which rendered them thus special from thoracic quantity. So in like manner do the lumbar vertebral proportionals 20, 21, 22, 23, 24, refer to the fibrous ventral structures 20, 21, 22, 23, 24, and describe the track of that hand of design which planned the special minus quantity from the plus original. The sacral proportionals from that marked 25, to the last caudal nodule, show that certain of those serial figures are still connected by fibrous bands (sacro-sciatic) with the pubic arches, 25, 26.

Thus it would appear that the special design of serial human formation proves itself to be resulting by the modification of an archetype series of whole quantities, such as those persisting at the thoracic region. And, therefore, if it shall at first sight seem rebellious to reason for any one to assert that laryngeal, ventral, and pubic specialties, such as we find them in the human skeleton, bear comparison not only with each other, but with the plus thoracic figures likewise, let it not be supposed that such an interpretation has been crudely ventured,* without having first examined the skeleton forms of an animal kingdom, and in them discovered abundant proofs in support of the same.

We do not say that skeleton quantities are all equal and uniform throughout an animal kingdom; we do not speak of the unity under any such idea as this. We do not even state that the special form is uniform throughout that species to which it belongs, for we see that the human skeleton is not thus absolutely and unexceptionably produced; and we see, likewise, that it would be as impossible to prove the created homologous quantity between any one order of apparatus of skeleton form, as it would be to prove that skeleton entireties develope the like quantities; in short, as it would be to prove that two and two make five, or that a part was equal to the whole. On the contrary, the only reading that we here venture to give, is that $a + b = c$, and so we call *c,* the archetype; for as much as it appears self-evident that *c,* contains *a,* just as plus contains minus, and also that certain addition to the minus quantity would equate it with plus, just as subtraction from plus would equate it with minus.

* *In philosophia mens mancipatur rebus;* in poesi solvitur a nexu rerum et expatiatur et fingit quæ vult—nam sub philosophiæ nomine complectimur omnes artes et scientias, et *quicquid denique a singularum rerum occursu per mentem in generales notiones collectum et digestum est.*"—Bacon, *Descriptio Globi Intellectualis,* caput I, vol. v., p. cxxvii.

Plate 41.

Fig A.

Fig B.

Fig C
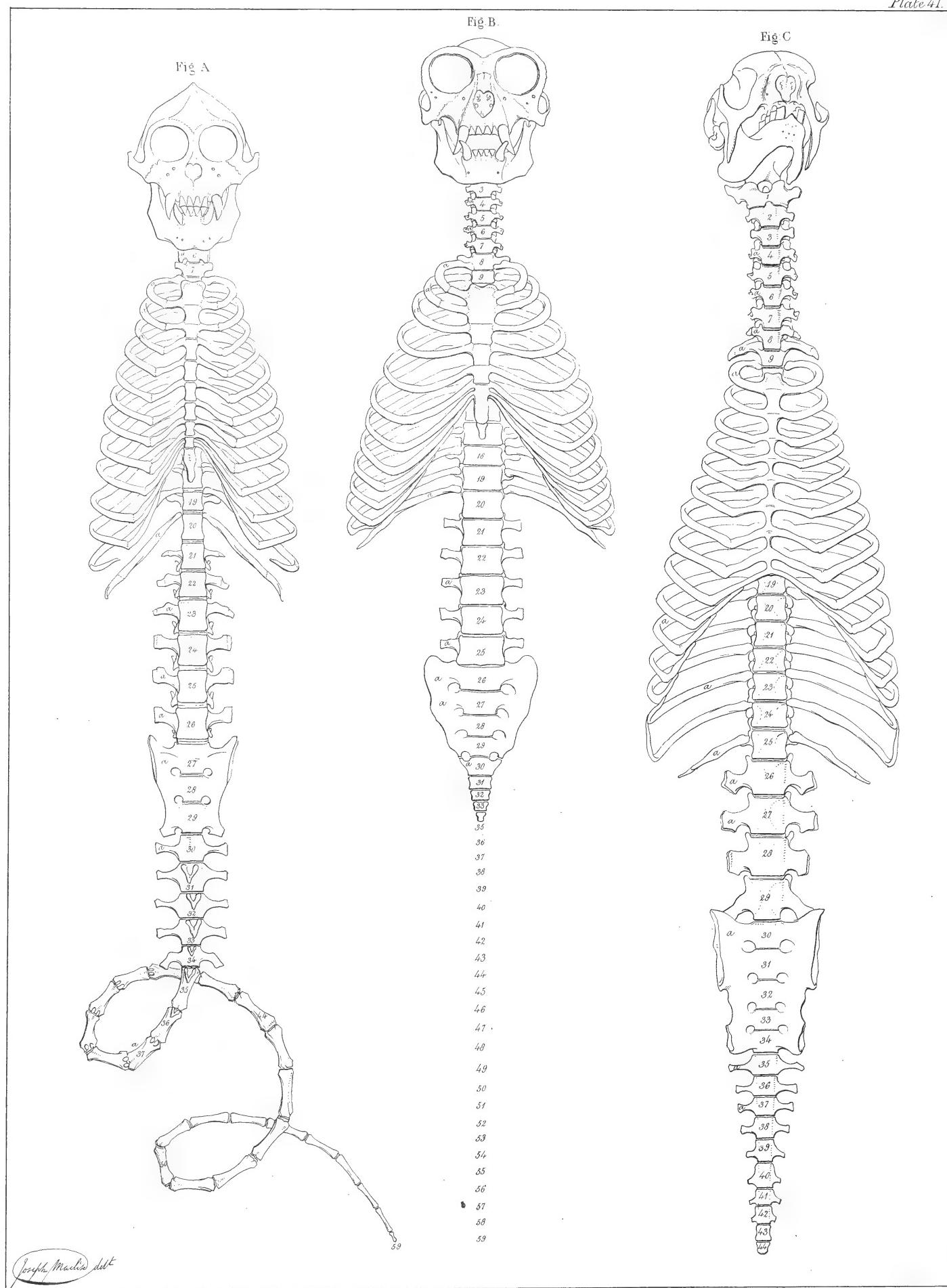
REMARKS ON THE FIGURES OF PLATE XLI.

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THE ARCHETYPE COSTO-VERTEBRAL SERIES PERSISTS FOR THE THORACIC OR RESPIRATORY APPARATUS.

STANDARD plus quantity is never seen to vary from itself by addition or increase ; but all the variations which it undergoes, obey the law of subtraction. In this respect the creation of form differs from that of number ; for whereas number may increase by mental operation to an infinite degree, the creation of form by natural operation never passes beyond certain prescribed limits. A whole or integral form is fixed and of finite character and dimensions. The thoracic whole quantity does not vary from itself by genetic or increasing changes ; but when, like the circle, it incloses space completely, it then may be said to have described the full sum of its development. As a whole quantity, however, this costo-vertebral thoracic figure may be said to contain an infinitude of variety ; and the law of metamorphosis or subtraction can subject it to all those degrees of minus variation.

Every generalisation springs from comparative research. Every natural law is one of generalisation. Every natural law is one of simple operation. Its character is the broad feature of simplicity; a myriad distinct facts are comprehended under one law ; a myriad facts are all interpreted as subservient to the law of gravitation ; a myriad facts are gathered together under the common law of chemical affinity; a myriad anatomical facts become plainly interpreted under the law of unity in variety—plus rendered minus, plus subtracted from, the archetypes metamorphosed.

Fig. A, one of the quadrumanous species, may be compared with itself, that is to say, its serial units may be compared to one another, and they will prove to be proportionals of an archetype, such as we find in the thoracic region of series. They will prove that plus has been rendered minus, and that this is the only distinction to be drawn between two or more quantities of the serial skeleton axis. The terminal caudal ossicle 59 is a proportional of the penultimate caudal bone, this latter being a proportional of the next above it, and so we may follow from the quantity 59 up through all the series of proportionals till we end at the thoracic archetype, thus advancing through the slow gradation of metamorphoses as through a series of arithmetic progression.

Now we should distinctly understand, that as any two lesser proportionals of series cannot have been metamorphosed from a greater third quantity which still actually exists, so must they therefore be interpreted as severally metamorphosed from their own archetypes, which are uniform, and which have suffered varying degrees of meta-

morphosis, in order to render those three minus quantities proportionally various to each other and to the archetype. Thus, when we say, that in fig. A, the first lumbar unit marked 21, is a proportional of the unit marked 20 a, we then mean that 21 has been metamorphosed from such as 20 a, and so the orders of serial skeleton proportions and progressions prove themselves to be one and all as varying quantities degraded from a series of figures such as the thoracic. The terminal caudal quantity marked 59 fig. A, must hence be the proportional of a quantity such as we find to be the fullest of thoracic series.

In figs. A, B, and C, the same spinal units bear the same marks, and a comparison of any unit similarly marked in A, B, or C, will prove that these skeleton forms themselves are rendered proportionally various to each other by the very same process of metamorphosis which renders the serial units of the one skeleton axis proportionally various to each other. Thus we see that in fig. C the skeleton axis of the sloth, its cervical unit 8 a, bears the same ratio to the unit below it marked 9 a, and this again to the first thoracic unit 10 a, which 9 a, of fig. C bears to 9 a, of figs. B or A.

Again, in fig. C we observe that unit 25 a, terminates the thoracic series below, and that unit 26 a is a proportional of the like quantity ; so, therefore, is unit 25 a, wherever it stands in series for figs. B or A, to be regarded as the proportional of the like quantity 25 a, fig. C, and for the same reason that we take this latter to be a proportional of the thoracic archetype, so must we read all the units of series to be proportionals of the like archetypes.

For evidently it is the subtraction from archetype plus which renders unit 59 fig. A thus degraded to the vanishing

point of series. This vanishing point is marked 33 in fig. B and 44 in fig. C. The serial spinal axis, therefore, varies as to the number of its units, for we find that fig. B compared with fig. A is 33 compared with 59; and fig. B compared to fig. C, is 33 compared with 44. Therefore, fig. B, so far as regards the existing number of serial proportional quantities is minus to fig. A, and taking fig. B as 33 and fig. A as 59, we say $33+26=59$, that is to say, fig. B is minus 26 proportional units compared to fig. A, and 11 proportional units compared to fig. C.

The comparison of figs. A, B, and C, afford demonstrable exceptions to the rule of complete and absolute uniformity. These exceptions must, therefore, be explained before we can furnish ourselves with the uninterrupted idea of uniform creation. Upon the explanation of these exceptions depends as well our knowledge of the law of uniformity rendered various, as of our ideas of uniformity and the actual meaning of the forms which we designate variety. It will be in vain for us or any one to speak of figs. A, B, and C, as absolutely uniform creations, when their presential and actual character denies the truth of such reading. And it will be equally in vain that we assert of them that each is absolutely difform and special to both the others, since it is the undeniable fact that this variety or species is solely dependent upon the law of proportioning, and, for this reason, we shall state plainly the exceptions to uniformity as follow:—

In the first place then, we find that figs. A, B, and C, are not presenting to us in uniform condition as to the number of those proportional quantities which comprise their graduated serieses, for fig. A reckons 59 serial forms, fig. B only 33 serial quantities, and fig. C numbers as far as 44. Secondly, the cervical regions of figs. A, B, and C, are developed in unequal numbers of proportional units, for though figs. A and B produce 7 cervical vertebræ, we find that fig. C numbers as much as 9. Thirdly, the thoracic regions of series in figs. A, B, and C, are also unequal as to the number of units, insomuch as fig. A develops 13, fig. B 13 also, but fig. C produces 16. Fourthly the lumbar regions of series in figs. A, B, and C, are likewise unequal as to the number of their units, for fig. A produces 6, and fig. B develops 5, while in fig. C we find only 4. Fifthly, the sacral region of series passing into the caudal serial prolongation, manifests in figs. A, B, and

C, a remarkable variety as to the number of serial quantities, for those of fig. A number as much as 32, those of fig. B number only as much as 9, while those of fig. C amount to 15; and thus it is evident that all their serial regions vary from each other. Sixthly, it is also true that when we number all the serial proportional units of figs. A, B, and C, from occiput to the last caudal bone, (a mode of comparison which may be reasonably adopted, forasmuch as the serial quantities are only proportionally various to each other,) we find that the several regions of those several axes commence and terminate at various numerical units. Seventhly, we have found in our dissections, that throughout the species of fig. A, or B, or C, the number of serial units is not fixed and constant for any one region, whether cervical, thoracic, lumbar, sacral, or caudal. These being the exceptions to the asserted rule of uniformity respecting figs. A, B, and C, we hold that rule to be prematurely advanced, inasmuch as we have as yet nowhere found their explanation given according to anatomical law.

The exceptions to a general rule may bear of explanation according to a universal law, and as this law appears to be the subtraction or metamorphosis of variable degrees of quantity proper to plus, serial, and archetype uniformity, so shall we advance in search of this whole condition of form, believing that we can never understand the law of proportioning all special variety, till we know of the whole quantity, and acknowledge that in it there is located the infinite sum of variation as to quantity. A universal law contains all general rules just in the same mode as any general rule includes all special particulars. And as in the word *animality* is comprehended every condition of living form which every class or species contains, so should all real knowledge of the law of development include all possible conditions of various formation. In an animal kingdom, hiatus or interruption appears nowhere to sunder the unity of type, except by the law of degradation, and it is even so with regard to the proportional variety of those serial osseous quantities produced in one skeleton axis and all skeleton axes *. Variety occurs according to the numerical situation of those plus serial units which are subjected to the metamorphosing act †, and hence we proceed to inquire what is the plus sum or archetype form which suffers metamorphosis.

* "Il y a un plan général qui rappelle tous les animaux á une idée d'unite, à un point de conformité par lequel tout animal, quel qu'il soit, est distingué des végétaux."—Réaumur, *Lettres à un Americain, &c.*, tome iv, p. 188.

† "Nature, however, passes so gradually from — to —, that, through the continuity, the confine and medium of these are latent."—Aristotle, *History of Animals*, book viii., p. 288, (Taylor's translation.)
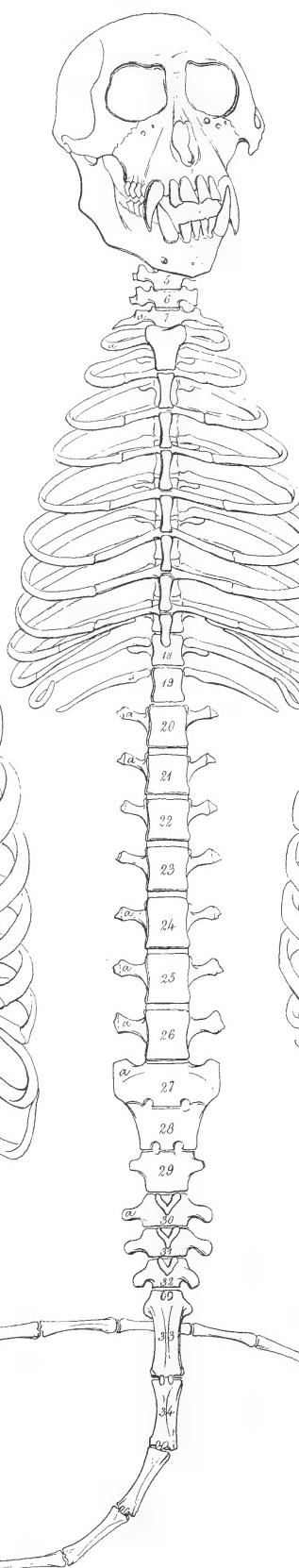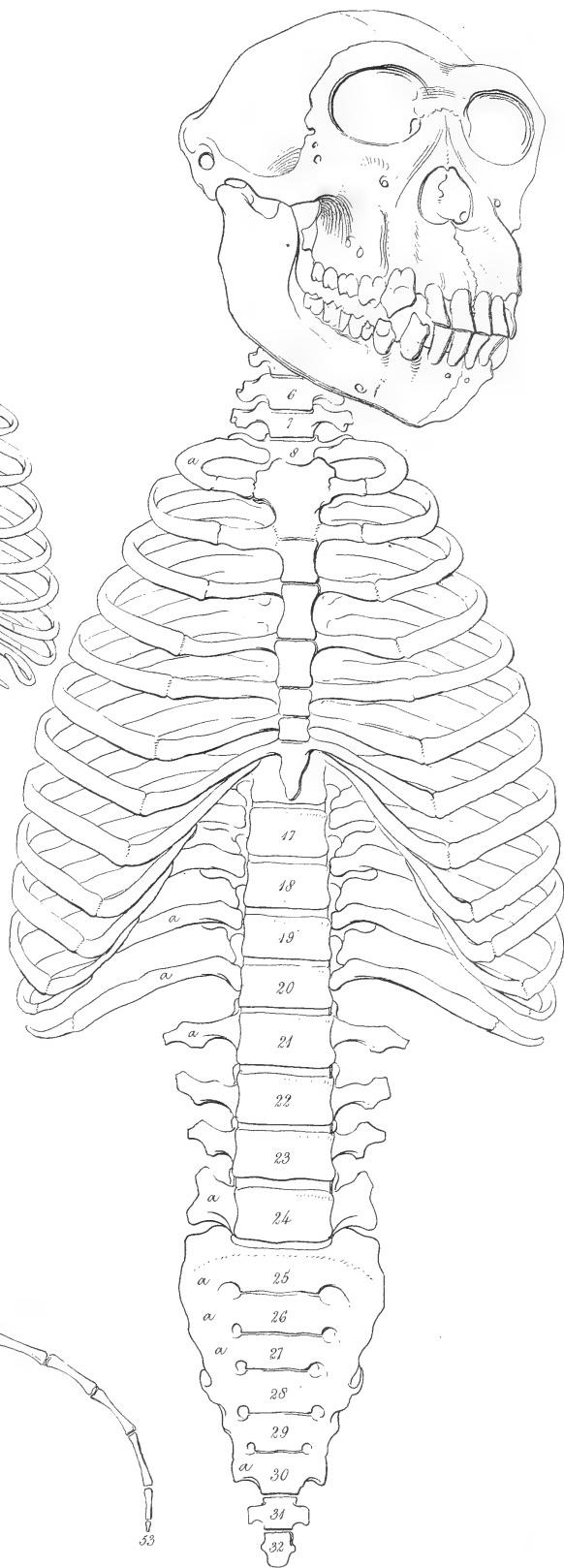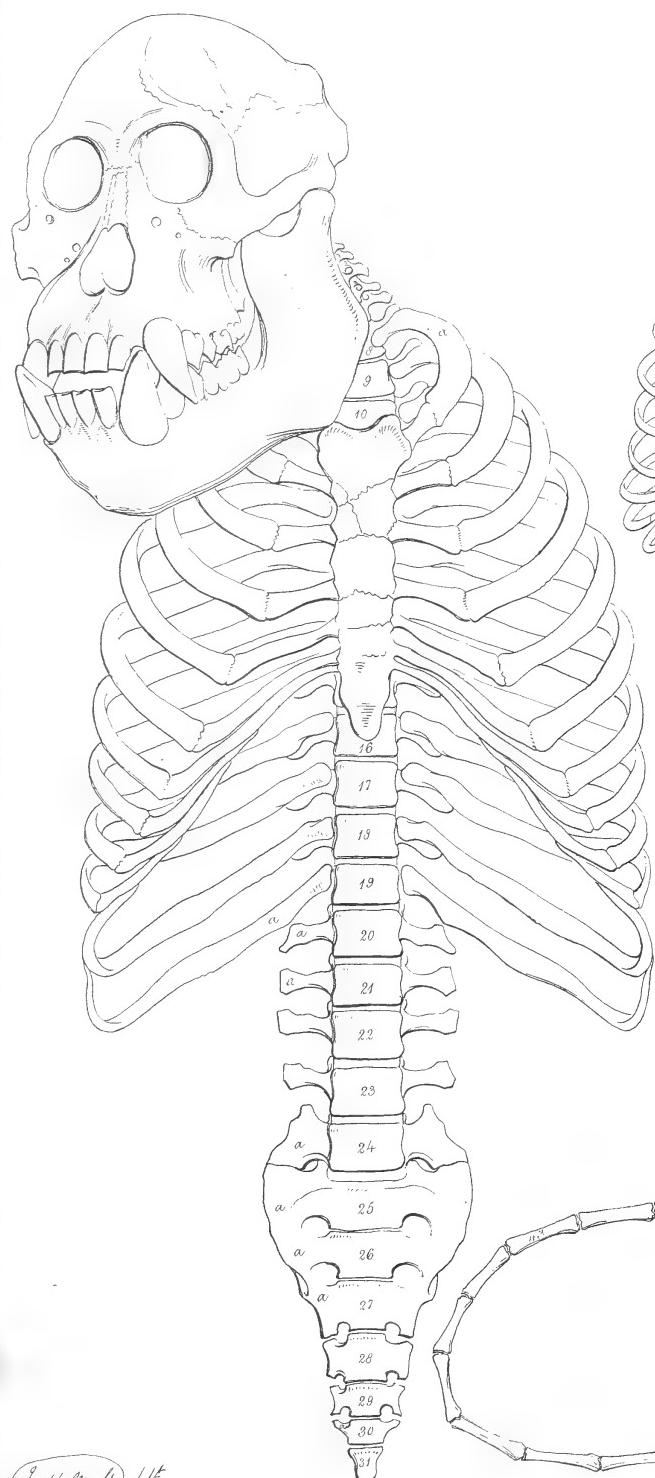
Plate 42.

Fig: A.

Fig B

Fig C.

REMARKS ON THE FIGURES OF PLATE XLII.

THE STERNAL COSTO-VERTEBRAL ARCHETYPES AS PLUS CONTAIN QUANTITIES EQUAL TO ALL THE MINUS FIGURES OF SERIES.

VARIETY is consequent upon the metamorphosis of certain parts which are proper to a whole. Hence when we give the name *species* to such variety, this name cannot imply any other meaning than that the form is special by reason of its being as a proportional of some fuller form. A semicircle is a species compared to the circle, but this special distinction does not prevent us from interpreting the semicircle to be half of the circle. A segment is also a species compared with the circle, but still we read the segment as being a proportional of the circle. A mere point may also be interpreted as a species or proportional of this same whole figure—the circle, especially if the point holds series with the circle.

The sternal costo-vertebral archetype or circle may be metamorphosed to quantities, equal to either the asternal costo-vertebral form, the vertebral proportional, or the caudal point; and therefore it is that we say, all those several quantities will still relate of the whole figure from which they have been produced.

As our comparisons are drawn in reference to the serial skeleton axis, we shall therefore ask ourselves the question to what end and idea would those comparisons tend. Is it simply to establish the fact, that skeleton axes are cast after a somewhat common plan or type. No, it is not simply this trite and already well-known reading that we would here repeat, for it is now-a-days as fully understood that skeleton axes are forms planned after the same general type, as it is that our right arm is the homologue of our left. But the main object which we have at present in view, is to prove that skeleton axes, such as they present to us, are one and all planned and proportioned from an archetype plus structure, which is the common prime model of them all, and from which all have been created, and that this is the source of their analogies and of their species.

Now a comparison of the three opposite figures will prove the following facts in support of the present argument, or else nothing at all beside what is well known by every one concerning them. We would have it here understood, first, that the several regions of the skeleton axis result by the subtraction of quantity from the archetype, and also that each minus region of series, such as a cervix or loins, is rendered of greater or lesser length according to the number of those serial archetypes which have suffered metamorphoses. Secondly, that figs. A, B, and C, possess the archetype quantity in thoracic series, and that this is the thoracic costo-vertebral sternal circle;

that the serial form of next degree in quantity to the archetype is the thoracic costo-vertebral asternal figure, which is therefore to be interpreted as a form produced from its own archetype, and which may be said to have suffered the least degree of subtraction. Thirdly, that each skeleton axis is a creation resulting by the proportioning metamorphosis or subtraction from serial archetype quantities, and that that form which results from an archetype which has suffered the greatest degree of subtraction or metamorphosis, is the last caudal bone; and consequently, that every skeleton axis terminates at that unit of series from whose plus figure the largest quantity has been withdrawn.

Fig. A terminates its cervical region at unit 7 *a*. Its thoracic region at unit 19 *a*. Its lumbar region at unit 26 *a*. Its sacral region at unit 29. Its caudal region at unit 53, and so we say that the law of proportioning has rendered this skeleton axis such as it stands, by having metamorphosed variable quantities from 53 archetypes, such as those of the thoracic costo-vertebral sternal form.

Fig. B terminates its cervical region in series at unit 7. Its thoracic region at unit 19 *a*. Its lumbar region at unit 24 *a*. Its sacro-caudal region at unit 31, and so, in like manner, we say that the law of proportioning has metamorphosed 31 archetypes, such as the thoracic circle.

Fig. C terminates its cervix at unit 7; its thorax at unit 20 *a*; its loins at unit 24 *a*; its sacro-caudal series at unit 32, by the same law of proportional metamorphosis.

In figs. A and B we say that unit 20 a, is a proportional of such as unit 19 a, and we find that in fig. C, the unit marked 20 a, is actually equal to unit 19 a, in figs. A and B, moreover we venture to assert that the "anomalies" of unit 20 a, in figs. A and B, would prove the truth of what we say, by this unit now and then equalling the quantity 19 a, in those same skeletons, and thereby it would also equal unit 20 of fig. C. In the human form we discover that the unit which generally commences the lumbar spine is occasionally produced like the last thoracic costo-vertebral quantity.

Where skeleton series terminates at the last caudal ossicle for figs. A, B, and C, our opinion is that the thoracic archetype has suffered metamorphosis or subtraction, just in the same way as if from the integer 9, we had subtracted 8, when 1 would only remain. It is sufficient for us that we know of the quantity from which 1 is left remaining. It is a proportional of the integer 9.

We believe that a caudal bone bears the same proportion to a sternal costo-vertebral archetype that 1 bears to the integer 9. And we rest awhile in order to examine the sense or the nonsense of this assertion, for it deserves a close inspection, since the whole truth of comparative osteology, contemplated under the idea of uniformity, together with the actual revelation of the natural law of formation, absolutely depends upon it alone. We ask, therefore, whether it stands within the range of probability that the whole thoracic form, which we here name the archetype unity, can pass through a metamorphosis of substance so as to be reduced to the quantity of a terminal caudal ossicle? If we can prove that this operation is quite possible, then we hold it to be impossible to regard a caudal ossicle or any minus quantity standing in the same serial order with the thoracic archetype, unless with the attendant idea that the originals of all those minus forms are the equals or homologues of the thoracic quantity, and the idea of those originals in serial order will establish the fact of uniformity even though this plus quantity is not now actually existing for either fig. A, B, or C.

Serial plus uniformity is not visible in either fig. A, B, or C. Where, then, does serial uniformity exist, since we confess it to be invisible. Our answer is, that it exists in the mind by the rule of comparison, the law of analogy, and the operation of the reason; for, in the comparison of $a+b$ and $a-b$, the simple mental act is the process of equating those two quantities and rendering both in the condition of plus equals. It being true that the addition of b, to $a-b$ raises it to the quantity $a+b$; it is no less true that the differential quantity apparent between the plus thoracic archetype and the minus caudal ossicle will, when added to this latter, render it plus and equal to the former.

Figs. A, B, and C are comparable creations, presenting certain characters in common, but not all characters. Their common character is self-evident and wants no further proof, but their differential characters overshadow, as it were, the law of their formation. If we name figs, A, B, and C uniform figures, either as to existing quantity or design, we then deny Nature to her own face, for the things are not so. The differences or varieties between them are still manifest; and, hence, the question must turn upon how those varieties have happened. How happens it that fig. A reckons 53 serial quantities, of which 27 fashion the sacro-caudal series, whereas figs. B and C number only 31 or 32 of which 7 are sacro-caudal? We were about to ask how it occurs that every animal skeleton axis which is plus in the caudex is minus in the cranial chamber? but as this condition of form is not strictly adhered to by Nature* (the sacro-caudal series of figs. B and C being the exact counterparts of this region in the human figure,)† so we shall pass on to examine the common law to which all forms owe their own proper fashion, with regard to this terminal appendage, and whether it be in Monboddo, in Lamarck, in Maillet, or in neither, that its true interpretation is to be found.

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* "Optime enim (referring to equivocal species) indicant compositionem ad fabricam rerum, et innuunt causas numeri et qualitatis specierum ordinariarum in universo, et *deducunt intellectum ab eo quod est ad id quod esse potest*. Harum exempla sunt: muscus inter putredinem et plantam; cometæ nonnulli inter stellas et meteora ignita; pisces volantes inter aves et pisces; vespertiliones inter aves et quadrupedes; etiam

　　　　　　Simia quam similis, turpissima bestia, nobis;

et partes animalium biformis, et commisti ex speciebus diversis; et similia."—Bacon, *Novum Organum*, Aph. xxx.

† "L'orang-utang est si semblable à l'Homme, que l'anatomiste qui les compare, croit comparer deux individus de la même espèce ou, au moins, du même genre; et frappé des ressemblances si marquées et si nombreuses qu'il découvre entre ces deux êtres, il n'hésite pas à placer l'orang-utang immédiatement après les grossier Hottentot."—Bonnet, *Œuvres d'Histoire Nat. et de Philosophie*, tome IV., part ii., chap. xlvii. *Contemp. de la Nature.*

Plate 43.

Fig. B.

Fig. A.

Fig. C.

Fig. D.

Fig. E
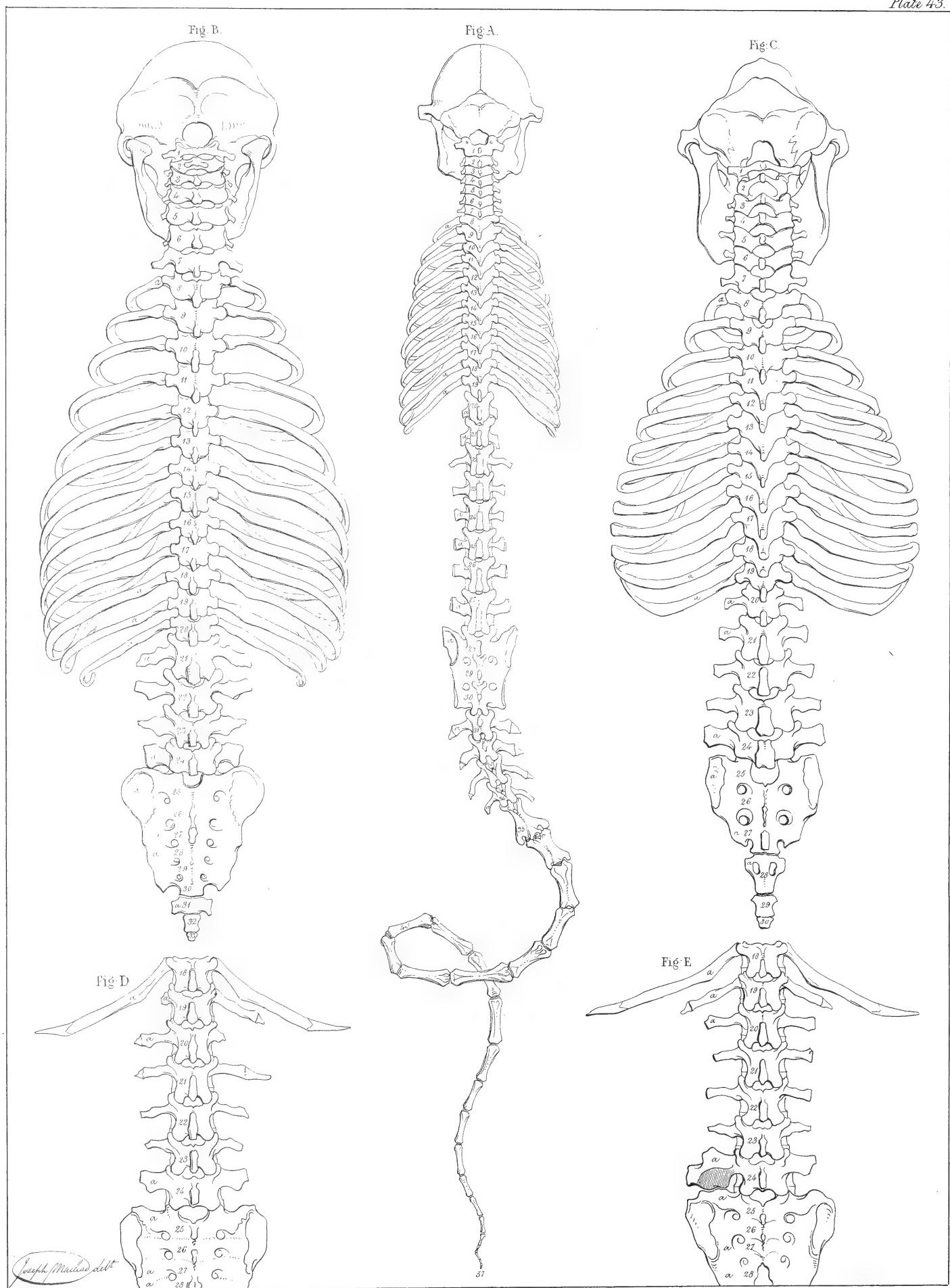
REMARKS ON THE FIGURES OF PLATE XLIII.

THE THORACIC PLUS ARCHETYPE SERIES HAPPENING BETWEEN THE CERVIX ABOVE AND THE LOINS BELOW IS LIKE A WHOLE QUANTITY PRECEDED AND SUCCEEDED BY MINUS QUANTITY.

CONTINUITY characterises as well the graduated chain of proportional forms as those forms which are in whole condition. The serial line is still continuous, whether as thus, 9, 8, 7, 6, 5, 4, 3, 2, 1, or as thus, 9, 9, 9, 9, 9, 9, 9, 9, 9. And so would the serial line of whole costo-vertebral structures form a continuity from beginning to the other extreme, were it not that metamorphosis degrades those plus units to their proportionals, but still, as proportionals they hold in continuous order, and when compared to each other they mutually interpret the present condition of one another. As plus quantity may be degraded to any minus degree or condition, so will each minus serial quantity relate of itself that it has been degraded from an original plus archetype, and upon this fact the idea of continuous plus uniformity is developed.

The skeleton axes, although manifesting a certain conformity of character in having one region of series plus and another minus, are still various as to the numerical position of those quantities which are plus and those which are minus. The like variation is observable in the human skeleton axis, as we have already seen, and therefore, as it is true that the number of thoracic plus figures varies, and thereby influences the condition of cervical and lumbar series not only for several animal species, but even for one, so must it follow that the variety of serieses depends altogether upon the numerical situation of those plus costo-vertebral thoracic quantities which have been subjected to the law of metamorphosis. And, for the same reason, it may be inferred that a continuous plus series of costo-vertebral figures is the only absolute uniformity which we can ever hope to know. Upon the structural quantity of such a series the law of subtraction or metamorphosis establishes all the minus regions of a cervix, a loins, a sacrum, or a caudal prolongation.

In the fullest thoracic quantity we read the archetype of series. In the smallest caudal quantity we read the smallest proportional of such an archetype.

In fig. A seven archetype quantities have been metamorphosed for the cervical spine; twelve of the succeeding archetypes persist more or less perfect for the thoracic region of the same spinal series; eight of the next succeeding archetype quantities have been proportioned for the lumbar spine, and thirty next succeeding archetypes have been metamorphosed or subtracted from for the creation of the sacro-caudal series. In fig. A we see a skeleton axis, consisting of variable proportions struck out from fifty-seven archetypes, and the length of each region of this series corresponds to the number of the archetype units which have undergone proportioning from plus to minus.

In fig. B seven archetypes have undergone metamorphosis for the cervical region of series; thirteen of those archetypes persist more or less complete for the thoracic series; four archetypes have been proportioned to the lumbar region of series; nine of the like archetypes have been proportioned to the sacro-caudal region of that same series.

In fig. C seven archetypes have also suffered metamorphosis for the cervix. Twelve archetypes persist more or less complete for the thorax; five archetypes are proportioned for the lumbar spine; and six of the same archetype quantities are proportioned to the sacro-caudal spine.

In fig. D, a human lumbar spine, we see that unit 18 a, terminates the thoracic region of series, and consequently that the lumbar spine is increased by one proportional figure, viz., that marked 19 a, which in ordinary cases is

thoracic by having the autogenous piece *a*, produced to costal form.

In fig. E, another human lumbar spine, we find that unit 19 *a*, is developed in such a cast that it is doubtful, and perhaps of little consequence, whether it be more correctly named thoracic or lumbar; for although its autogenous processes do not exceed the size of those proper to the other lumbar units below it, still they are articularly connected with the centrum, like the costal forms of a thoracic series.

A comparison therefore held between all the opposite figures must, if fully carried out, involve the following questions; first, What is the nature of that law which renders the serial axis difform as to its several regions named cervical, thoracic, lumbar, sacral, and caudal? secondly, How it happens that the transition units standing between any two regions of the one series partake of the characters proper to either region? thirdly, How it is that species differs from itself as to the number of units fashioning those several regions of the skeleton axes? fourthly, How different species are rendered difform to each other respecting the number of units proper to those regions of the skeleton axis, named cervical, thoracic, lumbar, sacral, and caudal? fifthly, How the length of the serial axis varies not only between two distinct species, but even between two individual forms of one and the same species? What is the meaning of this law of unity in variety—is it one of proportioning archetype quantities? If it be so, then a comparison held between the units of any one of the opposite figures will best explain in how much all those figures vary from one another.

If we find sufficient reason to interpret unit 20 *a*, of fig. A to be a proportional of such as unit 19 *a*, in this same axis, it is this fact which will fully explain all the rest.

The law of formation by which we have figs. A, B, and C presented to us in their several existing characters can only be understood from a comparison, first, of all the serial proportional quantities seen in each axis; secondly, by a comparison of the entire serieses of figs. A, B, and C with each other; thirdly, by a comparison of all three with the original plus series from which they have been metamorphosed.

This original plus series, which is the common archetype of figs. A, B, and C, is now non-existing with respect to the present state of those forms. Their actual condition is one of graduation, or the proportional serial converging line. How, then, are we to re-establish in idea the plus original from which each has been metamorphosed, to its proper special and minus character? Does comparative rule possess a means of furnishing to us any rational estimate of *the plus uniformity which is not*, by a measurement of *the graduated variety which is?* We believe that it does possess those means, and the first step of putting them in process for yielding the idea to a plus uniform original quantity is, to acknowledge fully that every series of proportionals whatever, must refer to that lost quantity which causes their present proportional variety; for, evidently, their difference is solely attributable to this loss of quantity by subtraction or metamorphosis.

The actual state of development in which we find figs. A, B, or C constitutes a graduated series; this is a visible and acknowledged fact, but these figures are not uniform; neither can we ever render them otherwise than what they are; neither, for this same reason, can we ever hope to establish their uniformity upon the obstructive fact of their present variety. And yet uniformity stands before the comparative anatomist as the goal of all his studies.

To this end we say, that every quantity which is liable to plus increase must be interpreted as a proportional of every phasis of such increase; and every increscent phasis must also be understood as a proportional of the whole plus quantity. The fact that $a-b$ is a proportional of $a+b$ admits of no dispute. The fact that the crescent moon is an illuminated proportional of the full planetary orb is likewise unquestionable; for, if we should doubt that she is actually of any greater dimensions than what she reveals lunatedly visible when rising to our view in the nocturnal west, she herself dispels those mental mists of doubt when after a time she demonstrates her complete quantity in the nocturnal east. Time, comparison, and phasial progress is that mode whereby we understand that all her minus stages are but transitory, incomplete, and only progressive to an equation with the whole plus disk of unity and intelligibility, and it is even thus with every minus serial quantity of the endo-skeleton axis. It is even so with unit 20 *a*, of fig. C, for this unit is a proportional of a whole quantity.

And while we here state that the idea of a plus uniformity rests centred in the fact that unit 20 *a*, of fig. C, is a proportional of a whole plus figure, we forthwith set out to prove it by keeping steadily to its numerical position in series, and by the comparison of two or more quantities, holding this fixed numerical place. If it be doubted that unit 20 *a*, of fig. C, is a proportional of such a quantity as unit 19 *a*, above it in the same series, then we refer for a proof of the existing law to unit 20 *a* of fig. B; and, advancing through this mode of comparing all the minus quantities with the plus quantity* in the same spinal axis, and also *the same numerical quantities of each axis* with one another, we may figure in idea the character of a plus serial original as completely, and understand the law of proportional variety as fully, as if we extended the view through all the series of the four classes of animals. The law of proportioning is as fully evinced by the comparison of $a+b$ and $a-b$ as if we were free to measure it through all the scale of a graduated infinity.

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* " Itaque convertenda plane est opera ad inquirendas et notandas rerum similitudines et analoga, *tam in integralibus quam partibus ;* illæ enim sunt, quæ naturam uniunt, et constituere scientias incipiunt."—Bacon, *Novum Organum Scientiarum,* Aph. xxvii.
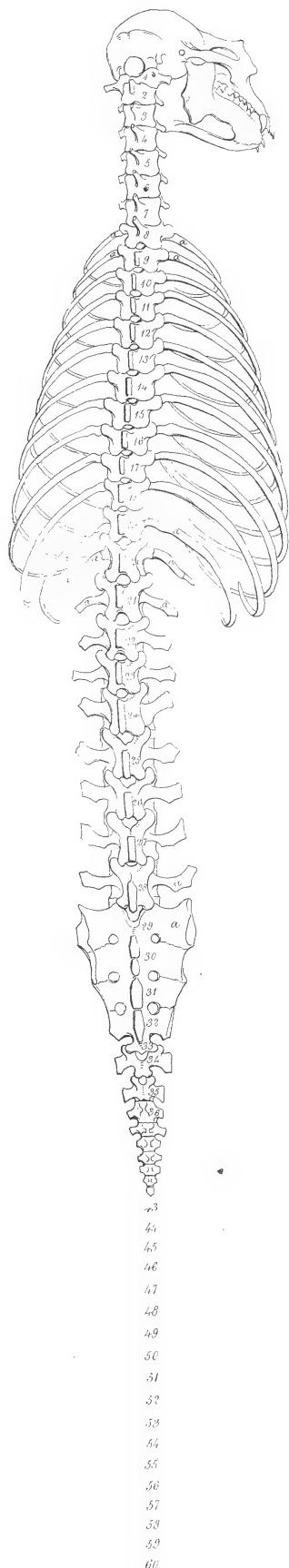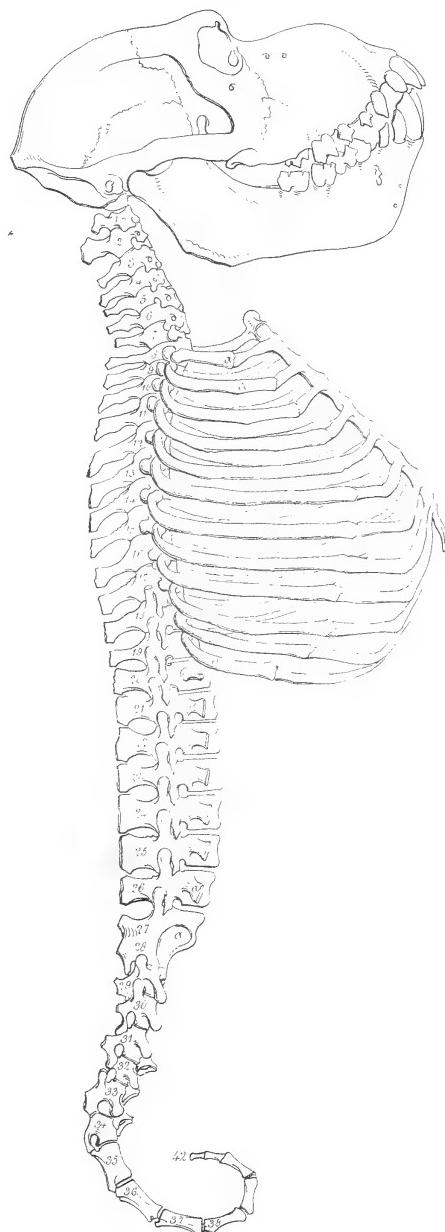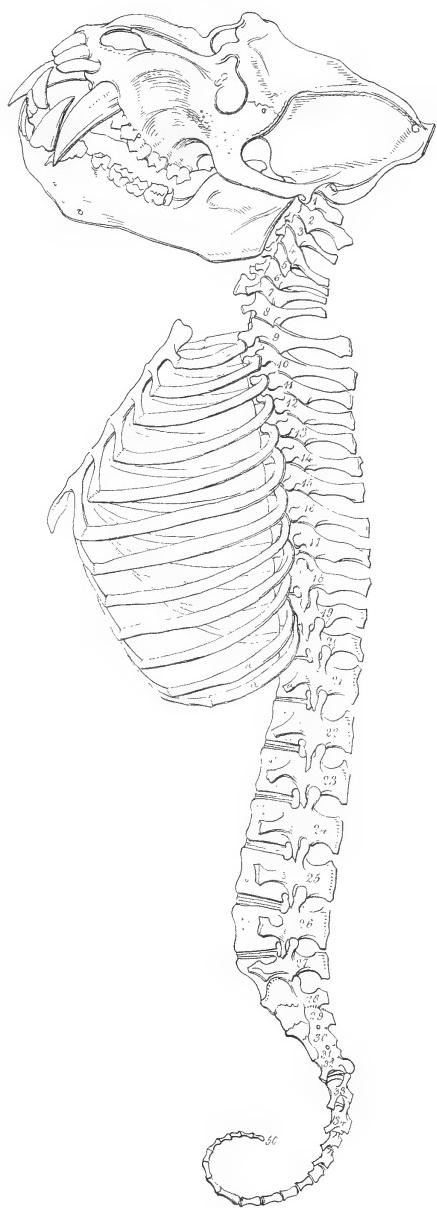
Plate 44.

Fig A.

Fig B.

Fig C.

REMARKS ON THE FIGURES OF PLATE XLIV.

WHERE THE FULL COSTO-VERTEBRAL ARCHETYPES EXIST IN SERIES THERE THE LAW OF METAMORPHOSIS HAS NOT OPERATED, BUT ALL THE MINUS QUANTITIES OF SERIES ARE THE PRODUCTS OF THIS LAW.

INTERMISSION or discontinuity occurs by the subtraction from some region of a plus uniform serial line. This intermission, or gap, may, therefore, be graduated through all the infinite phases of subtraction. It may be one which shall scarcely be perceptible, for as much as it is only infinitesimal, or it may take place to such a degree as altogether to disconnect two regions of the same plus serial line. Between both these opposite extremes of intermission or hiatus, possible to occur by rule of metamorphosis upon the plus uniform series of costo-vertebral units, the mammalian serial axis of proportional quantities is created as a design and fitness; and in order to give form to our ideas regarding the mode in which this creation has been planned, we shall express ourselves through the medium of symbols or numerals.

The plus costo-vertebral quantity we regard as represented by the integer 9, all the minus or proportional quantities which hold serial order with the costo-vertebral plus unit are as parts of the like whole quantities; and, therefore, may be represented by all the quantities contained in the integer 9. The plus series of costo-vertebral units, like the plus series of integers, or 9, 9, 9, 9, 9, 9, 9, 9, 9, will represent plus uniformity. Intermission or hiatus is, for design and fitness, to interrupt the plus continuity of this series, and to this end nature is free to operate through a wide extent of choice. If fitness requires that the intermission in such plus series should be confined to the degradation of one plus unit of the series, it may subtract from 9 each or all the quantities contained in 9. If, again, fitness demands the degradation of two or more of these plus units of series, nature is free to practise in her choice. She may metamorphose equal or unequal quantities from any one, or many, of the series of 9, 9, 9, 9, 9, 9, 9, 9, 9; and she is likewise free to operate upon few, or many, of those plus units, in various regions of the same series. If intermission is ordained to be slight and confined to one plus unit of series, it happens thus, 9, 9, 9, 9, 8, 9, 9, 9, 9. If series is to intermit by a subtraction of the like quantity from many units, it takes place thus, 9, 9, 8, 8, 8, 8, 8, 8, 9. If upon alternate plus units, thus, 9, 8, 9, 8, 9, 8, 9, 8, 9. If complete intermission is to disconnect series, the result happens thus, 9, 9, 9, 0, 0, 0, 9, 9, 9. The finity of a plus series is caused by the same operation of subtraction, and may be drawn as 9, 8, 7, 6, 5, 4, 3, 2, 1, 0. The caudal termination is thus produced by subtraction of quantity from one end of the plus serial costo-vertebral line.

We have already seen that the human skeleton axis varies not only as to the number of units constituting its length, but varies also as to the number of units standing for each region of series. We, therefore, cannot say that the human skeleton axis invariably terminates at the thirty-second unit of series, neither can it be said that either the cervical, thoracic, lumbar, sacral, or caudal region of series is produced invariably as to a fixed number of units. The quadrumanous species varies from itself in these same particulars, and there can be little doubt that either fig. A, B, or C, would be found also to vary as to the number of serial units, taken in its whole length and in its regional parts.

Figs. A, B, and C, produce the cervical and thoracic regions of series alike, as to the number of units constituting each region, and they, in this respect, are developed

equal to what we ordinarily find in the human type, namely, the cervix terminating at the seventh unit, and the thorax ending at the nineteenth unit of series. But in figs. A, B, and C, we find that the lumbar, sacral, and caudal regions of series, vary as to the number of their constituent forms.

In fig. A the lumbar region of series comprises 9 units. In fig. B it is limited to the number of 7 units, and in fig. C we find only six lumbar forms. The sacro-caudal series in each of these species, varies also as to the number of units under metamorphosis.

It should be remarked of fig. C, that the cervical spine which appears to consist of 8 units, may not have been thus developed in the original; its cervix may have presented the usual number of seven vertebræ; but whether this were the case or not matters little to our present reading, which will discover no greater marvel in the fact produced as we have seen it, or perhaps mistaken it, than attaches to the mammalian cervix of the sloth, which actually produces nine units in the cervical region of series, the 8th and 9th cervical forms being minus the costal arches, which remain as plus, and therefore as thoracic quantities in other mammalian cervices.

Figs. A and B produce the serial axis as consisting of 42 proportional quantities. Fig. C produces its serial skeleton axis as consisting of 50 units, the proportionals of plus serial achetypes also.

Now fig. A terminating at the caudal proportional 42, may be interpreted as thus ending by the archetype having undergone the extreme of subtracted quantity. From unit 42 has been metamorphosed all that plus quantity which, had it existed, would have rendered it equal to a thoracic archetype. Hence, as from unit 42 of fig. A, the subtraction of any further quantity would annihilate itself, so may this further process of annihilating subtraction be said to have taken place for all the units indicated by the numbers succeeding. Those units which would have taken order from 43 to 60, are now non-existent by reason of complete metamorphosis, or the subtraction of a quantity from each, equal to the integral costo-vertebral quantity, and thus $9 - 9 = 0$. The archetype quantity minus the archetype quantity terminates series at the last caudal ossicle.

The law of species follows *pari passu* after the law of form, and attends upon the presence of this latter as if it were its satellite. The law of form is the process of gradation, or the subtraction of parts from plus serial quantities; and directly as this metamorphosis takes place, directly special variety holds that place. The shadow reigns over that region always where the beam of light has ceased to exercise its dominion; and what is shadow but a state of negation, consequent upon the absence of the positive entity of light? Is shadow an ens?—It cannot be regarded as such, while we have reason to interpret it as a mere state of negation, or the absence of something; for to regard shadow as a palpable entity would be no less absurd than to set down the dark void of ignorance as being a presential substance, while experience proves that the God of day, like the torch of knowledge, dispels the phantom nothingness of ignorance and shade. If we will follow the progress of the law of form, by the subtraction of quantity from plus uniformity, we shall plainly discover that the condition of what we name special variety is a mere state of the absence of some form or quantity proper to plus uniformity, and hence that species is like darkness, or like ignorance, a non-existence or absence of a something, just as $a - b$.

Figs. A, B, and C, are special to each other by the selfsame operation of that law of metamorphosis or subtraction which has rendered the serial units of either fig. A, or fig. B, or fig. C, special to each other in the one axis. The subtraction from plus quantity is that process whereby unit 20 a, of fig. A, holds its present special or minus character in the same line with all the thoracic plus quantities above itself; and, when we would furnish the ideas with the knowledge of what form or quantity is now lost to unit 20 a, of fig. A, we have then only to view it persisting in any unit of the plus costo-vertebral thorax, or else make search for it in some other skeleton fabric, whose serial unit numbered 20 a, develops costæ, or, in addition to this evidence, the proof may be found by comparing fig. A. to all species of that same cast, and we shall not fail to find that unit 20 a, develops somewhere amongst these, the plus costal forms. Every unit of skeleton series may be subjected to the like rule of comparison, and to the same result.

The same law of metamorphosis or subtraction which creates the cervical and lumbar forms of fig. A as minus specialities in serial relation with the plus thoracic archetypes,* performs in like manner for figs. B, and C. It is the same law which also degrades for the caudal series of figs. A, B, and C. The convergent, or caudal series of figs. A, B, and C, are evidences of the degree to which subtraction has been carried upon the plus costo-vertebral originals; and general comparison, while holding to the fixed numerical position of the serial order of each unit, will prove the truth of this reading.

The law of subtraction or degradation of plus uniform serial archetypes does not exercise its influence to the same degree upon the same units of all skeleton axes, and hence arise their serial varieties; nor does this law practise to the same degree upon all the same units of even the same species of skeletons; and, hence, occur their "anomalous" plus or minus characters. The same law of subtraction from serial plus quantities does not terminate the caudal region at the same numerical point for all axes, nor for even one skeleton axis, invariably; and hence happen the varieties as to length, presented by these appendages. The existing length of every skeleton axis is a proportional of the transcendental or ideal length of an infinite right line.

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* "La partie a des rapports au tout, l'univers est un système immense de rapports ; ces rapports sont déterminés réciproquement les uns par les autres. Dans un tel système, il ne peut rien y avoir d'arbitraire. Chaque état d'un être quelconque est déterminé naturellement par l'état antécédent ; autrement l'état subséquent n'auroit point de raison de son existence."—Bonnet, *La Palingénésie Philosophique, ou Idées, &c. ;* tome i., huitième partie, p. 312.
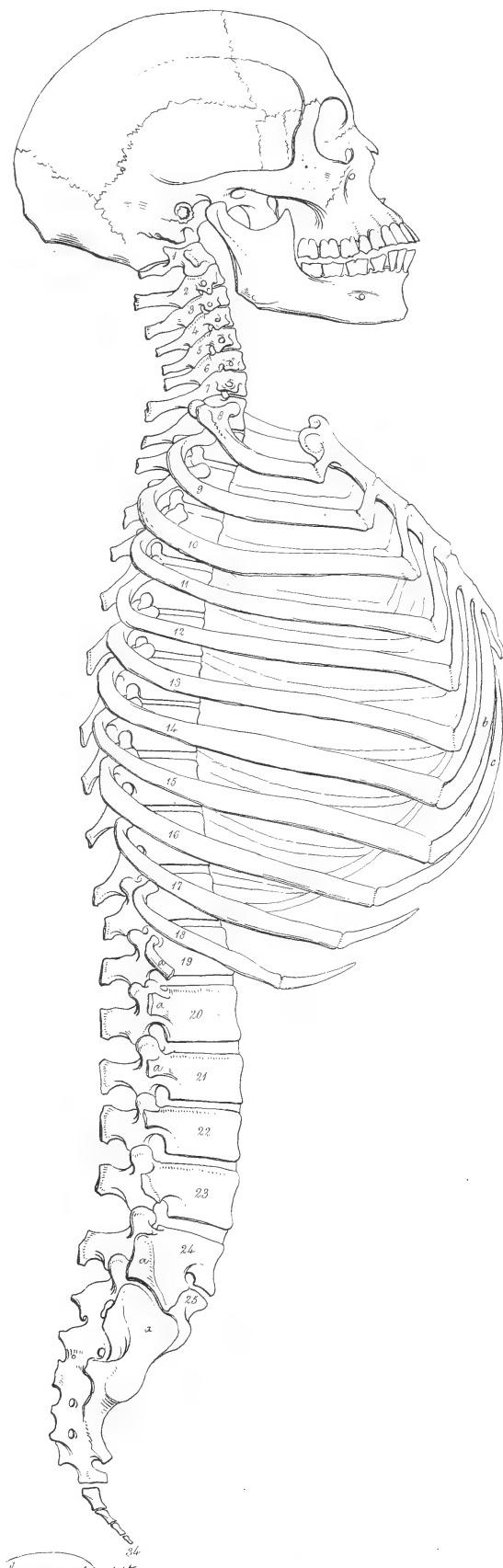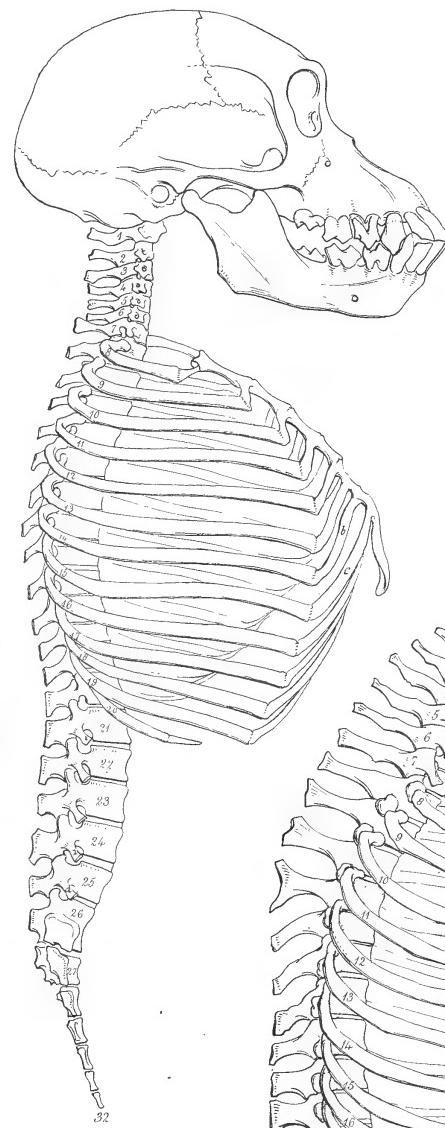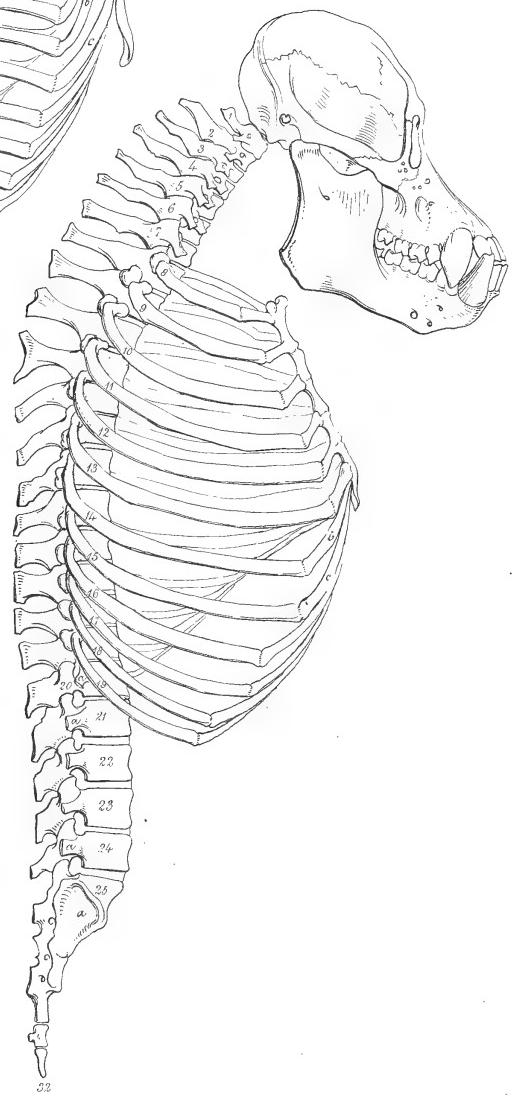
Plate 45.

Fig: A.

Fig: B.

Fig: C.

REMARKS ON THE FIGURES OF PLATE XLV.

THE COSTO-VERTEBRAL PLUS ARCHETYPES GRADUALLY DECLINE INTO THE VERTEBRAL OR MINUS QUANTITIES OF SERIES.

SUBTRACTED quantity is the cause why an interval or minus condition happens in a plus series.

If this interval be the design or effect, there can be no doubt that the subtraction from plus serial archetypes is the cause of this effect, and consequently it is not by the comparison of special designs as mechanical fitnesses that we can ever hope to attain to a knowledge of the law which produces these; but this knowledge can only be obtained by comparing those various designs under the ideas that they are the various proportionals of a common whole quantity, which is the plus archetype of these designs severally as well as collectively contemplated. If, for example, we still continue to compare the various series of $5, 5, 5, 9, 9, 9, 5, 5, 5$, with the still various series of $9, 5, 5, 9, 9, 5, 5, 5, 9$, and both these with another various series of $9, 5, 9, 5, 8, 7, 5, 4, 3, 2, 1$, then we may safely assert that this comparison of endless serial variety can never rise to the idea of uniformity; and without having first established this standard uniformity whereunto variety may be compared for the illustration of the law by which variety has occurred, the rule of comparison can never estimate the track of creation or the designs thereby produced.

But all minus or special varieties may be referred to the standard of plus uniformity. The plus series contains the subject of the minus series, and the comparison of the latter with the former must lead to the interpretation that the lesser has been planned of its own special design from such another series as the greater. Under this idea we refer the series of $9, 5, 5, 5, 9, 9, 9, 5, 5, 9$, to the plus series of $9, 9, 9, 9, 9, 9, 9, 9, 9$, for explanation, and in the same way we may refer every minus serial variety which it is possible to produce by metamorphosis of quantity proper to the plus series of 9. If the integer 9 be in every sense of the word equal to the integer 9, then 8, or 7, or 6, 5, 4, 3, 2, or 1 are quantities severally various to the integer 9, by reason of various degrees of quantity subtracted from 9. The mammalian serial axes may for the like reason be regarded as special varieties severally proportioned from an archetype plus series of costo-vertebral integers.

The comparison of skeleton forms, such as Nature presents them, and offers them to our consideration as completed and fitting designs, can never teach us the law by which she has created them. If we continue for ever to compare fig. A to B, and to C, and afterwards carry investigation, by the like mode of comparison, through all the species of mammalia, all those of the aves, the reptilia, and the pisces, and for no other purpose than to mark the points of character by which they manifest common analogy and special differences, the science of comparison will never rise to recognise the law of skeleton formation.

It is not by an everlasting repetition of the fact, that skeleton figures, such as we see them, do evidently describe a somewhat common identity of character, that we can ever hope to interpret the law of their formation. The common analogy of skeletons is well-known, and has been so to the disciples of the Stagyrite. They are planned upon a common type; we confess to this, and there the science of comparison at present stands. But skeleton forms are evidently varied by a countless number of plus and minus characters, and these are they which at present draw up a barrier against advancement, and through

which interpretation must clear for itself a passage, if any progress is to be attempted, for the comparative reasoning.

Evidently, there appears to be something more required for the understanding of a law of formation than the mere trite account of the homologous development of already-created forms of skeletons.   When we say that figs. A, B, and C, are homologues, at the same time that we discover how fig. B develops thirteen ribs, and figs. C and A only twelve, thus denying the fact that they are homologues; nay, when we further discover that fig. A of the human type manifests a plus and minus variation as to costal quantity, being in one instance limited to the number of eleven costæ, and in another example producing thirteen costæ—then we have reason to conclude that as yet we do not understand the law of formation, since we are unable to account for these "anomalies" to the rule of unity.

Hence we say, that it is not by a comparison held between the created forms of fitness, and confined to this reading only, that we can ever hope to appreciate the passages of that law which rendered them thus created. But it must be by advancing onwards in quest of that plus quantity of the archetype from which all minus variety has been planned by simple subtraction, that we are to give form and interpretation to the fabric of unity. The archetype or plus quantity can only be regarded as uniform, and when we compare with this all the minus varieties, then we come to some lucid understanding of a law.

Fig. A, the skeleton axis of an Australian, compared with fig. B, the skeleton of a chimpanzee, and with fig. C, the skeleton axis of an orang-utan, appears, as to general conformation, identically cast. Their facial angles manifest a plus and minus variety, owing to the increase of certain pieces of the facial apparatus; but still the elementary structures are one and the same, both as to number and relative situation.   This is not the case as to the thoracic quantities, for fig. C is minus a rib, compared with fig. B, which is plus a rib.   And furthermore, we well know that either fig. A, B, or C, may be minus or plus a rib, compared to that condition of development in which they present opposite.

It is unit 20 of fig. B, that develops the plus costa.   It is the same unit which is minus this costa in figs. A and C.   And this is the fact which requires to be interpreted before we can understand the law of unity in variety, which law can be no other than plus quantity subtracted from.

It is the subtraction of quantity from the archetype or prime model, which is plus, that yields figs. A, or B, or C, or any other denomination of skeleton variety in such fashion as Nature presents them, and hence it is that figs. A, B, and C, which are minus quantities compared with archetype plus, cannot, therefore, be accounted as expressive of the complete form of unity.

We have all along held the opinion, that all skeleton figures which manifest a special variety to each other as to serial quantity cannot, so long as they continue to be contrasted with one another as entities of fixed and invariable cast, establish for us the condition of uniformity.   The mere comparison of an ens of lesser quantity with an ens of greater quantity can never move these two things from out of their presential character; for $a-b$ taken as such, and contrasted with $a+b$ considered as such, will never make them otherwise than such as they appear.   Even if we view both these quantities of plus and minus variation through the lenses of the "Novum Organum" or the "Principia," still they will never move out of their present character.   The power of Ross's telescope cannot render them otherwise than what they are; and as they really are in plus and minus variety, we therefore say that it will be as vain to seek for an actual uniform structural plan in both, as it would be to establish an identity of purpose and argument between Locke's "Essay" and the "Pindaric Odes."   The variety of quantity exists between two or more skeleton axes of several classes, between two or more of several species, nay, even between two or more skeleton forms of human type; and where, then, is uniformity?   We proceed to answer this question by proving that it is an abstract idea of formation, and is the product of a comparison held between the serial proportional quantities of even the one skeleton axis, and may be as fairly established upon this isolated particular as if we passed in array the whole embodiment of form throughout animal nature.

Analogical inquiry has always proved this fact to those who have pursued the task, viz., that the progressive notice from particulars to generalities turns the mind back again from generalities to particulars;[*] and whether it be for good or otherwise that the excursion and return has been effected in the development of the subject, this much, at least, is certain, that the travelled reason has cultivated a roving spirit, and, from having observed the universality of Nature's oneness of operation, contents itself with the observation of things as they appear in masses, and ever afterwards renounces the wearisome, slow, and fruitless labour of searching purblindly for differential peculiarities between things which broadly manifest the open character of identity in the main and on the whole.   When we first contemplate the plan of fig. A as a particular cast of form, we might for ever rest satisfied with our knowledge of the law of development which produced it thus, were it not that its costal plus "anomalies" awake us to inquire the how and the wherefore of their creation; and this leads the inquiry forth from the particularity to range through the general condition of Nature, in order to know whether the normal agreements and abnormal disagreements apparent in the type, fig. A, bear any analogy to, and admit of explanation by, those which are occurring for the general or transcendental type of the animal through classes, orders, genera, species, and individuals.

* " Auctor systematis a particularibus ad universalia ascendat, Doctor vero contra a generalibus ad specialia descendat."—Linnæus, *Imperium Naturæ, Systema Naturæ.*
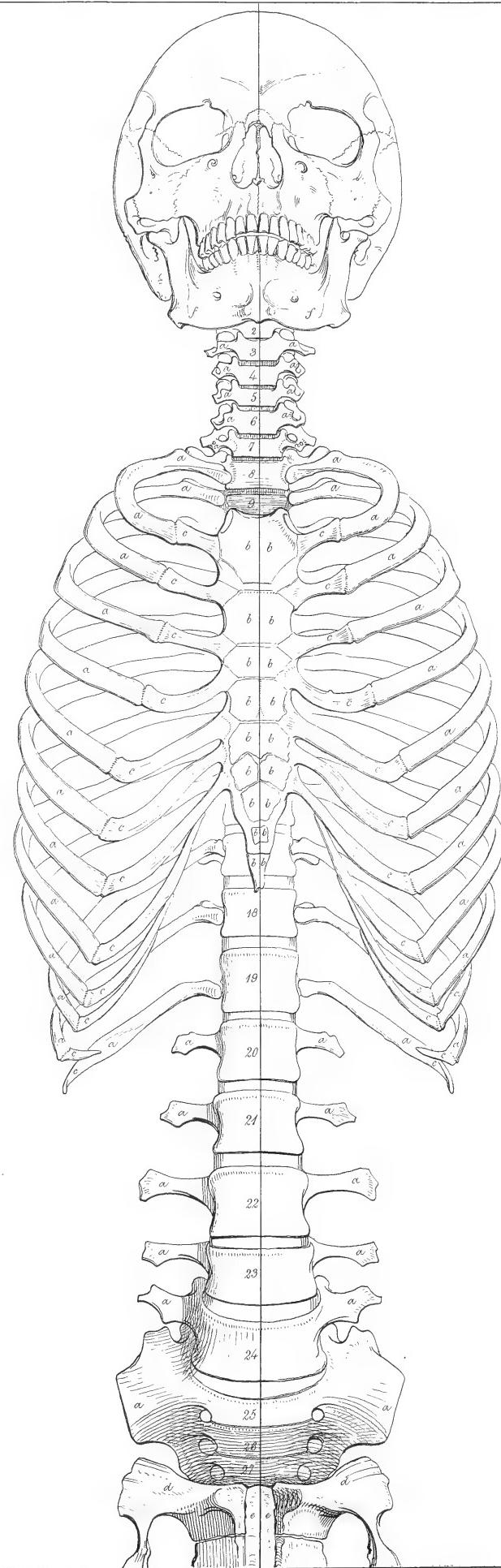
REMARKS ON THE FIGURES OF PLATE XLVI.

THE HUMAN SKELETON AXIS IS VARIED AS A SERIES OF PLUS AND MINUS QUANTITIES, AND HENCE MAY BE SAID TO YIELD THE IDEA OF ARCHETYPE PLUS UNITY, AS WELL AS THE IDEA OF SPECIAL VARIETY.

SPECIALITY is opposed to uniformity just as subtraction is opposed to addition. The result of these opposite conditions of development is the creation of a lesser quantity standing in serial relationship with a greater quantity. The integer 9, is followed by the proportional 5. The quantity $a+b$ is succeeded by $a-b$, and the law of form is to be read accordingly. This law is one of subtracting from a plus quantity or unity; and hence we have proportional variety or species as the result of this law. Not only is this law of formation to be traced through the endo-skeleton series of an animal kingdom wherein the minus quantity occurs as a species in the neighbourhood of plus quantity or unity, but even in the one serial skeleton axis the very same law of subtraction or metamorphosis is seen to operate, and to yield all minus serial figures as specialities succeeding or preceding plus archetype unity. The vertebral figures of a cervix, loins, sacrum or caudex are as species compared to the costo-vertebral form, by reason of the fact that the former have been metamorphosed from plus originals all equal to the latter.

The origin of species, therefore, is the genesis of subtraction from a plus quantity: for as $9-1=8$ so have we reason to name 8 as a species of the plus integer 9; and, therefore, on observing that 9 is followed in series by 8, so must we conclude that 8 is special to 9, by reason of the fact that 8 is minus 1, which 1, if it had not been subtracted from 9, could never have produced the species 8, as succeeding the integer 9; and thus we conclude that the origin or presence of such variety as exists between 9 and 8 is mainly owing to the absence of the quantity 1 from 8. Species, therefore, is the condition of subtracted quantity; and uniformity must, therefore, depend upon the presence of that quantity which, when subtracted, gives rise to species. If 8 be special to 9, by the loss of 1, so will the addition of 1 to 8 make 9, or the equal to 9 and 9, 9, 9, 9, 9, constitute a uniform series. The addition of that quantiy which we know to be lost at cervix, loins, sacrum or caudex, will re-establish the plus costo-vertebral uniform series, and by the contrast with this original plus we read the present created fitness of that which is now in minus character.

Between any two forms of skeleton quantity, one of which shall produce a plus amount of elementary parts and the other a minus proportion of the like elements, we hold it to be totally impossible for any one to establish the ideas of unity or to appreciate the law of formation by any other mode of interpretation except by equating minus with plus, and reading minus as a proportional of plus.

When we discover that two individuals of one and the same species may be thus produced as plus and minus, who is there that can rationally refuse to interpret that the lesser figure is a proportional of the greater? If we once grant this position in the interpretation of the plus and minus varieties of individuals of one species, who then can refuse to grant the like rule for interpreting the varieties of two or more individuals of distinct species, when we find that plus and minus quantities exist as the only difference between them?

Evidently it is required that we should first understand the meaning of plus and minus variation between all figures of the type opposite, and know how the uniformity of this one species becomes interrupted, before we undertake the

task of establishing uniformity between all the skeleton quantities of the four classes.

In the figure opposite we see a serial order of plus and minus quantities, and this renders the fact salient that such a form is various to itself, when we compare the units of one region with those of another. The unit marked 7 *a*, is a minus proportional of the first thoracic quantity marked 8 *a c b*, and the unit marked 20 *a*, is likewise a proportional of the last thoracic quantity 19 *a*. This cannot be for a moment doubted, forasmuch as we now and then discover units 7 and 20 to produce quantities which equal those of units 8 and 19; we mean such quantities as the " anomalous cervical and lumbar ribs."

In the opposite form we meet with units 7 and 20, produced as we now see them. In another form of the same species as that opposite, we discover units 7 and 20 to simulate the quantities of units 8 and 19; and therefore it is that we are called upon to interpret units 7 and 20 of the figure here represented to be proportionals of such quantities as units 8 and 20. Once grant this, and we cannot deny the like interpretation to all the serial units which succeed unit 20 and which precede unit 7; and hence must arise the following reading: viz., that a cervical and a lumbar series of units are proportionals fashioned from thoracic archetypes.

When we learn to interpret unit 20 *a*, as a proportional of such a quantity as unit 19 *a*, it is equal to saying that originally both quantities were in the plus condition of 19 *a*, and equal, also, to the knowledge that the lesser has been fashioned from a greater, by process of a law of formation. This, then, draws after it a connected chainwork of facts, all interpretable by the same law.

The cervical and lumbar regions of the opposite figure are minus quantities, compared to the plus thoracic regions of series. The common median line cleaves all the plus and minus figures, such as they present themselves in series. It cleaves the minus quantities symmetrically, as well as the plus quantities; and this can only happen by reason of the fact that the minus serial forms are the proportionals of the plus forms. When we interpret them under those ideas, we then interpret the law which struck the forms thus proportionally various, and this interpretation is equal to the recognition of the plus archetype of series, which has thus suffered metamorphosis for the regions named cervix and loins. The median line which bisects the sternal series *b, b*, in the thoracic quantities of the form, as represented opposite, does not bisect this sternal structure at the cervix or loins, because it has been subtracted herefrom. Still, we know that the hyoid apparatus of the cervix and the linea alba and lineæ transversæ of the abdomen hold series with the sternal apparatus of the thorax.

The opposite figure is constituted of a series of forms, whose only difference is caused by a variation in quantity. As it stands, we discover that the series is not uniform, but, at the same time that we admit thus much in exception to uniformity, we are forced to acknowledge, likewise, that the interruption to uniformity is the habitation of special variety. We find, that where plus quantity exists as a presence, there the minus quantity as a species is absent; and where this latter is, the former is not. Thus it is that plus uniformity and minus species are naturally repellant to each other; and where the plus thoracic series exists it would be as vain to make search for the minus cervical or lumbar series as it would be to seek for night where Sol is in his meridian. Where plus entity is not, there in this very place reigns the mysterious presence of species, which is nonentity, or the consequence of quantity subtracted.

The mammalian skeleton axis is produced as a series of alternating plus and minus quantities. Between the plus maxillæ and the plus thoracic quantities happens the cervical gap in series, and this cervix, being in minus condition, is special to the maxillæ and the thorax, which are in plus condition; therefore, if we would reconstruct the quantities, which are now lost to the cervical series or species, we must, in idea, bridge over this hiatus with thoracic costo-sternal quantity, and gather our materials for constructing this idea, not from the fruitful fields of loose imagination, but from the map and volume of natural creation and analogical inference, which is akin to mathematical rule.

Between the plus thoracic series and the plus pubic arches again the ventral hiatus occurs in series; and so far as regards skeleton formation the venter is minus, and special to the plus thorax and the plus pubic region. Those costo-sternal quantities which are lost to the ventral region must be found in nature, ere we can discourse of plus uniformity or the law of species and design. As the mammal skeleton axis exists, we acknowledge to its fitting proportions; but it is in the contrast of what it at present manifests * with the original from which it has been fashioned, that we are to track the way and method of the law of form. With Nature herself as our guide, we shall follow in her train, and never presume to forerun her evidences; and with her as leader, we shall hereupon make note of the facts chargeable to her alone: viz., that at the minus cervix of the mammal serial axis, appear the creations of cervical ribs pointing to the anterior median line, where happens the hyo-laryngeal apparatus, and also that at the minus venter of the same series happen the lumbar ribs, referring to the median line, which is figured by fibrous bands named linea alba and lineæ transversæ.

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* " The inferior are dissimilar to the superior parts, except that the inferior correspond in a certain proportion to the superior. Man, therefore, has the superior and inferior parts of his body arranged according to natural places in a greater degree than all other animals. For his superior and inferior parts are arranged according to the superior and inferior parts of the universe; and after the same manner his anterior and posterior, his right and left parts, have a natural position. The head therefore, indeed, in all animals, is upward with respect to the other parts of the body; but man alone, as we have just observed, being fashioned comformably to the order of the universe, has this part corresponding to the heavens."— Aristotle, *History of Animals*, pp. 24-26, book i.
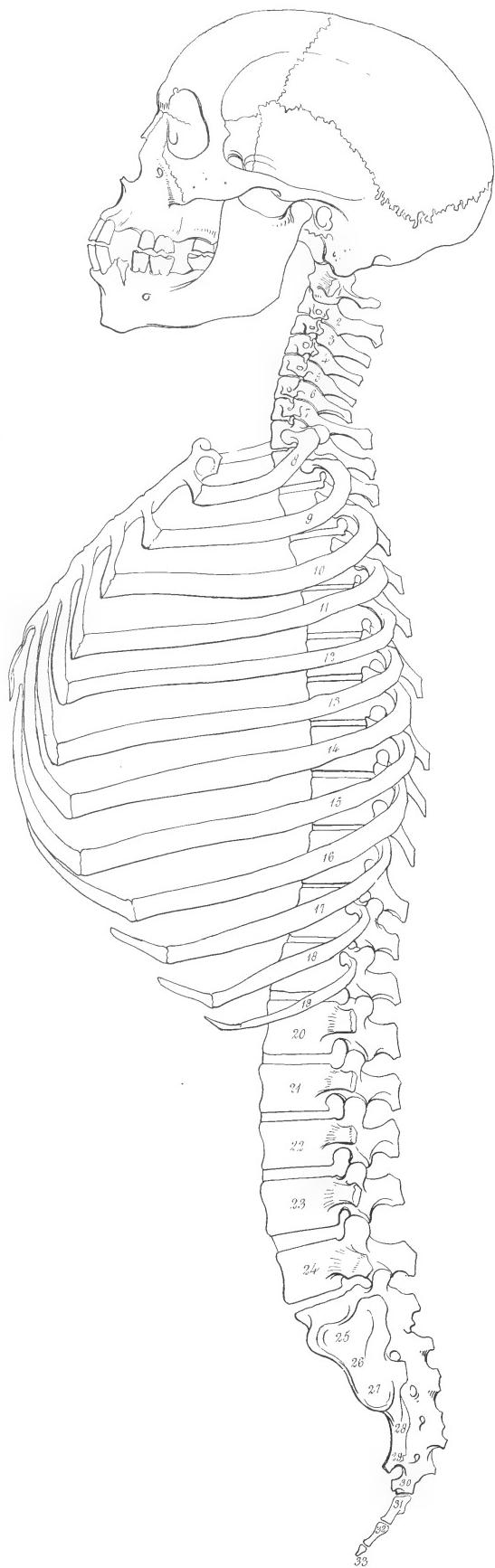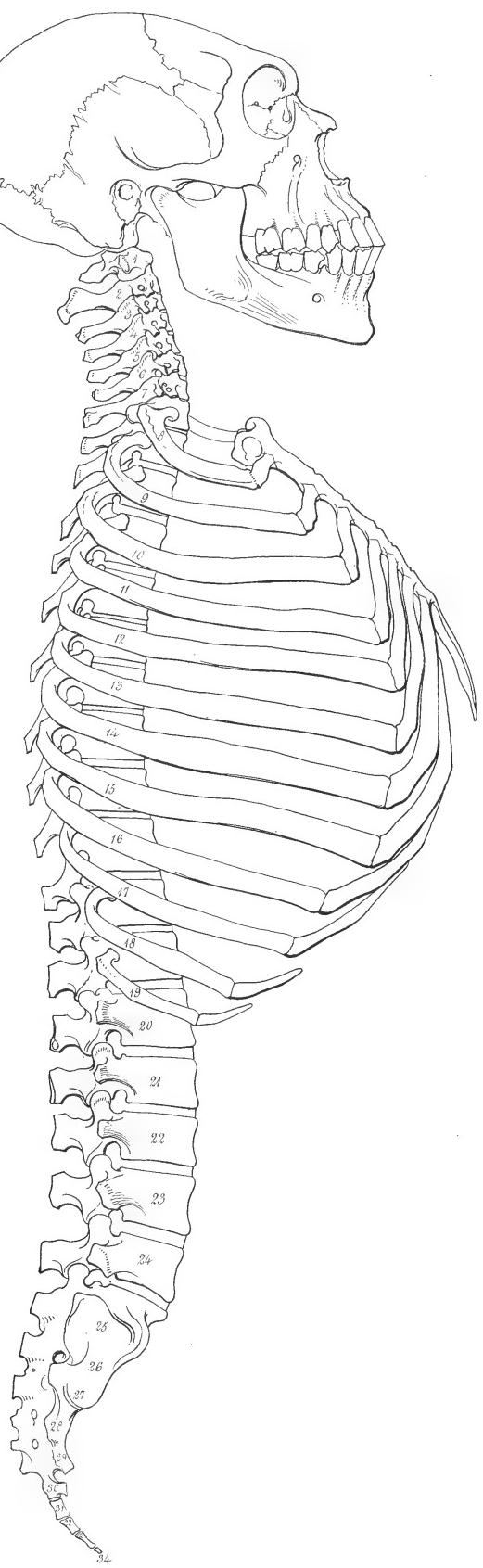
Plate 47.

Fig: A.

Fig: B.

REMARKS ON THE FIGURES OF PLATE XLVII.

THE THORACIC ARCHETYPE IS THE SYMBOL OF UNIFORMITY, AND CONTRASTED WITH THIS EVERY MINUS
SERIAL QUANTITY BECOMES THE SYMBOL OF VARIETY OR SPECIES.

CONTRASTS explain the law of their difference. Comparison is a mode of contrasting various quantities, and when those quantities manifest no other variety among themselves save that which occurs by the subtraction of a thing from one figure, which thing is present and persistent for another figure, then the object of comparison or contrast must be to re-establish the ideas of uniformity by a mode of equation; to the end that the figure which is now minus by design may explain the law of formation which has created it in its present condition. 'Tis true that there are some things so absolutely various to one another that contrast or comparison can never rationally expect, by any mode of computation whatever, to restore the idea of plus uniformity between them; as, for example, when we contrast a meteoric stone with the carapace of a tortoise, we cannot expect so to retrace the paces of the law of their difference as to read the one to be a proportional of the other. But while we are forced to acknowledge thus much as to the absolute difference which prevails between certain entities which have been struck specifically various to each other *ab origine*, and ordained to maintain this special character in opposition or contrast to one another *ad finem*, still it must be admitted, that the serial quantities found developed, whether in one skeleton axis, or as they stand created in one or more or all skeleton axes, do not repel the reason from entertaining an opinion that, by the contrast or comparison of these plus and minus varieties, it is quite possible to generate the idea of a whole standard quantity wherewith all minus or special variation may be contrasted and the law of formation explained accordingly.

The contrast of figures which differ only as to quantity will, like the contrast of $a+b$ and $a-b$, express the fact that the lesser has been fashioned from such as the greater.

The foregoing remarks apply to all varieties of human skeleton formation. The Caucasian, Mongolian, American, and Ethiopian varieties manifest the plus and minus development as to thoracic quantity. The rib may be produced upon the sixth and seventh cervical unit, as well as upon the twentieth and twenty-first in the lumbar region; and in whatever other respect these skeleton forms may be said to manifest distinctive characters, it is at once rendered evident that no mode of measurement, by the facial angle or minute examination of special character, can help us to an interpretation of the law which planned them, as they are, the proportionals of archetype unity.

While we compare fig. A, the skeleton of a Chinese, with fig. B, the skeleton of a Carib, we see every reason to name them homologues, fashioned upon the transcen- dental law. But if one or either of these figures developes the cervical or lumbar rib, then they are rendered propor- tionally various to each other; and hereupon we ask the question, how happens such variety? The answer to this question is part of the answer which must tell whence all other skeleton quantities are developed as proportional varieties, somewhat uniform, but proportionally various, nevertheless.

The knowledge of a law of formation should be extended as widely as the law itself appears to act, otherwise we cannot encompass all the possibility of creation which may happen in the process of this law, nor, while we fall short of this sum of knowledge, can we hope to erase the word "anomaly" from the chart and firmament of science. Where knowledge is minus, the "anomalies of formation" are in plus amount, and where knowledge is plus, the anomalies

of form are in minus number. Every condition of develop-ment whatever is "anomalous," and unaccountable to him who is totally unacquainted with any condition of form, and who will deny that as we progress in experience of the things which are, "normally," we may hope to find the proper serial place for those things which are, "abnormally." And what, after all, is this mystery of normal and abnormal variety in the same species? Is it more to be marvelled at than that variety of form which we find characterising various species by fitness and design?

When fig. A, or fig. B, shall manifest a plus or minus variety in any region of series to that condition of form which it now proves; when the numerical series of either cervix, thorax, loins, sacrum or caudex, shall be produced either plus or minus to its ordinary cast; and that those varieties upon the figure of either A or B shall prove to be only those which happen to individualise the skeleton fabrics of certain other animal species, then it is plain that the only way to gain a full acquaintance with all modes of special varieties, whether these be fitting or unfitting to the individual or to the many, is to study the law itself, in reference to the material of that whole quan-tity of serial uniformity upon which the law operates; and it is this method which, not being artificial or invented to suit with preconceived hypothesis, but being natural and according to fact and experience, will therefore yield an interpretation according to truth. If, for example, the law of metamorphosis shall subtract a costa from the present quantity of fig. A, which figure shall now be struck minus and various to fig. B, wherein the homologue of this lost costa still persists, then fig. B must be regarded as a plus, and hence, explicative form to fig. A, the minus form. And, pursuing this chainwork of connected and simple evidence, we say, that fig. A, or B, in each of which we now find the number of twelve thoracic costo-vertebral quantities, are both to be regarded as minus and special to either fig. A, or B, when these or their like shall pro-duce thirteen or fourteen thoracic quantities, for in this latter condition of development they will stand as plus fabrics to what they are at present.

Again, when fig. A, or B, as these structures now present to us, or as they or their like may present in plus costal condition, shall be compared with that skeleton fabric which developes a surplusage of thoracic archetypes in any number which shall exceed those "normal," or even those "anomalous," to the special design of figs. A, and B, then it is clear that figs. A and B must be accounted special to such a surplus skeleton axis, because they are minus quantities compared to the same. In support of this reading of the law of form, which creates minus specialities from out of the material of a plus whole quantity, we ask the question whether or not it be the fact, that when figs. A and B produce cervical and lumbar ribs, these surplus costal quantities involve within their own dimensions the "transverse processes" of cervix and lumbar spine, and shorten those regions of the skeleton axis in the same ratio?

Now the length of a serial axis is likewise wholly de-pendent upon the numerical position of that terminal unit whose original quantity is subjected to the operation of the law of subtraction or metamorphosis. It is a fact that the sacro-caudal form of the human species is by no means fixed as to the serial number of its quantities. The skeleton axis of fig. A produces thirty-three serial quanti-ties, whereas that of fig. B developes thirty-four, and we have ourselves numbered in many other human forms as much as thirty-seven. Therefore we say, that this variation of formation in human type must be read in company with the whole sum of variations which are to be found in the transcendental animal type, and all variations will, when summed together, prove that they are the minus quan-tities of some plus original series.* It is this series which we are proceeding in search of. And as it will not advance our present views to digress loosely from the anatomical investigation of the caudal entity (for in such condition it is created, more or less, for all animals), so shall we here be little concerned, whether in former times it stood out plus for "the first man," or whether Tamerlane the Tartar, Attila the Hun, young Ammon the Mace-donian, or any other character † before or since their time, had been familiarised with the visible presence of it produced from their outward person.‡ As the physiologist now-a-days finds it, so is he to discourse of it; for it is true that the ens cannot be disguised to analogical inquiry, even though it be termed κοκκυξ, as the vanish-ing point of human skeleton series, while we know it, under the name *caudex*, as finishing the serial axis of gra-duated quantities in other animals.§

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* If variation as to the number of osseous pieces found in two or more skeleton forms of the higher classes of animals, such as mammals, birds, reptiles, and osseous fishes, be accounted a sufficient reason for distinguishing them as species, then the like reason for establishing specific character between two or more forms of human type is also apparent. Not only do human forms vary as to the number of ribs, but they likewise manifest infinite varieties in respect to the number of vertebræ. And we may venture to assert that there is no one class or species of skeleton form throughout the four great groups of animals which can be said to present a fixed character as to the number of osseous elements.

† " Homo sapiens ferus tetrapus, mutus, hirsutus."—Linnæus, *Systema Naturæ.*

‡ " Les marchands de Tripoly qui trafiquent en esclaves noirs, m'assurèrent aussi, que ceux de ce pays étoient plus farouches, plus forts et plus difficiles à dompter, que de tout autre ; qu'ils avoient presque tous des queues, les femmes comme les hommes."—Maillet, *Telliamed, de l'Origine de l'Homme et des Animaux, &c.,* Tome second, sixième journée, page 178.

§ " La Nature n'est qu'un seul acte. Cet acte comprend les phénomènes passés, présens et futurs ; sa permanence fait la durée des choses." —I. B. Robinet, *Vue Philos. de la Gradation Nat. des Formes de l'Etre,* p. 2, chap. i.
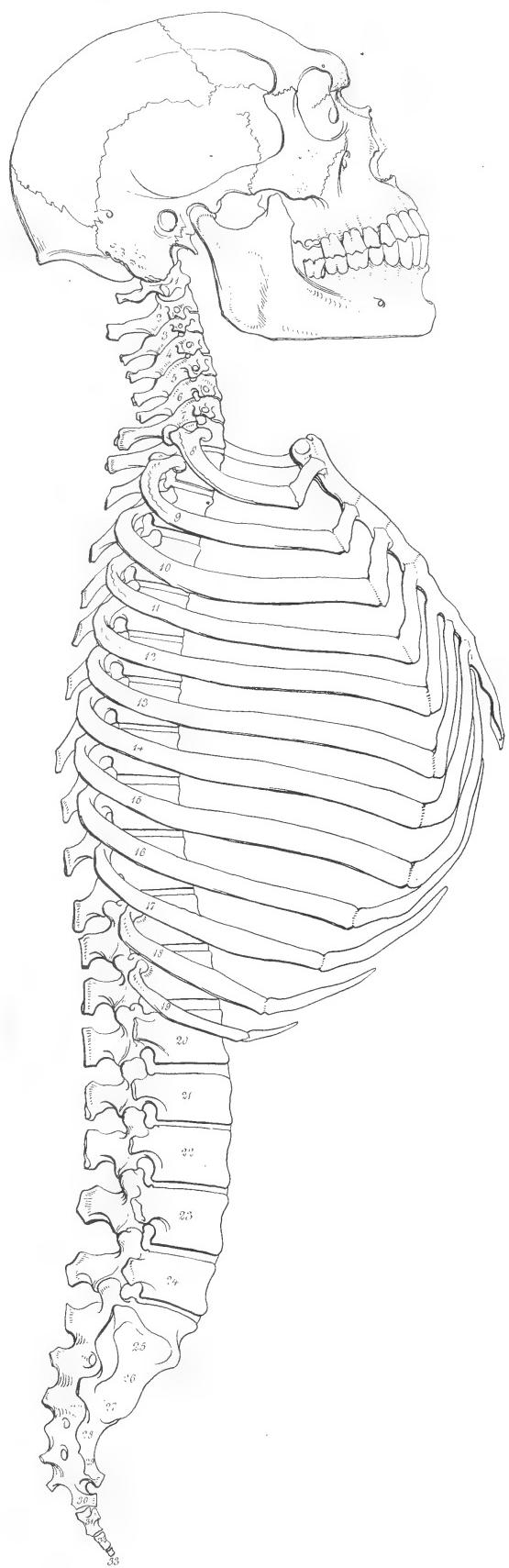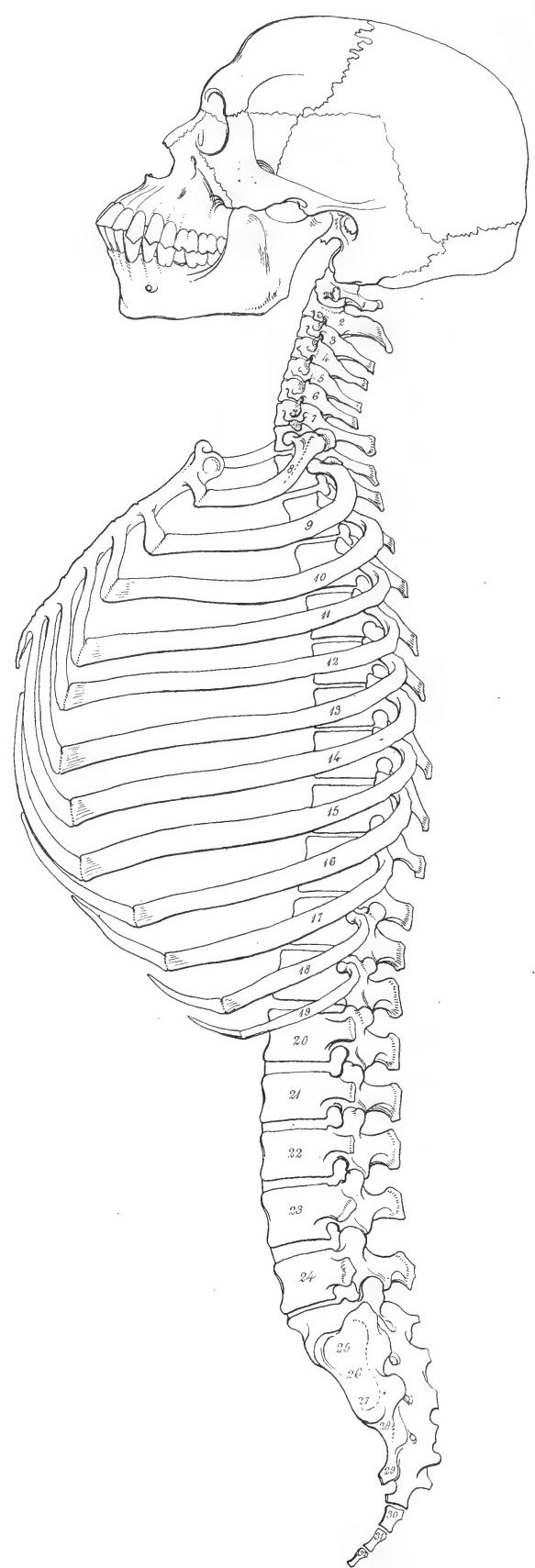
Plate 48.

Fig A

Fig: B.

REMARKS ON THE FIGURES OF PLATE XLVIII.

THE PLUS THORACIC ARCHETYPE AS UNITY EXPLAINS THE PRESENT CONDITION OF ALL THE MINUS QUANTITIES HOLDING SERIAL ORDER WITH ITSELF.

ORDER is the serial arrangement of similar and relationary entities. When those entities are in plus condition the order is absolute and uninterrupted, as thus, 9, 9, 9, 9, 9, 9, 9, 9, 9. When, on the other hand, those plus entities are subjected to a serial degradation, or metamorphosis of parts of their several quantities, then they take on the order of converging series, as thus, 9, 8, 7, 6, 5, 4, 3, 2, 1. The series of the integer 9, is therefore an absolute plus order, whereas the proportional series of the several quantities contained in 9, constitute a converging order. In addition to this, we remark that the disintegration of the proportionals contained in 9, will, when those proportionals are arranged in serial order, represent a converging series equal to that which occurs by the serial degradation of nine integers, such as nine following each other. Thus, as the proportionals of the one integer, or 9, may be drawn thus, 9, 8, 7, 6, 5, 4, 3, 2, 1, so will the series of 9, drawn nine times, as thus, 9, 9, 9, 9, 9, 9, 9, 9, 9, yield, by a metamorphosis of various quantities of each, the proportional series of 9, 8, 7, 6, 5, 4, 3, 2, 1 ; and therefore it is that we here understand each quantity of this latter series to be a proportional of the integer 9.

Order, therefore, may characterise series, whether the units be all as plus integers, or as the proportionals of such integers. Now, the same plus series of the integer 9, which can, under a serial metamorphosing act, yield a proportional, or converging series, as thus, 9, 8, 7, 6, 5, 4, 3, 2, 1 ; may also yield an unequal, or (so to speak) an eccentric series, by the subtraction of variable quantities from various regions of the plus series of 9, as thus, 9, 5, 5, 5, 9, 9, 9, 5, 5. But, if this latter series be eccentric as to the inequality of quantities in the same order, it still may be pregnant of fitness and design ; and it is so, in fact ; for applying it to illustrate the creation of the human skeleton series, we shall find both to correspond, as well in the eccentricity of serial arrangement as in the fitness for design. The human skeleton series is alternately produced in plus and minus serial quantities. The cranio-facial apparatus is plus, the cervix is minus, the thorax is plus, and the loins is minus ; and just as the series of 9, may be varied as to quantity, so is the series of a thoracic archetype varied as to quantity.

Fig. A, the skeleton of a New Zealander, compared with fig. B, the skeleton of a Negro, proves a morphological identity between both forms. The same number and relative position of elementary parts are visible in the two figures. So, also, are the like parts found in the skeleton quantity of a baboon, a mandril, an orang, or a chimpanzee. But whenever we discover a plus variety to happen between forms of the bimanous species, or those of the quadrumanous character, that plus variety is created upon the transition units standing between two regions of series.

The plus cervical or lumbar costa may render fig. A various to itself. So may the like formation vary the fig. B from itself. The same may occur for any of the quadrumanous species, and thus we find that plus and minus proportioning varies individuals of one species. Why may

it not be the same law of proportioning minus from plus which renders all the individuals of all species various to each other? Hence, also, arises the question, what is the form of that archetype serial quantity from which the law of metamorphosis subtracts certain parts for the creation of species? If plus contains minus, then plus must be the archetype unity; for it is evident that minus cannot contain plus, and cannot, therefore, contain unity.

Fig. A equals fig. B, as to present created quantity, but fig. A, as we now see it, is minus to itself when it, or its fellow, shall produce cervical and lumbar ribs; and when once it produces these plus quantities, it becomes archetype of fig. B, as well as of its former self.

The knowledge of a plus sum or whole quantity, taken as standard unity, together with the knowledge of the law of metamorphosis, becomes the span and encompassment of all the multitudinous conditions of minus variety. It is sufficient to understand, at first sight, how possible it is for the law of subtraction to vary a whole quantity to infinity, without following this infinite degradation, for while we freely grant that the integer 9, or the series of 9, may pass through a metamorphosis sufficient to create special differences in infinitely infinitesimal account, then the choice of pursuing this endless process and evidence of creation, can never furnish us with an idea new to those which we had already entertained of the same. Two plus integers, such as 9, and 9, are plus equals; two plus costo-vertebral archetypes are likewise equals or homologues; a series of the integers 9, will form a plus and uniform series, however far we extend this serial line; and a series of plus costo-vertebral archetypes will also establish a plus series of those forms, however much nature extends such line, in fact, or we ourselves, in idea.

When we substract from the integer 9, any given quantity, such, for example, as 5, then the integer 9, is left in the condition of 9−5, that is to say, 4. When nature subtracts from the costo-vertebral archetype a certain costal quantity, then this archetype is left in the condition of a cervical or lumbar vertebra. When subtraction takes place upon the integer 9, to the amount of the quantity 8, then the integer 9, is reduced to the proportional 1; and when the costo-vertebral archetype is submitted to a metamorphosis in extreme degree, then this archetype is reduced to a caudal nodule.

When from two integers, such as 9, equal quantities,

such as 5, are subtracted, then the two integers 9, and 9, are reduced to 4, and 4. When a certain amount of subtraction takes place upon two costo-vertebral units of the plus series, then those archetypes are left in equal minus condition, such as we find in two cervical vertebræ, in two asternal costo-vertebral forms, in two lumbar vertebræ, in two sacral or two caudal quantities, all of which will vary from thoracic form according to the degree of subtraction practised upon their common plus archetypes, which are of thoracic quantity.

When upon two serieses of 9, equal degrees of subtraction take place, then the original series of either, which was 9, 9, 9, 9, 9, &c., is reduced equally, for either, to the series of 9, 8, 7, 6, 5, 4, 3, 2, 1, in one place, and 9, 8, 7, 6, 5, 4, 3, 2, 1, in another. And, when from the original serieses of costo-vertebral archetypes equal degrees of metamorphosis annihilates quantity at *the same numerical units in both*, then the forms of series which result are such as figs. A, and B, now present. Hence it will be seen that equal metamorphosis, carried out upon the plus original serieses of costo-vertebral quantities, is that law whereby figs. A, and B, and their like, through all the human type are now special homologues; but we, at the same time, may readily understand how they could be varied to each other, by the simple process of subtracting unequal quantities from numerically different units of their plus originals. It is solely owing to this latter mode of formation that we occasionally find fig. A, different to fig. B, in respect to the surplusage of ribs at neck or loins; and who will deny that the varieties of all animal species take rise by the self-same process of formation?

The plus uniform or archetype series is that quantity upon which the law of metamorphosis is exercised for the creation of special variety. When we shall know of this serial original or prime model, then shall we be enabled to refer, not only all " normal conditions of form " to it for explanation, but even all the "abnormal varieties,"* which have, or can have, or do actually happen to any created design of skeleton form, whatever. For by the simple law of subtracting from whole quantities, it is possible to include the infinite minus variation as they at present stand upon the globose surface of this planet's actual state, or as they have appeared in all the past epochs of time, since in the sentence of " unity in variety " is summed up all the evidence of the one law of creation.

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* " Une personne de votre pays m'a assuré, que feu M. de Barsabas et *sa sœur Religieuse*, tous deux fameux par plusieurs traits qui marquent en eux une force extraordinaire, avoient une queue.† "—" Du reste il est constant que cette race d'hommes à queue est beaucoup plus nombreuse qu'on ne se l'imagine ; et que ce proverbe si commun parmi vous (homines caudati) pour désigner des gens sans esprit, n'est nullement métaphorique. Il est fondé sur la vérité §. Il y a beaucoup de ces hommes en Ethiopie : il y en a aux Indes, en Egypte, en Angleterre, surtout en Ecosse. Toutes vos rélations en font foi."—Maillet, Telliamed, *Sixième Journée. De l' Origine de l' Homme, &c.*

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† " Nullum characterem hactenus eruere potui, unde homo a simia internoscatur."—Linneus, *Fauna Suecica*, Preface.

§ We do not make use of this experience of the French author as though we implicitly believed in the anatomical occurrence of that outer appendage which interests him in regard of human formation. The *nihil frustra* being that law in Nature which gives creation to no form which fitness does not absolutely require ; it is, therefore, that the human spinal axis manifests its present condition as terminating at that place where the anatomist *invariably* finds the coccygeal series of ossicles. We say invariably ; but this assertion can extend no further than what we have ourselves found, and what we have drawn from the verbal testimony of others. Let us therefore, if it be possible, regard the subject with a serious air ; let us for the time forget Monboddo, Ackermann, Lamarck, Rousseau, Maillet, and that school. Let us only consider the fact— *the coccygeal fact*—and draw its meaning according to the evidence of comparative science.

Plate 49.
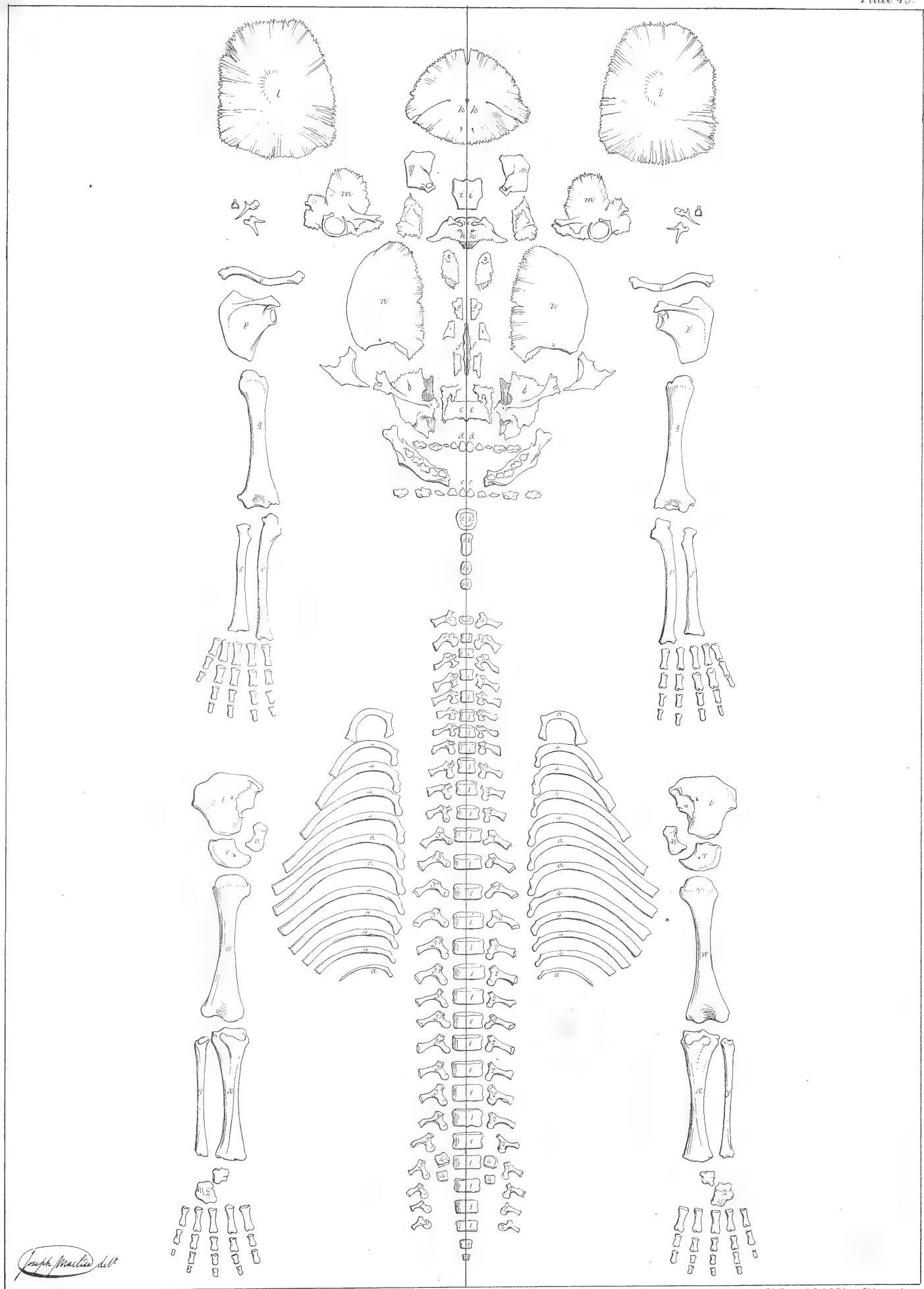
REMARKS ON THE FIGURE OF PLATE XLIX.

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THE LAWS OF SYMMETRY AND SERIAL HOMOLOGY PRESIDE OVER THE GENESIS OF FORMATION.

QUANTITY is not created equally for all forms which are produced of the same order or cast. Skeleton quantity is not equal for all animal fabrics. Not only is this the fact with regard to the skeleton forms of the four animal classes of mammals, birds, reptiles, and osseous fishes ; but even mammal forms themselves present unequal skeleton quantities, and the same inequality of osseous quantity is manifested amongst birds as a class, amongst reptiles as a class, and also amongst osseous fishes. Equality or absolute uniformity is not in Nature. Inequality may be seen to characterise even two or more human skeletons at the adult age. And as, through all the phases of development or formation, inequality is the word, so is there no other condition of formation presented to the contemplation of the comparative anatomist, except that of minus quantity standing in the presence of plus quantity. The law of serial proportionals is, therefore, the only existing theme ; and serial progressions and proportions is the subject, whether we rise with the growth of the individual framework from infancy to manhood, or pass, with the operation of this transcendent law, from one extreme to the other of an animal kingdom. What the giant is to the dwarf, the adult is to the fœtus, viz., a plus fabric in presence of a minus quantity. Where then is uniformity ? If absolute equality or uniformity cannot be found either in the individual at various stages of its being, or even between two beings of one species at the same stages of formation, or even between any two beings of an animal kingdom at various or the same phases of development ; if an ever-moving metamorphosis be the law of Nature, which, by the creation of inequality everywhere, leaves equality or uniformity persistent nowhere ; what then is to be the goal and object of comparison ? This object resides in the differentials of serial proportionals ; and we believe that the exact knowledge of the quantity which differences proportionals to one another, can never be attained without having some fixed standard of comparison, to which, as being uniformity or the whole quantity, those infinite proportionals may be referred. Therefore, uniformity is the rational object of the comparative method, and equation is the means by which we are to develope the ideas of it.

The endo-skeleton increases from minus to plus quantity in the individual animal body. In the embryonic state of the mammal body the skeleton fabric is minus. In the adult state of the mammal, the skeleton has become plus, and hence the adult state must be regarded archetype of the embryonic state. The process of growth is the process of perfectioning. 'Tis true that the fœtal condition of a skeleton quantity is as perfect and fitting for that stage of the being as the adult full skeleton quantity is for the adult being ; so, therefore, what we here mean by the term "process of perfectioning," is the process of increase from minus to plus quantity, the addition of quantity to the fraction, until the integer be created. Every stage of development for the individual skeleton which has added an elementary part to the quantity existing at a former stage, may be regarded as archetype of all former stages of the growing ens, and every arrest of development at any one stage of the individual's growth, may be regarded in the light of subtraction compared with adult quantity, forasmuch as the form is similarly affected whether it be arrest of development or subtraction of parts. If the 12th costa be never produced,

the effect is the same as if, after having been developed, it were again subtracted. Under those ideas all fashions of endo-skeleton produced in the four great classes may be interpreted, when it will be seen that all variety is only minus quantity arrested in some one stage of development between extreme minus and the plus integer or archetype quantity.

As, in general, the adult stage of the individual skeleton figure is plus compared with all prior stages of that form in process of growth, so must the adult stage be accounted archetype of all the earlier minus stages. And upon a general survey of the skeleton quantities of the four classes, as we discover that variety is alone produced by minus proportioning, subtraction of quantity, metamorphosis, or arrest of development, all effecting the same thing, so have we chosen to regard that skeleton which is plus of all the series of class and species, as the archetype, or integer, or fullest quantity. For, compared with this skeleton archetype, it will be seen that all varieties are but as minus quantities.

Now the skeleton form which is destined to be symmetrically produced at adult age, is deposited in the embryonic stage also symmetrically. The law of serial and symmetrical arrangement governs nucleary deposition as well as adult fashioning. And, though it appears most true, that all skeleton species are but as the varieties of plus and minus, the archetype unity under metamorphosis, still, it is not correct to say that skeleton forms of the higher animal classes have passed through stages of development similar to the adult stages of all the lower classes. It is not correct to say that the mammal skeleton form was, at one stage of growth, identical with a bird, a reptile, or a fish; for we see that the adult cast of every species is previously sketched out in its embryonic condition. Two skeleton quantities, which, at adult age, manifest the plus and minus condition, have, even at the fœtal stage of development, been also plus and minus as to elementary quantity. The opposite figure of a human fœtal skeleton is, even at this stage of growth, indicative of the adult human form and no other.

The common median line bisects the fœtal skeleton as completely as that of the adult. The fœtal skeleton, indeed, is already naturally cleft through the median line. The parietal bones l, the frontal bones n, the temporal bones m, and the maxillæ, are all bipartite at birth. This median line passes through the centre of k, the occipital bone; through $i\ i$, the basilar element; through h, the sphœnoid bone; through f, the vomer; through e, the palate bones; through d, the incisors of the upper maxilla; through c,

the incisors of the lower maxilla; through b, the sternal pieces; through all the serial homologous elements of the primitive spinal chain marked 1, 2, 3; and through all the costal forms in series from a to a.

The pectoral limbs marked o, p, q, r, s, are symmetrical opposites *. The pelvic organs marked t, u, v, w, x, y, z, are symmetrical opposites also. All the elementary pieces happening on one side of the median line, are repeated by homologues on the opposite side, and all the serial homologous pieces, such as those marked 3, or 2, or 1, are representatives of each other. The costal forms are also laid in serial order, and thus we see that the law of series, as well as the law of symmetry, are creative of homologues. If we name the symmetrical rib of one side a, and that of the other side 4, this difference of name does not spoil them of their identity as to form; nor if we name the costa of series as a, and another of the same series as 4, does this difference of title deprive them of their homologous cast. Serial order, as well as symmetrical order, expresses the homology of form, whether it be of fœtal or adult growth.

Every animal skeleton, at every phasis of its progressive development, may be accounted an integer or plus quantity compared with all its prior stages. Every adult human skeleton is a sum-total or whole quantity which may be said to contain the infinite phascal variety of all its earlier and minus conditions of growth. Every fœtal and all immature stages of formation are, to the adult normal cast of form, in that same ratio which every past stage of the now adult figure bears to this same figure. Every form, as it at present stands, is various to all those prior conditions in which it once stood. Hence, every form which is, is special to what it formerly was, and special also to what in future it will be. There is nothing fixed in Nature. There is no death chemically speaking, and there is no staid endurance to any phasis of development anatomically speaking; for is it not absolutely thus? Variety is infinite; the individual form is a history of infinite variety; and who, therefore, shall number the osseous elements of any skeleton fabric? † Where is the integer or whole quantity of form? To this we answer that the adult stage of every being is the entirety to all its immature phases of growth; and when we ask, where is the whole quantity of all special varieties which stamp the infinite characters of all individual forms, we answer, that it is the plus sum or archetype which we are proceeding in search of, for in the degradation of this quantity may be seen the infinite operation of a law.

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* "Il y a des os, qui seuls sont symétriques, c'est-à-dire, qui ont une certaine réciprocité de côté et d'autre—ces os sont impairs et placés dans le milieu, qui distingue la partie droite du corps de la partie gauche. Tous les autres os, pris séparément, n'ont point de symétrie; mais chacun d'eux, pris avec celui qui lui répond de l'autre côté, fait une figure régulière; ces os sont pairs et placés à droite et à gauche."—Winslow, *Exposition Anatomique de la Structure du Corps Humain.*

† Authors are not unanimous as to the number of bones proper to the normal cast of adult human formation. Not only does the numerical method transcend the labours of the Anthropotamist by the variation of the number of osseous pieces which are seen to compose the being at different stages of its development, but it is also a fact that manifold varieties, in this respect, characterise two or more adult human skeletons. Hence, we find Meckel numbering the bones to the amount of 253, Monro and Sœmmering reckoning them as 260, others as 197, and Cruveilheir 198. The uncertainty and confusion which attends this mode of computation is mainly owing to the circumstance of a separation holding permanently between two or more osseous pieces which, in other forms, obey the law of fluxion.
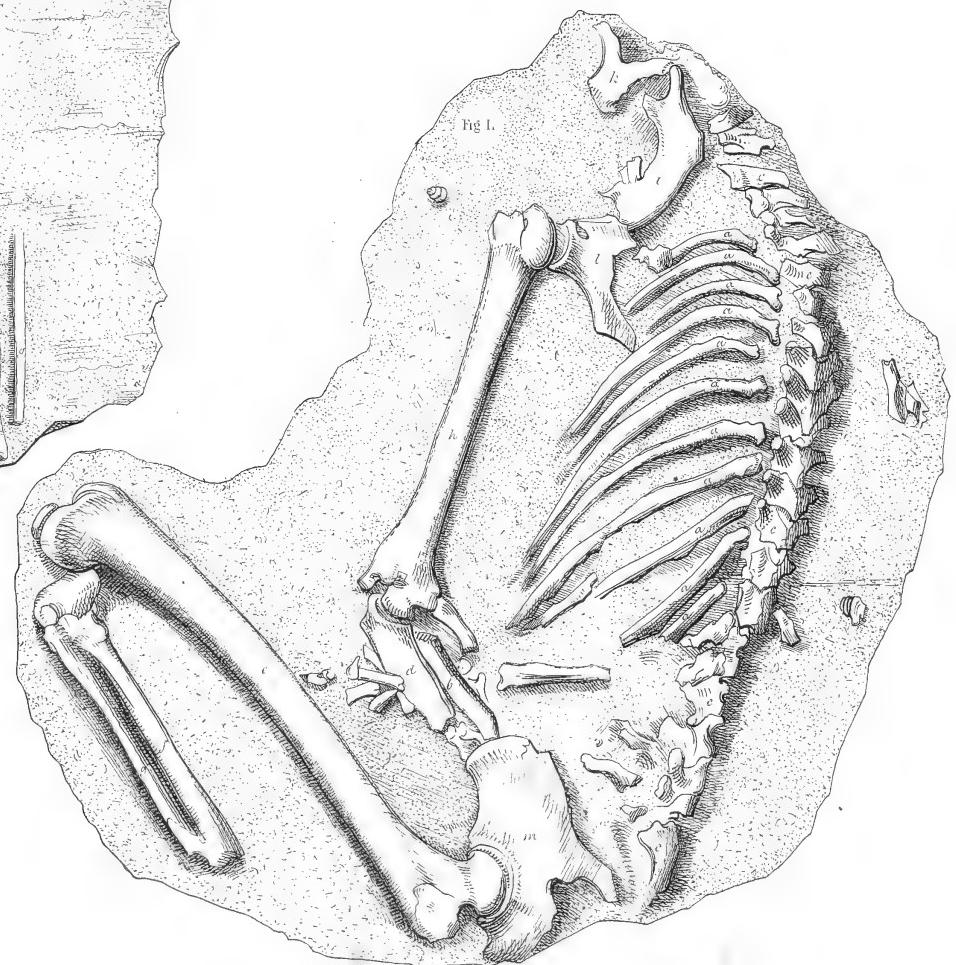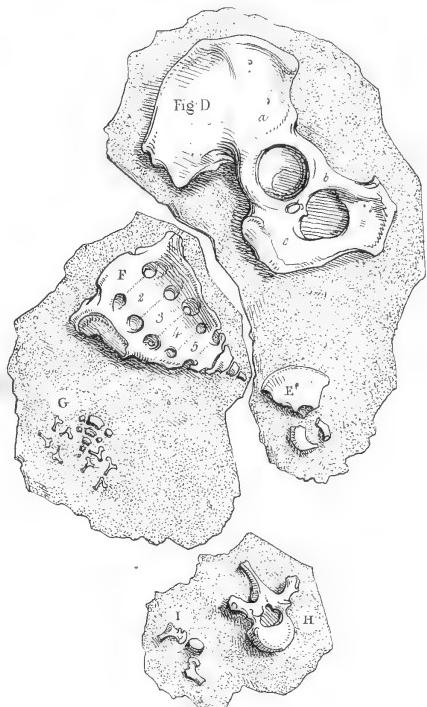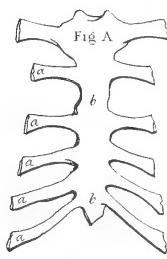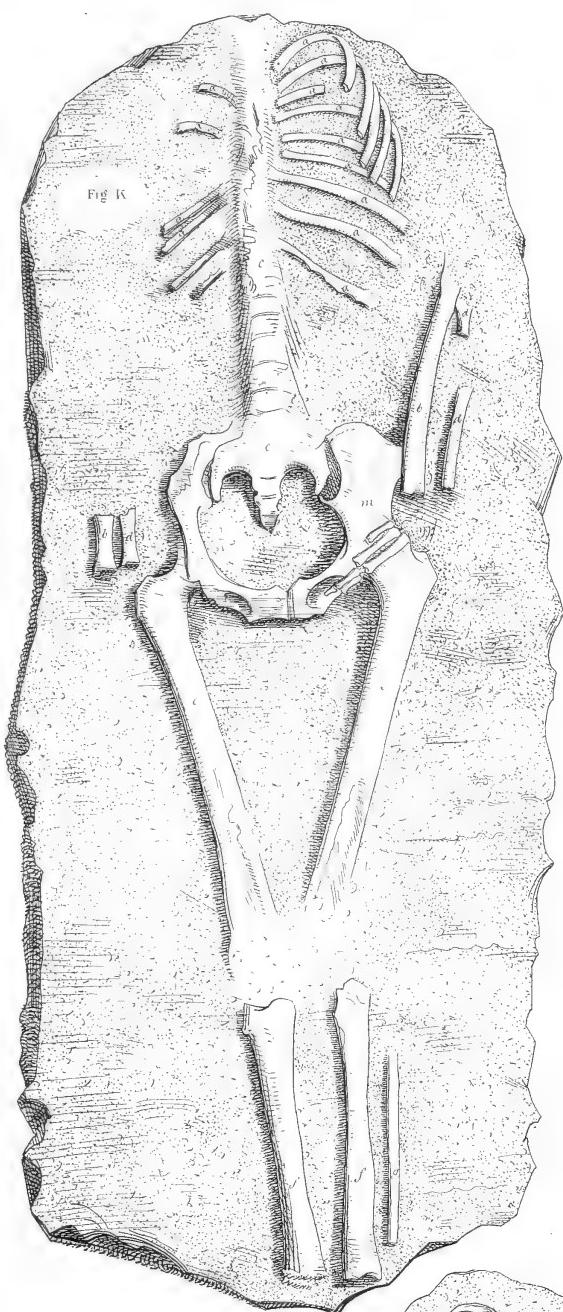
Plate 56

Fig A

Fig D

Fig K

Fig L

REMARKS ON THE FIGURES OF PLATE L.

FRAGMENTAL VARIETY NATURALLY COMBINES TO ESTABLISH THE INTELLIGIBLE FORM OF UNITY.

PLURALITY is always attendant upon the dismemberment of parts which are proper to a whole quantity ; and as the parts of a whole may be infinitely subdivided, so will variety be infinitely multiplied in the same ratio. Comparison, therefore, may have its choice of two different modes of study, viz., the infinite and the finite ; the former being the pursuit of special variation, the latter being the reconstruction or adaptation of all various parts for the purpose of fashioning forth the whole quantity or unity. Unity or the whole is finite, and therefore the reason worships it as being a thing encompassable by the understanding. Species or variety is infinite, and therefore the reason renounces the pursuit of it as being a condition of form immeasurable and boundless as time, space, or number.

The subdivision of any given integer into its parts is the creation of species, and as subdivision may be infinite, and hence yield the infinity of species, it is all-sufficient to know this fact, and set it aside as an idea which can never be rendered more perfect than it is at present, for we can never outpace the possibility of special operation or the creation of plurality, even if we held a lease of time and counted facts by the myriad every moment.

The part expresses its relationship with the whole, otherwise the part has no meaning considered as a thing *per se.* A caudal ossicle, an epiphysis or a phalangeal bone describes itself as being a thing produced as part of a whole skeleton quantity ; or, if either of such parts be unaccompanied by this interpretation, it is altogether unintelligible. Unity or the whole quantity suffers a division into its integral parts ; such parts are the species of unity or the whole quantity, and if the species do not interpret themselves as being the parts of unity, then they express nothing truthful or interesting considered severally and isolatedly. Every fragment or species of the human skeleton form is a thing relationary to this form. And every fragment, part, or species of osseous quantity developed amongst the four animal classes is related to and expressive of some whole quantity, unity, or integer, whose dismemberment has been their creation.

It matters not as an objection to the present argument, whether adult skeleton quantity be rendered minus by accidental subtraction, or whether it takes place by natural design, and through a natural law of formation, for still the ideal restoration of lost parts is, in either case, a mental operation, assisted by the rule of analogy.

Our knowledge of the normal quantity proper to any adult skeleton figure, teaches us of the quantity of which accident may have rendered it minus, and it is by the homology of skeleton creation, and by the comparative reasoning, that we ascertain clearly how much is plus or minus to any skeleton species.

For example, fig. K is a fossilized human skeleton, minus in quantity to that which we know to be proper to the human species. We know well that fig. K is now in minus condition. How do we know this ? We know it by the rule of analogy, by the homology of form, by the unity of organisation, by the previous knowledge of the quantity proper to a normal skeleton, and by comparative reasoning. Hence, when we compare fig. K to the complete plus human skeleton, we then can unerringly ascertain how much is wanting to the thorax, spine, pelvis, and limbs of fig. K.

Now, already understanding that fig. K, such as it presents to us, could never have been a fitness as to human form, we then do not turn to compare it with fig. L, which is also a minus quantity compared with the human plus figure. We do not compare minus with minus in order to

know the sum of quantity subtracted from either fig. K or fig. L, but on the contrary, we turn at once to the full human skeleton form; and it is this plus design which tells us that varying quantities are lost to figs. K and L, which renders them thus various to each other as to quantity, and various also to the complete human skeleton as to quantity, but still we clearly identify the parts standing for each, as not being new creations. This is unity rendered various by metamorphosis or subtraction, and it is the knowledge of the normal plus human quantity which informs us how much is minus to figs. K and L. Therefore, it is self-evident that if we had to characterise unity between figs. K and L and the plus human skeleton, we must turn to the latter, and knowing it to be plus, call it the archetype unity of the minus figs. K and L.

Now, it is just by the same simple process of comparative reasoning that we are to learn the figure of that archetype quantity of a skeleton which is unity or plus to all special skeleton varieties, which latter are but the several minus proportionals of such a plus archetype. Fig. K is not now equal to fig. L, but still both can be rendered equal when both are equated with the normal plus skeleton quantity, for this quantity is archetype of them. There is in Nature a plus archetype skeleton form, from which Nature subtracts quantity, and thus creates proportional variety, and it is only by a rule of equation held between every skeleton minus quantity and the plus archetype that we can ever hope to regard unity, or estimate the law of design.

There is a broad difference between accidental subtraction of skeleton quantity and that which Nature designedly performs upon her prime model or archetype, and it is this, namely, that where we ourselves, or unmeaning accident, occasion an absence of parts or hiatus in full quantity, we but lessen form without increasing fitness; we subtract form and at the same time we annihilate design, as, for example, fig. K or L; but where, on the contrary, Nature subtracts quantity from her plus archetype, she still creates her all-perfect marvels of design. She obliterates the costal quantity from some mammalian skeletons, and creates for these the regions of a cervix and lumbar spine, which regions are not found in certain other skeleton figures, because the plus archetype of costo-vertebral series still fittingly persists for these, and hence the cervix is wanting.

The part is ever expressive of the whole quantity, when once we have known the whole. Even the part, at primitive stages of development, expresses the whole history of genetic changes destined to take place afterwards in the lifetime of the being, when once we know this history. Thus fig. C, a fœtal sternum, suggests the whole history of sternal growth through which it is destined (according to the immutable law) to pass. Figs. C, B, and A, are serial genetic changes for sternal form, from fœtal condition to the octogenarian stage.

We say that our ideas of a part are inseparable from that continued enchainment of ideas which encompasses the whole form, whether this latter be present or absent. It is impossible to regard either fig. D, E, F, G, H, or I, separately from the idea of that entire connected skeleton quantity of which those figures are the parts. An articular surface invariably suggests the idea of some other skeleton element with which that surface articulates, and thus it is that the mind cannot choose but to rise to the survey of a whole quantity.

That part which, by accident or human interference, has been separated from an entire quantity, could not have been produced in Nature isolatedly. Fig. F, the sacrum, and fig. D, the ilio-pubic bone, are elemental parts, which have been created within an animal economy. They can have no other proper name than that of being parts of the human skeleton entirely, therefore we cannot view them rationally without their suggesting the idea of a whole quantity.

The skeleton unity of the four animal classes must also be a full quantity or archetype. Unity can only properly attach to a skeleton archetype. Plus quantities are those only which, being equal to each other, can be said to contain elemental quantity homologous to all minus proportionals of themselves. It is very true that two or more equal proportionals may be accounted as homologous to each other as two or more archetypes are to each other; but then the name proportional demands of what whole form the element thus named is the part. Two or more semicircles are homologues of each other, as well as two or more circles are of each other, but the archetype quantity of semicircles and segments is the circle; and so, the fullest skeleton quantity in Nature must be the archetype of all skeleton proportionals, whether these proportionals result by natural subtraction from archetype quantity or by accident. If the archetype quantity be unity, then the part of such a quantity cannot be unity.

In figs. K and L*, we have marked similar pieces with the same letters, and both figures, as they present themselves, can have their lost quantity restored by comparison with the perfect human skeleton type. Now, the complete human skeleton itself, however perfect it may be as to design and fitness, is nevertheless to be regarded as a proportional of the skeleton archetype; and it is in this light only that we can clearly comprehend its present design, and the law of its formation.

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* These figures represent the two fossilized human skeletons "découverts à la Guadaloupe dans une rocher formée de parcelles de madrépores rejétées par la mer et unies par un suc calcaire." Our object in copying them was merely for what we have described in the text. They have been found embedded *in a rock*, which though it would require the thunderbolts of natural truth to split and give egress to the spirit of truthful interpretation therein immured, and watching over the contents, has been readily dissolved and rendered light as air by the touchstone of that reputation which surrounds the name of Cuvier preceding the following assertion—"Il est certain qu'on n'a pas encore trouvé d'os humains parmi les fossiles; et c'est une preuve de plus que les races fossiles n'étaient point des variétés, puisqu'elles n'avaient pu subir l'influence de l'homme. Je dis que l'on n'a jamais trouvé d'os humains parmi les fossiles, bien entendu parmi les fossiles proprement dits, ou, en d'autres termes, dans les couches régulières de la surface du globe; car dans les tourbières, dans les alluvions, comme dans les cimetières, on pourrait aussi bien déterrer des os humains que des os de chevaux ou d'autres espèces vulgaires; il pourrait s'en trouver également dans des fentes de rocher, dans des grottes où la stalactite se serait amoncélée sur eux; mais dans les lits qui recèlent les anciennes races, parmi les palœothériums, et même parmi les éléphants et les rhinocéros, on n'a jamais découvert le moindre ossement humain."—Cuvier, "*Discours sur les Révolutions de la Surface du Globe*," sixième édition Française, p. 135.

Plate 51

Fig A

Fig. B
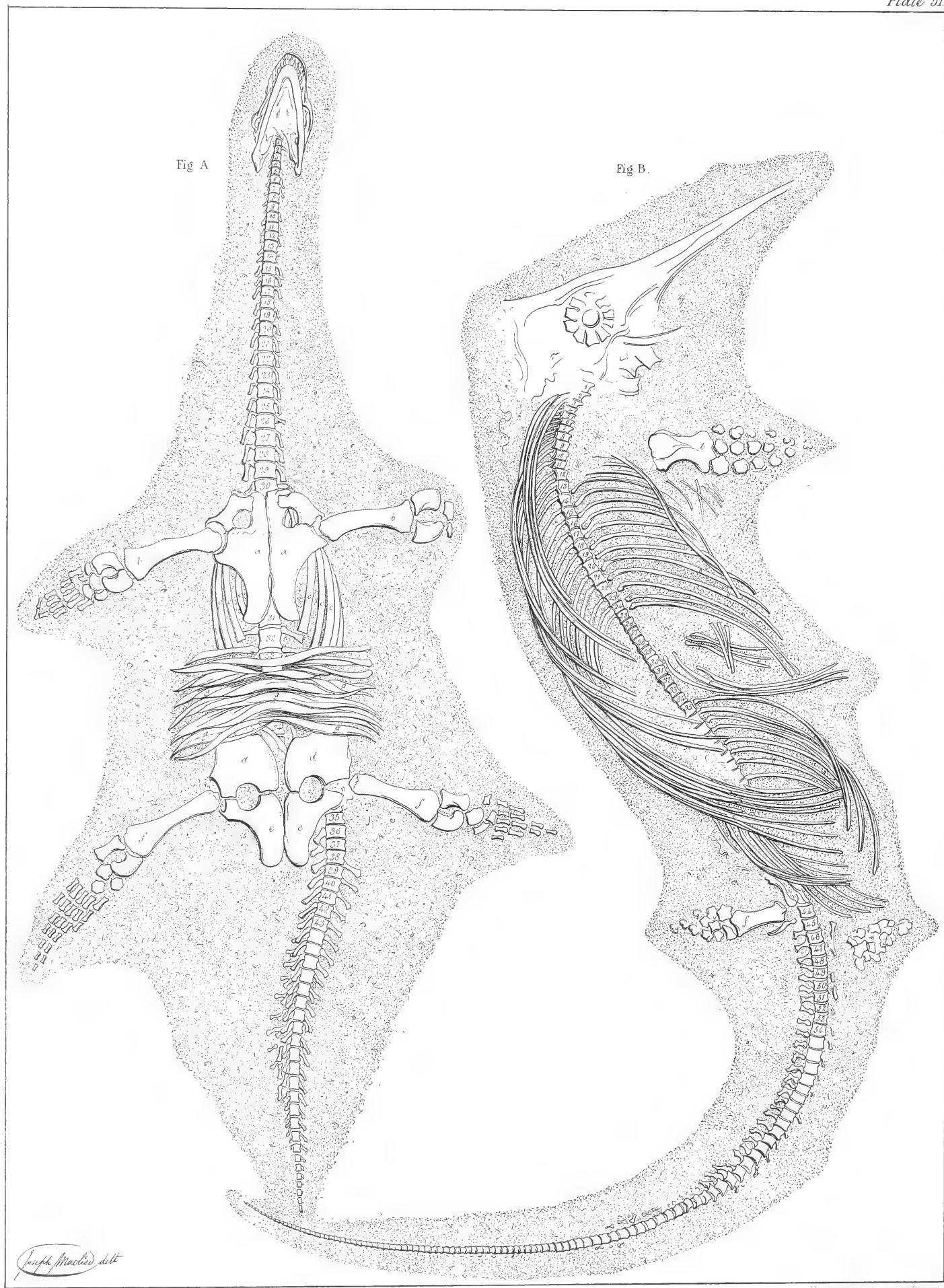
REMARKS ON THE FIGURES OF PLATE LI.

FOSSIL REMAINS BEAR COMPARISON WITH RECENT STRUCTURES.

TIME, space, number, and metamorphosis, are those conditions belonging to the *natura* which are without limitation. The actual and mathematical state of fact regarding these attributes of Nature is immeasurable immensity. The universal has no boundary line, and therefore it must follow that the origo and finis, having no absolute occurrence in Nature, are ideas which the mind creates as descriptive of its own infirmity or finity. The mental, like the physical eye, has a limited vision, and therefore all limitation is only absolute and real with regard to the faculty which draws it. That which seems to be a boundary line is not one in fact and with regard to Nature, but it is one in fact with regard to *mens*. The mind, by reason of its own incapacity, becomes its own obstruction, and carries no further than its strength will allow it to advance. Its own weakness creates its own ΟΥΡΑΝΟΣ or horizon, and when it penetrates into the vast expanse of time or space it makes a measurement of itself only. The abstract and general state of truth has never yet been manifested, nor will it ever be explained. A demonstration of the full glory and majesty of entire truth would be, instead of a favour granted, a boon to no purpose, for the human mind is not a fitting recipient for it, has not a capacity equal to receive it, and therefore could not acknowledge to the gift.

The utmost stretch of human capability in reaching to truth is the recognition of a law founded upon the natural concatenation of relationary facts or phenomena; and this general manifestation, which we designate a law, encloses the mind which recognises it as within a circle; for a law, whatever way we turn to consider it, is, while we stand at its centre, still equidistant from us on all sides, and still circumscribing us as a fact whose commencement and termination is nowhere. The law of skeleton formation includes within its compass as well those remains of extinct races of animals as those now existing, and this law furnishes to us no real evidence of either a first or last passage in the act of creation with regard to this planet's history and age.

The skeleton part relates to the skeleton whole,—this to the animal,—the animal relates to its proper element, whether land or ocean,—these relate to the natural world, and this to the planetary system,—this system to countless other systems, and these to the whole regions of space. The enchainment of ideas holds together continuously as far as physical vision can take in an impression, but all beyond this operation is void, unless we people this void, as some propose, with vertebrated animals.

But the skeleton part is not equal to the skeleton whole. This skeleton is not the animal. This animal is not its proper element either of land or ocean, and for the same reason may it be added that neither element has of itself ever constituted all nature, at any one period of past time. It is when we begin to generalise with the part as though it were a whole quantity, and complete created design, that we commence to err; and perhaps when we hear it said that figs. A and B once formed the general character of animal nature, peopling the then existing state of things, the idea may be no less absurd than if, on meeting with a vertebra isolated and apart from all the subject with which it naturally connects itself, we gave it the name of the osseous skeleton entirety. Be this as it may, however, the anatomical remarks which may be made respecting the forms of figs. A and B may be well separated from the question as to the probable state of nature to which such animal frameworks had in a bygone age been fitted. Viewing the skeleton conformation of a Plesiosaure and an Ichthyosaure, we now know them to be anatomical facts not so totally difform to existing skeleton species as

that they may not be comprehended under an interpretation springing from a knowledge of the law of unity in variety, as we find it existing and operating at the present hour.

Fig. A, the skeleton form of a Plesiosaure, manifests itself as being a structure fashioned of plus and minus serial figures. The general form of this skeleton is symmetrically developed, and the serial structures from cranium to the extreme caudal nodule express the arrangement of serial homologues subjected to the rule of proportioning. The length of its cervix is owing to the number of those serial units which have had costal quantity subtracted from them. Their costal circles have been withdrawn, no portion of which structures remain except the proximal extremities. The caudal series of the units of fig. A likewise manifests the graduated rule of proportioning from archetype quantity. We see the thoracic series of units producing the costæ marked *c*, and also that the ventral region of costal series produces the costal quantities marked *g*.

In fig. B, the Ichthyosaure skeleton, we find that the same law of fashioning minus from plus quantity has rendered it specially various to fig. A. The costal structures which are minus at the cervical units of fig. A still persist at this region of series in fig. B, and therefore it is that the units succeeding the occiput of fig. A have been struck in cervical fitness, whereas the like numerical units in fig. B still remain in thoracic character.

The caudal regions of series in fig. B and A demonstrate the law of graduated proportioning, and both figures may be cleft symmetrically from the cranium to the extreme caudal bone by the common median line. This mode of cleavage can only happen to those forms whose archetype series is one of costo-vertebral quantity, and whose special plans are such as result from archetype series being subjected to proportional degradation or metamorphosing subtraction.

We shall afterwards see that the now extinct varieties of figs. A and B do not stand beyond the girding circle of archetype unity rendered proportionally various, any more than do the existing skeleton species of a Swan, a Porpoise, and a Lion.

We here remark that the extinct fig. A is not more difform to the extinct fig. B than the existing creation, an Ostrich, is to the existing form of a Whale; and moreover the fact is demonstrable that the extinct form fig. A is no less comparable to the existing form of an ostrich than this latter is to any one of its existing vertebrated congeners. Whereupon we say that as a common analogy of type spans all the multiform *existing creations* of the four higher classes of animals,* and as the direction in which science is at present advancing is to interpret all variety as it now exists to be sprung of unity by the exercise of some force or law, so therefore as the hope remains for gathering together under one law all present varieties which manifest no greater contrast to each other than they do to figs. A and B, the hope may be also entertained that figs.

A and B may, one time or other, bear an interpretation more consonant with reason than what the Geological song, the Miltonic rhyme, or the epic verse of Dante can furnish. What! have we not all enough to struggle with while heaving along upon this raft of reason through the open and shoreless ocean of time and space to which hypothesis alone can furnish limitation, without conjuring up those daggers of the mind from the "Inferno" of a fevered imagination, and because in a state of delusion itself regarding the past or future of body and the natural, must the mind therefore people the foregone or the forthcoming period (which it is equally ignorant of) by any other fancies which, not coinciding with the existing laws of order, must therefore be chimerical disorder. We are as liable to transcend the bounds of the natural, when seeking for the interpretation of a fact which may not be within the limits of our present rules of causation, as we are to fall short of the natural truth which such fact expresses, by reason of our own incapable effort in the explanation of the same. A fossil bone extracted from the soil of England serves the Geologist either as a proof of "sudden and universal catastrophy," in past time, or else it is called a "*jeu de la nature*."†

Our generalisations, if they be founded upon the observations of relationary facts at present in Nature, should not include within their measure any mode of interpretation regarding the past but such as will rigorously coincide with natural, that is to say, possible and existing operation. What can we reason but from what we know? Nature is order, and we know it. If Nature has been, in past time, disorder, how can we know of it? Is it because we dig out of the Lias and Oolitic "secondary formations," fig. A or B, combining the characters of a bird and a dolphin, that we are therefore to idealise the past of Nature as being either a dreary sea-shore or universal swamp, and draw the frontispiece of our "books of sea dragons" according to the slime and ruin of this libellous fancy? when in fact we are as totally ignorant of the relative age of strata from Post Pliocene down to the Silurian rocks as we are of the first or the future appearance of this planet's entire framework. How stands Nature as she is, despite her law of metamorphosis, and her creation of forms no less bizarre to one another than figs. A and B are to each other or to them? Is Nature now all ocean to suit the oary limb, or is she now all forest gloom to be the habitation of lions and the elephantine denizens only? Is she all night because the vampyre lives? Is she all day because the eagle soars? How is it that when we generalise upon past Nature we may know where we err? It is by idealising to an undue magnitude any single fact in presential Nature, and judging of the result which, though it may be a source of the sublime in idea, will still be nothing else than the sublimity of nonsense. For when Euphrates overflows its banks, the Hindoo, in his sublime panic, drowns the moon, and all Nature to him suffers universal catastrophe, because to every self the self is all; but is this Nature's

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* "Cette vérité est incontestable ; car un coup d'œil rapide jété sur le règne animal nous a convaincu qu'il existe un dessein primitif qu'on retrouve dans toutes ces formes si diverses."—Goethe, *Œuvres d'Histoire Naturelle*, Introduction, p. 42.

† "Ces pierres figurées sont fort communes ; on les appelle Zoomorphites quand le jeu de la nature leur a imprimé la ressemblance imparfaite de quelques animaux."—Voltaire, *Des Singularités de la Nature.*

order? Are the interpretations of the Palæontologist, the Geologist, or the Cosmogonist much more according to reason and the physical laws than this? And when these talk of "carboniferous ages," of the "age of reptiles," of "cataclysms," of "nebular states,"* of "universal fire," of "universal flood," of the "Neptunian or Plutonian times," of genesis in all, and all in genesis, what is it else but vagrant and bewildered fancy? Whence is its source but in omnipotent self, that regent whose eye, if a cataract should blind, pronounces all to be enveloped in its own robes of universal night. As it is with physical so it is with mental vision, for to this latter, ignorance is a cataract in its eyeball which causes darkness, and which raises the magician in all its walks, acknowledging that "the earth hath bubbles as the waters hath, and these are of them," figs. A and B, taken as the type of "a reptilian age."

And suppose it be granted that figs. A and B are expressive of some change in animal form, is it therefore necessary that we must, in order to suit with this simple evidence, bend all the order of a starry host and the immutable laws of φνσις to any other condition in the past than what we know of in the present? May it not be probable that when doing this we are only admitting an error in generalisation? such as some Mongol *savant* of a future day will be committing when digging out of the Ganges Delta a crocodile's remains now fossilizing, he shall hold it up to his wonderstruck auditors and proclaim it to be a type of this our own "age of reptiles." If it were said that, all circumstances considered, the past state of this planet at the period which we name, "secondary" in stratification, when figs. A and B, and their like, are supposed to have represented an animal kingdom, is as far from truth as what the blind mole conceives of the whole and general fact of the nineteenth century; we believe that it would be as impossible to find a mathematical confutation of that opinion as it would be to freeze torrid Sol at the equator with the gentle passages of a silken fan; and we have heard it said by one who is acknowledged at present to manifest in advance of the Cuvierian doctrines what the adult understanding contrasts with foregone immaturer imagery, that with the existing sum of Geological evidence it would be no less absurd to advance a generalization in respect to the truth of any mundane epoch in past time than it might be to chronicle, as the actual truth, all which the peasant fancy entertains of what exists on this and the other side of the drop-scene of the blue concave. We blind ourselves with that generalisation which a single fact gives rise to in the mind's eye; and just as it is possible to eclipse with regard to ourselves the sun in the heavens, by drawing between our eye and it a saurian's bones, who knows but when those bones are held so as to intercept our view of the luminary of probability in regard to the past that this is the sole origin of the eclipsing idea of "Reptilian ages." The Siberian mammoth's bones have successively frozen, burned, and flooded with a rush of southern waters, the

natura in the imagination of Gmelin, Pallas, Buffon, Camper, Blumenbach, Cuvier, and just as poetically

——————— to set forth
Great things by small, *if Nature's concord broke,*
Among the constellations war were sprung,
Two planets rushing with aspéct malign
Of fiercest opposition in mid sky,
Should combat, and their jarring spheres confound.

Comparative osteology as studied under the present view will, in spite of our willingness to bind it within recognizable limits, still branch out into the subject of the Geologist, and lead us on as far as the confine of a theme which can lend no support to that which most nearly concerns us through these pages—we mean the law of form. We would isolate our studies of the law of skeleton formation, which must include those of fossil as well as those of recent character, from any speculative consideration as to the probable condition of a past *natura*. When regarding the skeleton figure, whether fossil or recent, merely as an anatomical fact or quantity produced at one time or another by the operation of a law of development, this consideration need not concern itself with an inquiry into the probability of that mundane state in which the ens was fitted to live and act. For while we see that the lost species of A or B still bears comparison with the recent species of any vertebrate form, the purpose of this comparison will be to know in what points they agree and disagree, as also how their differences of caste have happened under the common law which we believe to have presided over the creation of both. To this end we say that fig. A and B taken as an organic entity need not concern us about the *where* and *when* of their existence any more than if we viewed them to-day or to-morrow in one place or in another, for they will still remain of their own anatomical characters whenever or wherever we find them, whether this locality be a case of the British Museum or an *armoire* of the Jardin des Plantes, a stratum of Blue Lias Stone or a bed of Oolite; since it is probable that any one of those places may with as much reason be regarded the natural habitation of fig. A or B as the other. As they lie before us, there can be no doubt that they manifest plainly a relationship to the general type of vertebrated animals, proving that the law of formation in the past was an emanation of the same creative force which exists in the present, and that the general history of this force is an eternal oneness or uniformity passing through a metamorphosis for the production of special variety.

As vertebrated creations we therefore consider A and B, and we say of them what we have already said respecting the mammalian skeleton axis; namely, that the one is, as the other, the product of a law of metamorphosis exercising itself upon the serial costo-vertebral archetypes; for we see that plus quantity persists at a certain region of the axis of fig. A or B, and that this region is thoracic; whereas minus quantity fashions certain other regions of their serieses, which regions still pass by the names of

cervix, loins, sacrum and caudex. In this respect figs. A and B agree with recent formations.

But if the marvel will still attach to figs. A and B because we do not now recognize any living form cast after the same exact mould as they are, what odds can this make to the law of natural operation any more than the oddity of a recent turtle when compared to the singularity of a recent porpoise? Wherefore is it, we ask, that Nature should have been struck bizarre to suit the epoch of fig. A or B, when she is now in 1847 regnant in a majesty of glorious order for that strange figure the Boa, as for that which it entwines about,—the Behemoth of the wild. Anatomically considered and interpreted according to the possible operation of a law of development, the one form is no less a marvel than the other, and neither the one nor the other is anomalous to the creative passage of this law, which has ruled over creation in the past as it still rules it in the present.

How is it that fig. A, compared with fig. B., and both with recent structures, gives us cause for pause and wonder? It is because we have not as yet ascertained the nature and essential meaning of that sentence of design which one recent form expresses while comparatively contemplated in the presence of another recent skeleton structure; and hence we say, that before we engage to penetrate into the mystery of a past, it is required that we should have explained away the mystery of a present, for this is the subject which more immediately touches us.

The metamorphosis of form is an operation which, in present nature, takes place before our eyes, and still the planetary system is as little disturbed by the occurrence of the same, and the firm-set earth on which we stand holds its own fixed orbit in the region of space, as little moved by the fact that a horse's shank and hoof is a modification of the parts proper to a human hand, as in all probability it held at the period of time when figs. A and B possessed life, and acted as the denizens of a *natura* such as we now find it. And what are the objections which can be set in opposition to this commonplace and homespun idea? If we will dispassionately examine those objections, in order to estimate their actual value in a serious subject, it will be found that they take root in an original error, in an assumed hypothesis, which is of as little akin to science and to the attributes of Ζεὺς as are the contents of the Alkoran while recordative of the physiological character of the author, winging his passage to the seventh tier of the Olympian realm. The Palæontologist still cleaves to the idea of a Γένεσις,* but the Physiologist can nowhere define that fact. For where does it occur? and when has it had place in the *natura?* Who knows of an absolute Γένεσις now in Φύσις?† We mean such an absolute occurrence of that operation as may be understood *ab nihilo ens fit,* and judging of the foregone by the present state, who shall speak demonstratively of that act in the past when it does not appear in the present? If the lost species of fig. A or B be a thing past when compared with existing species, wherefore should we spoil the majesty which is attendant upon the idea of an eternal law immutable and fixed, by any introduction of the idea of a *finis* or an *origo,* which are but the products of our own weakness. For while we know that the extinction of fœtal cast is necessary to the existence of the adult form, and that in the metamorphosis of the *ens* the law is still continuous and remaining of its own integrity, as being a force which cannot be retraced to its rise any more than it can be followed onwards to its fall or decline, may not the same creative force have operated anterior to and co-existing with the epoch of fig. A and B, and peopled the *natura* through all the stages of eternal time with an animal kingdom, uniform and yet various to itself, for purposes the same as are now rendered evident to us?

Upon what phenomena at present manifesting themselves to the Geological speculator does he found his impossible system of cosmogony, and set himself to retrace the footsteps of the *natura* back to her fountain-head *in nihilo, in nubibus,* that is to say *in mente?* The Geologist is with reason astonished by the revelation that figs. A and B lie strewn beneath the soil of Britain, together with the fact that the remains of Elephants, Rhinoceroses, and Hippopotami, are also entombed within this soil; and therefore he concludes that either this planet was once in that condition which it no longer presents, or else that these species being produced in those regions to which their existing species are now confined, have been borne hither by some catastrophe or fitful outbreak of the ocean flood, causing a general and sudden death to animality. To what end? To make an epoch in Γένεσις, and give a place to man. What place? When? and where? By what arm could this quick slaughterous act and passage in creation have had occurrence? By the arm of all-potent imagination; for there is reason to believe that this ruinous and headlong operation has had no more occurrence in the *natura* at any time or place than the following feat could have:

"——————— And in Ausonian land
Men called him Mulciber; and how he fell
From Heaven, they fabled, thrown by angry Jove
Sheer o'er the crystal battlements; from morn
To noon he fell, from noon to dewy eve,
A summer's day; and with the setting sun
Dropt from the zenith like a falling star
On Lemnos th' Ægean isle."

The purely imaginative is as unallied to the reason as it is to the possible and natural. What part, therefore, can the imaginative play in the presence of the natural but that of a ridiculous disorder sullying the sublime majesty of order? We make causes for natural revelations, rather than reason them out according to probable and possible operation. We impatiently soar to the empyreal atmosphere of our own region of error, instead of humbly following in the footmarks of the form and body of the *natura.* We still Whistonise, still Burnetise, and Woodwardise in the laws of causation, and bending all the natural aside to make way for the abortive anomalies of our own fancy, we burst a world just as readily as we burst a bubble; and entering the lists with the spear and buckler of a quixotic vanity, we tournay against the holy writ of the natural, and overthrow ourselves.

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* "Or this great all was from Eternity—
Not even the Stagyrite himself could see."—DRYDEN.

† "Il y a des choses que tout le monde dit, parce qu'elles ont été dites une fois."—Montesquieu, *Consid. sur les Causes de la Grandeur des Romains, &c.*
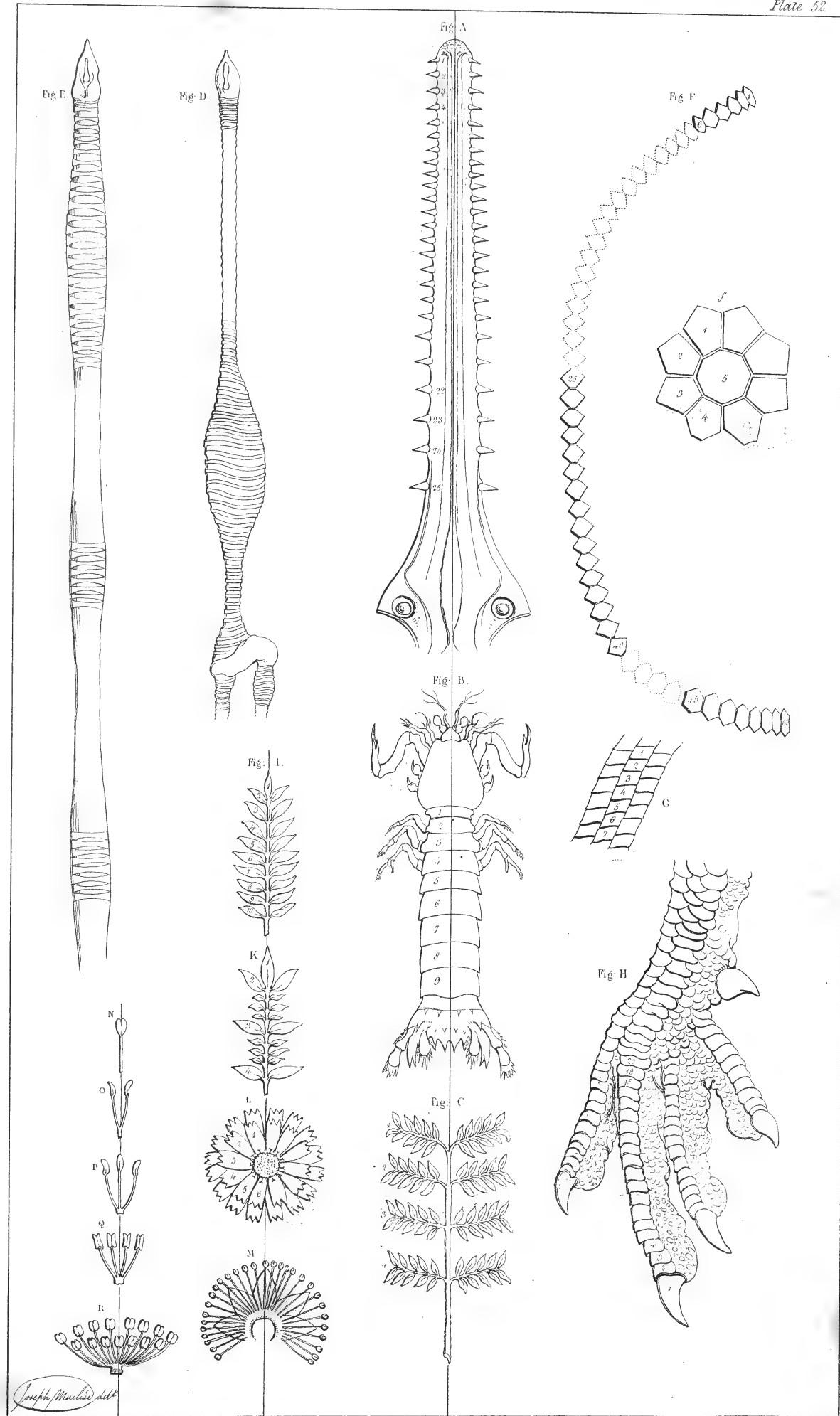
Plate 52.

Fig: E.

Fig: D.

Fig: A.

Fig F

Fig: B.

Fig: I.

G

K

Fig: H

N

O

P

Q

R

L

M

Fig: C.

REMARKS ON THE FIGURES OF PLATE LII.

———◆———

THE LAWS OF SERIAL UNIFORMITY AND SYMMETRY MANIFEST THEMSELVES IN THE PRESENTIAL CHARACTERS OF ALL ORGANIC PRODUCTS.

HOMOLOGUES are samenesses or identical creations. All created forms are not homologous or identical with each other ; and, therefore, absolute specific difformity must reign somewhere amongst them ; and this has never been doubted, for there is no one who would characterise as uniform bodies a flower, a shell, and a golden ingot. As absolute special variety has, therefore, an actual existence, it must follow that uniformity does not encompass all creations ; and for this reason it is required to define clearly the meaning of the term "uniform," as distinguished from the term "special." Uniform bodies are those which appear to be the exact repetitions of each other, both as to general cast and essential character. Specifically difform bodies are those which in no respect contain any character, whether of essence or cast, in common. Two or more bodies, which are thus difform as units, will, when severally repeated each after its own kind in series, still manifest two or more difform serieses ; for being singularly various, multiplication can only render them plurally various ; and just as a rectangular triangle is various to a circle, so will the repetition or multiplication of a triangle on the one side, and of a circle on the other side, still only produce a plurality of triangles and of circles on separate sides.

Uniformity can, therefore, alone characterise plural numbers of bodies, which are cast after the same mould and constructed of the like essential parts. The repetition of such bodies in series produces serial uniformity ; and the variety which is now and then apparent amongst such forms is mainly owing to the subtraction or metamorphosis of quantity. The serial repetition of form is the law of uniformity. The serial repetition of two or more difform bodies will produce two or more difform serieses, and when we say that the simple rule of repetition is that law which presides over the creation of both these serieses, we by no means would thereby imply that both serieses were identically cast.

When we speak of serial uniformity, as characterising the continuous order of the one entity, we isolate that uniform fact from all other serial creations, which are specifically difform to this particular one. When we speak of the serial uninterrupted order of the line of endo-skeleton osseous quantities, and call it a unity in proportional variety, the unity being plus and the variety being minus, we do not mean that all serial creations whatever, throughout the three kingdoms of entity, viz., the animal, the vegetable, and the mineral, are come of such a unity, and that they are rendered various by such a law of variety. Still it is true that every specifically distinct serial line is produced by the simple law of repeating the first unit throughout the same line, and this operation is creative of counterparts.

The combined laws of symmetrical and serial homology, together with the law of proportioning minus from plus quantity, here and there through series, govern organic nature in all its branchings. The vegetable as well as the animal kingdom furnishes innumerable examples of these laws of formation. Whatever be the character and constitution of forms which take on the same serial order, we discover plainly that the variety which is introduced amongst them, is no other than what may be effected by the law of proportioning. Nature is uniform in the

arrangement of her products, but not so as to quantity. The law of serial and symmetrical homology is the same as the successional and lateral repetition of form; and this law, subjected to the law of metamorphosis or the subtraction of quantity, is that natural agency under which the shell of a nautilus, the painted head of the passion-flower, and the skeleton axis, are severally created. By this assertion we do not mean that these entities are uniform and identical to each other; the one is a series specifically distinct from the other two; they are plurally various because they are singularly various, but it is quite true that in the serial composite of each may be seen the repetition of the first unit of each.

Fig. A represents the upper maxilla or rostrum of the Saw Fish (*Squalus pristis*); it is a symmetrical organ, and its dental apparatus is arranged in series; the one side is homologous with the other, and the first dental unit marked 1, holds series with the other dental units, all of which are homologues.

Fig. B, an articulate animal (Squilla Mantis), is symmetrical, and its dorsal scales are arranged in a symmetrical series from 1 to 9.

Fig. C describes the branch of a plant whose leaves are characterised by the arrangement called " duplicato-pinnated," its entire figure is symmetrically cleavable through the midrib, and its leaves are in serial order from 1 to 4.

Fig. D represents the trachea of the Golden-eyed Duck (*Anas clangula*). The tracheal rings are serially arranged, and the entire organ is symmetrical.

Fig. E represents the tracheal organ of the Swan (*Anas cygnus*). It is symmetrical, and its rings are arranged in serial order.

Fig. F shows the serial marginal arrangement of the pieces of the carapace of the extinct Glyptodon clavipes. From 1 to 6, from 25 to 40, and from 45 to 52, we see that the serial repetition of form holds together, and it is by the unerring rule of serial homology that the Palæontologist is enabled to restore lost quantity, such as that represented by the dotted forms between unit 6 and 25, as also between 40 and 45. The form marked *f*, is one of the tesselated pieces of the carapace of the extinct Glyptodon ornatus. It is symmetrical, and its elements are arranged in circular series from 1 to 4.

Fig. G shows the linear serial order of the scales of the Lepidosteus.

Fig. H represents the foot of a gallinaceous bird; on it we see the serial arrangement of the scales of the cuticular membrane. Homologous development or serial repetition of form may be traced from unit 20 to unit 2; and the next scale which succeeds unit 2 is the nail marked 1,

which terminates the scaly series at the distal extremity of the toe. The horny spur is such another scaly appendage, shielding the rudiment of a toe.

Fig. I shows an arrangement of leaf termed "pinnated with an odd leaf:" it has serial and symmetrical order.

Fig. K is a form of leaf termed "interruptedly pinnated:" its general form is symmetrical, but its serial leaflets vary from plus to minus; between the plus leaflets 2, 3, 4, occur the minus proportionals, giving the serial order of forms an alternate variation of greater and lesser quantities.

Fig. L describes a flower of the Linnæan class (Polygamia necessaria): it represents symmetry, and a serial repetition of petals arranged in a circle.

Fig. M describes a flower of the Linnæan class (Icosandria). The stamens are developed in a serial circular order, and the whole form is symmetrical.

Fig. N shows the single stamen of the class of flower (Monandria.) It is a form of symmetry.

Fig. O shows a symmetrical repetition of form in the stamens of the class (Diandria.)

Fig. P represents a triplex repetition of stamens in the class (Triandria.) A stamen of one side is repeated by a stamen on the opposite side, the median stamen falling with the median line, which bisects the whole figure of symmetry.

Fig. Q represents the class (Tetrandria) where the two stamens of one side are repeated on the opposite side, and symmetry results.

Fig. R shows the character of the class (Dodecandria) in which the laws of serial and symmetrical homology still prevail. The same line which cleaves the centre of N passes also through the centres of O, P, Q, and R.

The opposite figures have been drawn to illustrate the fact that nature in the creation of each serial entity performs her work by the repetition of form in imitation of a first quantity.* In this process, she may be said to act uniformly; but though we have every reason to designate her according to this manifestation as a uniform operator, it by no means follows that all her products are samenesses. It is required, therefore, that we should define the line which separates her laws of uniformity and variety, as well as that line which separates those entities which are produced in absolute specific diversity to one another.† To this end, and principally in reference to the subject in hand, we remark as follows:

Every organic quantity which is constituted of a series of units, and amongst which we can discover no other condition of variety save that of quantity, may be numbered, and may be said to have reference to some serial line of whole or plus forms.‡ This variety as to quantity can only have been produced by the law of degradation acting upon the line of plus serial

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* Laertius observes of Pythagoras that he made unity the principle of all things, and that hence arose duality.

† " Now because we cannot be certain of the truth of any general proposition, unless we know the precise bounds and extent of the species its terms stand for, it is necessary we should know the essence of each species, which is that which constitutes and bounds it. Because, not knowing this real essence, we cannot know what is, or what is not of that species; and consequently what may or may not with certainty be affirmed of it." —Locke, *Human Understanding—Universal Propositions*, chap. vi., p. 145.

‡ It was a common opinion amongst the ancient Philosophers, that the species of things have to each other the nature and relation of numbers. Whatever reason there may be to object to this assertion, when applied to forms whose substrata, intimate essence, and outward character manifest no manner of analogy whatever, we need not stay to inquire. But it seems self-evident that the several pieces which, taking serial order *in the same ens*, constitute the whole and connected serial design of the same, have actually a numerical relation with one another.

homologues. Under the joint operation of both these laws of uniformity and metamorphosis, the reason can never account for that variety which distinguishes two or more entities from one another; such as a muscle, a bone, or a nerve in the animal body, or such as a leaf, a feather, and a ligament in different organised beings. A muscle, a bone, a nerve, a leaf, a feather, and a crystalline lens, are what we here understand to be things so absolutely diverse to each other, that they can never be subjected to the rule of analogy or interpreted under the same common law.* But granting thus much to the actuality of special variety originally founded in nature, and granting also that to take account of the chemical and functional characters of structures thus created diverse be the lawful province of the physiologist, we believe that the science of formation which the morphologist or comparative reasoner pursues through the graduated series of structures created of the same physiological identity, such as an osseous piece or an osseous framework in all animal bodies, which produce the like, may claim a place amongst the first within the territory of reason. It cannot be denied that the osseous quantities of the skeleton serial axis manifest an analogy to each other, despite the fact of their variation as to quantity, nor can it be denied that all the varieties which characterise all skeleton axes are only those which may occur by the metamorphosis of quantity at different regions of series, or to different degrees upon each unit in series; therefore, these facts may be interpreted under a common law of formation. This law which, there is every reason to believe, is one of rendering a plus uniform serial line of quantities proportionably various by the subtraction of elements, is that which we are seeking to establish in reference to the endo-skeleton axis only.

This osseous fabric, which we find to be produced within the bodies of certain classes of animals, is that particular alone to which our observations tend. The law which governs its development, and presents it to our notice as a unity in variety, is that subject which alone interests us in this place, and to this we look for information. It is necessary to set this limitation to our subject; for we conceive it to be no less essential to the development of knowledge to define the character of those entities which agree with each other, and disagree from all the rest, than it is to particularise one order of study from another and distinct order. When we engage in inquiry after the law which presides over the structural designs of osseous quantities, we do not include amongst those designs any other parts which are not of this structural growth; such, for example, as the dermal covering, &c., but we here separate these as distinctly the one from the other as we do the subject of anatomy from that of metaphysics. The law which gives creation to the tegumentary membrane throughout the series of an animal scale, can no more teach us of the law which rules the creation of endo-

skeleton formation throughout the serial line of these figures, than can the laws which govern psychical phenomena yield to us an insight of the laws which manifest themselves in the animal economy. Bone refers to bone in a connected argument, and wherever we find bony tissue we never find tegumentary tissue, and therefore we isolate our remarks to the osseous skeleton quantities. It is true that all structures whatever which are to be found in the animal entity bear a certain relation to each other, as being related to the one living body, just as all the physical sciences have a connection amongst themselves, owing to their common bearing in the body and framework of the φύσις: it is true that, in order to know *the all* of the animal ens, we are required to investigate the sum total of its structural variety, just as in order to understand *the whole* of the physical ens would require us to study all variety which in congeries constitute it; but this mode of inquiry imperatively demands, first of all, that we should mark those distinctions between structures which Nature has actually created specifically distinct in the one body as well as in the other. The dermal covering, which in some animals has undergone such modification as to include them within a case of skeleton armour, and between which and the osseous skeleton some anatomists have drawn analogies, is nowhere in serial Nature seen to flux and confound itself with this latter. The dermal skeleton is distinct from the osseous skeleton; the one never fuses with the other; and this being the demonstrable fact, we ask, who shall identify as entities of the same system, such structures as Nature herself creates of distinct species to one another? The philosophy of Geoffroy has not made them one and the same. Again, who shall draw the differential line between structures which, to the commonest observer, seem evidently to blend with each other, such as the fibrous tissue, cartilage, and bone, and which so completely obey the law of phaseal transformation that the first or fibrous gives place to the second or cartilaginous, and this to the third or osseous? The reputation of Cuvier has not rendered them distinct from each other, nor obliterated the written fact from the chart of Nature or of science, that in the intimate connection which fibrous substance, cartilage, and bone manifest throughout the endo-skeleton system, resides one of the principal illustrations of the law of osseous skeleton formation.

The transcendental anatomists have drawn analogies between structures which Nature holds specifically distinct, not only in the body of one animal, but from one extremity to the other of the graduated scale of being. They have overstepped the differential line which Nature herself draws between structural distinctnesses, and have identified those structures as one, which Nature never confounds together, either by a oneness of place, a one-

* "Denique illud omnino præcipiendum est, et sæpius monendum, ut diligentia hominum in inquisitione et congerie naturalis historiæ deinceps mutetur plane, et vertatur in contrarium ejus, quod nunc in usu est. Magna enim hucusque, atque adeo curiosa fuit hominum industria in notandâ rerum varietate, atque explicandis accuratis animalium, herbarum, et fossilium differentiis; quarum pleræque magis sunt lusus naturæ quam seriæ alicujus utilitatis versus scientias. Faciunt certe hujusmodi res ad delectationem, atque etiam quandoque ad praxin; verum ad introspiciendam naturam parum aut nihil. Itaque convertenda plane est opera ad inquirendas et notandas rerum similitudinis et analoga, tam integralibus, quam partibus: illæ enim sunt, quæ naturam uniunt, et constituere scientias incipiunt."—Bacon, *Novum Organum*, aph. xxvi.
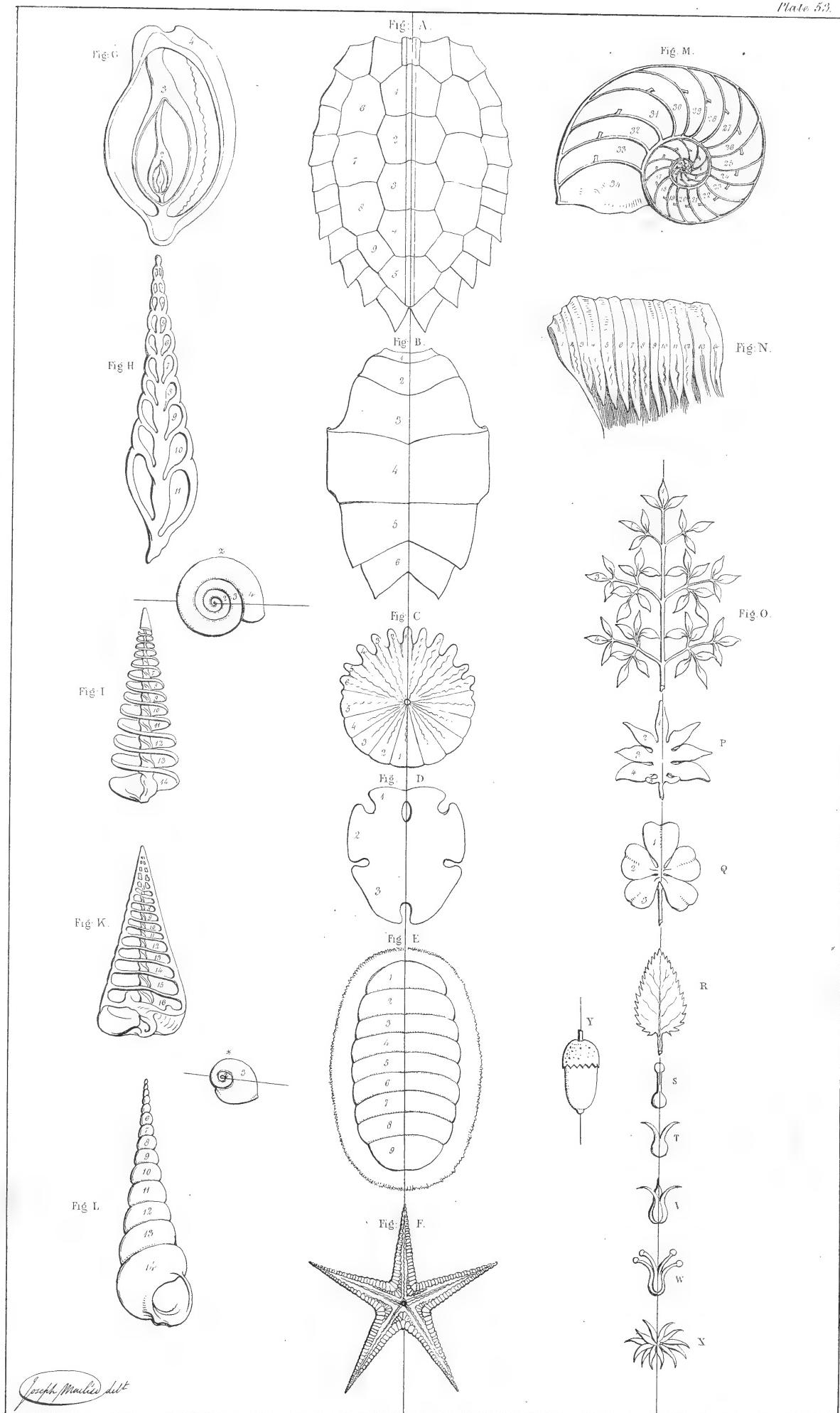
ness of function, or a oneness of essential character, in any respect or in any measure whatsoever. They have again, on the other hand, passed heedlessly by that line of fluxion which Nature establishes for relationary structures, and hence have read as specific distinctnesses those creations which Nature always transforms *in the same place*, through the phaseal development of the one animal body, as well as through the graduated series of an animal kingdom. They have confounded the dermal skeleton with the osseous skeleton, notwithstanding the difference of place, of function, and of structure; while they have overlooked that close analogy which reigns between the fibrous, the cartilaginous, and the osseous skeleton, structures which may be said to evince such a serial and connected argument, both as to place and function, that the same blood-vessels are the agents of their successive deposition; and the stages of the ossific process from fibrous to cartilaginous, and thence to bony tissue, are so enchained together, that these express a oneness in every sense of that word excepting that of time. A general view of the graduated scale of the animal kingdom will render it manifest that two or more animal structures, specifically distinct from each other, such as dermal and osseous tissues, do here and there assume a greater or lesser importance for several classes of forms, according to circumstance and requisition. Many of the lower classes of animals produce a dermal outer skeleton to the exclusion of the osseous internal fabric; and this point of transition, from the absence of the osseous skeleton to the presence of the dermal skeleton, is occupied by the Sepiæ. These animals are examples of where a dermal structure assumes the office, in some degree, of an osseous structure; but still, both these distinct structural species remain as evidently unallied to one another, and can with as little reason be designated the same structural ens, as can the scaly armour of an armadillo be identified with its osseous framework. That structure which is deposited internally in one class of animals, such as the osseous skeleton, cannot have been laid externally for another class of animals, in the new character of a dermal skeleton; and therefore these structures are to be accounted as distinct from each other, in two classes of animals, as the like structures are held distinct in the one animal form.* But the phaseal metamorphosis from ligament to cartilage, and thence to bony tissue, is a process carried on internally at the same fixed localities; and as we discover that these several transition deposits occupy, from time to time, the one place, so therefore do they express the one design of an endo-skeleton, to whose development and form of a unity rendered proportionally various, we confine our observations. Where osseous tissue now stands, there cartilaginous and fibrous structure once stood; where cartilaginous tissue now is, there fibrous tissue once was, and here osseous tissue will be; and where fibrous tissue now appears, there cartilaginous and osseous tissue will appear. This is the

history of the *natural skeleton* as it passes through the phases of development for the one animal body, and it is most true that those stages of the ossific process which are transitionary for the one animal skeleton of mammalian cast, are holding permanently for the special designs of other endo-skeletons throughout the four classes of animals. This subject expresses, no doubt, an intimate bearing on the law of endo-skeleton variation, and proves to the searcher after analogies that the unity of this form, to which anatomical science would fain direct attention, can never be embodied unless by taking full account of the ossific process.

The variety which has place in the progressive growth of the mammalian skeleton form is mainly owing to the difference as to time in which several parts of this structure present of one or the other of the three phases of the ossific process. As this cannot be denied, let us take footing upon this sure groundwork of a fact, and we shall find, while we look around us at the creative operation of the *natura* throughout an animal kingdom, that fact will cleave to fact, and all facts in mass will body forth the evidence that all variety apparent amongst the skeleton figures of mammifers, birds, reptiles, and osseous fishes, is attributable to the natural rule, viz., that various parts of a whole quantity present in one or other of the three stages of the ossific process. As in the human skeleton that part which, in embryonic life, was of cellular material, and destined, through after phases, to assume the cartilaginous and the osseous form, so in the plurality of the four classes of animals, their variation depends upon this, viz., that the part which is fibrous or cellular in one cast of formation, and which gives it its special and fitting character, has become, in another form, of cartilaginous structure, and in another, of osseous texture.

The mechanical fitness of skeleton form is not that rule of development whereby a unity or whole quantity can ever be summed together out of comparative method; and while the fact is openly manifested, that this mechanical design, throughout not only the phaseal growth of the one being, but also throughout the graduated scale of the four classes of osseous skeletons, is dependent upon those skeleton parts which Nature gives fixation to in either the fibrous, cartilaginous, or osseous forms; then there is every good reason to conclude that skeleton unity or the whole can no more be discerned according to those parts alone which are of the *osseous phasis in several forms*, than it can be read in the comparison of those parts which are *of cartilaginous condition alone*, or of those which are *of fibrous cast alone*. The osseous material of any animal body no more constitutes the entire skeleton form than does either the cartilaginous material or that which presents of fibrous character. If we limit our ideas of the skeleton fabric to parts which are of osseous growth, we will fall as far short of recognising the whole quantity of unity as we will fail of summing together the full evidence of the law which, by degrading several regional parts of this whole form, establishes all special varieties.

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* " La loi de la continuité porte que la nature ne laisse point de vide dans l'ordre qu'elle suit, mais toute forme ou espèce n'est pas de toute ordre."—Leibnitz, *Œuvres Philosophiques. Nouv. Essais, &c.*, liv. iii., p. 267.

Plate 53.

Fig: G.

Fig: A.

Fig. M.

Fig H

Fig: B.

Fig: N.

Fig: I

Fig: C.

Fig. O.

Fig: D

P

Fig: K.

Q

Fig E

R

Y

S

Fig: F.

T

Fig: L.

U

W

X

REMARKS ON THE FIGURES OF PLATE LIII.

ENTITIES OF DISTINCT SPECIES ARE SEVERALLY PRODUCED UNDER THE OPERATION OF THE LAWS OF
SERIES AND SYMMETRY.

FINITY, when contrasted with infinity, manifests, through this mode of comparison, the law which operates for the creation of finite entities; and lends interpretation also to the creations of finite uniform serieses themselves. Every finite line of serial uniform creations in organic nature terminates by one or other of the following modes, viz.: either by the cycle and some of its modifications, or by the graduated scale caused by the subtraction, metamorphosis, or increation of quantity proper to the plus units of series. Every finite right line is composed of a series of uniform points: the genetic point is equal and homologous with the terminal point of such line; and its finity is owing to increation, a process which may be said to be the cause of its finity, for as much as we may ourselves produce it of greater dimensions, or even conceive it possible that by a simple extension it may be produced to infinity. But the line is, in nature, created finite, and increation is the cause of its finity. Every quantity standing in the same serial order is represented by every point of that serial line. The plus unit of every series will, if repeated as plus *ad infinitum*, extend series *ad infinitum*. We can fancy this, even though we find that all serial creations are actually rendered finite in Nature. This finity of a serial order produced in right lines is effected by the graduated metamorphosis of serial quantity; and the series, whichever it may be, presents itself in plus and minus variety, the vanishing point or termination bearing the same ratio to the plus unit from which it has been metamorphosed, as $a - b$ bears to $a + b$; and thus we have the serial line of plus quantities 9, 9, 9, 9, 9, 9, 9, 9, 9, proportionally degraded to the converging series 9, 8, 7, 6, 5, 4, 3, 2, 1, &c.

The repetition of form, which is creative of symmetrical and serial homology, produces an entire figure whose character is an aggregate of similar elements. The series of quantities which constitute the entire structural form takes order similar to an arithmetic series of proportions and progressions. The series may present itself in simple linear order of equal plus quantities, or those quantities may be graduatedly proportioned from extreme plus to extreme minus. As an example of the first arrangement we may view 9, 9, 9, 9, 9, 9, 9, 9, 9; and as an example of the second, 9, 8, 7, 6, 5, 4, 3, 2, 1. Both these varieties of series, regarded as structural designs, may again vary the general character of their serial forms in very many ways; as, for example, the series may remain as linear, or it may be afterwards curved upon itself, spirally twisted upon itself, circular, or radiated.

Fig. A describes the carapace of a species of Chelonia. Its general figure is symmetrical, and its several elemental pieces are serially arranged from 1 to 5, and from 6 to 9.

Fig. B, the plastrum of the same animal, is also symmetrical, and its pieces are laid in serial order from 1 to 6.

Fig. C, a Scutella dentata, is symmetrical, and its pieces take the serial order from 1 to 6, and from 5 to 1.

Fig. D, another form of Scutella, is symmetrical, and having its pieces, 1, 2, 3, serially homologous.

Fig. E, a Chiton Goodallii, is symmetrical, and its pieces are laid in serial order from 1 to 9.

Fig. F, a star-fish, is symmetrical, with its rays serially ordered; each ray, from its base to apex, showing a graduated order of proportional tesselated structure, plus at the base, minus at the apex.

Fig. G represents the section of a convoluted shell, each volute, from the small internal one to the outermost, being a repetition of the other. The series from 1 to 4 is rolled upon itself, and describes the progressive stages of the animal development from minus to plus form.

Fig. H is a section of a spiral shell, describing the serial order of development from 1 to 11.

Fig. I is the spiral lamellar series of a shell, showing the order of progression from minus to plus, 1 to 14.

Fig. K shows a section of a spiral shell, describing serial compartments whose areas are progressively proportional from 1 to 16, increasing from minus to plus according to the stages of the animal increase.

Fig. L is a spiral shell, showing the series of continued proportionals as 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14.

Fig. M is a section of the many-chambered nautilus shell, which shows the series of continued proportionals from the nucleary centre, 1 to 34, indicating the progressive animal increase from minus to plus.

Fig. N is a section of the molar tooth of the Indian elephant, shewing its lamellar serial elements taking order from 1 to 14.

Fig. O represents a leaf, described as "triplicato-ternate." Its general form is symmetrical, and its triplex leaflets are arranged in serial homologous order, from 1 to 4, on each side.

Fig. P describes a leaf of " pinnatifid form." It is symmetrically cleavable, and its serial parts, 1, 2, 3, 4, are homologous.

Fig. Q is a form of leaf termed "partite." It is symmetrical, and the leaflets, 1, 2, 3, are in serial homology.

Fig. R is a leaf termed "serrated." It is symmetrical, and its serræ form a series.

Fig. S describes the pistil of a flower of the class Monogynia. Fig. T, that of the class Digynia. Fig. V, that of the class Trigynia. Fig. W, that of the class Tetragynia. Fig. X that of the class Dodecagynia. These organs may be regarded as a series of continued proportions from Monogynia to Dodecagynia, just as the stamens progress in continued series from Monandria to Dodecandria. Both orders of organs are symmetrical, and situated in reference to the common median line.

Fig. Y, an acorn is symmetrically bisected by a line carried through its axis.

Fig. Z represents a shell (*Solarium lævigatum*), showing serial repetition occasioned by convolution.

Fig. * is a shell (*Turbo tenebrosus*), describing also a serial repetition by convolution. If a secant line be carried through the axes of figs. Z and *, it will indicate the serial order of the homologues 1, 2, 3, 4.

An examination of the opposite figures will prove the fact that the laws of symmetry and series preside over their creation in common. The laws of series and symmetry, regarded purely as natural forces, act by repetition : this act of repetition is one for the production of form, but let us not confound the act or force with the created ens or form, otherwise we will confound together those forms which manifest a distinct species with one another.

When we say that the laws of series and symmetry are the same forces by which all the opposite forms have had creation, we do not mean that all those forms are identical with each other, but only that the form of each manifests the characters of symmetry and serial order. When we say that fig. A is a symmetrical and serial form, we may describe figs. C, D, E, and F as having this character also, without at the same time asserting that these forms are one and all uniform. We do not say that fig. A is uniform with fig. B, or C, or D, or E ; but we distinctly state that fig. A. is a congeries of similar parts, so disposed in reference to a common median centre, that symmetry and series are the two natural forces by which this arrangement has occurred ; and especially we remark that all the pieces of fig. A are homologous, having no other condition of absolute variety characterising those pieces one from the other than such as the difference between $a + b$, and $a - b$; that is to say, a difference as to quantity. The separate form of the compound fig. A may be regarded under the above remarks ; and the same remarks may safely be applied to fig. B, or C, or D, or E, or F, or any other form opposite, without implying therewith that these actually various forms are uniform. If we do not distinguish the law or creative force from the productions or created entities, we shall, when naming this force as a uniform act, perhaps be accused of blindly asserting that the creations of this force are also uniform amongst themselves. Openly we state, that the dermal skeleton fig. E, is as distinct a species from the vegetable production fig. O, as either of these forms is from that of an osseous mammalian skeleton ; * but the fact cannot be denied, that any one of those figures considered *per se* is a symmetrical and serial congeries of homologous parts, whose only difference is caused by the variation of quantity ; and the same remark applies to the mammalian endo-skeleton axis.

The serial line of plus quantities, such as 9, 9, 9, 9, 9, 9, 9, 9, 9, undergoes a serial metamorphosis of quantity ; and hence we have the finite converging series of 9, 8, 7, 6, 5, 4, 3, 2, 1. The same law has given finity to each of the opposite serial figures ; and it is by the operation of the same law that the mammalian skeleton axis manifests its present finite serial condition, for it has been metamorphosed from an archetype plus series of costo-vertebral quantities. The law or force is one, but the creations of this force are not all uniform. Specific variety does exist between two or more creations such as those drawn opposite ; but such a variety does not exist between the serial parts of the same ens, and this is the extent of our meaning in reference to the endo-skeleton serial axis.

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* " Parmi les espèces dont ces familles naturelles sont composées, il s'en trouve encore qui se tiennent plus particulièrement que les autres. Cette marche de la nature, une fois bien connue, donnerait ce qu'on appelle la méthode naturelle.—Rien n'est plus propre à étendre la science et à généraliser les découvertes."—Malesherbes, *Observations sur l'Histoire Naturelle*, tome 1, pages 11—18.

Plate 54.

Fig G.

Fig I.

Fig H.

Fig A.

B.

Fig C.

D.

Fig E.

F.
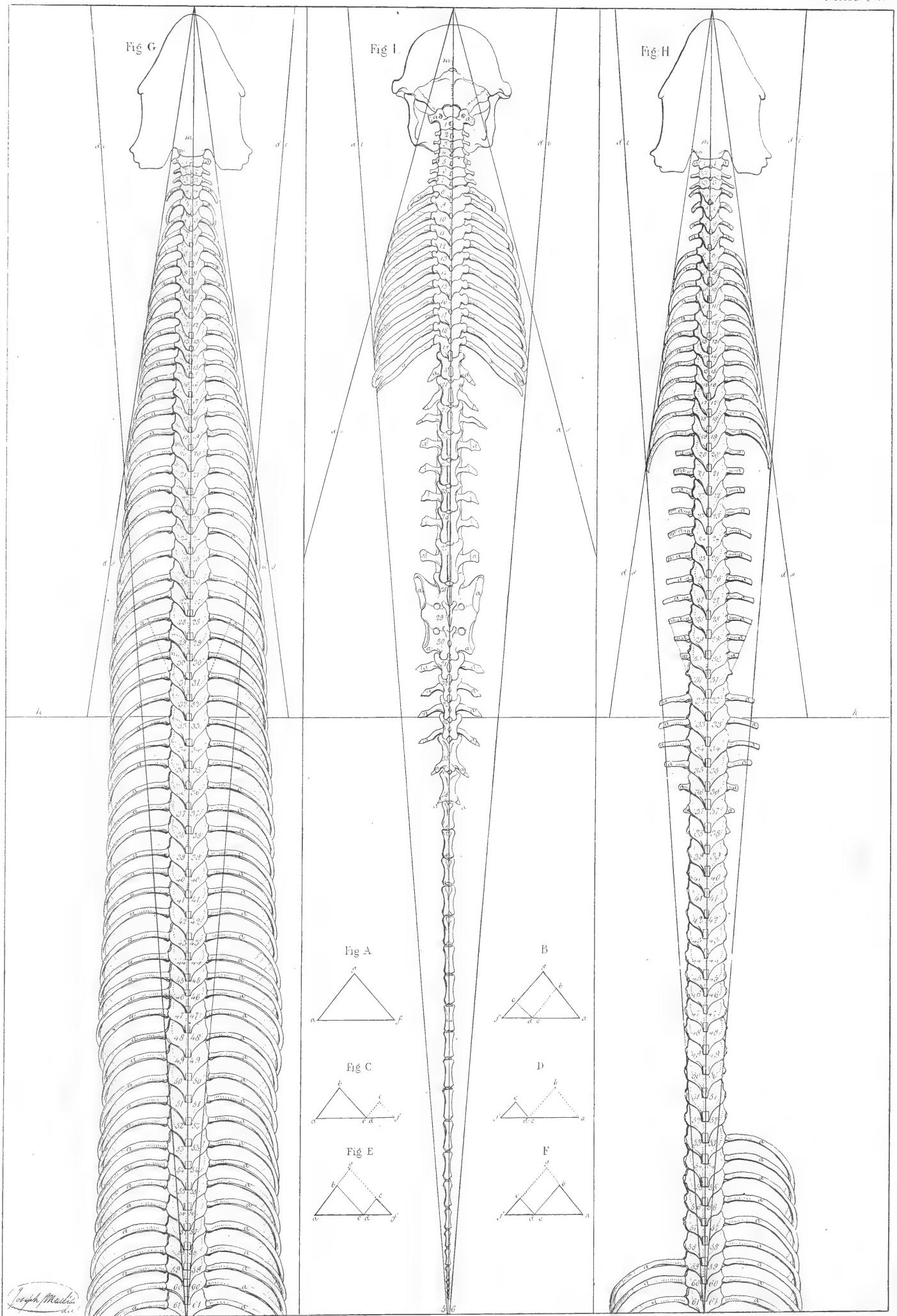
REMARKS ON THE FIGURES OF PLATE LIV.

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THE ARCHETYPE PLUS SERIAL AXIS UNDERGOES A METAMORPHOSIS OF QUANTITY FOR THE PRODUCTION OF SPECIES.

UNIFORMITY considered *per se* is like unity measured by itself; for the one, like the other, cannot be a species either to itself or its counterpart; and in whatever light we regard this ens, it will still produce only the same idea;—it is uniformity or unity fixed and unchangeable; it is a sameness, a thing holding its own identity, a creation bearing but one character as to dimensions, and it is invariable as to the quantity contained in itself. There is no subject-matter in uniformity or unity isolately contemplated, because we then set it apart from contrast, and it is impossible to compare any such entity with itself or its fellow, and produce any other idea save that of itself. One is one, and the comparison of one with itself will never furnish us with any other idea save that of one; therefore, one is barren of all interest: and so is unity or uniformity, while severed apart and insulated as a lone entity in nature.

Now the repetition of any given quantity or form, whether once or twice, or in infinite series of this first quantity, although this will generate the idea of plurality, is still bound down to sameness; for the unit, the dual of this unit, and the infinite serial plural of this same unit, will only be an extension of unity through a uniformity without end. Infinite repetition of the same form is infinite sameness; and although the fact will, by its eternal recurrence, overpower us with its prolixity, still, by its very dullness and wearisome continuity, it thereby symbolises and impersonates the sublime. The infinite series is an emblem of the sublime; and because the very nature of infinite series is the infinite repetition of a first quantity, which quantity is unity, and which repetition is uniformity, so we regard uniform series as the very φυσις and embodiment of sublimity. Nature repeats her first form and quantity: she creates the serial skeleton axis by the repetition of a given quantity, and this skeleton figure, as being typical of the serial uniformity throughout an animal kingdom, is no less generative of the idea of the sublime than is the incessant serial order of the form of ocean waves, whose very sounds are simple monotones, and repetitions of the one noise in the one voice—πολυφλοίσβοιο θαλασσης.

Since the repetition of plus form is creative of uniform series *ad infinitum* for the circle as for the integer 9, so will the metamorphosis of the line of serial circles or the line of serial integers produce special variety *ad infinitum;* and therefore, since the infinite plus series is as immeasurable as the infinite gradations of minus series, the one serving the idea of uniformity, and the other yielding the idea of species, and both ideas being without limitation, so must both the subjects of uniformity and species, while numerically considered, transcend the furthest stretch of mental reach. But, as we have before said that an infinite serial line of plus quantities cannot exist in fact, although it may exist in idea, and as Nature renders her serial lines finite by the law of metamorphosis, graduation, or the subtraction of quantity, so will the graduated serial design be read and interpreted according to this operation. The series of plus forms constitutes uniformity, whereas the series of graduated or minus forms constitutes the variety or species; and this is equal to knowing that every skeleton form which is only thus special, is the

proportional of a plus skeleton form which is uniformity and the archetype.

The integer 9 contains the proportionals 8, 7, 6, 5, 4, 3, 2, 1, therefore, each of those proportionals may be interpreted as a proportional of the integer 9; this integer being the whole quantity. Now, if we disintegrate the proportionals of the full quantity 9, and place them in progressive series, thus, 1, 2, 3, 4, 5, 6, 7, 8, 9, it must be understood that each of these digital numbers (now separate and isolated) still is a proportional of the integer 9, and consequently when we compare those proportional quantities with each other, although we by no means can name them as equals, yet it is most true that each of them refers to the one whole quantity or 9 from which they have been separated. And so, when we view the series of proportions 1, 2, 3, 4, 5, 6, 7, 8, 9, we consider them severally in relation to the integer 9; for 1 is a proportional of 9, so is 2 another proportional of 9, and so of all the other quantities contained in 9. The integer 9 is archetype of its own series of proportionals, and those proportionals can never be accounted uniform unless under the idea of equating them with the integer which is the common quantity to which all refer. One is not equal to two, nor is two equal to the integer nine; but $1 + 8 = 9$, and $2 + 7 = 9$, consequently $9 - 8 = 1$, and $9 - 7 = 2$.

Fig. G represents a thoracic skeleton series. Its serial quantities are all costo-vertebral from first to last, the units of this series manifesting no other variety than that of proportioning from archetype quantity; thus units 1, 2, and 3, are simply minus quantities compared to units 4, 5, 6, 7, &c. The common median line cleaves all the serial quantities in order, from occiput to unit marked 61. And those units are simply repetitions of form throughout the entire series.

Fig. H is a skeleton axis, which, *when its units are numerically compared to those of* fig. G, manifests no other variety than that of minus compared to plus. The first 7 units of series in fig. G are costo-vertebral plus quantities. The first 7 units of series in fig. H are vertebral minus quantities, being simply minus as to costal structure. Again, in fig. G we find that the next 12 units of series succeeding unit 7 are also costo-vertebral and plus, when on turning to fig. H we find that the like plus forms are persistent for it also. In fig. G again we see that all the units of series which succeed unit 19 are persistent in their plus quantity; but when we seek for the like *numerical* quantities in fig. H, we find them to be minus.

Fig. G is an archetype series of plus costo-vertebral originals. Fig. H is a serial structure proportioned or metamorphosed from such an archetype as fig. G. It is possible to subtract quantity from fig. G so as to equate it with fig. H. It is also possible to fill up in idea that quantity which is lost to fig. H, so as to equate it with fig. G, and this can only happen because fig. H has been proportioned from such another form of archetype quantity as fig. G. The comparison, therefore, which is to be held between figs. G and H, can lead to nothing worth knowing if it be not the interpretation that the original or archetype quantity from which fig. H has been proportioned is fig. G.

Now fig. I resembles fig. H both in general form and quantity; and, therefore, we say, that if ever we are to appreciate the natural law of formation which created fig. I, it must be by understanding that fig. I has been also proportioned from the original or archetype quantity fig. G.

We name figs. I and H to be homologous forms, because they contain forms of equal quantity and proportion. But when we further compare figs. I and H with fig. G, we then are obliged to name the latter a plus archetype, and the former the minus proportionals of such plus archetypes; therefore, fig. G is unity, and figs. I and H are proportional varieties or species of such a unity.

Metamorphosis or subtraction of quantity is that natural process by which fig. H has been proportioned from fig. G. The same process, no doubt, has fashioned the mammalian form fig. I from the archetype quantity fig. G. Or if it be doubted that fig. G is archetype of fig. I and fig. H, then let us ask ourselves the question, to what other goal of interpretation is the science of comparison promising to lead the anatomical reasoner?

If anatomical science be ever destined to reveal the law of unity in variety, as governing the development of animal form, let it determine well first of all between the rational and irrational, and when it turns to the comparison of the opposite figures, let its first duty be to separate the impossible from the possible, let it understand that it is impossible to demonstrate a whole quantity in a part, or fig. G, in either fig. I or fig. H; whereas it is on the other hand possible to demonstrate the part in the whole quantity, or figs. I and H in fig. G.

We have drawn through fig. G various secant lines indicating the lines of metamorphosis and symmetry. The median line marked m, divides the whole serial form from occiput to the 61st unit of series, and would thus bisect the whole serial order of quantities, which in the Ophidian skeleton amounts to some hundreds, reckoning from occiput to the extreme caudal unit. The same line of median cleavage m, divides the serial proportional quantities of figs. I and H. It passes through fig. I from unit 1 to the ultimate caudal proportional marked 56, and through fig. H from unit 1 to unit 61, all the serial quantities of fig. H being evidently proportionals of such as the thoracic quantities of the same figure, or such as unit 61 of the same.

The superior diagonal or oblique lines $d\ s$, of fig. G, indicate the law of proportioning, which creates minus quantities immediately succeeding the occiput. The same lines $d\ s$, of figs. I and H, point to the cervical creation or minus proportioning of the 7 uppermost units of series: those units, which are now vertebral quantities, and marked 1, 2, 3, 4, 5, 6, 7, manifest no other difference to those of the thoracic region of figs. I and H, or to the cervical region of fig. G marked 1, 2, 3, 4, 5, 6, 7, than that of minus to plus.

The inferior diagonal or oblique lines $d\ i$, of fig. G meet each other at the median line of unit 61, and indicate the law of proportioning minus from plus quantities by the simple rule of metamorphosis, obliteration, or subtraction of all those parts of the serial costo-vertebral units which stand outside of those lines. Thus, supposing this sub-

traction of quantity to have taken place on fig. G, it is evident that all the serial proportional parts which would remain persistent within the lines *d i*, would one and all, even to the smallest fractional quantity within those lines at unit 61, be the remains of archetype plus quantities such as constitute now the entire serial skeleton axis. The same oblique lines *d i*, of figs. I and H describe that the like subtraction of quantity from plus archetypes has yielded the lumbo-sacro-caudal spine for those skeleton axes. The last caudal nodule 56 of fig. I, is a proportional of such a plus quantity as we find in its own thoracic region, and also of such a quantity as that marked 56 in fig. G. Consequently this caudal ossicle must be granted to be a proportional of any serial plus quantity in the skeleton axis fig. G, forasmuch as all units of this axis are uniform with each other.

Now the horizontal line *h*, divides fig. G through the 33rd costo-vertebral unit of series, and shews that all the units above this line are homologues of the units now happening below it. It must follow, therefore, that even when subtraction of quantity pursues the oblique lines *d i*, through all the serial units ranging between unit 20 and unit 61, and shall leave those units as proportional quantities, still we must regard them as the parts of full archetypes such as we now see them; and hence we must say that the line *h*, which divides the *actual* serial arche-type of fig. G through unit 33, divides also the *ideal* serial archetype of fig. H through unit 33; forasmuch as fig. H is a proportional creation of such as fig. G. Consequently we conclude that the line *h*, passing through unit 33 of fig. I, divides the *ideal* serial archetype, of which fig. I as well as fig. H, are minus proportionals.

In fig. G we see that homologues happen above and below the line *h*. In figs. I and H we discover that unequal proportionals of such homologues happen above the line *h*, and below it. How then stands the law of unity in variety between these three figures? How can it be interpreted truthfully, otherwise than by saying that the archetype plus unity is fig. G, while variety marks fig. I or H, which are the proportional quantities of such an archetype as fig. G?

In figures A, B, E, and F, we see homologous forms such as the geometrician would draw them, but these forms are not more absolutely homologous to each other both as to figure and quantity, than are the serial costo-vertebral units of fig. G, such as Nature herself draws them.

The geometrician means by the term homologous, *corresponding*. Rectilineal figures are said to be similar when the angles of the one are respectively equal to the angles of the other, and the sides about the equal angles proportional: hence that in similar figures the correspond-ing sides and angles are homologous.

In a series of four proportionals, the antecedents are homologous to each other, and also the consequents. Fig. A is a triangle homologous to fig. B, both in form and quantity. Now, if the angles of one triangle be respec-tively equal to the angles of another, the three sides of one triangle have, to the corresponding sides of the other, respectively, the same ratio. Thus, let *a b c—d e f*, be

two triangles drawn in fig. B, the one having the angle *a b c*, equal to the other angle *d e f*, the angle *a c b*, equal to the angle *d f e*, and, consequently, the angle *b a c*, equal to the angle *e d f*. Then, as *a c*, is to *d f*, so is *a b*, to *d e*, and as *a c*, is to *d f*, so is *b c*, to *e f*; and also, as *a b*, is to *d e*, so is *b c*, to *e f*.

Full quantities are homologues: fig. A is homologous to fig. B. Equal proportionals of such full quantities are also homologous, just as fig. C is homologue of fig. D. Now, it is evident that the only difference existing between figs. C D, and A B, is that occurring by the subtraction of quantity; for we see that fig. B, minus the parallelogram *g,e,d,b*, would equal fig. D, or C, and so we have equalled figs. C and D, with figs. A and B, by filling up the parallelogram quantity for C and D, as seen in figs. E and F.

Fig. A contains a proportional quantity equal to fig. C; and fig. B shews within itself that proportional quantity which is equal to fig. D; and hence, as we know that fig. B, minus the parallelogram, *g,e,b,d*, would equal fig. D, so we reasonably infer that fig. D is now a speciality, owing to that quantity, *g,e,b,d*, which has been subtracted from it.

Fig. A, therefore, may be accounted archetype of fig. C, and the equation of both these quantities is shown in fig. E. The presence or absence of the parallelogram *g,e,b,d*, is that which renders them proportionately different: plus quantity has been subtracted from, and minus quantity persists; and so it is that we interpret the vertebral quan-tity as a minus figure or species compared with the thoracic costo-vertebral archetype. The archetype has been sub-tracted from, and rendered minus or vertebral. A cervix or a lumbar spine of the skeleton axis, fig. I, is in minus condition compared with the plus thoracic series of fig. I, and also minus compared with all the serial quantities of costo-vertebral form seen in fig. G; therefore fig. I, as it presents to us, still refers to the archetype unity from which it has been proportioned, and to the law of design which has fashioned it as a special form, when we know it to be a proportional of the archetype uniform series, which fig. G now manifests.

The persistence of archetype quantity through all regions of series renders the skeleton axis thoracic through all regions, such as is shown in fig. G; whereas, the persistence of archetype quantity in some one region of series, and the metamorphosis or subtraction of quantity from the like archetypes in other regions, establishes the thoracic series in one region of fig. I, and the cervical, lumbar, and caudal proportionals, in other proper localities of the same serial axis.

The skeleton serial axis fig. G, is that condition of formation to which our comparisons have conducted us, and with it we shall for the present terminate our obser-vations upon the laws which preside over the development of skeleton quantity. It will be necessary, however, to recapitulate briefly those facts which, under comparison, have led us here to recognise fig. G as the integer or archetype form of all those serial skeleton designs, whether of "normal" or "abnormal" cast, which we have figured

through these pages; and also to see if fig. G, taken as a whole quantity, can, under a process of metamorphosis, yield the equals or analogues of each and all of those forms which are in minus condition compared to its presential self. The comparison of proportional or minus quantities has advanced so far in the present argument, as to demonstrate the natural existence of fig. G, in the character of a whole or integral quantity, and we have now only to inquire whether the subtraction of parts from fig. G can render this figure equal and homologous to any other design of skeleton axis which is minus to fig. G.

Fig. G is not here represented as a creation of our own vain imagining. We have had no part in idealising the structure of it in order to give support to the fabric of our own commentary, and, to speak in truth, we may fairly add, that our acquaintance with the existence of fig. G under that character of formation by which it now reveals itself, viz., *the character of an integer or archetype*, only dates from the present chapter. It is most true that in the conduct of our comparative method, which was one of slow process, we could not prevent the spontaneous evolution of the idea that some such form as fig. G was in process of development, and that to this figure our comparisons must inevitably lead us; but nevertheless it will be freely granted that we have in no one instance hitherto suddenly leaped to a conclusion over those various obstructive facts, such as " anomalies," without first unravelling their characters, in order to know in how far they could agree or disagree with the course in which Nature seemed to us to be leading. It cannot be said that we have cut the Gordian knot of this law of " unity in variety," when it was our duty to untie it; nor can it be objected, while we here regard fig. G as uniformity and fig. I as the variety to such uniformity by reason of the metamorphosis of quantity from the original or archetype of fig. I, that either of those figures are the creations of our pencil, or that the interpretation of the law of their creation is springing only from our pen. Both forms are *natural* productions, and their comparison is *naturally* productive of the interpretation, that the lesser quantity is fashioned from such as the greater.

By what natural process is it possible to design the form fig. I from the form fig G? This question may be much more easily answered than if it were asked by what natural rule it were possible to fashion from fig. G either the physiological character of El-Borak—the celestial ass of the prophet Mahomet, or the winged Pegasus of the poets, or the Theban sphynx, or the Cretan minotaur.* Our present inquiry is bound within the limits of natural operation and creative probability; we are not here prepared to account for the mundane existence of a Mythological animal kingdom, nor to reconcile with a natural law of formation the monstrous chimeras of an unbridled imagination, such as the mystic images of arabesque adornment, the Griffin, the Centaur, the Triton, the Pan, the Faun, the Dryad, the Mermaid, the Naiad; these we will leave for "teleological" speculative ingenuity, and as they who can find a place for them in past *natura* will not make much ado in warping the natural law to fashion a wreathy garni-

ture around the bower of fancy, so may they in that retirement peruse also the account relating of the Beast of the Apocalypse and the Lions of Daniel with as little cause for questioning the probability as they discover in the story about the " Carnivorous Bull," the " Herbivorous Tiger," or the vocal bleeding tree of Virgil's transformed Polydore. That law of metamorphosis to which we shall here subject the archetype fabric fig. G, and from out of which whole quantity we shall track the possible creation of the minus and special varieties figs. H and I, needs not, for the understanding thereof, so high an endowment of the imaginative faculty. Our remarks upon this process of formation are as follow.

Firstly.—We have represented in fig. G the skeleton axis of an animal species which is living in present nature as a member or link of that general organic chain which constitutes an animal kingdom. This form of skeleton quantity is one whose character, neither the mystery of a past or of a future state of nature envelops; and we shall, while holding it in comparison with all those forms which manifest an analogy, whether more closely or remotely to it, thereby guard ourselves from shedding over it that far denser cloud of mystery by which we ourselves too often pervert the presential fact,—we mean that of a nomenclature not grounded upon a law of formation. In fig. G, Nature presents us with a uniform plus series of osseous quantities holding an uninterrupted order from first to last: these quantities may be named costo-vertebral, and their linear order may be named costo-vertebral uniformity, forasmuch as it is evident that all those quantities are identical, both as to form, structure, and functional character. In every respect save that of numerical situation, these serial forms agree with one another, but it is true nevertheless that the transposition of those several homologous units might be made without occasioning any change of character in the general line of their series. If we cause unit 35 *a*, to change place with unit 52 *a*, of fig. G, this would not interrupt serial order; and the reason is, that all the serial units are identical. In the whole archetype quantity of fig. G there is no regional division into Cervix, Thorax, Loins, Sacrum, or Caudex, because all the serial quantities persist in thoracic plus character.

Secondly.—In fig. I, Nature presents us with a form whose serial design cannot be designated serial uniformity, because its serial quantities are not all equal to one another; and we find, consequent upon this inequality as to quantity, that those serial units which fashion it, cannot now be read as identical, either in form, structure, or functional character; on which account it is that we give those several regions of the units constituting the serial axis of fig. I the names cervical, thoracic, lumbar, sacral, and caudal. We now find that the transposition of those regional various quantities could not be made without interfering with the general design of fig. I; and because the skeleton axis of fig. I does not naturally yield to us the character of plus uniformity, it will hence be in vain that we pile up the Pelion on the Ossa of verbose argument, in determining what we may name uniform or what is abso-

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* Semibovemque virum, semivirumque bovem.—*Ovid*, Ars. Am., 2, v. 24.

lutely various, for Nature will still remain unmoved and the same. What is the difference between fig. G and fig. I ? The answer to this question may be had in the knowledge of that difference which exists between the several regional quantities of fig. I itself; and hereupon we ask the question, what else is the variety which characterises fig. I from fig. G, if it be not the same as that which exists between fig. H and fig. G, viz., a variety as to quantity ?

Thirdly.—A thoracic costo-vertebral series characterises fig. G, and stamps it as a plus uniform quantity, whereas in fig I we find a condition of formation which, when we compare it with fig. G, cannot be read as uniform with fig. G, even if we equated the specific difference which reigns between them with all the anatomical reasoning of Germany, France, and Britain, marshalled by the names of Göthe, Geoffroy, and ——. In this strait, let us therefore apply ourselves to Nature rather than blind ourselves with words or names, and let us, with the Janus or double aspect of a comparative method, take up our stand between the quantity fig. G on one side and the quantity fig. I on the other. What is that quantity which, by being present to fig. G, and absent from fig. I, gives them their present differential character ? Is it not a costal quantity ? Will the interpretation pale or flush the cheek of reason if we here assert that Nature presents to us her whole archetype framework or prime model in fig. G, and that from this quantity she fashions the special minus variety of fig. I, just in the same way that we ourselves have shaped fig. H as a minus special figure from the same whole original of fig. G, and have thereby simulated the present form of fig. I ? The metamorphosis of seven costæ succeeding the occiput will render fig. G cervical, like what fig. I presents; the persistence of twelve thoracic quantities succeeding a cervical series of vertebral proportionals will also simulate the thoracic series of fig. I; the metamorphosis of eight costæ from unit 20 to unit 27 in fig. G will represent the lumbar series of fig. I; and the metamorphosis or subtraction of costal quantities from unit 28 to unit 61 of fig. G will again yield a series equal to the sacro-caudal line of fig. I. This simple progress of a law subtracting from archetype quantity such as fig. G, may be seen in the present condition of fig. H, and in this latter form we have the analogue of fig. I, both as to cervical, thoracic, lumbar, sacral, and caudal proportioning.

Fourthly.—In the plus fabric of fig. G we may find as well the "abnormal" as the normal quantities of special and minus formation, such as figs. H or I. If the anthropomorphous cast of form which fig. I now presents shall at times produce the cervical and the lumbar ribs, the interpretation of these may be had in the plus serial form of fig. G, which is thoracic throughout its whole extent. All the superadditions of costal quantity which may be found produced at the now minus regions of fig. I, are already apparent in the plus fabric of fig. G; and while we set ourselves to measure the oscillations of the law of formation, we may discover that all the plus increase of osseous quantity which is ever found to vary the minus character of fig. I as it now stands, may be as easily interpreted according to the plus design of fig. G, as all the minus

decrease to which we have subjected fig. G, in order to produce fig. H, which is the counterpart of fig. I.

Fifthly.—While we find fig. G in one place and fig. H in another, since we cannot now read them as one and the same entity, they must exist as duality; and therefore, as the special minus quantity fig. H bears comparison with the archetype plus quantity fig. G, and relates itself so closely to fig. G that we can readily understand how fig. G, subjected to a metamorphosis of parts, could yield the special homologue of fig. H, although we cannot say that the entity of fig. H is the entity of fig. G, in this case we contend that it becomes impossible to view the existing quantity of fig. H without being reminded of the archetype quantity from which it has been metamorphosed, and this archetype must be such as fig. G. Since fig. I is in all points equal and homologous to fig. H, so will it for the same reason be impossible to contemplate the existing design of fig. I without bearing in mind the plus archetype of fig. I, which can be no other than such as fig. G in the condition of plus uniformity.

Sixthly.—It is because all the minus regions of fig. I, named cervical, lumbar, sacral, and caudal, have been metamorphosed from such a plus serial thoracic archetype as fig. G, that we now find those units standing at the several minus regions of fig. I to present no other condition of variety to the plus thoracic region of fig. I, save that which can result by the simple subtraction of serial quantity. It will be concluded, therefore, that the archetype of fig. I is such a form as fig. G, and consequently, that a cervical, a lumbar, a sacral, and a caudal quantity of fig. I are the various proportionals of their archetype costo-vertebral structures.

Seventhly.—The force or law which yields the creations figs. G, H, and I, as a unity in variety, appears to us to be the same as that process of metamorphosis which, subtracting from plus quantity, leaves this in the condition of minus variety. The plus quantity fig. G is representing uniformity, whereas the minus quantities, figs. H and I, &c., are representing variety by the loss of those parts which are proper to plus uniformity. Variety or species, therefore, is resulting by the loss of quantity, and the presence of the phantom species is simply owing to the absence of some parts of the plus ens. The shank and hoof of a horse is a modification of the human hand, and fig. I is a modification of fig. G, by the process of that selfsame law of metamorphosis. Who will deny it? Where are the objections to this theory? Who will dissent from the opinion of a plus unity of organisation, subjected to a variety by the metamorphosing process? Who? except it be him who is ignorant of the ways of creation. If we lay before us the following sentence spoken by Herschel, viz., "that the character of true philosophy is to hope all things not impossible, and to believe all things not unreasonable," we then may know that as it is not impossible for Nature to degrade the plus quantity fig. G to the minus variety fig. I, so it cannot be unreasonable to believe in that process of a law of formation.

Eighthly.—Fig. G represents serial continuous uniformity; and while we compare the several costo-vertebral

units of this series with one another, the only idea which springs from this comparison is, that all those units are samenesses, and that an uninterrupted continuity of linear forms is the result. In fig. G, therefore, we find that the form of *unity* enshrines itself; and that the plurality of this unity, that is to say, the *repetition of one* in a succession, is the cause of *uniformity*. The repetition of unit 30 *a*, which is a costo-vertebral quantity, when drawn sixty-one times in linear series, produces the structure represented by fig. G. Now, while Nature terminates at a given point, the series of uniform quantities comprising the design, fig. G, and while she establishes its finality at this point, still we may, in idea, by an imitation of this simple process of repeating a first quantity, imagine fig. G produced of such a serial length as would be sufficient to traverse the whole region of space; and hence it is that every uniform series in Nature is generative of the idea of the sublime. The idea of an infinite series of any uniform quantities cannot be conceived apart from the majesty which attends upon the sublime always.*

Ninthly.—But Nature has given to fig. G its finity, and cuts it as a proportional of the line of infinity, because no form can exist in the shape of animality unless it be of limited length; and, in fact, the knowledge of this is a proof that mind is a something distinct from physical sense, inasmuch as it can extend the thought, not only poetically, but mathematically, beyond what the mere sense receives the impression of; for though the eye reads the finity of the presential series of fig. G, still this generates in the mind the idea of an infinite series of fig. G, produced to any length whatever through space, and thus the finite series which *is*, may be comparatively mated with the infinite of a like series which *is not*. To be sure, we will here not presume to imagine what sort of beings the infinite series of fig. G will encounter, when, with this idea of a continuous infinitely linear uniformity, we transfix the orbits of Mercury, Saturn or Herschel, but, bating this flight of the soaring imagination, and resting careless for the time whether the animal population of these planets produce skeleton forms bearing any analogy to the whole or the part of fig. G, we shall here content ourselves with the homestead earthly question, whether or not all the skeleton axes of the animal kingdom, which surrounds us and breathes the same air with ourselves, may be interpreted as various finite lengths of an infinite serial line of costo-vertebral quantities undergoing metamorphosis. To this inquiry as to whether it be possible to develope the ideas of uniformity by comparison held between the members of our Mundane animal kingdom, and also as to the source of its variety, we have heard it gravely stated by more than one philosophic anatomist, that to do so would require a knowledge of the inhabitants of other planets, wherein some links which now seem wanting to the universal chain of form were no doubt to be found. But as a journey to these places is scarcely to be hoped for under existing circumstances, we must rest satisfied with an examination of what we have placed within our reach, such as fig. I in the presence of fig. G,—the proportional side by side with the whole quantity, and ordinary reason brought to bear in the comparison of the two.

Tenthly.—Our knowledge of the law of anatomical form must mount by the steps of reason's ladder rather than soar upon the wing of imagination; and the speech of reason must be by facts demonstrable, rather than by words impeachable. It is not by the fact, but by the word that we are liable to be misled; and fig. G is a fact, laid sidelong with fig. I, whereas uniformity is a word which applies to the serial form of fig. G, while species is a word applying to the form of fig. I. Now, fig. I is a fact which no living anatomist can account as uniform with fig. G, even if he were the metempsychosis of a Göthe or a Geoffroy, for fig. I is a quantity as unequal to fig. G, as the series 9, 8, 7, 6, 5, 4, 3, 2, 1, is to the plus series 9, 9, 9, 9, 9, 9, 9, 9, 9. And this being the case, we may further add, that fig. I, compared with fig. G, explains a difference which cannot be called species in any other sense save that of quantity by any modern anatomist, even if the soul of Cuvier be transmigrated into him; and therefore we conclude, that as fig. I is to fig. G, so is the word "species" to the word "uniform."

Eleventhly.—To what form or quantity as a whole have our comparisons conducted us? To the *costo-vertebral quantity*; which, as unity, or a whole, we believe to be a more capable instrument for generalising upon the law of skeleton formation, than that figure which anatomists name the *vertebra*; for the costo-vertebral quantity as plus unity can, by metamorphosis or subtraction, yield the vertebral quantity, as minus variety or species; but this latter cannot be metamorphosed so as to yield the quantity of the former, or the idea of a unity of type, even if we built synagogues instead of hospitals or museums, for biassing the anatomical belief to its possibility.
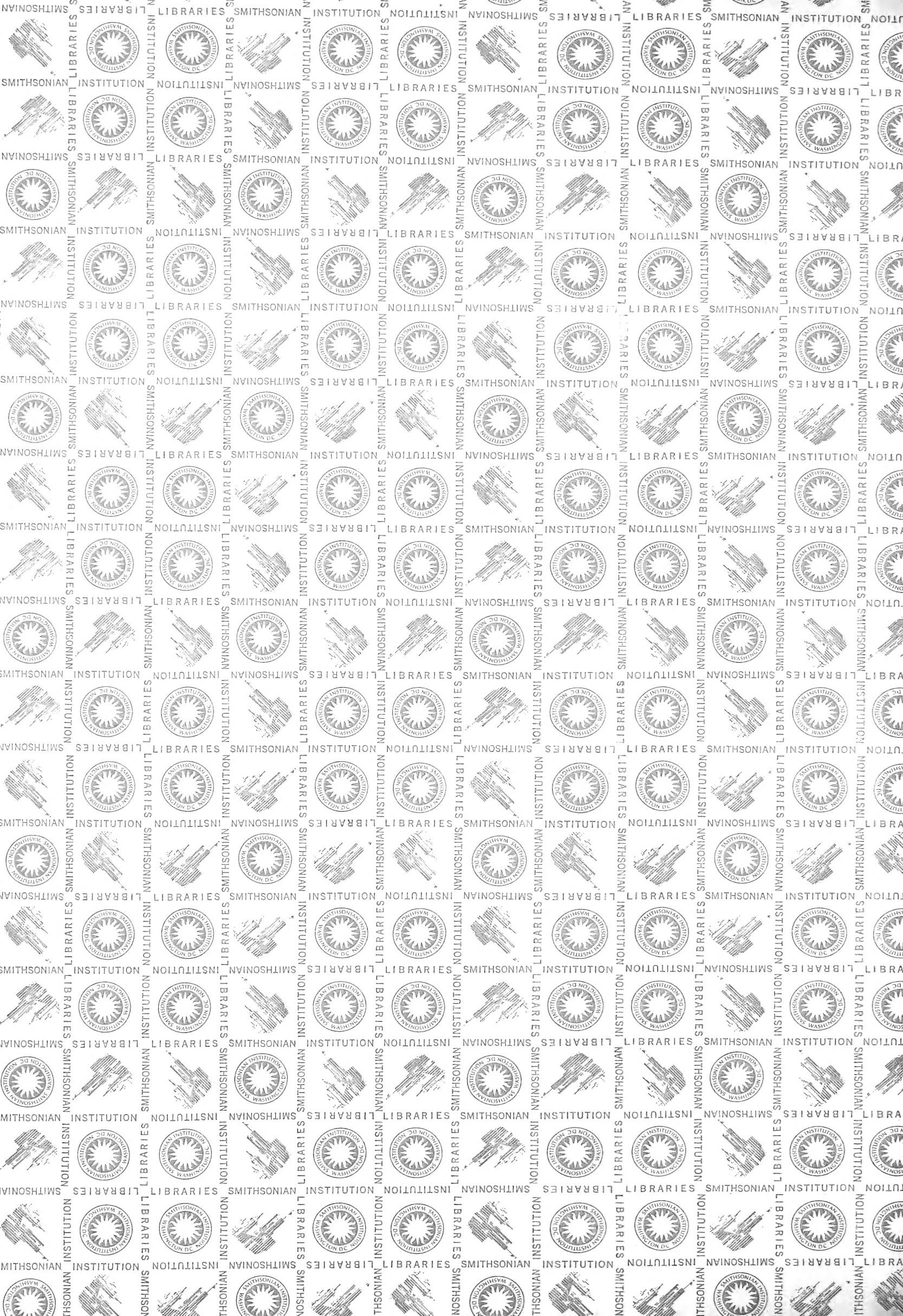
Twelfthly.—If, therefore, the vertebra be a proportional of its costo-vertebral archetype, it will be observed that this idea, while rising from the root or basement of comparative method, must move the superstructure of the facts of *cranial vertebræ* reared prematurely over itself, and prove, that before we can with any degree of correctness interpret the composition of the osseous skull as being that of vertebræ modified, we should first ascertain the character of a spinal vertebra itself, and decide whether or not it be a proportional of a whole Archetype Costo-Vertebral Quantity.
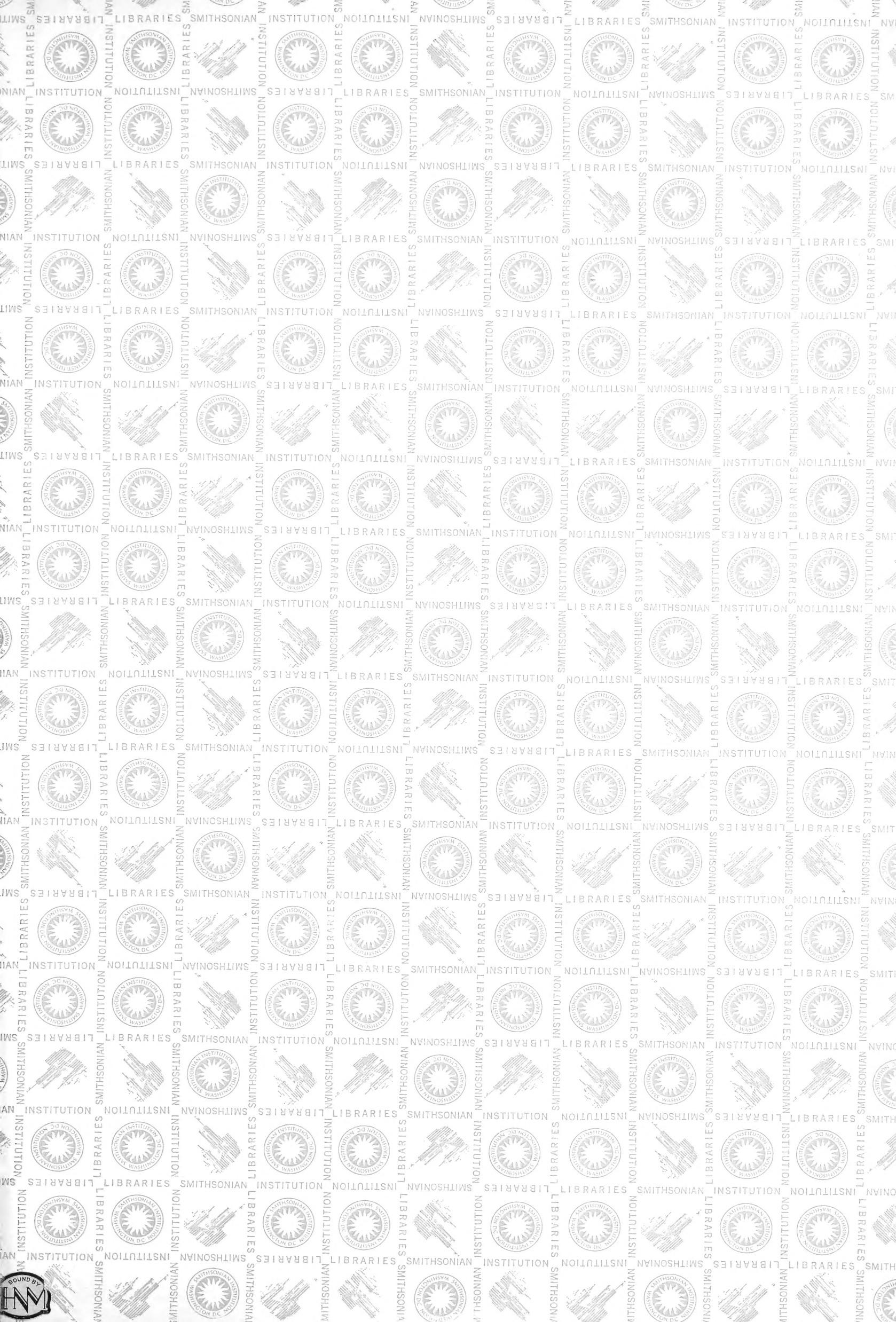
* Another source of this sublime is infinity: there are scarce any things which can become the objects of our senses, that are really and in their own nature infinite; but the eye not being able to perceive the bounds of many things, they seem to be indefinite, and they produce the same effects as if they were really so. We are deceived in like manner, if the parts of some large object are so continued to any indefinite number, that the imagination meets no check which may hinder its extending them at pleasure.

Succession and uniformity of parts are what constitute the artificial infinite. *First*, Succession; which is requisite that the parts may be continued so long and in such a direction as, by their frequent impulses on the sense, to impress the imagination with an idea of their progress beyond their actual limits. *Second*, Uniformity; because, if the figures of the parts should be changed, the imagination at every change finds a check; you are presented at every alteration with the termination of one idea and the beginning of another; by which means it becomes impossible to continue that uninterrupted progression which alone can stamp on bounded objects the character of infinity. To produce, therefore, a perfect grandeur in such things as we have been mentioning, there should be a perfect simplicity, an absolute uniformity in disposition, shape, and colouring.—Burke, *Philosophical Inquiry into the Origin of our Ideas of the Sublime and Beautiful.*